Holistic Multi-Methods Approach in the Investigation of Environmental and Restorative Functions of Courtyard Gardens in Malaysian Public Hospitals

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DECLARATION

I, the author, confirm that this thesis is the results of my own research. I am aware of the University's Guidance on the Use of Unfair Means (www.sheffield.ac.uk/ssid/unfair-means). This thesis has not been previously accepted for any other degree at this, or any other university.

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Madihah binti Mat Idris

20 / 2 / 2020

DEDICATION

This thesis dedicated to those who care about users' experiences in the healthcare facilities to enrich the environment of care and to those who are enthusiastic about the functionality of the physical environment and the benefits of nature to well-being.

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ABSTRACT

The introduction of the hospital courtyard garden (HCG) in Malaysia can be traced as early as the 1970s. To date, it is still incorporated in the current planning of newly built hospitals. However, their design quality is yet to be systematically evaluated and no specific framework or design guidelines or evaluation criteria exist to assess HCGs with a focus on the integration of the environmental and restorative functions. Therefore, this study aimed to investigate how the different types of courtyard gardens that have been included in the planning of Malaysian hospitals after 1998 **are currently performing** in relation to the environmental and restorative functions and **how they are used and perceived** by the intended users (i.e. patients, staff and visitors). This study also explored **how the HCG can be improved** to achieve an optimal HCG design to enhance the users' experiences in the hospital.

A representative sample of three different HCGs in three Malaysian public hospitals were selected to systematically evaluate them with a particular focus on users' perceptions, preferences, experiences and level of satisfaction with the overall HCG design concerning the environmental and restorative functions. To achieve the aim and research objectives, this study employed **a mixed methods and case study approach** through the intervention of a **diagnostic post-occupancy evaluation (POE)** which included multiple methods, namely: i) field observation (site analysis and field measurement); ii) participant observation and behaviour mapping; iii) survey interview with the HCG users (n=120) and non-users (n=135); and iv) semi-structured interviews with the architects (n=2) and landscape architects (n=2).

Regarding the environmental performance of the HCG, the findings revealed that a proper consideration of both environmental and restorative functions resulted in improved thermal comfort in the HCG and adjacent spaces. The findings also showed that the air temperature in the HCG were found to be several degrees lower than the corresponding air temperature outside the hospital during the day. In terms of restorative functions, this study found that the HCG with a proper combination of landscape elements (a ratio of 70:30 for softscape and hardscape) received a higher restorative score compared to the HCG with a lower percentage of softscape (less than 40%). HCGs also has a significant influence on users' well-being; the study revealed that over 75% of the 120 users perceived a positive mood change and felt more relaxed and less stressed whilst spending time there.

Additionally, based on a total of 48-hours of the video-based and direct observation on both a weekend and a weekday, this study found that all the three HCGs were most used by visitors (72% adult and 22% children), followed by staff (4%) and patients (2%). A Chi-square analysis on users' satisfactions levels revealed the four most significant factors with the overall planning of the HCG: i) landscape elements ($p<.000$, $C=.442$); ii) wall conditions ($p<.000$, $C=.429$); iii) access from the main entrance ($p<0.04$, $C=.393$); and iv) visibility ($p<.000$, $C=.382$).

Based on the overall research findings gathered from difference source of data, this research has contributed to the **establishment of a comprehensive HCG framework for a Malaysian climatically context** which comprised of four interrelated components; i) physical; ii) environmental; iii) social; and iv) operational aspect. The study also has successfully **provided recommendations for policy and practice** related to the functional and spatial arrangement of HCGs to assist in reviewing and updating the planning and design requirements for optimal HCG design in future.

Keywords: *Post Occupancy Evaluation, Hospital Courtyard Garden, Environmental Functions and Restorative Functions.*

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LIST OF SYMBOLS

TA	Air temperature
rh	Relative humidity
AV	Wind velocity
ºC	Celsius
kmh	Kilometer per hour
ms-1	Meter per second
W	Width
H	Height
L	Length

LIST OF ABBREVIATIONS

HCG	Hospital Courtyard Garden
POE	Post Occupancy Evaluation
EBD	Evidence Based Design
TSV	Thermal Sensation Votes
WSV	Wind Sensation Votes
HSV	Humidity Sensation Votes
MREC	Medical Research Ethic Committee
SOA	School of Architecture
MOH	Ministry of Health
PWD	Public Work Department
AR	Architect
LAR	Landscape Architect
ART	Attention Restorative Theory
SRT	Stress Reduction Theory
PRS	Perceived Restorative Score
RH	Relative humidity
GIS	Geographic Information System
HM	Hospital Manager
HP	Hospital Provider
ME	Mechanical Engineer
RQ	Research Question
WHO	World Health Organisation

CHAPTER 1:

Introduction

1.1 Introduction

This thesis investigates the current performance of the different types of hospital courtyard gardens (HCG) in Malaysian public hospitals built after 1998 and how they are used by intended users. Further, this thesis explores how they can be successfully designed to achieve a functional HCG that integrates both the environmental and restorative roles in the overall design and planning. This chapter starts with an overview of the research background. Then, it highlights the research problem and identifies the research gap, followed by the importance of the research. This chapter also presents the research aim, objectives of the research, the main research question and the sub-research questions. The scope of research and the overall research flow is outlined and followed by an explanation of the thesis structure.

1.2 Research background

During the British Colonial period (1874 -1957), there were two types of hospital forms built during that time, namely single stories with a pavilion type arrangement in rural areas and a type of a medium rise hospital in urban areas (Aripin, 2007). Then, in the 1960s, the new hospitals were built which followed the standard plans of a small-scale hospital (Nawawi et al., 2013). During this time, private consultants were not involved in the hospital design and courtyard gardens were yet to be implemented in hospital planning. Over the years, several improvements have been made by the Ministry of Health (MOH) regarding the quality of hospitals in Malaysia, including physical and social facilities. The medical approach keeps changing and being refined by the MOH to ensure that Malaysian hospitals' environmental quality is able to cater for the changing environment and user expectations (Suleiman and Jegathesan, 2001). This has resulted in changes in hospital planning focused towards providing a greening and healing environment, as well as environmentally friendly buildings (Nawawi et al., 2013; Aripin, Othman and Nawawi, 2015).

Moreover, concerning the importance of contact with nature with regard to the occupants' well-being, in 1998 the Minister of Health made it compulsory that all hospitals in Malaysia under the MOH must incorporate gardens in the planning and design of hospitals (MOH, 2013 cited in Shukor, 2007). Since 1998, the integration of a courtyard garden in the planning of large or medium type hospitals have become common practice as a way of providing a passive cooling strategy by particular private consultants involved in hospital projects (This is elaborated further in Chapter 2, Section 2.2.3.2). Implementation of this practice continues in recent and newly built hospital projects (See Section 7.7.1). However, to date it remains unclear whether the space functions as intended either in providing a comfortable environment, as a positive experience or utilised well by the intended users (i.e. patients, staff and visitors).

1.3 Problem statement

The introduction of courtyard gardens in the design of hospitals in Malaysia can be traced back as early as the 1970s. However, their design and landscape quality are yet to be systematically evaluated. To this author's knowledge no previous systematic research on HCGs in Malaysia can be found. Further, no specific design guidelines and/or HCG framework of hospital courtyards in a Malaysian climatic context with a focus on both environmental and restorative roles has been produced to date. Starting with an open type plan courtyard, also known as a 'left over space' between building blocks in the 1970s, since 1998 this courtyard typology has been developed into different types of courtyard designs including the closed type courtyard, the interlinked type courtyard and the clustered type courtyard. These courtyards have been implemented in a majority of the recently built hospitals in Malaysia but embody the different perspectives and intentions of the particular architects and landscape architects involved in each project.

Until now, only a few studies focusing on the environmental role of courtyard design, particularly in residential buildings in a hot humid climate like Malaysia could be found (Kubota et al., 2017; Jamaludin et al., 2014; Sadafi et al., 2011). Studies which focused on the courtyard design in hospital buildings remain scarce. Indeed, only one experimental study has been carried out using parametric simulation covering the environmental aspects of courtyard design particularly in hospital buildings (Almhafdy et al., 2015). Nevertheless, this study did not cover the perception of the users on the quality of the courtyard design. Apart from any environmental role, it has been argued that the quality of outdoor gardens in Malaysian hospitals are lacking in quality in terms of the restorative roles which lead to the underutilisation of the garden (Adnan and Shukor, 2015). However, this study primarily focused on all types of outdoor gardens in the hospital context and did not focus specifically on HCGs. To this author's knowledge, extant studies that focus simultaneously on both the environmental and restorative roles of courtyard design, particularly in Malaysian hospitals, are virtually non-existent.

1.4 Identifying a research gap

A study by Almhafdy et al. (2013a) found that the courtyard is a common feature that has been incorporated in hospital buildings in Malaysia to improve the microclimatic condition of the courtyard space. A well-designed courtyard can promote cross-ventilation that eliminates warm air in the surrounding spaces whilst providing daylighting into the adjacent indoor rooms. In addition, it acts as part of a passive environmental cooling strategy by providing a comfortable environment to the occupants (Rajapaksha, Nagai and Okumiya, 2003; Rajapaksha and Hyde, 2005). A recent study by Hussein and Jamaludin (2015) conducted in a residential college revealed that an enclosed courtyard has a significant impact on the perception and level of satisfaction of the residents. It found that a majority of the residents were satisfied with the overall building performance including the architectural elements, indoor air quality, thermal comfort, acoustic comfort, visual comfort and landscape elements.

In the context of Malaysian hospital buildings, a number of studies cover the environmental aspects in the hospital building that emphasises the perceptions of users regarding their comfort level concerning daylighting (Ahmad et al., 2007 cited in Nawawi et al., 2013; Aripin, 2007) and thermal comfort in the ward (Kushairi et al., 2015; (Azizpour et al., 2013; Yau and Chew, 2014). Although studies by Ahmad et al. (2007) cited in Nawawi et al. (2013) and Aripin (2007) were conducted in a hospital with a courtyard design (e.g. clustered type courtyard and closed type courtyard), these studies placed more emphasises on the perceptions of the users regarding daylighting, particularly in the indoor area (i.e. ward area) and did not focus specifically on the user perceptions of the outdoor area (i.e. the courtyard garden) of the hospital.

In fact, very few studies have focused on the microclimatic performance of courtyards in a hospital building. As mentioned previously, only one experimental study by Almhafdy et al. (2014; 2015) focused on the microclimatic performance of courtyard in the hospital building in the Malaysian hot humid climate. This study highlighted that the courtyard enhanced the microclimatic conditions of the courtyard in the hospital building with regards to certain design criteria such as courtyard configuration, orientation and height. Nonetheless, a key lack of this experimental study was that it did not focus on how the users perceived the courtyard spaces in relation to their environmental roles; in contrast, such focus will be conducted in this present study. Further critical reviews of these previous studies are provided in Section 2.3.3.

In addition to their environmental roles, outdoor gardens (i.e. courtyard garden, rooftop garden) has also been found to improve the well-being of hospital occupants and visitors (Ulrich et al., 2019; Cooper Marcus and Sachs, 2014; Ulrich, 1999) and contributes to their relaxation and a reduction in stress levels, hence improving their health and well-being (Ulrich et al., 2018; Amat, 2017; Gonzalez et al., 2011; Kim et al., 2009; Verderber and Reuman, 1987; Ulrich, 1984). Interaction with nature such as walking through nature or taking a break in nature have been shown to provide a positive impact in alleviating stress levels among adult patients in the hospital (Gonzalez et al., 2011; Kim et al., 2009) and family members of ICU patients (Ulrich et al., 2019).

Several studies have revealed that the courtyard garden not only provides a restorative and pleasant view but also act as a stress mitigation resource for the hospital users (Toone, 2008; Naderi and Shin, 2008) (See Section 2.4.3.2). Toone (2008) reported that the parents of sick patients experienced stress relief when being in the courtyard garden of the hospital and when they looked at the views of nature, compared to being inside the hospital without a view of nature. Moreover, several post-occupancy evaluation studies recommended outdoor gardens as an effective restorative setting to ameliorate stress and bring positive change in the mood of hospital users including patients, staff and visitors during hospital garden visitation (Jiang et al., 2018; Sachs, 2017; Reeve et al., 2017; Pasha, 2013; Sherman et al., 2005; Cooper Marcus and Barnes, 1995). However, these studies focused on the outdoor garden in hospitals located in different climatic contexts and were not specifically focused on the hospital courtyard design in a Malaysian hot humid climate context.

Despite the positive outcome of the garden on the well-being of garden users, the quality of outdoor gardens in Malaysian hospitals has been argued by several researchers as lacking consideration of their restorative roles (Adnan, 2016; Shukor, 2007). Many outdoor gardens in Malaysian hospitals do not fulfil the criteria of the restorative garden as the majority of hospital garden designs incorporate bare ground, simple paving and a lack plants and greenery (Shukor, 2007). However, the limitation of these studies was that it focused on all types of outdoor gardens in a single case study hospital and did not specifically focus on courtyard gardens. Yin (2014) highlighted that having different case studies to compare multiple findings helped researchers produce an in-depth understanding of a case. It is important to avoid bias by depending only on data from a single case study and enhance the reliability of a study by demonstrating a proper case study protocol which can be repeated and replicated across multiple case studies in order to arrive at the same findings or conclusions (Yin, 2014, p.47). Further critical reviews of the Post-Occupancy Evaluation (POE) of restorative gardens in various countries including Malaysia are provided in Section 2.4.3.

1.5 Importance of the research

Following from the above discussion, this study is pertinent as there is a need to systematically evaluate the quality of courtyard designs in the Malaysian hospitals through the investigation of its uses and the perceptions of the courtyard users in terms of environmental and restorative roles. This study seeks to determine whether the provision of the courtyard in Malaysian hospitals is able to achieve an environmentally friendly design while avoiding compromising the aspect of a restorative setting. Thus, the outcome of this study aims to assist hospital planners, architects and landscape architects to review and update the planning and design requirements for optimal courtyard design for future hospital buildings and the hospital provider to improve the hospital project brief.

1.6 Research aim and objectives

This study aims to investigate how different types of HCG in Malaysian public hospitals that were built after 1998 are currently performing, used and perceived by the intended users in relation to the environmental and restorative roles.

i. To identify the positive and negative aspects of the selected HCGs in Malaysian hospitals based on users' perspectives.
ii. To examine users' perceptions, preferences and satisfaction levels with the overall design and planning of the selected HCG in Malaysian hospitals.
iii. To assess microclimatic conditions in the selected HCG and users' perceptions of outdoor thermal comfort.
iv. To investigate the users' space use pattern and their experiences in the selected HCG.
v. To examine the designers' intentions, challenges, collaboration practices and their suggestions for future improvement in the design and planning of the selected HCGs.
vi. To develop a framework for an effective HCG design for a Malaysian public hospital and to provide recommendations for policy and practice.

1.7 Main research question and sub-research questions

How are different types of HCG in Malaysian public hospitals that were built after 1998 currently performing, used and perceived by the intended users in relation to the environmental and restorative roles?

In order to address the main research question, this research has outlined the following sub research questions:

i. What are the positive and negative aspects of the current conditions in the selected HCGs based on users' perspectives?
ii. What are the users' perceptions, preferences, and satisfaction levels with the overall design and planning of the selected HCGs in Malaysian hospitals?
iii. What is the microclimatic conditions in the selected HCGs and how does it influence the users' perceptions of thermal comfort?
iv. What are the users' space use patterns and experiences in the selected HCGs?
v. What are the intentions, challenges, and suggestions from the architects and landscape architects for the future improvement of the design and planning of the selected HCGs?
vi. What are the criteria for an effective HCG design in a Malaysian public hospital and what are the policy and practice recommendations?

1.8 Scope of research

The scope of the research involved an investigation and evaluation of the performance of three representative samples of the case study HCGs related to their intended environmental and restorative functions based on users' feedback. This is a critical step to assess the important components of an effective HCG design, and to further establish the HCG framework and provide recommendations for policy and practice (Discussed in detail in Chapter 8). Thus, multiple sources of data were employed to achieve the research aim and objectives including: interview surveys with HCG users and non-users; field investigation of the physical site conditions and microclimate; direct and video-based observation on the users' space use patterns; and interviews with architects and lansdcape architects were employed to achieve the research aim and objectives. The data sources are elaborated further in Chapter 3.

1.9 Research flow

Research starts with understanding the issues and problems within the field, then identifying the research gap through a critical review of past research and understanding theories underpinning the research (Stress Reduction Theory (SRT) and Attention Restorative Theory (ART)). Following on from this understanding, an initial conceptual framework was developed which integrated both the environmental and restorative functions of the HCG (See Figure 1.1).

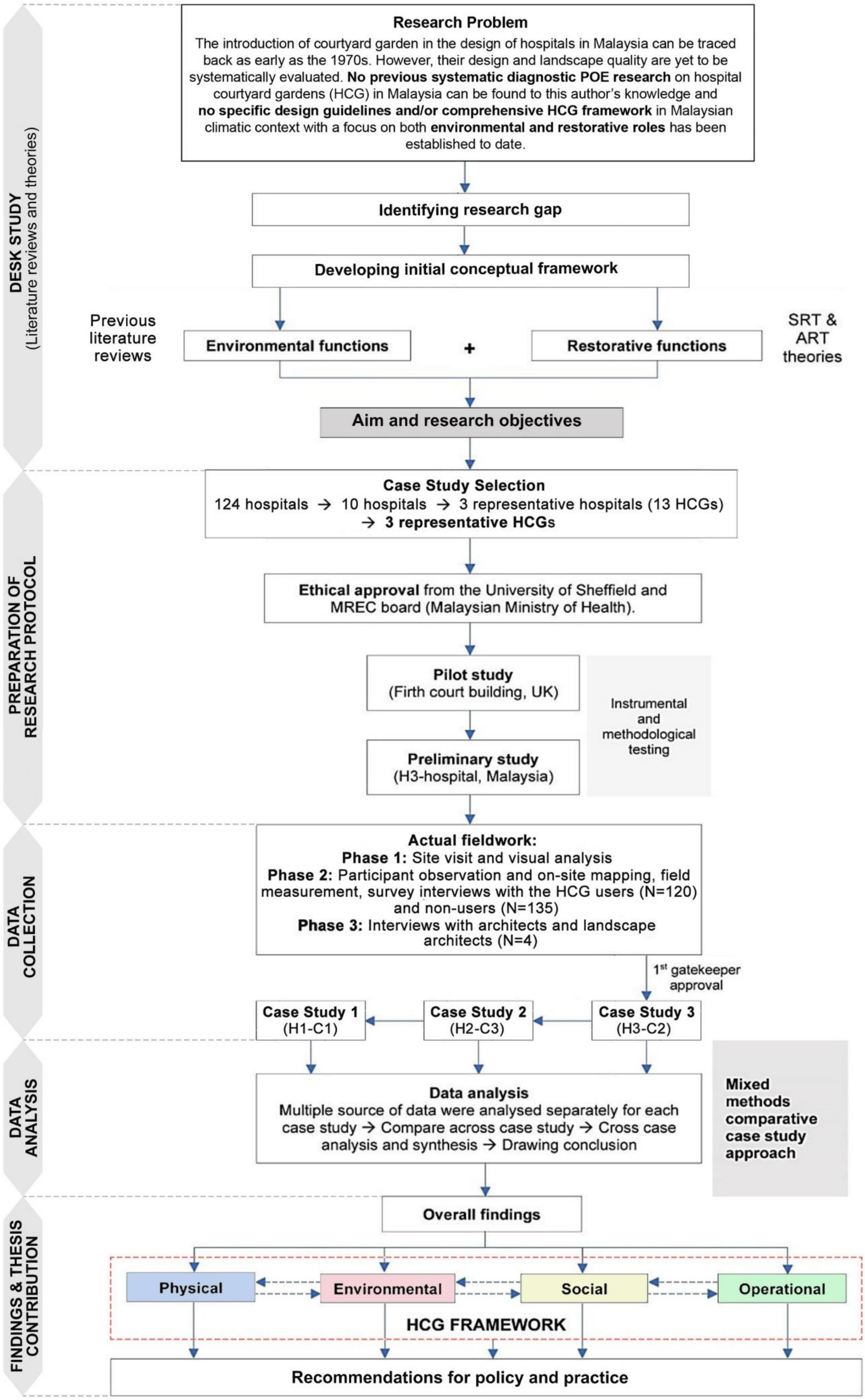


Figure 1.1: Flow of the research

Further, the process includes developing the research aim and objectives, conducting case study selection and applying for ethical approval. After obtaining ethical approval, the pilot and preliminary study were carried out to test the practicality of instruments and methods. After incorporating improvements, the actual on-site field work was carried out in three phases (See Section 3.4.6). The data analysis was conducted using a mixed method comparative case study convergence analysis. Based on the overall findings, the HCG framework was developed with four important components: physical, environmental, social and operational. Finally, specific recommendations for policy and practice were outlined based on the HCG framework.

1.10 Thesis structure

This thesis comprises nine chapters. **Chapter 1** presents the introduction and the research background as well as context of the research. The chapter highlights the research problem, the research gap and the importance of the study. Further, it outlines the main research aim, research objectives and the research questions. It also describes and illustrates the research flow and thesis structure.

Chapter 2 reviews the contextual and historical background of the study and highlights the origin of the integration of the environmental and restorative roles. This chapter also critically reviews previous studies on both the environmental and restorative functions of courtyard gardens, and presents the theories underpinning the current study which are SRT and ART.

Chapter 3 presents the methodology of the study. This chapter describes the research approach which includes a mixed method and a case study research approach. Further, this chapter outlines the justification for adopting the multiple methods approach utilised in the current study namely: field investigation, survey interview, observation and interview with designers. This chapter also elaborates on the data collection procedures, the study population, data sampling and the analysis carried out in the current study.

Chapter 4 presents the case study selection and the context description. This chapter elaborates on the selection of the representative case study hospitals and the final selection of the representative case study HCGs which were chosen for evaluation in the current study. Further, it provides an overview of the functional use and the characteristic of each courtyard garden in the hospitals. This chapter also presents the context of the selected representative case study HCGs including the site, space functions and landscape features.

Chapters 5, **6** and **7** present the results and discussion in response to sub-research questions 1,2,3 and 4. **Chapter 5** mainly focuses on the ***physical and operational aspects*** of HCG design to answer sub-research questions 1 and 2. The chapter first presents the results on: i) users' evaluation on the positive and negative aspects of the HCG; ii) users' perceptions on the importance of the landscape elements and their preference of the HCG images; and, iii) users' satisfaction levels with the design and planning of the HCG images. Following that, the chapter discusses and compares the results with the findings from previous research.

Chapter 6 primarily concentrates on the results and discussion of the ***environmental and social aspects*** of HCG design to answer sub-research questions 3 and 4. This chapter describes the results and discusses the: i) microclimatic conditions of the case study sites and users' perceptions on thermal comfort in the HCG; ii) Users' perceptions of the importance of environmental design; iii) Users' space use patterns in the selected case study HCGs; and, iv) Users' experiences and perceived restorative scale while spending time in the HCG.

Chapter 7 presents the ***views of the architects and landscape architects*** in terms of design intention, challenge and suggestions for improvement to answer sub-research question 5. This chapter also describes the development stage and collaboration practice between the stakeholders based on interviews with these designers. Further, the important findings in this chapter are also discussed.

Chapter 8 is answers sub-research question 6. The chapter presents the final outcome of this research which is ***the generation of the HCG framework and the recommendation for the policy and practice*** based on the overall findings which are described and discussed in **Chapters 5**, **6** and **7**, in relation to the literature review and theory underpinning this research. The chapter also presents the final HCG framework and implication of the study.

Chapter 9 presents the achievement of this research in answering the main research question and sub-research questions and illustrates how these questions are linked to the findings and the thesis structure. It also concludes the key contributions to knowledge, limitations of the current research and recommendations for future research (See Figure 1.2).

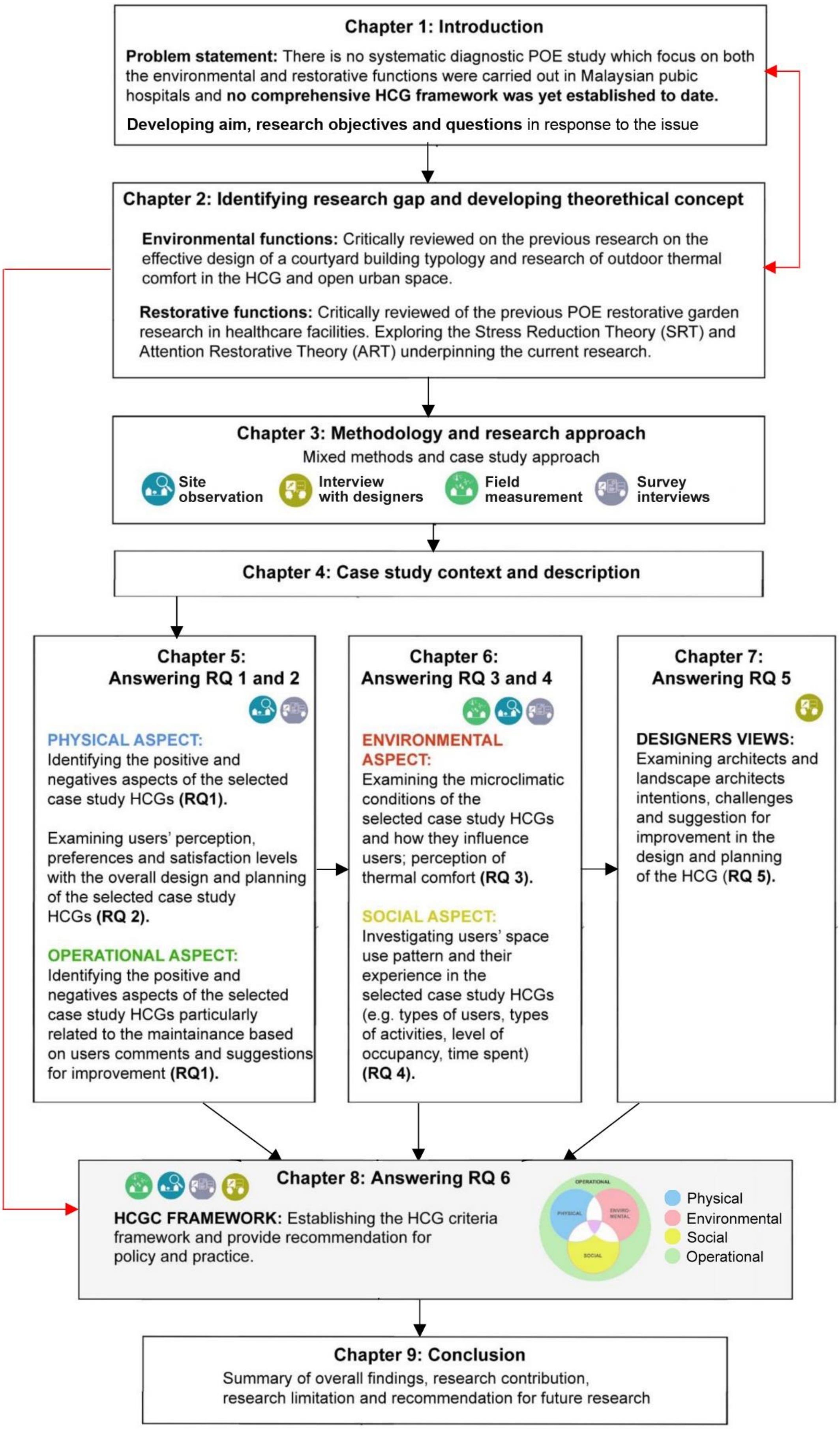


Figure 1.2: The research structure

CHAPTER 2:

Literature review

2.1 Introduction

This chapter presents the research contextual background, the literature review of previous studies on both the environmental and restoratives roles of HCGs and the theory underpinning the field study of the current research. First, it starts by explaining the context of the research and defining the origin of the integration of environmental and restorative functions in hospital courtyard buildings. This chapter also discusses the significance of courtyard hospitals in medieval times regarding their dual roles in comparison to contemporary hospitals. Further, this chapter sets out the background study of the development of courtyard gardens in Malaysian public hospitals and illustrates the evolution of courtyard hospital typology over time. This chapter also discusses the roles of the architect and landscape architect in relation to the needs of the environmental and restorative functions in the HCG design.

This chapter then critically reviews several previous studies related to the environmental roles of the HCG. This includes a review of the courtyard as a passive design strategy in a building, a review of the studies carrying out an environmental assessment of Malaysian courtyard hospitals, to highlight the gap in this study. This section also provides a review of the assessment of outdoor thermal comfort. Subsequently, this chapter also reviews previous studies on the enhanced microclimatic conditions in the courtyard buildings to understand the fundamental design criteria needed for improving microclimatic conditions within the courtyard space.

Additionally, this chapter presents a critical review of earlier studies which focused on the restorative roles of the hospital courtyard garden. It provides an overview of the user groups in the HCG (i.e. patients, staff and visitors) and their needs. Then it presents the role of nature in reducing stress and improving health outcomes for different groups of users. This chapter also reviews and critiques previous studies on restorative gardens in Malaysian hospitals. Several examples of POE studies of outdoor gardens conducted in healthcare settings and their methods are also described and discussed.

2.2 The research context and background

2.2.1 The definition of courtyard and its functions

The word ‘courtyard’ is defined in The Cambridge University Dictionary (2016) as “an area of flat ground outside that is partly or completely surrounded by the walls of a building”. Several scholars defined courtyards as an enclosed outdoor space surrounded by a building or wall and open to the sky (Abass et al., 2016; Almhafdy et al., 2013a). Reynolds (2002) described the courtyard as a unique space which can be considered as an outdoor space in between indoor spaces, open to the sky and commonly in contact with the ground. Additionally, a courtyard is viewed as not physically confined to the centre of the building with an enclosed wall but perhaps two walls formed around the space that are still considered as a courtyard; further, it is often integrated with subversive elements such as plants and water (Reynolds, 2002). For the current study, a courtyard garden is specified as a **semi-outdoor space in a hospital enclosed by a wall and open to the sky which is intentionally functioned to be used by patients, staff and visitors and designed by both the architect and the landscape architect.**

As explained previously in Chapter 1, the focus of this study is to investigate how the different types of courtyard gardens in Malaysian public hospitals are currently performing in relation to the environmental and restorative functions and how they are used and perceived by different users. In this context of study, **the environmental function** can be defined as ability of the courtyard garden to environmentally function as a cooling strategy to provide thermal comfort to those in the HCG and the indoor spaces and maximise the use of the daylighting in the building by considering various architectural design parameters (e.g. orientation, aspect ratio, vegetation and wall enclosure). Moreover, it does not only avoid a deep plan nature of a large-scale hospital building (Short and Al-Maiyah, 2009) but also contributes to a lower energy consumption of the building (Jamaludin et al., 2014; Short and Al-Maiyah, 2009).

The restorative function can be defined as the ability of the courtyard garden to support the physical environment of the HCG and to significantly enhance the users’ experiences in the HCG provided that several restorative features to support the functional needs of different types of users (i.e. patients, staff and visitors). These features include a combination of hardscape and softscape, a place to sit and relax, social interaction, physical movement and exercise. Providing a restorative environment can contribute to the renewal of psychological resources depleted in the surrounding environments and a reduction in stress levels (Ulrich, 2019; 1999).

2.2.2 The changing roles of courtyard hospitals from the medieval to contemporary time

Looking back at the historical courtyard during medieval times in the West and the Middle East reveal that these courtyards in the early medical settings have similar characteristics and qualities that intentionally integrated the dual aspects of environmental and restorative roles in their setting (See Appendix 14). The elements of water, plants, flowers, fresh air and light were all interrelated design qualities practised in most of the historical courtyard gardens in the hospitals of that time (Tschanz, 2017; Ragab, 2015, p.23; Riva and Cesana, 2013; Cooper Marcus and Sachs, 2014). The inclusion of courtyards in the built form of the hospital buildings were not only designed to provide comfort to the occupants by improving their microclimatic conditions (Almhafdy et al., 2013b; 2014) but also provided restorative ambiences to enhance their well-being (Cooper Marcus and Barnes, 1995; Naderi and Shin, 2008).

Courtyards in early hospital settings had their own restorative qualities by providing a place of seclusion, meditation and peace for patients. Arcades surrounding courtyards in medieval hospitals were commonly used as waiting areas and places for patients to have a momentary escape from their hospitalisation (Lehrman, 1980, p.3). Providing views onto natural features such as water fountains, pools and plants at the centre of the courtyards added a soothing and pleasant restorative environment for the patients. In addition, the sound of running water and light instrumental music also played a role in the therapy commonly found in the courtyards of early Islamic medical settings (e.g. Al-Argun Bimaristan in Aleppo) by providing surroundings that calmed patients during treatment (Tschanz, 2017; Ragab, 2015). Moreover, the benefits of sunlight and fresh air were also practised in Sanatoriums in the West as part of the healing process for people who suffered from tuberculosis (Eylers, 2014).

In addition to the restorative roles that promoted a contemplative and healing environment for patients, the use of courtyards in hospitals were found to improve their microclimatic conditions and enhanced physical comfort in the building (Almhafdy et al., 2013b; 2014). The courtyard, then, is part of an environmental passive design that utilises the natural elements including sunlight and fresh air for heating, cooling or lighting the building (Hyde, 2013). Several hospitals based in the West (e.g. Santiago de Compostela in Spain, Ospedale Maggiore of Milan, Christopher Wren's Royal Chelsea Hospital in London and the Royal Infirmary Hospital in Scotland) and the Middle East (e.g. Al-Sultan Qalawun Bimaristan in Egypt, Al-Nuri Bimaristan in Damascus (1154) and Bimaristan Al-Argun in Aleppo) (See Appendix 14 for a the illustrations of this hospitals), were found to have incorporated a central courtyard to provide light and fresh air within the courtyard itself and the adjacent spaces as well as to provide shade within the courtyard area (Ragab, 2015, p.23; Cooper Marcus and Sachs, 2014; Riva and Cesana, 2013; Allen, 2003).

When comparing historical hospitals to modern hospitals, the latter rely on air-conditioning particularly in large-scale hospitals in Malaysia (Moghimi et al., 2014). This technology has replaced the use of natural ventilation to provide cooling in the building. Although recent hospitals in the 21st century are found to have an incorporated courtyard in their design and planning to maximise the use of natural ventilation, the workability and effectiveness of the existing courtyards to promote comfort in the courtyard itself and the adjacent spaces is questionable because of the use of air conditioning in the hospital building (Moghimi et al., 2014; Yau and Chew, 2014; 2009).

The earlier 'Nucleus' type hospitals built during the 1980s were designed to maximise the use of natural cross ventilation in the wards. These hospitals were more environmentally friendly compared to today's contemporary large-scale hospitals that rely more on air conditioning for indoor comfort which resulted in poor indoor air quality (Aripin and Nawawi, 2011; Nawawi et al., 2013). In fact, today, hospitals **still rely on the artificial lighting throughout the corridor adjacent to the HCG and some windows in the adjacent rooms around the HCG are not opened to allow for ventilation**, regardless of the intentions of the architects in implementing the courtyard as a strategy for maximising the daylighting strategy and ventilation strategy as observed in the current study.

Understanding the context of the historical hospital in terms of their environmental and restorative roles as practised during medieval times provides a clear understanding that these dual roles are significant in improving the environmental and well-being aspects in hospital buildings. However, **in today's contemporary world these interrelated dual roles have been forgotten in many of the modern conventional hospitals.** It appears that many hospital designers have tried to implement these environmental and restorative roles in the planning of hospital buildings, but they tend to disjointedly look at these aspects as two separate aspects. Management and operational aspects also play fundamental roles to ensure the hospital functions with regard to the intended goal of achieving an energy efficient and environmentally friendly building as well as providing a positive experience to the hospital users. **Thus, it is crucial to bring back these dual functions to be wisely integrated and implemented into the courtyard design for todays' contemporary hospital buildings within the appropriate climatic context in a way that could effectively function to meet the needs of a variety of building users.**

2.2.3 Development of hospital courtyard garden in Malaysian public hospital

2.2.3.1 The development of Malaysian healthcare system

i) Pre-independence

In 1874 during the period of British colonisation, the development of the hospital in Malaysia was directed by the tin mining industries in which services were provided for the workers of the tin mines, the armed forces, the estate labourers and government servants. Before the time of independence in 1957, there were 10 major general hospitals and 50 districts hospitals in operation (Suleiman and Jegathesan, 2001). Some of these hospitals are still in existence and continue to operate until today. There were two types of hospital forms built during that time: single stories with a pavilion type arrangement which can be seen in rural areas and a type of a medium rise hospital in urban areas (Aripin, 2007).

The built forms of the hospital in Malaysia has evolved significantly over the course of time. Changes in the physical and conceptual aspects of hospital designs are influenced by several factors including changes in technological advancement, medical practices and government guidelines (Nawawi et al., 2013). During the colonial period, the hospital built form was that of a type of pavilion arrangement and most of the hospitals are designed as a climate friendly building in which the arrangement of the spaces of these hospitals are mostly for the utilisation of natural ventilation and daylight. During that time, most hospitals were located close to the seaside and the hillsides which allowed views from the wide veranda and openable windows (Nawawi et al., 2013). Figures 2.1 (a) and (b) show two common types of hospital-built forms during the time of colonisation including the single storey and double storey built forms.

(a) (b)

Figure 2.1: (a) Single storey colonial hospitals, Balik Pulau Hospital, (b) Double storey colonial hospital, Taiping hospital.
Source: Nawawi et al. (2013).

Figure 2.2 (a) shows a typical type of colonial single storey hospital, Tanglin hospital in Kuala Lumpur. This hospital successfully embraces climatic design considerations such as openable door panels, louvered doors and windows, high ceilings, a hot air ventilated roofing system with wide overhang and the use of local materials. Figure 2.2 (b) shows the multi storey pavilion hospital in Malacca which was designed with high ceilings, multi louvered timber windows and a concrete overhang.

(a) *Source: Aripin (2007)*

(b) *Source: Nawawi et al. (2013).*

Figure 2.2: (a) Typical colonial single storey hospital. (Tanglin hospital, Kuala Lumpur), (b) Multi storey pavilion type hospital (Hospital Melaka, 1936).

ii) Post-independence

Malaysia gained independence from the British in 1957. In the 1960s, the *Affordable Health Services for All* policy was established by the Ministry of Health (MOH) in which the Rural Health Services has been developed which required the provision of new hospitals in all states (Aripin, 2007). During this time, the old hospitals were replaced with new hospital designs based on the standard drawing of either one or two storey buildings with a modular block arrangement (Nawawi et al., 2013). The standard plans which refer to a ‘Jertih Type Plan’ and ‘Kuala Berang Type Plans’ was implemented and replicated in most of the new district hospitals of 50 to 150 beds (Aripin, 2007). Figure 2.3 shows a modular block planning of a Sikh Hospital in Kedah which implemented the ‘Jertih type standard plan’.

Figure 2.3: Master plan and ariel view of Pavilion type hospital - *Jertih type (Sikh hospital , Kedah)* *Source: Nawawi et al. (2013).*

Figure 2.4 shows Baling hospital in Kedah which replicated the 'Kuala Berang type' standard plan. These types of 'Jertih and Kuala Berang type' hospitals were typically designed to have a shaded and open corridor attached to the outdoor gardens.

Figure 2.4: Master plan and ariel view of Pavilion type hospital – Kuala Berang type (Baling Hospital, Kedah)
Source: Nawawi et al. (2013).

In the late 1970s, some of the hospitals in several states in Malaysia were designed by the Public Work Department (PWD) or locally known as *Jabatan Kerja Raya* (JKR). Since then, the standard plan of Jertih and Kuala Berang type was no longer used. In total, six hospitals were built to replace the old general hospitals. These hospitals were designed with a podium and a tower configuration due to the constraint of land in urban areas. The first template of a podium and tower configuration plan hospitals was the Seremban hospital, with a capacity of 700 beds. These hospital types were constructed in six states in Malaysia. Figure 2.5 shows the typical state of General hospital design in the late 1970s.

Figure 2.5: Typical state of general hospital design in the late 1970s
Source: Nawawi et al (2013).

In the 1980s, the World Health Organization (WHO)s *'health for all'* strategy was adopted into the Malaysian health development plan through a formal agreement with the British Government in line with the goal of the national policies: *Towards Nation Building* and *Health for All.* (Aripin, 2007). This resulted in a better improvement of healthcare services for the rural communities. During this time, the United Kingdom (UK) nucleus hospital design concept was implemented in 12 district hospitals in all states throughout Malaysia through a turnkey system (Aripin, 2007; Nawawi et al., 2013). The nucleus hospital template from the UK, a country located in the temperate region, was adopted and modified to suit the Malaysian tropical climate in which it was built with additional perimeter corridors covered with an overhanging roof, covered and shaded skylights and equipped with a mechanised ventilation system in the ward areas (e.g. fans and exhaust fan). These hospitals were built either from a single storey design for 90-108 beds or a two-storey building for 300 beds depending on the health service requirements (Nawawi et al., 2013). Figure 2.6 indicates the layout plan of a nucleus concept hospital used in the 12 sites in Malaysia.

Figure 2.6: Master plan and ariel view of the Nucleus concept hospitals
Source: Nawawi et al. (2013).

In the early 1990s, the 'one-off' hospital design was built for the development of large district hospitals with a capacity of 300 to 500 beds. These hospitals were constructed to replace the existing state general hospitals and to establish new referral medical specialist hospitals or hospitals for teaching institutions. These hospitals also functioned as a second general hospital. During this time, most of these hospitals were designed by private consultants, with the PWD as the project manager.

Moreover, the Malaysian government called for the buildings **to be designed and constructed in an ecologically sustainable and environmentally friendly way** (Nawawi et al., 2013; Aripin, Othman and Nawawi, 2015). This acted as **the driver for the designers of these hospitals to implement this concept into their design planning with their individual aesthetic views and design considerations**. This resulted in different styles and design concepts being implemented in each of these hospitals, either the vernacular, corporate, or resort and garden concept (Aripin, 2007; Nawawi et al., 2013). Figures 2.7 and 2.8 show the 'one-off' design hospital: Jempol Hospital, Negeri Sembilan and Temerloh hospital, Pahang.

Figure 2.7: Master plan and ariel view of Hospital Jempol, Negeri Sembilan
Source: Nawawi et al (2013).

Figure 2.8: Master plan and ariel view of Hospital Ampang, Selangor
Source: Nawawi et al. (2013).

2.2.3.2 Trends in healthcare practices in Malaysia

Over the years, several improvements have been made by the Malaysian Ministry of Health (MOH) in improving the quality of hospitals in Malaysia, including the physical and social facilities inside the hospitals. A new strategic plan by the MOH (2016-2020) emphasises '*promotive and preventive'* healthcare by improving the quality of health delivery systems. As highlighted by Tong (2008), the trend in Malaysian hospitals had shifted towards promotive and preventitive approaches rather than curative healthcare as hospitals become more patient-focused which emphasises the needs and well-being of the users including patients, visitors and staff. In addition, these medical approaches keep changing and being refined by the MOH to ensure good quality of hospital services able to cater for the changing environment and users' needs (Suleiman and Jegathesan, 2001). This is in line with the Malaysia Health Vision 2020: 'Malaysia is to be a nation of healthy, individuals, families and communities' (MOH, 2004 cited in Merican, Rohaizat and Haniza, 2004).

The healthcare facilities and services in Malaysia have been developed to cater for the needs of all communities since the independence. In the 1960s, the MOH established the Affordable Health Services for All policy. This led to the development of new hospitals in all the states throughout Malaysia to replace the old hospitals. These hospitals were built based on the standard plan of the Jertih and Kuala Berang type. In the 1970s, a new type of hospital, of a podium and tower configuration-built form, were constructed to replace the old hospitals and as an alternative due to the issue of land constraints in urban areas. As mentioned earlier in Section 2.2.3.1, by the early 1970s, several hospitals had incorporated open type courtyard in the hospital planning.

Trends in the medical approach, the types of healthcare services and hospital planning in Malaysia were all dynamically developed based on the agenda 'Health for All' from the World Health Organization (WHO). This agenda has been popularised and was practised in Malaysia since the 1980s to the 1990s (Nawawi et al., 2013). The vision of this agenda was to secure the health and well-being of nations by promoting health and enhancing the quality of life through 'healthy hospitals'. The design of hospital planning during this time was based on the UK type of nucleus hospitals which were adapted and modified to suit the local context and medical requirements in Malaysia with the aim to achieve a climate friendly hospital.

i) The different types of Malaysian healthcare facilities

There are two types of the healthcare provision in Malaysia which encompasses of the Public Health sector and Private Health Sector. According to the Ministry of Health Malaysia (2016), there were four types of hospitals in the public sector that encompass the state general hospitals, the district hospitals, national referral hospitals and special institutions. The Malaysian national healthcare referral system is comprised of the primary, secondary and tertiary level of care (See Figure 2.9).

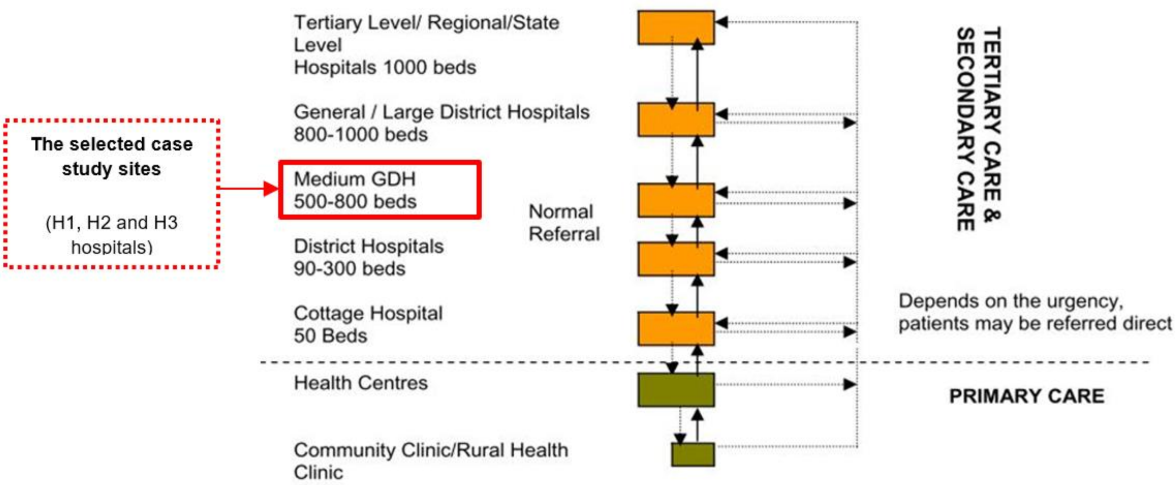


Figure 2.9: Diagram illustrate on the Malaysian National Healthcare Referral System.
(Source: Aripin, 2007, modified by Author, 2020)

As defined by WHO, a referral system is a channel filtering system that refers the patients to the appropriate care (Aripin, 2007). In this system, the patients who receive a service from the primary care level will be referred directly to either the secondary or tertiary level of care depending on the urgency of the cases. These secondary and tertiary levels of care have a higher complexity in the hospital facilities and specialisations which can cater to the needs of the patients in urgent cases.

ii) The provision of courtyard gardens in Malaysian hospitals

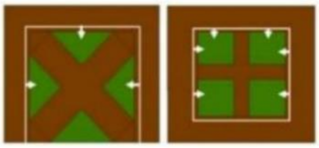
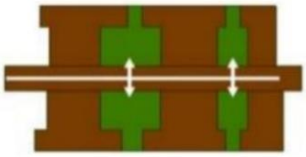
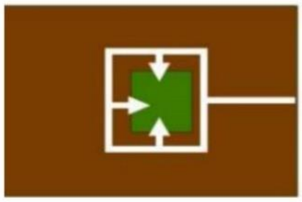
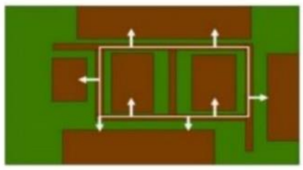
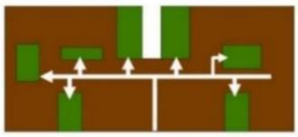
From the 1980s to the 1990s, the Malaysian authorities also improved many aspects of the implementation of the hospital planning through the improvement in the regulations on the requirement for a passive design in order to fulfil the green agenda of the nation. In the early 1990s, there were several one-off type hospitals developed for large district hospitals. In 1998, the Minister of Health also stated that all government hospitals under MOH control must incorporate the outdoor garden in the hospital planning (MOH, 2013 cited in Shukor, 2007). Since then, almost every hospital which was built since the 2000s has incorporated different types of courtyard garden into hospital planning. In line with the Malaysia Vision 2020 ‘Towards a developed nation’, in the 2000s most of the project briefs for building in Malaysia had integrated green design requirement that aim to achieve environmentally friendly building as well as green healing environment. The brief for hospitals is under the non-residential type of buildings and is separately prepared to include the medical requirement brief, the architecture brief, the mechanical and the electrical brief.

Today, the design of hospitals keeps changing according to the demands of physical facilities, medical requirements, green requirements and the provision of healing environments. In the 1990s, the Government of Malaysia called for ecologically sustainable and environmentally friendly building. Then, in 1998, the MOH urged that all hospitals in Malaysia under the MOH must incorporate gardens in hospital planning due to concerns over the importance of contact with nature and the improvement of occupants’ well-being. Over time, many hospitals integrated gardens and courtyards into the buildings to create a healing and restorative environment for the users.

iii) The different types of courtyard garden in Malaysian hospitals and its function

The various courtyard garden designs in Malaysian hospitals can be categorised into four types. These include cluster courtyards, closed courtyards, open courtyards and interlinked courtyards. The cluster courtyard is either spinal or multiple types of courtyard (Almhafdy et al., 2013a) (See Table 2.1). Since the 2000s, the healthcare facilities were designed by private consultants with different design concepts and approaches. The different outlook of each hospital design can be seen with a different type of courtyard design implemented into the hospital building in which it was designed for different uses and purposes. Different architects will have their own views and design considerations during the design planning process of the courtyard hospital.

Table 2.1: The types of courtyard design in Malaysian.
(Source: Almhafdy et al. (2013a)

TYPES OF COURTYARD		DESCRIPTION	IILUSTRATION
1. Clustered courtyard	Multiple	Four fully enclosed courtyards integrated in the layout planning of the hospital.	
	Spinal	More than one courtyard attached to the hospital central circulation route.	
2. Closed courtyard		The courtyard is fully enclosed and often located at the centre of the building (4 sides).	
3. Open courtyard		A group of building blocks frame an open space into the courtyards.	
4. Interlinked courtyard		Courtyard located at a different floor and for different purposes.	

2.2.3.3 The evolution of the hospital-built form in Malaysia from Pre-Colonial period to date

Healthcare facilities have been dynamically developed to ensure the best facilities and health services provided for all Malaysian communities since the pre-independence days. Figure 2.10 shows the evolution of the built-form of hospitals in Malaysia since Independence Day and maps the time in which the provision of the courtyard was implemented in Malaysian hospitals.

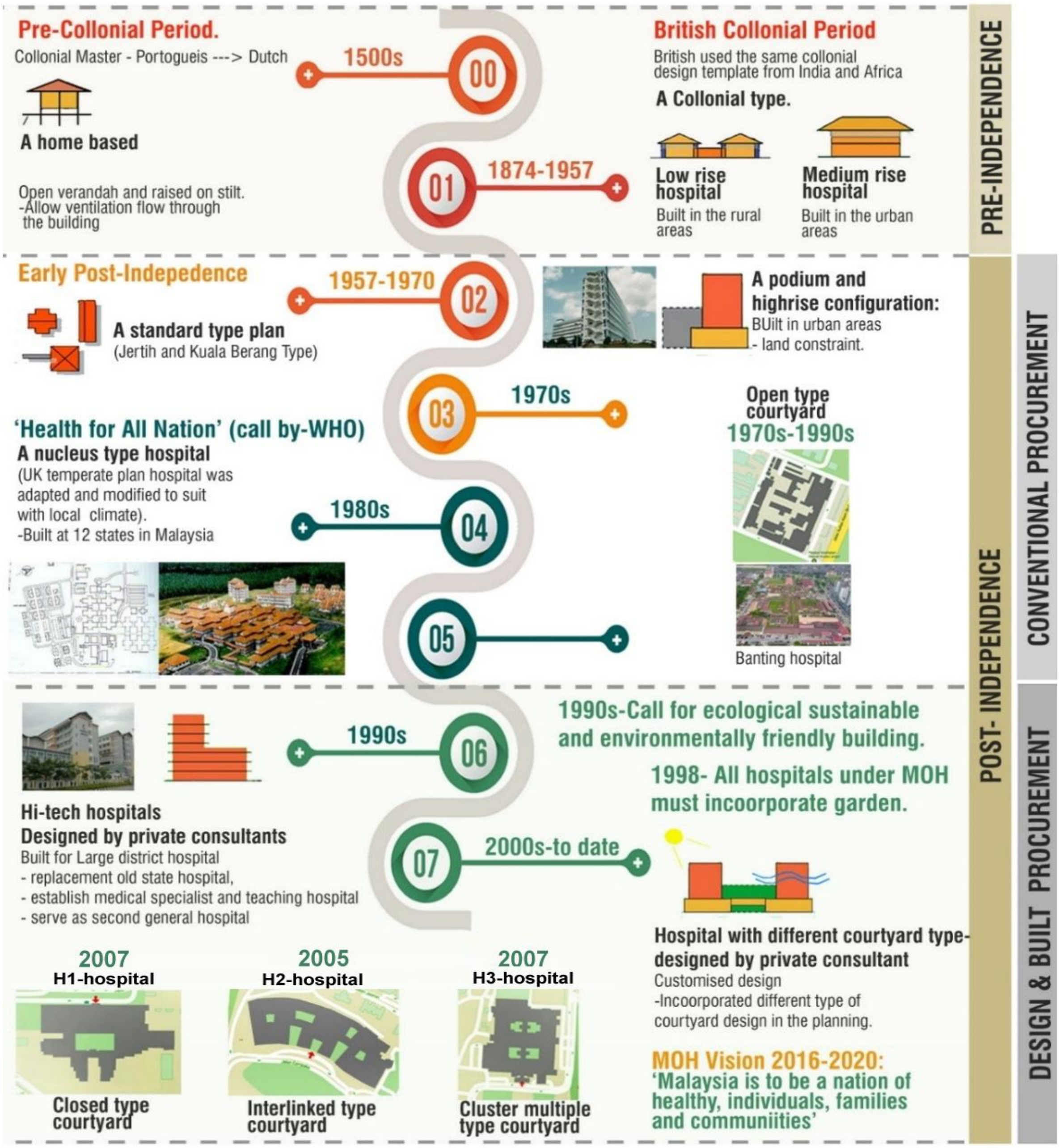


Figure 2.10: Timeline of the evolution of hospital-built form since pre-independence until to date. *(Other hospital pictures. Source: Nawawi et al., 2013). Pictures of Banting hospital (Source: Yew, 2017). Map of the master plan for the hospitals retrieved from https://www.google.co.uk/maps.*

2.2.4 The separate role of the architect and landscape architect in designing gardens in hospitals

Both the architects and landscape architects play an important role in designing the HCG so that it can effectively function according to their environmental and restorative roles for users to benefit from it. The architect needs to ensure that environmental aspects, such as daylighting, ventilation, comfort (e.g. acoustic comfort, visual comfort and thermal comfort) are carefully considered and functional to meet the needs of the intended users. Regardless of thinking on the complexity of the overall hospital masterplan, architects also need to consider the design and spatial planning of the HCG so that it functions well. This includes accessibility, wayfinding, views, and visibility of the HCG function well. The landscape architects' roles are concentrated on delivering a well-designed courtyard garden in terms of spatial planning and a good combination of hardscape and softscape to achieve users' restorative spatial experience.

Verderber (2010, p.60) has raised criticism that "too often landscapes are created as an afterthought and are not treated as part of the architecture composition". In addition, Cooper Marcus (2007) claimed that architects tended to focus more on the overall building layout and often overlooked the garden as a separate thing or 'left over'. In most cases, landscape architects often design the garden after the architect has finalised the spaces and specified the building configuration. As a result, the idea of having a well-planned courtyard tends to be separated or disconnected from the overall master planning and design process of the building. It is also important for the landscape architect to be involved at the start of the master planning process so that they can guide the design team on the design requirements for outdoor spaces such as location and accessibility as well as microclimatic aspects (Cooper Marcus, 2007). Therefore, investigating the design intentions of the architects and landscape architects form a crucial part of this study to examine the matters that they have taken into consideration that led to the inclusion of courtyards in hospital settings (This is discussed further in Chapter 7).

2.3 Environmental functions of a hospital courtyard garden

2.3.1 Courtyard as a passive design strategy in a building

The courtyard form is found to be utilised in many building typologies across different climates and regions including Iran, China and the Middle East (Edwards et al., 2006). Passive design is a design approach that utilises the natural elements including sunlight and fresh air for the purpose of heating, cooling or lighting in buildings (Hyde, 2013). It has been highlighted that the use of courtyards as a climatic control strategy results in the ability to minimise the need for a mechanical system in the building such as air conditioning and artificial lighting, for example to regulate the indoor temperature (Hyde, 2013, p.221).

Courtyards have also been highlighted as a climatically responsive form that mitigate the cooling effect in the building of a hot humid climate and provide physical comfort to the building occupants' by promoting cross-ventilation into the building which removes warm air away from the courtyard space and cools the heat sink within the adjacent spaces (Rajapaksha and Hyde, 2005). In addition, courtyards provide a microclimate or buffer zone between the outdoor and indoor spaces to encourage a comfortable environment as well as promoting better natural ventilation and daylighting in a building (Hyde, 2013). Moreover, it has been highlighted that courtyards in Malaysian hospitals not only function to promote ventilation and daylighting into the courtyard space and adjacent spaces, but also serves as a garden which provides opportunity to the building users to have a connection with the natural environment (Almhafdy et al., 2013a).

2.3.2 Courtyard as one of the Urban Heat Island mitigation strategies

Rapid urban development has contributed to an urban heat island impact in East Asian countries including Singapore, Malaysia and Hong Kong (Aflaki et al., 2017) and other countries; such as the United Kingdom (UK) (O'Malley et al., 2015); Australia (Imran et al., 2018) and the United States of America (US) (Kim et al., 2018). Several strategies were suggested by previous studies to mitigate the urban heat island effect by increasing the amount of green space (e.g. the application of the green roof, green wall, courtyard garden) as a cooling strategy to improve the thermal comfort in semi-outdoor spaces or urban open spaces (Srivanit and Iamtrakul, 2019; Kim et al., 2018; Taleghani, 2018; Sharmin et al., 2017; Morakinyo et al., 2016; Ghaffarianhoseini et al., 2015).

Comfortable outdoor spaces in the hospital are fundamental to facilitate positive users' experiences in the HCG because a majority of hospital users (e.g. the visitors and families) are found to stay outdoors as an alternative place away from a congested indoor waiting area and sterile hospital environment (Idris et al., 2018). Thus, and as discussed previously in Section 2.3.1, enhancing the thermal comfort in a semi-outdoor space such as the courtyard garden in a hospital is crucial as one of the urban island mitigation strategies regardless of its passive design strategy.

2.3.3 Previous environmental assessment studies of courtyards in Malaysian hospitals

Very few studies have been conducted in courtyard buildings in hot humid climates. Only several studies focused on residential buildings in Malaysia (Sadafi et al., 2012; Kubota et al., 2017). Sadafi et al. (2011) conducted a study in terraced housing in Malaysia focused on the interaction of outdoor and indoor thermal comfort. Sadafi et al. (2011) found that the inclusion of the internal courtyard in the terraced house significantly enhanced the thermal comfort of the adjacent spaces provided that an efficient opening to the outside environment promoted natural ventilation, as well as the implementation of appropriate shading devices.

Moreover, a recent study conducted in a shophouse in Malaysia focused on the five types of courtyard design (Kubota et al., 2017). The parameter of the study included height, orientation, location of the courtyard, thermal properties, sky plant coverage, area of the water bodies and vegetation. Kubota et al. (2017) recommended that a closed, cross ventilated courtyard was preferable to be utilised in a shophouse in a hot humid climate to obtain optimum indoor thermal comfort and avoid excessive humidity within the courtyard area. This study also suggested that V-shaped roofs be implemented to increase the inflow of air from the roofs into the courtyard area during the night time.

2.3.3.1 Assessment of the performance of courtyards through building simulation

In the context of a hospital building in a hot humid climate, a building simulation study using computer modelling conducted by Almhafdy et al. (2013b) studied the microclimatic conditions of the hospital courtyard. This study highlighted the point that less consideration was given regarding the appropriateness of the courtyard design criteria impacts on the microclimatic performance of the building. In other words, the courtyard acted as a microclimatic modifier as it had the capability to improve microclimatic conditions by moderating the high temperature, controlling the amount of dampness and promoting air flow within the courtyard space (Almhafdy et al., 2013b). A related study revealed that improper consideration of the basic design criteria including the orientation, height and forms resulted in the uncomfortable courtyard conditions due to minimal shade, lower airflow and higher temperature in the courtyard space and yet considerably contributes to the heat build-up inside the adjacent spaces (Almhafdy et al., 2014).

Almhafdy et al. (2013a) showed that three physical environmental variables including air temperature, relative humidity and wind velocity (i.e. wind flow and direction) are significantly influenced by the design criteria of the courtyard including the form, height and orientation. In the related study (Almhafdy et al., 2014), it was found that a semi-enclosed courtyard (U-Shape) performed better than an enclosed type courtyard (O-Shape) provided that the courtyard is elongated along the east-west axis and open to the south for better natural ventilation and maximum shading (See Figure 2.11). This suggested that better comfort conditions of the courtyard can be achieved if the height, orientation and aspect ratio are carefully considered and appropriately designed. Additionally, this study provides insight for the current research in the preparation of the fieldwork, in terms of the selection of the tools used to measure the microclimatic conditions in the courtyard (Almhafdy et al., 2014).

Figure 2.11: Illustration of O-shape courtyard (Enclosed) and U-shape courtyard (Semi-enclosed) in the hospital building.
Source: Almhafdy et al. (2014)

2.3.3.2 Assessment of users' perceptions of daylighting and visual comfort

Apart from the experimental study of the microclimatic performance of courtyard in the hospital by Almhafdy et al. (2014), the evaluation study has been conducted by Aripin (2007) to investigate the users' satisfaction levels on the quality of daylighting in the wards of three different hospitals in Malaysia. The result revealed that a courtyard type hospital provides a higher satisfaction level from the building occupant on the quality of daylighting in the four beds wards that are elongated to north-south direction. This courtyard type hospital (H3) provides essential amount of daylighting into the wards area and reduce the discomfort glare in the patients' wards compared to another type of hospital design (H1 and H2) which almost 20 to 30% of the four bed wards are directly facing the east-west direction (Aripin, 2012) (See Figure 2.12). Aripin (2007) highlighted the importance of obtaining feedback from users to suggest necessary improvements related to the enhancement of users' experiences in the hospital setting.

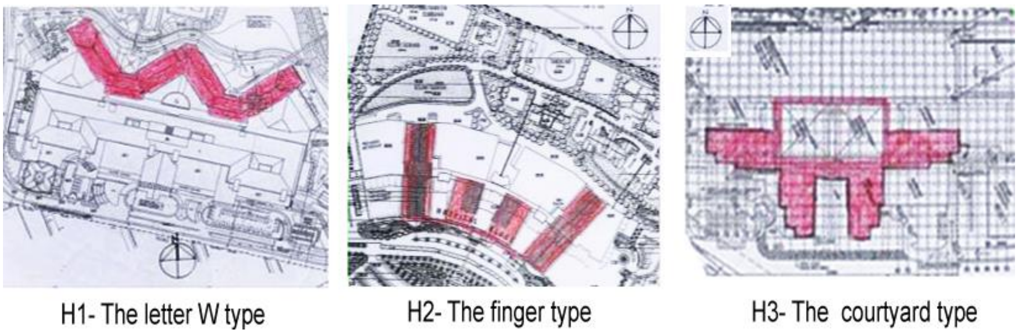


Figure 2.12: Illustration of three case studies of the previous studies on the perception of users on the daylighting in the hospital wards.
Source: Aripin (2012).

Further, another study has been conducted in two Malaysian hospitals of a similar square plan with a clustered type courtyard (Ahmad et al., 2007 cited in Nawawi et al., 2013). The study investigated the optimal design for efficient daylighting in the wards (See Figure 2.13 and Figure 2.14). Findings from this study clearly suggested that in order to achieve efficient daylighting, the most preferable ward-plan is to be elongated towards the north and south direction to receive maximum daylighting and ventilation. As such, it will reduce the solar radiation and heat received from the east and west Directions (See Figure 2.14). This study also suggested that the length for the wards area should be within or less than 14 metres for better daylighting penetration from the courtyard.

Although studies by Ahmad et al. (2007) cited in Nawawi et al. (2013) and Aripin (2007) are conducted in a hospital with a courtyard design (i.e. clustered type courtyard and closed type courtyard). However, these studies are not specifically focused on perception of users in the outdoor area (i.e. the courtyard garden) of the hospital. Instead, the emphasis of such studies was more on the perception of users on the daylighting particularly in the indoor area (i.e. ward area). **In-depth studies on how the users utilise and perceive the different type of courtyard gardens in the hospital building remain rare in Malaysia**.

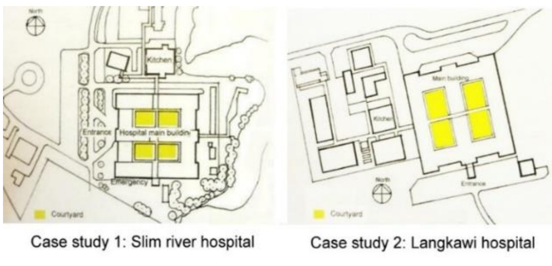


Figure 2.13: Illustration of the 2-case study site of a similar square plan with a clustered type courtyard.
Source: (Ahmad et al., 2007 cited in Nawawi et al., 2013).

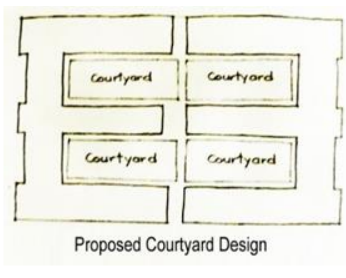


Figure 2.14: Illustration of proposed design for an optimum daylighting in the wards area of a square type hospital plan.
Source: (Ahmad et al., 2007 cited in Nawawi et al., 2013).

Courtyard garden is a common feature that has been incorporated in many of the hospital planning in Malaysia and several parameters have been studied to improve the environmental condition of the hospital building (Almhafdy et al., 2013a). However**, a systematic evaluation of the quality of existing courtyard gardens within hospital buildings have not been studied in detail.** Nonetheless, knowledge on the utilisation of the courtyard by the intended users and the perception of the users on the environmental and restorative roles of different types of courtyard design in Malaysian hospitals still remains scarce.

2.3.4 Outdoor thermal comfort research

Previous POE of restorative gardens research in healthcare facilities did not carry out a field measurement study to measure the important microclimatic parameters that can significantly influence users' level of thermal comfort in the HCG (Discussed further in Section 2.4.3.4). Most discussion on the previous POE of restorative garden research presented information on the microclimatic conditions of the study sites based on direct observation during the site analysis on sunny or cloudy days and/or in shaded or unshaded areas (e.g. Jiang et al., 2018; Sachs, 2017; Pasha, 2013; Shukor, 2012; Davis, 2011; Cooper Marcus and Barnes, 1995). Therefore, it is fundamental to review the related research which focused on outdoor and semi-outdoor thermal comfort to understand how this research was carried out and to become acquainted with the earlier research findings related to the field. This will act as a basis to enhance the methodological approach of previous POE of restorative gardens in healthcare facilities which lack assessment of semi-outdoor comfort (See Table 2.12, in Section 2.4.3.4).

2.3.4.1 Definition of thermal comfort and the layers of thermal environment

Based on the American Society for Heating, Refrigerating and Air-conditioning Engineers (ASHRAE), thermal comfort is defined as a state of mind that expressed satisfaction with the surrounding environment which can be varied across different individuals due to the different physiological and psychological factors of each person (ASHRAE Standard 55, 2017). According to environmental engineering perspectives on the different levels of environmental control applied (See Figure 2.7), the thermal environment can be classified into three layers, which is indoor environment, semi-outdoor environment and outdoor environment (Fong et al., 2019; Nakano, 2003, p.12) (See Figure 2.15).

The outdoor environment is the outermost layer, which is beyond control and does not depend on any mechanical equipment to adjust the outdoor conditions. However, people would need to adjust themselves (e.g. move to a shaded area, drink cold water, or wear different layers of clothing) to adapt to the outdoor conditions to achieve comfort (Fong et al., 2019; Nakano, 2003).

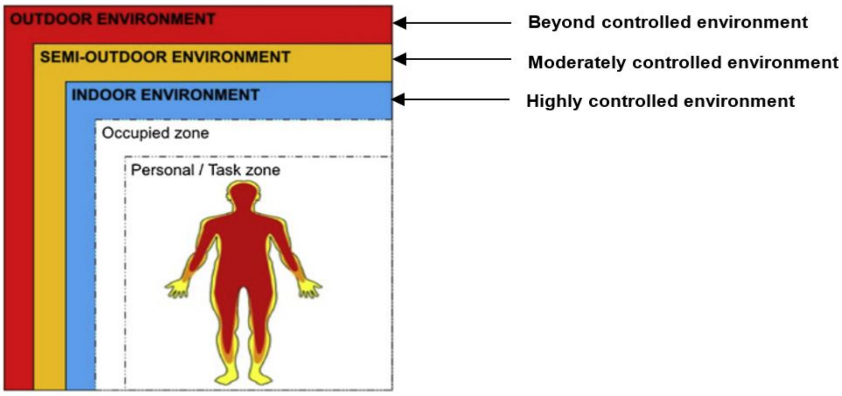


Figure 2.15: Layers of thermal environments
(Source: Modified from Fong et al., 2019 and Nakano, 2003)

The middle layer is the semi-outdoor environment which is located between the indoor and outdoor layers or intermediate spaces, for example, lobbies, terraces, atriums, arcades and courtyard (Yang et al., 2013; Potvin, 2004; Nakano, 2003). The environmental conditions of the semi-outdoor environment can be moderately controlled or modified using varying techniques. For instance, the use of simple shading and/or wind shielding in a terrace or a mechanical heating and/or cooling system in a closed atrium space (Nakano, 2003). The third layer is the indoor environment which is often located in an enclosed building and less affected by the wind and solar radiation. Indoor environmental conditions can be personally controlled by adjusting the cooling or heating system to provide the desired thermal comfort for the occupants within their occupied or personal zone.

2.3.4.2 Environmental and personal factors

Personal factors (physical and physiological) have been found to have a significant influence on thermal perception in the outdoor environment (Lindner-Cendrowska and Błażejczyk, 2018). Havenith et al. (2002) revealed that clothing properties and metabolic heat production are important parameters to define thermal comfort conditions. These two personal factors, namely clothing insulation (CLO) and activity level (MET) can be estimated based on ASHRAE Standard 55 (Azizpour et al., 2013). Additionally, other individual factors such as gender, age, health effects and adaptability to the surrounding environments also influence perceptions of thermal comfort in a hospital environment (Sattayakorn et al., 2017; Ferraro et al., 2015; Yau and Chew, 2009; Hwang et al., 2007). The current research focused more on environmental factors (e.g. air temperature, relative humidity, wind velocity and thermal radiation) in order to examine their influence on the users' perceptions of outdoor thermal comfort (Nikolopoulou and Lykoudis, 2006; Sharmin et al., 2018). If time was not a constraint in the current study, an in-depth analysis that considered both the environmental and personal factors is highly recommended as these factors are fundamental to determining people's sensations of thermal comfort.

2.3.4.3 The different categories of spaces in outdoor and semi-outdoor environment

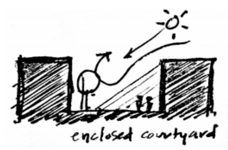
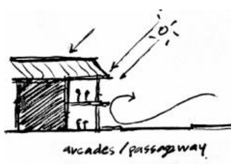
Thermal comfort in the outdoor and semi-outdoor environment is more complex than for the indoor environment because it involves different conditions and issues that might not be encountered in research on indoor comfort (Givoni et al., 2003; Spagnolo and de Dear, 2003). People who stayed outdoors or semi-outdoors, The thermal comfort perceptions of people staying outdoors or semi-outdoors can be influenced by variability in the environmental factors: variation of sun and shade or the variation of the wind speed movement (c; Givoni et al., 2003; Spagnolo and de Dear, 2003).

To the best of this researcher's knowledge, no research on the assessment of thermal comfort using both the field measurement and subjective assessment has been conducted in a semi-outdoor environment such as a courtyard garden in a hospital in a hot humid climate. The attention of earlier research on the subjective assessment of thermal comfort in a semi-outdoor environment in a hot humid climate and other regions focused more on areas such as the atrium (Hien et al., 2017; Nakano and Tanabe, 2004), semi-open reading and dining areas (Oual and Hassan, 2018), terraces and semi-open auditoriums in a high-rise building (Cao et al., 2018), arcades (Potvin, 2004)) and courtyards found in educational campuses (Bakar and Gadi, 2016; Makaremi et al., 2012). Additionally, past research carried out thermal comfort assessment in various semi-outdoor spaces such as railway stations, bus stations, ferry terminals and parks (Spagnolo and de Dear, 2003) and a cultural centre, national museum, art centre and university campus (Hwang and Lin, 2011).

Nakano (2003) defined the semi-outdoor environment as an architectural environment designed with the aim of integrating natural elements as part of the environmental control for the improvement of thermal comfort. The current study defines a semi-outdoor environment as a space in between the building or surrounded by a building or intermediate space which has some degree of enclosure and exposure to environmental factors such as wind flow and solar radiation (Wong et al., 2013; Nikolopoulou, 2011; Spagnolo and de Dear, 2003).

Table 2.2 sets out the different categories of spaces and examples of the space for both outdoor and semi-outdoor environments. Types of semi-outdoor environments such as the semi-open library, semi-open auditorium, arcades, terraces, or atriums will have less exposure to the wind or sun because the top floor is covered by a concrete slab or roof skylight (i.e. atrium) compared to the enclosed courtyard garden which is opened up to the sky and thus receives more direct solar radiation, particularly in the afternoon.

Table 2.2: The different categories of spaces in the outdoor and semi-outdoor environment *(Source: Author, 2019)*

Categories	Define	Example of the spaces	Sample sketch	Related researches
Outdoor environment	It has the highest degree of exposure to the sun and wind flow.	**Open urban space** Plaza Park Square Beach		(Ghaffarianhosseini et al., 2019; Yang et al., 2013; Nikolopoulou and Lykoudis, 2007; Mayer and Höppe, 1987)
	It has a slightly high degree of exposure to the sun and wind flow.	**A space between the building** A street canyon in between the buildings		(Sharmin et al., 2018; Hoppe and Seidl, 1991)
Semi-outdoor environment	It has no roof. It has a slightly high degree of exposure to the sun and wind flow compared to the arcades, balcony or atrium.	**An open space surrounding by a building and open to the sky:** Enclosed or semi enclosed courtyard		(Kubota et al., 2018; Bakar and Gadi, 2016; Almhafdy et al., 2013; Makaremi *et al.*, 2012)
	The open space in a building which is covered by a roof skylight to provide the feeling of space and light.	**An open space surrounding by a building and covered by a skylight:** Atrium		(Hien *et al.*, 2017; Nakano and Tanabe, 2004)
	It is covered by floor plate or roof. The outer wall is open, and the upper floor is supported by columns and arches. A space located close to the building wall and have some degree of openness.	**Intermediate or transitional or in between spaces:** Arcades Passageway Terrace Loggia Lobbies Verandah Corridor Balcony		(Cao *et al.*, 2018; Oual and Hassan, 2018; Hwang and Lin, 2011; Spagnolo and de Dear, 2003; Potvin, 2004).

2.3.4.4 Outdoor and semi-outdoor thermal comfort in hot humid climates and other climatic regions

Most of the earlier research carried out an assessment on thermal comfort in the outdoor environment (e.g. open park, urban open area, square, beach or street canyon) (Sharmin et al., 2019; Johansson et al., 2018; Sharmin et al, 2015; Yang et al., 2013; Krüger and

Rossi, 2011; Thorsson et al., 2007; Nikolopoulou and Lykoudis, 2006; 2007; Höppe and Seidl, 1991; Mayer and Höppe, 1987. The pioneering work on outdoor thermal comfort was conducted by Mayer and Höppe (1987) who assessed the subjective responses of thermal comfort among people in three different urban outdoor spaces within the city of Munich, German. Höppe and Seidl (1991) also carried out prominent research on outdoor thermal comfort in Italy, revealing that sunshine and weather are among the influential factors significantly impacting visitors' preferences to choose the beach as their preferred destination. Another prominent research in the UK suggested the importance of the design of outdoor space because it can influence users' thermal comfort and thus impact on the use of the space (Nikolopoulou, Baker and Steemers, 2001). This study found that the usage of outdoor spaces in different sites increased with increasing temperature. The details of the findings of these studies are presented in Table 1, Appendix 16.

Today there is a growing body of recent research conducted in the outdoor environment in various regions (Johansson et al., 2018; Krüger and Rossi, 2011; Thorsson et al., 2007; Nikolopoulou and Lykoudis, 2006; 2007; Höppe and Seidl, 1991; Mayer and Höppe, 1987) and hot humid climates (Heng and Chow, 2019; Sharmin et al., 2019; Ali and Patnaik, 2018; Koerniawan and Gao, 2015; Yang et al., 2013; Ng and Cheng, 2012; Ahmed, 2003) (See Table 2, in Appendix 16). This far outweighs the research carried out on the semi-outdoor environment. Following on from the research on thermal comfort in the semi-outdoor environment, previous pioneering researchers in several countries started to focus on the semi-public environments (e.g. Japan (Nakano and Tanabe, 2004); UK (Potvin, 2004); and Australia (Spagnolo and de Dear, 2003). This research, with a focus on thermal comfort in semi-outdoor environments, has received increasing attention in the last decade in hot humid climate countries (Cao et al., 2018; Oual and Hassan, 2018; Hwang and Lin, 2011) (See Table 2.3). However, these studies are more focused on a different category of semi-outdoor environment such as atriums (Nakano and Tanabe, 2004); arcades (Potvin, 2004); terraces or semi-open indoor spaces (e.g. auditorium, library) in different building typologies (Cao et al., 2018; Oual and Hassan, 2018; Hwang and Lin, 2011; Spagnolo and de Dear, 2003).

Table 2.3: A summary of the critical reviews on previous research in thermal comfort in semi-outdoor environments in a hot humid climate and other region

RESEARCH ON THERMAL COMFORT IN SEMI-OUTDOOR ENVIRONMENTS IN VARIOUS REGION			
AUTHOR (YEAR)	**CASE STUDIES**	**METHODS AND NO OF CASE STUDIES**	**FINDINGS AND CRITICS**
Cao et al. (2018)	**China**	**Methods:** • Field measurement 9am to 6pm (case 1) 8.45-10am (case 2)	This study assessment thermal comfort of a semi-outdoor environment during a hot summer and warm winter zone.

	Case 1 - Open terrace in a high-rise office building **Case 2** - Semi-open auditorium	• Subjective survey (ASHRAE 7-point scale) **Microclimatic parameters:** Air temperature Relative humidity Wind speed **Instrument:** PMV and PPD indices meter Self-recording thermometer and hygrometer Placed at **<u>0.6 meter</u>** from ground **Sample:** N=75 (Case 1) N=149 (Case 2)	**Findings:** • The study found that more than 70% of the respondent felt thermally comfortable in the three-sitting area in the semi-open auditorium. • The study found that 65% respondents perceived the open terrace as comfortable although the temperature close to 30ºC. • This study suggested that the presence of the wind flow in the terrace contributed to the increase of thermal comfort among the respondents in the open terrace **Critics:** There is possible bias in the data sampling in the open terrace where two third of the respondents are male. The height of the instrument was very low, which could be affected by the temperature surface. The suggested height for the environmental meter from the ground level is between (1.1m to 1.5 m) at the centre of gravity for an adult (Mayer and Hoppe, 1987)
Oual and Hassan (2018)	**Malaysia** 3 case study sites Educational building **Case 1** - Indoor reading room (air conditioned) **Case 2** - Semi-open library (natural ventilation) **Case 2** - Semi-open dining hall (mechanical ventilation)	**Methods:** • Field measurement (8am to 11pm) • Subjective assessment (Survey). **Microclimatic parameters:** Air temperature Relative humidity Wind speed **Instrument:** Micro-meteorological instruments placed on a tripod at **<u>1.0-meter</u>** height from the ground level. **Sample:** N=226	**Findings:** **Thermal comfort perception**: The results showed that the Semi-open library with a natural ventilation perceived a higher comfort range followed by the air-conditioned indoor reading room and semi-open dining hall. **Preferred temperature:** This study also found that the international student preferred cooler air temperature compared to the local student. The observation also revealed that a higher number of foreigner students' study in the air-conditioned reading area, whereas more local student studied outdoor. **Preferred cooling methods:** The majority of the respondents preferred a natural ventilation with a mechanical fan (62.4%), followed by air conditioner and natural ventilation. **Thermal adaptability**: The results also showed a higher number of student consumed more cool drinks in a semi-outdoor reading area. Whereas, the majority of students in the airconditioned library preferred to wear extra layers of clothing to adapt with the temperature and improve their thermal comfort.
Hwang and Lin (2011)	**Taiwan** Five semi-outdoor public places 'Exterior space that is sheltered and naturally ventilated' • Railway station • Cultural centre • National museum • Art centre • University campus	**Methods:** • Field measurement • Subjective assessment (survey) - ASHRAE 7-point scale and McIntyre 3-point scale. **Instruments:** Micro-meteorological instruments placed on a tripod at **<u>1.1m height</u>** above the ground level. **Microclimatic parameters:** Globe temperature Air temperature Relative humidity Wind speed Global radiation **Microclimatic parameters:** Air temperature Air relative humidity	**Findings:** **Tolerance to thermal comfort:** The results showed that people in both semi-outdoor and outdoor environment are highly tolerant regarding thermal comfort compared to those who are in indoor environment. **Preferred temperature:** This study revealed that the preferred thermal temperature for semi-outdoor area in Taiwan was at 24.6ºC and for outdoor was at 26.9 ºC which both lower than neutral temperature at 1.2 ºC and 0.3 ºC respectively. **Wind sensation votes (WSV) and sun sensation votes (SSV):** Based on linear regression analyses, respondents reported a significant association between WSV and SSV in which people reported that they felt warm when they felt the sun is too strong and the wind movement is too weak. **Preferred change:** People who experienced the discomfort (i.e. voted the extreme values outside the three central categories in the TSV) would prefer change to both the wind flow and the sun sensation.

		Solar radiation **Sample:** N=877 Semi-outdoor (N=3470) Outdoor (N=3027) Indoor (N=1580)	**Sun radiation vs wind movement**: This study also concluded that the sun radiation was found to be the higher influential in people thermal sensation compared to the wind movement.
Nakano and Tanabe (2004)	**Japan** Four case studies four atria / terraces with different levels of environmental control • **Atria with HVAC** Case P (Closed atrium) Case B (Closed atrium) • **Atria with no HVAC** Case O (Arcade and sunken garden) Case T (Wooden deck)	**Methods:** • Field measurement • Seasonal field survey • Observation (Occupancy and clothing adjustment) **Microclimatic parameters:** • Air temperature • Wind speed • Wind direction • Relative humidity • Solar radiation • Surface temperature **Sample:** N=2248	**Findings:** **Thermal sensation:** People in a semi-outdoor can tolerate with a wider temperature range (two to three times higher) compared to the predicted temperature using the PMV-PPD model by Fanger. **Duration of occupancy:** The average time of occupancy of people who stayed in the atria with HVAC I longer (19 minutes) compared to the atria without HVAC (11 minutes). **Clothing adjustment**: People was found to dress differently to adapted with the different climate, in which a greater clothing insulation were observed for both the autumn and winter season compared to the spring and summer. **Critics:** There is a possible bias among the sample selection in which they were selected among those who voluntary to participate in the survey. Those who choose to not want to stay were not accounted in the survey and it does not apply to all visitors in the atria.
Spagnolo and de Dear, (2003)	**Australia** Semi-outdoor and outdoor environment Four case study sites: • Railway station • Bus station • Ferry terminal • Parks The sites have different surfaces (e.g. pavers, grass and asphalt)	**Methods:** • Field measurement • Subjective assessment (survey) - Adapted from ASHRAE 7-point scale **Microclimatic parameters:** • Air temperature • Relative humidity • Wind velocity • Solar radiation **Instruments:** Micro-meteorological sensors mounted on an aluminum camera tripod. **Surveyed Sample:** N=1018 **Analysed sample**: Summer (N=585) Winter (N=433)	**Findings:** The study focused on comparing the outdoor and indoor results. **Thermal neutrality:** The study found that the thermal neutrality of the outdoor thermal comfort in the subtropical setting (Australia), based on the index OUT_SET (26.2ºC) is higher than the indoor SET counterpart (24 ºC). **Preferences of sun/shade:** The study found in the winter; the largest proportion of the respondents preferred more sun. Whereas in summers, a higher number of the sample voted 'no change'. **Critics:** There is a possible bias in the sample selection, because both the sample in the outdoor and semi-outdoor were combined in the analysis. These two different environments have a differ microclimatic conditions, which might has influenced on the results of people thermal sensation.
(Potvin, 2004)	**Cardiff, UK** Arcades in Cardiff city centre. **Three case studies:** Case 1: Royal arcade	**Methods:** • Field measurement (in the afternoon) • Subjective assessment (Summer and Winter survey) **Microclimatic parameters:**	The study focused on the thermal transient when people move from the space between the indoor and outdoor (Arcades space - an intermediate spaces) by measuring the temperature difference of an outdoor and in the arcades space when people move between these two spaces. **Findings:** When people moved from the open street into the arcade, it was recorded a drop in the air temperature (0.9ºC in

	Case 2: Morgan arcade Case 3: Castle arcade	• Air temperature • Relative humidity • Wind velocity • Solar radiation **Instrument:** Portable sensors array attached to the respondents' bodies **Sample:** Not reported	Summer, 1.6 ºC in autumn, and 2.5ºC in winter) with a graduation decrease of two-thirds from the wind speed in the open street. **Critics:** The environmental monitoring was recorded using the portable sensors attached to respondents when people they from the indoor and outdoor. It is not based on a static monitoring system using the meteorological instruments or weather station fixed on a tripod in an outdoor or semi-outdoor environment. Thus, the accuracy of the wind speed reading can be argued as it was recorded when people move, which possibly had increased the reading of the actual on-site wind flow.

2.3.4.5 Thermal comfort research in courtyards in other building typologies in Malaysia

As mentioned earlier, numerous research on semi-outdoor comfort either in another region or a hot humid climate did not specifically focus on a courtyard building typology. Earlier research that focused on courtyard building typology in Malaysia were mostly carried out on educational campus. Very few were conducted in the hospital setting either in hot humid climates or in temperate regions. A possible reason for a lack of studies in the context of healthcare could be because of the complexity of the procedures and protocol of ethical approval acting to refrain the researcher to carry out studies in such environment. The thermal comfort studies in hospital buildings that do exist are mostly focused on the indoor wards (Khalid et al., 2019), medical and administration working spaces medical (Yau and Chew, 2014), and various indoor spaces in the hospitals (Azizpour, Moghimi, Salleh, *et al.*, 2013). Only one study was conducted in a semi-outdoor space (i.e. enclosed and semi-enclosed courtyard) in a hospital (Almhafdy et al., 2013). However, this research is highly based on the parametric model and does not carry out any subjective assessment with the HCG users (See Section 2.3.3.2 and Table 2.4).

Previous research found that the courtyard garden in a hospital was used as an alternative place for family members to sit and relax, for patients and families to socialise and meet in a comfortable atmosphere away from the congested waiting area in the indoor hospital (Idris et al., 2018). Further, it was found that the HCG was also utilised by the staff to sit and rest during the lunch hours under the pergola shaded area in the HCG (Idris et al., 2018). Hence, ensuring a better thermal comfort in the outdoor areas or better microclimatic conditions in the courtyard garden in a hospital are crucial as not only affects HCG users but also influenced the indoor spaces or rooms adjacent to the HCG, which will in turn, affect the energy consumption of the hospital. This clearly show the importance of a thermal comfort study in a semi-outdoor space such as the HCG in the context of Malaysia. To the researcher's knowledge, this current study is the first attempt conducted in a semi-outdoor and semi-public area in the context of a Malaysian hospital. A critical review of the research of thermal comfort in a semi-outdoor environment in a courtyard building typology in Malaysia is presented in Table 2.4.

Table 2.4: Summary of a review of thermal comfort research in a semi-outdoor environment in a courtyard building typology in Malaysia

AUTHOR (YEAR)	CASE STUDIES	METHODS AND NO OF CASE STUDIES	FINDINGS AND CRITICS
SEMI-OUTDOOR ENVIRONMENT (COURTYARD GARDEN)			
Kubota et al. (2017)	**Commercial** 16 Shophouses in Malacca heritage sites A total of 25 courtyards **Clustered into 5 types of** enclosed courtyard. **Type 1:** Open and staggered **Type 2:** Small and staggered **Type 3:** Shallow and large **Type 4:** Deep and large **Type 5:** Deep and close	**Methods:** Field measurement (10am to 5pm) **Instruments:** T&D TR-73U data logger Davis Vantage Pro Weather station The instrument was placed 1.5 meters above the floor level **Microclimatic parameter:** Air temperature Air relative humidity Wind direction and wind speed Solar radiation Sky views factors – Used fish-eye lens photos **Sample:** NA	**Findings:** • This study recommended that a closed, cross-ventilated courtyard can enhance the indoor thermal comfort in the adjacent spaces around the courtyard in a hot humid climate. • This study revealed that a V-shaped roof highly influenced the increasing flow of cool air into the adjacent spaces around the courtyard during the night-time. • The presence of the plants and water bodies in the courtyard contributed to a lower air temperature in the courtyard and to the surrounding spaces during the day and night-time. • Courtyard should be elongated towards the prevailing wind directions, particularly for a deep and narrow courtyard to improve cross ventilation into the building. • This study also found that the courtyard configuration (the space volume, openness and height) have a significant relationship with the air temperature. **Critics:** • **<u>No subjective assessment</u>** with the occupants were carried out or reported in this study.
Bakar and Gadi (2016)	**Educational Campus** (IIUM) **A total of four case study sites:** 3 courtyard gardens: **C1** (5,484 sqm) Fully paved **C2** (2,500 sqm) Partially paved **C3** (520 sqm) Turfed surface 1 open recreational area at the residential area (18,211 sqm)	**Methods:** • Field measurement (9am to 6pm) • Subjective assessment (survey) with those who sit in shaded and under direct sunlight areas. • Shadow simulation (Sketchup) **Microclimatic parameters:** • Air temperature • Radiant temperature • Air relative humidity • Wind velocity • Solar radiation **Instruments:** • Whirling psychrometer (measure dry and wet bulb temperature) • Globe thermometer (Globe temperature) • Digital anemometer (Wind speed)	**Findings:** • **Field measurement results:** This study found that the higher the reading of the aspect ratio, the more the courtyard surface is exposed to the sun radiation. • The study revealed that the open area recorded a higher air temperature than for the semi-shaded and covered areas. This implies the importance of reducing solar radiation onto the courtyard surface to reduce the air temperature. • This study found that the courtyard with the turfed surface (C3) recorded the lowest surface temperature (the floor levels adjacent to the courtyard), compared to the fully paved and partially paved courtyards. • The study found that the use of black tarmac surrounding the periphery of the courtyard (C2) contributed to the high level of temperature surface of the adjacent floor around this courtyard. • **Subjective assessment results:** The results of the TSV showed that 70% of the respondent voted it as comfortable-neutral. Thermal sensation was not report in detail in the paper.

		• Cole-parmer infrared thermometer (measure surface temperature) • Illuminance meter (measure lighting level) **Courtyard parameter:** Aspect ratio (W/H) The surface materials Orientation **Sample:** N=123	**Critics:** • **Thermal comfort assessment:** This study only utilised the 7-point scale based on Banfort (Fong et al., 2019) and did not integrated the 3-point Mc-Intyre scale which is fundamental to assess the preferred thermal sensation to validate the findings and enhance the accuracy of perception of the thermal comfort. This is because people who felt neutral did not necessarily want any changes or they may prefer cooler or warmer temperature (Shahzad et al., 2018). • **Sample selection:** There is the possibility of bias in the sample selection because it is not based on the sample that really spent time in the courtyard. The sample could be selected from passers-by or students who were recruited to be the participants for the study. There was also a bias in the data reporting. •
Almhafdy et al. (2014)	**Hospital building** Out of 7 courtyards, 2 courtyards were selected for a simulation study **U-form** – semi enclosed courtyard (Area: 893 sqm) Square form **O-form** – enclosed courtyard (Area: 381 sqm) Rectangular form	**Methods:** • Field measurement (10.00am to 6.00pm) • Parametric simulation **Instrument:** Three sets of weather station PortLog were placed at the centre of the courtyard (The instrument was placed 1.1m above the ground level – Based on the average height of the centre of gravity of an adult) **Microclimatic parameters:** • Air temperature • Radiant temperature • Air relative humidity • Wind speed and wind direction • Solar intensity **Courtyard parameter:** • Form • Size • Orientation **Sample:** NA	This study investigated the thermal and visual performance of the two courtyards of different shape (U-shape and O-shape) based on three parameters (form, height and orientation). **Findings:** • The O-form (fully enclosed and no air flow) recorded a higher **air temperature** compared to the U-form (semi-enclosed and allowing air flow). • The U-shape HCG recorded a higher **wind speed** compared to the O-shape due to the orientation of the opening of the U-shape facing the prevailing wind. • This study reported a higher **solar intensity** recorded in the U-shape HCG (larger in size and not fully enclosed) compared to the O-shape (smaller in size and enclosed all around). • The study suggested that the O-form performed better than the U-shape form in reducing the **amount of glare** in the HCG (i.e. Based on the researchers' observations) **Critics:** **The methods:** No daily in-depth daily observations were carried out to investigate how people utilised the space. No report on the validation of the simulation study. **The assessment of thermal comfort:** No thermal assessment was carried out with the actual HCG users. The findings on thermal comfort and performance of the microclimatic conditions in the courtyards were solely based on the simulation software.
Makaremi et al. (2012)	**Educational campus** (UPM) 2 case study sites: **Case A:** an enclosed courtyard surrounded by a 3-storied building. **Case B:** At the open outdoor spaces surrounded by a	**Methods:** • Field measurement • Subjective assessment **Sample:** Local and international students **Thermal comfort scale:** 9-point thermal comfort sensation scale based on (Lin and Matzarakis, 2008)	This study assessed the actual thermal conditions and peoples' perceptions of thermal comfort in a shaded outdoor space. **Findings:** • This study revealed a significant difference between the thermal perceptions of international students and local students which suggested that people from different cultures and regions have a different perception of outdoor thermal comfort. • This study found that the acceptable outdoor thermal comfort (less than 34°C) were only recorded in the early morning (9-10am) and late afternoon (4-5pm). • This study recommended that the use of vegetation and trees can improve the outdoor thermal comfort. The trees provided shade and filtered the solar radiation

	one-storey building.	Thermal perception Very cold Cold Cool Slightly cool Neutral Slightly warm Warm Hot Very hot	and contributed to a reduction of the air temperature in outdoor spaces. • This study also found that those who stayed longer to sit and relax in the outdoor areas perceived the outdoor as comfortable compared to the passer by.

2.3.5 The criteria used to assess the microclimatic conditions of courtyards in buildings

It is crucial that the design criteria be considered when designing a courtyard space in a building as it not only impacts on the environmental performance of the courtyard space itself but also the adjacent spaces around the courtyard (Hyde, 2013; Rajapaksha et al., 2003; Yang et al., 2012) The focus of this study will be on the assessment of the outdoor space of the hospital, specifically the courtyard garden and how the users perceived the intended environmental and restorative roles of the courtyard design.

Accordingly, several design criteria used to assess courtyard design for improving microclimatic condition within the courtyard space has been adapted and developed from Almhafdy et al. (2013a) and other researchers (Kubota et al., 2017; Ghaffarianhoseini et al., 2015; Berkovic et al., 2012; Sadafi et al., 2012; Makaremi et al., 2012; Muhaisen, 2006; Safarzadeh and Bahadori, 2005) which include: (1) Form; (2) Aspect ratio; (3) Orientation (4) Opening; (5) Building Envelope; (6) Shading Devices; (7) Vegetation; and (8) Water bodies. These will be discussed below:

2.3.5.1 Form

Several studies have highlighted that the outdoor temperature and the amount of solar radiation received are influenced by the geometric form of the courtyard focusing on both semi-enclosed or enclosed courtyard of a hot humid climate (Almhafdy et al., 2014; Ghaffarianhoseini et al., 2015). Almhafdy et al. (2014) revealed that a semi-enclosed courtyard which is oriented along the east-west axis and opened towards the south provided a better microclimatic conditions compared to an enclosed courtyard of a similar orientation of a hospital building in Malaysia. Moreover, a recent study (Ghaffarianhoseini et al., 2015) found that a semi enclosed courtyard where the opening of the courtyard faced the northeast direction creates a slightly lower temperature within the courtyard compared to the enclosed central courtyard as the northeast wind is channelled through the opening of a semi-enclosed courtyard. This study also pointed out the importance of avoiding excessive solar exposure and the increased cooling effect from the natural breezes to achieve a thermally comfortable courtyard condition.

2.3.5.2 Aspect ratio

The aspect ratio refers to the height, the length and the width of the courtyard. Several authors have evaluated that the height and dimension of the courtyard space also affects the microclimatic conditions of the courtyard in a hot humid climate (Ghaffarianhoseini et al., 2019; 2015; Alhamfdy et al., 2014; Muhaisen, 2006). Muhaisen (2006) found that a three-storey height enclosed courtyard performed efficiently in a hot humid climate (from a case study in Malaysia). It has been concluded that the optimum angle of the enclosed courtyard in a hot humid climate is at 30º and any additional increment over this value resulted in a reduction of the sunlit area within the courtyard.

In addition, a study in a hospital building of a hot humid climate revealed that the increased height of the courtyard wall significantly increased the amount of shading in both semi-enclosed (U-shaped) and enclosed courtyards (O-shaped) (Almhafdy et al., 2014). A related experimental study (Almhafdy et al., 2015) revealed that a semi-enclosed courtyard with a ratio (width: length) of 1:2 (i.e. rectangular shape) indicated a lower temperature and better ventilation than that of a courtyard with a ratio of 1:1 (i.e. the square shape), which resulted in better Predictive Mean Value (PMV) results with a gradient from 0.8 to 1.4 (See Figure 2.16 and Figure 2.17).

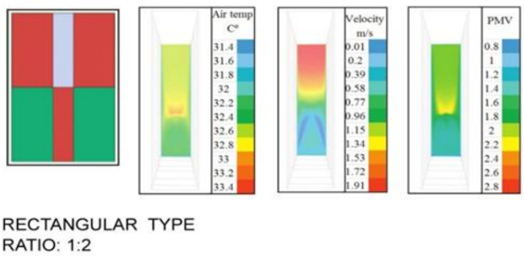


Figure 2.16: Result of the CFD simulation in U-shape courtyard of a ration 1:2 (rectangular shape). *Source: Almhafdy et al. (2015).*

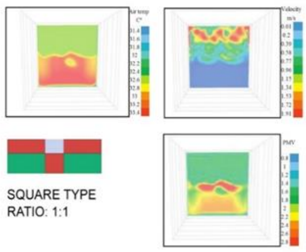


Figure 2.17: Result of the CFD simulation in U-shape courtyard of a ration 1:2 (rectangular shape). *Source: Almhafdy et al. (2015).*

Additionally, further research conducted in Malaysia found that a semi-enclosed courtyard with a ratio (height: width) of 6:1 (6-storey) created a better thermal performance followed by a courtyard with ratios of 2:1 (3-storey) and 1:1 (1-storey) (Ghaffarianhoseini et al., 2015). This study also revealed that an increase in the height of the wall of a semi-enclosed courtyard resulted in a reduction in wind speed within the courtyard area.

2.3.5.3 Orientation

Several studies in a hot humid climate highlighted that courtyard orientation was another crucial aspect of design criteria for the cooling effect in the courtyard and better microclimatic performance (Almhafdy et al., 2014; Ghaffarianhoseini et al., 2015). In a hot humid climate, Almhafdy et al. (2014) found that the orientation of the semi-enclosed courtyard that is elongated in east-west axis and opened to the south allowed the wind flow to penetrate the courtyard and improve its outdoor thermal condition. A further study by Ghaffarianhoseini et al. (2015) revealed that a semi-enclosed courtyard with the opening facing North produced a slightly lower temperature and a higher level of relative humidity within the courtyard space due to the northeast wind that was channelled into the courtyard through the opening side and due to maximum shading generated within the courtyard. Aside from the importance of the orientation of the courtyard to improve ventilation within the courtyard space, it was determined that the orientation of the courtyard and the building also influenced the penetration of natural daylighting into the interior space. In contrast, Aripin (2007) and Ahmad et al. (2007) cited in Nawawi et al. (2013) suggested that the courtyard and the building should be elongated to the north-south axis to achieve better daylighting and visual comfort in the ward areas of hospitals in Malaysia.

2.3.5.4 Opening

In an enclosed courtyard, the opening refers to the upper side of the courtyard that is exposed to the sky. In a semi-enclosed courtyard, the opening is at one side of the courtyard; the other side of the courtyard is enclosed by the wall and is also open to the sky (Almhafdy et al., 2013a). The opening also refers to the degree of open area (e.g. door or window) on the courtyard wall that is opened to the outside environment that can be found in both enclosed and semi-enclosed courtyards. A semi-enclosed courtyard is found to provide a better thermal condition compared to an enclosed courtyard in Malaysian hospital building (Almhafdy et al., 2014). In a study of an enclosed courtyard in a two-storey terrace housing in a similar country, Sadafi et al., (2011) suggested that an efficient opening to the outside environment within a courtyard area served to promote natural ventilation and enhance the thermal comfort within the adjacent spaces. Moreover, a recent study conducted in a shophouse in Malaysia revealed that the opening within the courtyard area enhanced the air flow and avoided excessive humidity (Kubota et al., 2017).

2.3.5.5 Building envelope

The building envelope of a courtyard refers to the type of wall material and type of glazing as well as the insulation within the boundary of the courtyard space. Sadafi, et al. (2011) studied the effect of materials on the indoor thermal performance of a terraced house in Malaysia. The results showed that the concrete wall contributed to a lower temperature than a brick wall at the living area from 8 am to 2 pm in March. In contrast, the temperature of a living area with a concrete wall recorded a slightly lower temperature from 11 pm until

5 pm compared to a brick wall. Apart from that, a further study on a mid-rise house with an internal courtyard in Dubai revealed that the wall material including the type of glazing, the thickness of the wall and glazing as well as the type of the insulation influenced the amount of energy consumption (Al-Masri and Abu-Hijleh, 2012).

2.3.5.6 Shading devices

Apart from increasing the height of the courtyard wall to generate more shading within the courtyard, several studies suggested other means of shading that could also be utilised within the courtyard building such as **roof shading, cantilevered roof and galleries.** Sadafi et al. (2011) suggested that the use of a shading roof for the courtyard area in a hot humid climate could decrease the amount of solar radiation that penetrate the courtyard area and the adjacent spaces especially during the afternoon hours; further, this contributes considerably to the improvement of the indoor thermal condition.

In another simulation study under a similar climatic context, Almhafdy et al. (2015) revealed that a courtyard with a cantilevered roof provided a better microclimatic performance compared to a courtyard without a cantilevered roof (See Figure 2.18 and Figure 2.19). Additionally, Berkovic et al. (2012) revealed that the use of galleries within the enclosed courtyard provided shading and significantly decreased the temperature within the courtyard space. As such, it considerably improved the outdoor thermal comfort in the space.

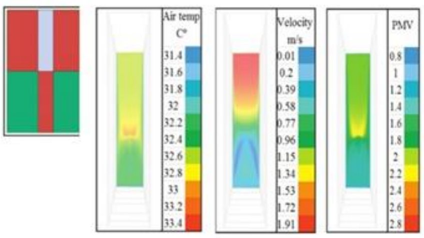


Figure 2.18: Result on the CFD simulation on the U-shape courtyard with cantilevered roof. *Source: Almhafdy et al. (2015).*

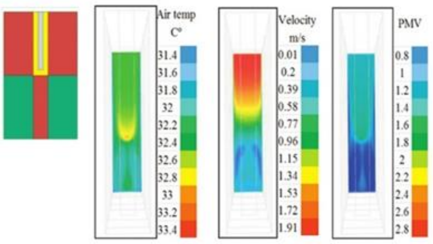


Figure 2.19: Result on the CFD simulation on the U-shape courtyard without cantilevered roof. *Source: Almhafdy et al. (2015).*

2.3.5.7 Vegetation

Several studies found that the inclusion of trees in a courtyard space provided a better outdoor thermal condition compared to a courtyard without any trees (Ghaffarianhoseini et.al., 2019; 2015; Makaremi et al., 2012; Berkovic et al., 2012). A study conducted in an educational building in a hot humid climate revealed that the trees and plants in a courtyard reduced the amount of direct solar radiation received and improved the outdoor thermal condition (Makaremi et al., 2012). In addition, further research that used a simulation study in a similar climate revealed that the use of grass to cover the ground in the courtyard decreased the air temperature and produced only a little improvement in thermal comfort as grass does not provide shade. This study showed that covering the courtyard with 75% trees decreased the air temperature in the courtyard and increased the humidity compared to a courtyard without any vegetation. However, this study highlighted that the use of trees in a hot humid climate can increase the air temperature at certain times because the trees acted to block the wind flow into the courtyard space, thus considerably reducing the cooling effect during the night (Ghaffarianhoseini et al., 2015).

Moreover, another simulation study of an enclosed courtyard in a hot dry climate showed that the inclusion of trees next to the north and south wall and at the centre of the enclosed courtyard significantly reduced the outdoor temperature as the trees provided shading within the courtyard space (Berkovic et al., 2012) (See Figure 2.20).

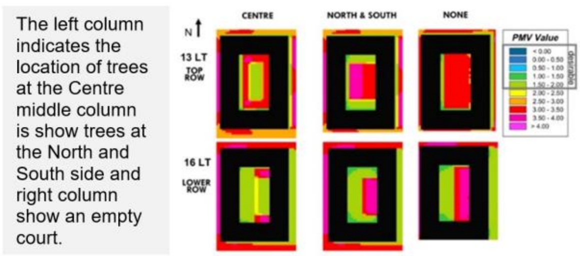


Figure 2.20: Result on courtyard with ratio (1:2) AT 13LT (Top row) and at 16 LT (Lower row). *Source: Berkovic et al. (2012).*

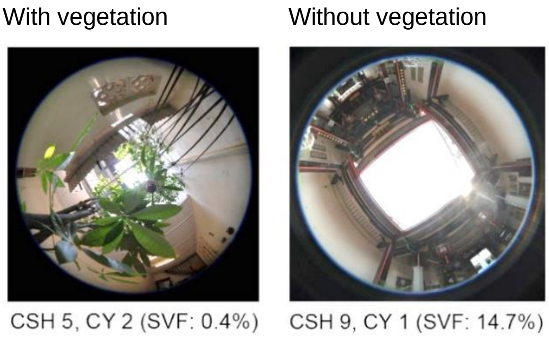


Figure 2.21: Measurement of sky view factors in courtyards of shophouses *Source: Kubota et al. (2017).*

Sky view factors is an effective visualisation technique and spatial analysis to show the percentage of coverage of the sky area or surface geometry of a courtyard space (Kubota et al., 2017) and various urban geometry (Charalampopoulos et al., 2013). Kubota et al. (2017) found a strong relationship between the SVF and the air temperature in the HCG in which the air temperature in the courtyard is found to be higher than the outdoors when the SVF exceed 14% (See Figure 2.13). Fish-eyes pictures can be captured using a wide-angle lens camera, and the SVF can be calculated using a range of software; Rayman, Sky Helios, Arc View, Steyn and BMSky (Hämmerle et al., 2011).

2.3.5.8 Water bodies

It has been suggested that water bodies such as a pool in the middle of the courtyard created a pleasant space for the residents to spend their time in the courtyard garden in summer (Safarzadeh and Bahadori, 2005).This study also highlighted that the use of pools and water features within the courtyard with other landscape elements such as trees, flowers, shrubs created a micro-environment which reduced air temperature and promoted a slightly higher humidity within the courtyard space. In addition, a study in urban courtyard blocks in Netherlands in a temperate climate revealed that the implementation of water pools provided a better microclimate because it provided a cooling effect from the evaporation process, thus reducing the air temperature within the courtyard area (Taleghani et al., 2014). Moreover, a previous study found that water bodies within urban areas in a hot humid climate have the ability to provide a cooling effect from the evaporative process as it absorbed the solar radiation during a hot day (Wong et al., 2012). Nevertheless, it is important to note that an adequate amount of water body coverage within an urban area or building should be properly proportioned to optimise the cooling effect from the evaporation process and to avoid excessive humidity in a hot humid climate (Thani et al., 2012).

Based on the previous cited works, several design criteria used to assess courtyard design for improving microclimatic conditions within the courtyard space are illustrated in Figure 2.22. To sum up, the understanding on the basic design criteria for optimum courtyard design acts as a basis for the formulation of the HCG framework and recommendation for policy and practice (Chapter 8). Table 2.5 summarises parameter of study by previous researchers on the criteria used to assess courtyard design in improving microclimatic conditions in a hot humid climate and other climate. Table 2.6 summarise parameter of study by previous researchers on the criteria used to assess courtyard design in improving microclimatic conditions in a hot humid climate and other climate.

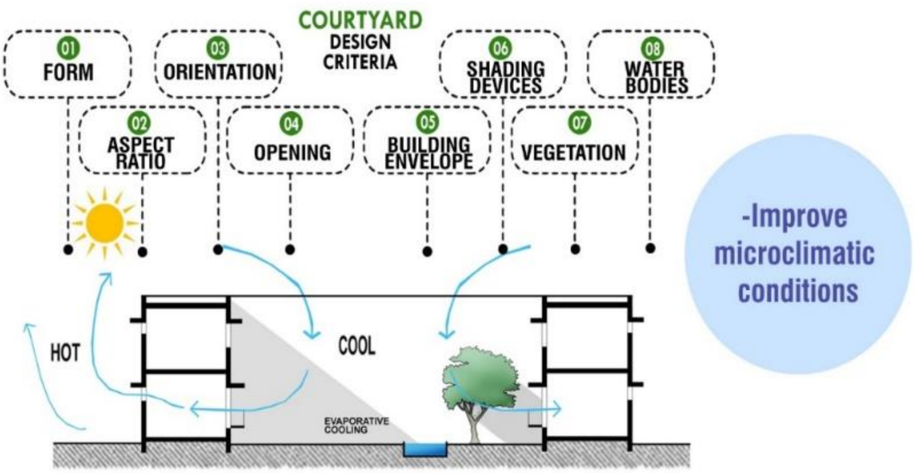


Figure 2.22: Design parameters that need to be considered to improve the microclimatic conditions within courtyard garden in hospitals
Source: Author (2017).

Table 2.5: Summary of the parameter of study by previous researchers in a hot humid climate and other climate on the courtyard design criteria.

COURTYARD DESIGN CRITERIA: PARAMETER OF STUDY BY RESEARCHERS											
Author (Year)	Climatic Context	Building typology	Form		Aspect ratio	Orientation	Opening	Building envelope	Shading Devices	Water Bodies	Vegetation
Almhafdy et al. (2013b; 2014; 2015)	Hot Humid Climate	Hospital building	(Enclosed & Semi-enclosed)	✓	✓	✓					
Ghaffarianhoseini et al. (2015)	Hot Humid Climate	NA (3D model)	(Enclosed & Semi-enclosed)	✓	✓	✓					✓
Sadafi et al. (2011)	Hot Humid Climate	2 storey Terrace house	(Enclosed)				✓	✓	✓		
Kubota et al. (2017)	Hot Humid Climate	2 storey shophouse	(Enclosed)	✓		✓	✓				✓
Muhaisen (2006)	Hot Humid Climate Hot dry climate Temperate Climate Cold climate	NA (3D model)	(Enclosed)	✓	✓	✓					
Safarzadeh and Bahadori (2005)	Hot dry climate	Residential building	(Enclosed)							✓	
Teleghani et al. (2014)	Temperate climate	Residential building.	(Enclosed)							✓	
Meir et al. (1995)	Hot dry climate	Residential building	(Semi-enclosed)	✓	✓	✓					
Berkovic et al. (2012)	Hot dry climate	NA (3D model)	(Enclosed)				✓		✓		✓
Al Masri & Abu-Hijleh (2012)	Hot dry climate	Mid-rise house	(Enclosed)		✓			✓			

Table 2.6: A summary on the results of the previous studies for improving the microclimatic conditions of courtyard in buildings in a hot humid climate.

COURTYARD DESIGN CRITERIA	AUTHOR (YEAR)	EVIDENCES AND RECOMMENDATION FOR IMPROVING THE MICROCLIMATIC CONDITIONS OF COURTYARDS IN A HOT HUMID CLIMATE.
FORM	Almhafdy et al. (2014)	• This study revealed that a semi enclosed courtyard which oriented along the East-West axis and opened towards the South provide better microclimatic conditions compared an enclosed courtyard of a similar orientation of a hospital building in Malaysia. **(A study in a hospital building).**
	Ghaffarianhoseini et al. (2015).	• This study suggested that semi enclosed courtyard with opening of the courtyard facing the North and East direction creates a slightly lower temperature within the courtyard compared to the enclosed central courtyard as the Northeast wind is channelled through the opening of a semi-enclosed courtyard. • This study pointed out the importance of avoiding the excessive solar exposure and increase the cooling effect from the natural breezes to achieve a thermally comfortable courtyard condition.
ASPECT RATIO	Muhaisen (2006)	• A three-storey height enclosed courtyard perform efficiently in a hot humid climate (a case study in Malaysia). • The optimum angle of the enclosed courtyard in a hot humid climate is at 30º and any additional increment over this value would result in the reduction of the sunlit area within the courtyard.
	Almhafdy et al. (2014)	• The increase of the height of the courtyard wall has significantly increased the amount of shading in both semi-enclosed (U-shaped) and enclosed courtyard (O-shaped) **(A study in a hospital building).**
	Almhafdy et al. (2015)	• A semi-enclosed courtyard with the ratio (width: length) 1:2 (i.e. rectangular shape) indicate a lower temperature and better ventilation than the courtyard with ratio 1:1 (i.e. the square shape) in which it resulted in a better PMV results with a gradient from 0.8 to 1.4. **(A study in a hospital building).**
	Ghaffarianhoseini et al. (2015).	• A semi-enclosed courtyard with a ratio (height: width) of 6:1 (6-storeys) creates a better thermal performance followed by a courtyard with ratios of 2:1 (3-storey) and 1:1 (1-storey) • The increase of the height of the wall of a semi-enclosed courtyard result in the reduction of the wind speed within the courtyard area.
ORIENTATION	Almhafdy et al. (2014)	• The orientation of the semi-enclosed courtyard that is elongated in East-West axis and opened to the South allow the wind flow to penetrate the courtyard and improve its outdoor thermal condition. (A study in a hospital building).
	Ghaffarianhoseini et al., (2015)	• This study revealed that a semi-enclosed courtyard with the opening facing the North produces a slightly lower temperature and a higher level of the relative humidity within the courtyard space. • This has resulted from the northeast wind that has been channelled into the courtyard through the opening side and due to a maximum shading generated within the courtyard.
	Muhaisen (2006)	• The maximum shaded area was achieved in the case study in Kuala Lumpur (hot humid climate) when the courtyard is elongated along the North-South axis.
	Aripin (2007) & Sh. Ahmad (2007) cited in Norwina et al. (2013)	• These studies suggested that the courtyard and the building should be elongated to the North-South axis to achieve a better daylighting and visual comfort in the wards area of the hospital in Malaysia. (A study in a hospital building).

OPENING	Almhafdy et al. (2014)	• A semi enclosed courtyard is found to provide a better thermal condition compared to an enclosed courtyard in the hospital building in Malaysia. **(A study in a hospital building).**
	Sadafi et al. (2011)	• This study suggested that an efficient opening to the outside environment within a courtyard area able to promote natural ventilation and enhance the thermal comfort within the adjacent spaces. (A study in a two-storey terraced housing).
	Kubota et al. (2017)	• This study revealed that the opening within the courtyard area enhance the air flow within the courtyard and avoid the excessive humidity within an enclosed courtyard. (A study in a shophouse).
BUILDING ENVELOPE	Sadafi et al. (2011)	• The result shows that the concrete wall contributes to a lower temperature than the brick wall at the living area from 8 am to 2 pm in day time in March. In contrast, the temperature of a living area with a concrete wall recorded a slightly lower temperature from 11 pm until 5 pm within compared to the brick wall. (A study in a two-storey terraced housing).
SHADING DEVICES	Sadafi et al. (2011)	• This study suggested the use of the shading roof for the courtyard area in a hot humid climate can decrease the amount of solar radiation penetrate the courtyard area and the adjacent spaces especially during the afternoon hours and considerably contribute to the improvement of the indoor thermal condition. (A study in a two-storey terraced housing).
	Almhafdy et al. (2015)	• This study revealed that a semi enclosed courtyard with a cantilevered roof provides a better microclimatic performance compared to a semi-enclosed courtyard without a cantilevered roof. (A study in a hospital building).
VEGETATION	Makaremi et al. (2012)	• This study revealed that the trees and plants in a courtyard reduce the amount direct solar radiation received and improve the outdoor thermal condition. (A study in an educational building).
	Ghaffarianhoseini et al. (2015)	• This study revealed that the grass to cover the ground in the courtyard decrease the air temperature in the courtyard and produce only a little improvement on the thermal comfort as the grass does not provide shade. • This study showed that by covering the courtyard with 75% trees can decrease the air temperature in the courtyard and increase the humidity compared to the courtyard without any vegetation. • The use of trees in a hot humid climate can increase the air temperature at certain times because the trees will block the wind flow into the courtyard space and considerably reduce the cooling effect during the night.
WATER BODIES	Thani (2012)	• Adequate amount of water bodies coverage within an urban area or building should be properly proportioned to optimise the cooling effect from the evaporation process and to avoid excessive humidity in air temperature of a hot humid climate. (Note: This study by Thani (2012) is not a study focus on the courtyard, but this study is relevant as it emphasis on the water bodies as part of the landscape elements in a hot humid climate)

2.4 Restorative functions of a hospital courtyard garden

2.4.1 User groups of hospital courtyard gardens and their needs

Spending long hours in a hospital can be a stressful experience for patients, staff and visitors. Thus, having access to natural settings in the hospital buildings can improve health outcomes and the ability to cope with stress (Ulrich et al., 2019; 2018; Cooper Marcus and Sachs, 2014). Cooper Marcus and Barnes (1995) highlighted that an outdoor garden in the healthcare setting, including the courtyard garden, was utilised by three distinct types of users including the patients, the staff and the visitors. Paine (1984) conducted observations at three different hospitals. These case studies showed that out of the three distinct types of users, staff utilised the outdoor space the most, either alone or in groups, with visitors who accompanied the patients utilising the space the second most, followed by the patients alone who used the space the least (Cooper Marcus and Francis, 1997, p.267).

2.4.1.1 Patients

The ability of patients to go outdoor is determined by their health condition. Patients who have the ability to walk and who are not attached to monitoring equipment, as well as long term care patients, are most likely to use the outdoor space (Cooper Marcus and Francis, 1997, pp. 267-269). However, it is also important to note that besides being in the garden, the bedridden patient also can benefit from viewing the garden through the window (Ulrich,1984; Verderber and Reuman, 1987). The different patient groups may also have different requirements for the outdoor garden as they also use the garden for different purposes. The requirement of the outdoor garden for each patient is dependent on the length of stay, whether as short-term or long-term inpatients or as outpatients (Cooper Marcus and Francis, 1997, pp. 267-269). In addition, it also depends on the patient's disability, and their physical and psychological needs.

The types of patients who are considered as physically healthy are those who have the capability to move independently and do not need continuous monitoring (Cooper Marcus and Francis, 1997). These groups of patients include the orthopaedic patients (those with broken leg or bones), maternity care patients (those who are either pre or postpartum) and rehabilitation patients (those who use an outdoor space to do physical exercise as part of a therapy process). Another special type of patient who needs access to the garden is the pediatric patient. For instance, it has been observed that child patients utilised the courtyard garden in the Kaiser Permanente Medical Centre in California which they used to play in the children’s maze provided in the courtyard area while waiting for their pediatric appointments: this provided them an opportunity for respite from the painful and stressful time of being hospitalised (Cooper Marcus and Barnes, 1995).

2.4.1.2 Staff

The staff are the most critical user in the hospital who spend continuous 24 hours of working in the hospital environment to provide service and care to the patients. Thus, they need a space such as an outdoor garden to enable them to escape from their daily routine of working in the hospital (Cooper Marcus and Francis, 1997, p.271). A pre and post occupancy study of the preference and usage of courtyard gardens in the hospital building has been conducted among the nurses and revealed that the majority of the nurses felt that it was important to them to be in the outdoor spaces; further, they most likely went outside alone and used the courtyard as a place for privacy (Naderi and Shin, 2008).

In addition, an observational study at the courtyard in the Novato Community Hospital in California recorded that the staff use the courtyard as a place for them to escape from the hectic indoor hospital environment. They mainly used the courtyard garden as a place for them to take a coffee break and have lunch with their colleagues (Cooper Marcus and Barnes, 1995). Paine (1984) also showed that the administrative staff are the most likely to use the outdoor space as they have enough free time during the lunch hour compared to physicians and nurses who rarely had the time to use the outdoor area because they were often busy providing service and care to the patients (Cooper Marcus and Francis, 1997, p.267).

2.4.1.3 Visitors

Although patients and staffs are the main building occupants and spent the longest time in hospitals compared to visitors, the visitors are also one of the hospital users who require access to the outdoor garden as a place for them to relieve their stress while waiting for their families who were being warded or have medical appointment. For instance, the courtyard in the Novato Community Hospital in California was utilised as a place for quiet outdoor respite by the visitors and serves as a waiting area for the family members of patients in surgery (Cooper Marcus and Barnes,1995).

In addition, Toone (2008) conducted a study in the courtyard of the Dell Children's Hospital in Austin, Texas. In this study, he determined that the parents and family members of sick children experienced reduced stress levels after spending time in the courtyard garden while enjoying the view of nature instead of sitting and waiting in the interior spaces of the hospital (Toone (2008). Moreover, the opportunity to receive visitation from family members and colleagues is important for most patients (Cooper Marcus and Francis, 1997, pp. 267-269). The patients' rooms are often too small and do not have enough space for visitors and family to gather there in comfort. Therefore, an outdoor garden is an essential place for social interaction for the patients and visitors (Cooper Marcus and Francis, 1997).

For the present study, courtyard gardens in the hospitals which have been designed for all types of users including the patients, the staff and the visitors **will be the focus of this study to examine the activities and space use patterns of the three types of users**. Thus, it is important for the selection of the case studies **for this study to select a hospital which has a courtyard garden that is utilised by all types of users**. It is also important to note that the different users groups who utilise the courtyard space depend on the type and function of spaces that are clustered around the courtyard garden. In the selected case studies, these spaces include a pediatric ward, a rehabilitation centre, surgery wards, maternity wards, administrative offices, pharmacy, waiting area and cafeteria.

2.4.2 The role of nature in reducing stress and improving health outcome for different users group

There is substantial scientific evidence emphasising the role of being in contact with nature (either by having a view onto a garden or being in a garden) as having a positive influence on the recovery process of hospital patients, particularly as nature contributes to relaxation and the reduction of stress levels in humans, hence improving their health and well-being (Ulrich et al., 2018; Amat, 2017; Gonzalez et al., 2011; Kim et al., 2009; Verderber and Reuman,1987; Ulrich, 1984). For instance, a high percentage of ICU patients' families reported a greater reduction in feeling of the 'sadness' and a higher reduction of stress while sitting in a garden compared to sitting in indoors (Ulrich et al., 2019). A recent study also revealed that a decrease in aggressive behaviour were reported from psychiatric patients who stayed in a new hospital that exhibited several stress reduction features (e.g. access to nature, nature window view, noise reducing design and daylight exposure) (Ulrich et al., 2018).

Additionally, studies in the past have found that patients and staff provided with a window overlooking a garden evidenced a reduction in their stress levels and health related complaints (Ulrich, 1984; Verderber and Reuman, 1987). A study by Ulrich (1984) showed that the restorative effects of natural views provided a better health outcome by fostering the restoration from stress, reduced muscle tension, lowered blood pressure and increased pain tolerance. Ulrich (1984) also reported that surgical patients exposed to a view of trees through a window in their rooms experienced a shorter length of stay in the hospital, lower consumption of pain killers, fewer complications with surgery, and received fewer negative comments in their nurses' reports compared to those exposed to the view of a brick wall.

In another study, Verderber and Reuman (1987) concluded that patients who stayed in a windowed room that overlooked the natural environment experienced a better health status and shortened length of stay in the hospital compared to those who stayed in a windowless room and/or a window with unpleasant views. This study also reported that staff therapists who worked in windowless areas or areas with poor views reported a decrease in their well-being.

Additionally, interaction with nature either by being in a natural setting or walking through nature have a positive impact in alleviating stress levels amongst adult patients, as reported in several interventional studies (Kim et al., 2009; Gonzalez et al., 2011). Kim et al. (2009) conducted a study in a hospital in Seoul of 63 patients diagnosed with major depression which consisted of three groups. These included 19 patients in the hospital group, 23 patients in the forest group and 21 patients in the control group. This study reported decreased cortisol levels (i.e. stress hormone level) in the forest group compared to the other two groups. The study by Kim et al. (2009) also highlighted that the forest group included various natural instruments that could enhance the effect of the psychotherapeutic intervention in reducing depression among participants. Another interventionist research revealed a positive effect of garden exposure therapy on some depressive patients (i.e. ordinary and easy gardening activities) (Gonzalez et al., 2011). Table 2.7 summarised a review of nature and its effect on stress reduction and health outcome by patients, staff and visitors in a healthcare setting.

Table 2.7: A review of nature and its effect on stress reduction and health outcomes by patients, staff and visitors in a healthcare setting

HEALTHCARE SETTING			
TYPES OF USERS	**AUTHOR (YEAR)**	**TYPES OF EXPERIMENTS**	**FINDINGS**
Patients	Ulrich et al. (2018)	**Methods:** Comparing data on two clinical markers in 3 hospitals which exhibit different characteristics in terms of their stress reducing features **Sample in 3 hospitals in Sweden:** • New hospital • Old hospital • Control hospital The new hospital has nine out of ten stress-reducing features and had an atrium and **courtyard garden** which provided access to nature	• Psychiatric patients in the new hospital showed: **- a decrease in the average number of injections needed** **- required less physical restraint** compared to patients in the old hospital and control hospital. • This study suggested that the psychiatric hospital designed with a variety of stress-reducing features showed that: **i) a reduction of crowding stress,** **ii) a reduction of environmental stress,** **iii) stress reducing positive distraction, and** **iv) design for observation**, contributed to low aggressive behaviour among the psychiatric patients and enhanced staff safety.

Visitors	Ulrich et al. (2019)	**Methods:** Based on a self-reported survey asking on their stress level. **Case studies:** Garden ICU café ICU Waiting room **Sample:** 42 ICU patients' families	• The ICU patients' families reported **a greater reduction in the 'sadness' feeling** and **a greater reduction of stress** while sitting in a garden compared to sitting indoors. • This study suggested that **an unlocked garden with a high percentage of nature elements located close to the ICU** can significantly contribute in lowering the stress level of the family members of ICU patients.
Patients	Amat (2017)	**Methods:** Experimental study Observation **Case study:** A **courtyard garden** in an acute care hospital. (Note: similar sites to the current case study - H3-C2) **Sample:** 40 cardiac survivors	• The results revealed a lower heart rate among patients when they exercised outdoor compared to exercising indoors. • A higher number of patients preferred outdoor exercise rather than indoor exercise due to the positive ambiance in the outdoor garden.
Patients	Kim et al. (2009)	Comparing the amount of cortisol levels **Sample:** 19 patients in the hospital group; 23 patients in the forest group; and 21 patients in the control group.	• This study reported decreased cortisol levels (i.e. stress hormone level) in the forest group compared to the other two groups. • The forest group included various natural instruments that could enhance the effect of the psychotherapeutic intervention in reducing depression among participants
Patients	Verderber and Reuman (1987)	Windowed room with a view of nature **VS** Windowless area and area with poor views. **Sites:** 6 hospitals in Chicago **Sample:** 137 staff and 100 inpatients	• Patients who stayed in a windowed room that overlooked the natural environment experience - a better health status and - shortened length of stay in the hospital compared to those who stayed in a windowless room and/or a window with unpleasant views.
Staff			• The staff therapists who worked in windowless areas or areas with poor views reported a decrease in their well-being.
Patients	Ulrich (1984)	View of nature **versus (VS)** View of a brick wall. **Site:** A suburban hospital in USA **Sample:** 23 surgical patients	• The restorative effects of natural views provided a better health outcome by fostering restoration from stress, reduced muscle tension, lowered blood pressure and increased pain tolerance. • The surgical patients exposed to a view of trees through the window in their rooms experienced: - a shorter length of stay in the hospital, - a lower consumption of pain killers, - fewer complications with surgery, and - received fewer negative comments in their nurses' reports compared to those exposed to the view of a brick wall.

Apart from the positive effects of the interaction with nature in reducing stress and improving patients' well-being, as well as other hospital users within the hospital context, recent studies (Song et al., 2015; Honold et al., 2016; Thompson et al., 2012) and several past studies (Ulrich et al., 1991; Ulrich, 1981) also found that viewing nature brought benefits to non-patients (See Table 2.8).

Table 2.8: A review of nature and its effect on stress reduction and health outcome in a non-healthcare setting.

NON-HEALTHCARE SETTING			
TYPES OF USERS	**AUTHOR (YEAR)**	**TYPES OF EXPERIMENTS**	**FINDINGS**
Male participant walking in an urban park during fall (autumn) in Japan	(Song et al. 2015)	Physiological and psychological measure: Compared heart rate variability and mood state level after walking in an urban park and city areas. Sample: 23 Japanese males (University students)	• The participants who walked in an urban green space showed decreased heart rate level and perceived a lower level of negative emotion and reduction in anxiety compared to the results of walking in the city centre.
People in a neighbourhood area in Germany.	Honold et al. 2016)	Compared the amount of cortisol levels in participants who lived in a house within a neighbourhood area that has a higher amount and various types of greenery **VS** a lower amount and reduced variety of greenery.	• The study revealed that a participant who lived in a house within a neighbourhood area that has a higher amount and various types of greenery had significantly lower cortisol levels (i.e. stress hormone level). • This study also reported that those participants who travelled along the vegetated routes and waterways during their daily commute reported a significant higher level of satisfaction than that reported by the less frequent user of this route.
People in urban areas of Scotland	(Thompson et al. (2012)	Compared the amount of cortisol level in participants who have more interaction with greenery within their neighbourhood **VS** less interaction with greenery in their neighbourhood.	• The results of this exploratory study revealed that people who lived in a greener neighbourhood reported a decrease in the amount of cortisol level and lower self-reported stress.
Non-patients	Ulrich et al. (1991)	The participants first watched a stressful video followed by one of six videos set in either a natural or urban scenery.	• This study revealed that viewing unthreatening nature fostered the restoration from stress among participants. • The results showed that those who viewed the natural scenery reported faster recuperation from stress compared to a video of urban scenery.
Non-patients (University students)	Ulrich (1981)	The participants viewed sixty colour slides consisting of images of: (1) nature with water; (2) nature dominated with greenery; or (3) an urban environment without greenery and water.	• The respondents who viewed nature with water and with greenery showed that they perceived a better reduction in their stress levels compared to when they viewed urban scenery without any natural elements.

2.4.3 Post-occupancy evaluation (POE) of an outdoor garden in a hospital

POE is a systematic and comprehensive assessment of a building that has been built and occupied for a period of time which concentrated on the needs of the building occupants and learnt from the consequences of past design decisions and planned for a better building in the future (Preiser et al., 2015, p.3). The use of POE is not restricted to the evaluation of building performance (e.g. Stevenson, 2019; Jamaludin et al., 2014; Behloul, 1991). The application of POE is also found as a common practice in the landscape field to assess the different types of outdoor gardens (e.g. courtyard garden, terrace garden, rooftop gardens, open type garden and park) in different buildings or urban contexts (e.g. Jiang et al., 2018; Davis, 2011; Sherman et al., 2005). POE can be used for a number of purposes, for example, in obtaining feedback for problem solving and assessing building performance, providing recommendations for correcting problems which involved systematic techniques, and varying processes and methods depending on the research subject (Preiser et al., 2015; Hadjri and Crozier, 2009; Bordass and Leaman, 2005).

In the Malaysian context, POE is important in the planning and development process of government and public buildings to ensure the facilities are well maintained (Nawawi and Khalil, 2008). In 1997, the first POE was carried out by The Malaysian MOH and the Public Work Department (PWD) to evaluate the hospital building. The assessment is concentrated on the hospital facilities, including the medical laboratories, clinics and wards (Mastor and Ibrahim, 2010; Nawawi, 2011). However, there is no record of a systematic investigative POE conducted by governmental bodies or scholars specifically on the courtyard gardens of public hospitals which are used by different types of users (i.e. patients, staff and visitors). To this researcher's knowledge, only one POE study was found in the existing literature (Ghazali and Abbas, 2012) which was carried out in Malaysian hospitals to assess the quality of the physical and healing environment in paediatric wards. However, this study did not systematically conduct a POE in the courtyard gardens of the hospitals and feedback was not obtained from users on outdoor comfort; also, no field measurements were carried out in the paediatric gardens. This implies that such studies remain scarce in the Malaysian hospital context.

2.4.3.1 Level of POE and the application in the current research

There are three levels of POE namely indicative, investigative and diagnostic (Preiser et al., 2015; Hadjri and Crozier, 2009; Behloul, 1991), as described and illustrated in Figure 2.23. Indicative POE is the basic level of POE which can be completed in a short time span and usually involved activities such as walkthrough evaluations, inspections, as well as interviewing key people or end-users (Preiser et al., 2015 Investigative POE is a more robust evaluation involving in-depth analysis. Interviews and questionnaires were also used in the data collection across several buildings of similar type (Hadjri and Crozier, 2009). Diagnostic POE is an in-depth and comprehensive investigation involving sophisticated methodologies and requires extensive work. It also usually has a wide focus of comparable facilities and involves a broad range of technological and anthropological research (Hadjri and Crozier, 2009). This in-depth investigation generates *'a high validity and generalisability of data collected (that has) the potential of being transformed into guidelines'* that is useful for the community (Preiser, 1995, p.53, cited in Hadjri and Crozier, 2009).

For the current study, the POE is a diagnostic POE as it employed a multi-methods approach in the data collection including survey, interview, field measurement, and observation to investigate a similar facility (HCGs) in comparable public hospital buildings. According to Preiser et al. (2015, p.57), a diagnostic POE is the most comprehensive and robust evaluation which involved multi-methods and is aimed not only to improve the facilities in the particular building but also the state of the art of that particular building. It is an in-depth investigation to evaluate multiple performance variables including technical, behavioural and functional performance to provide a greater understanding of the association between those studied variables (Preiser et al., 2015, p.17).

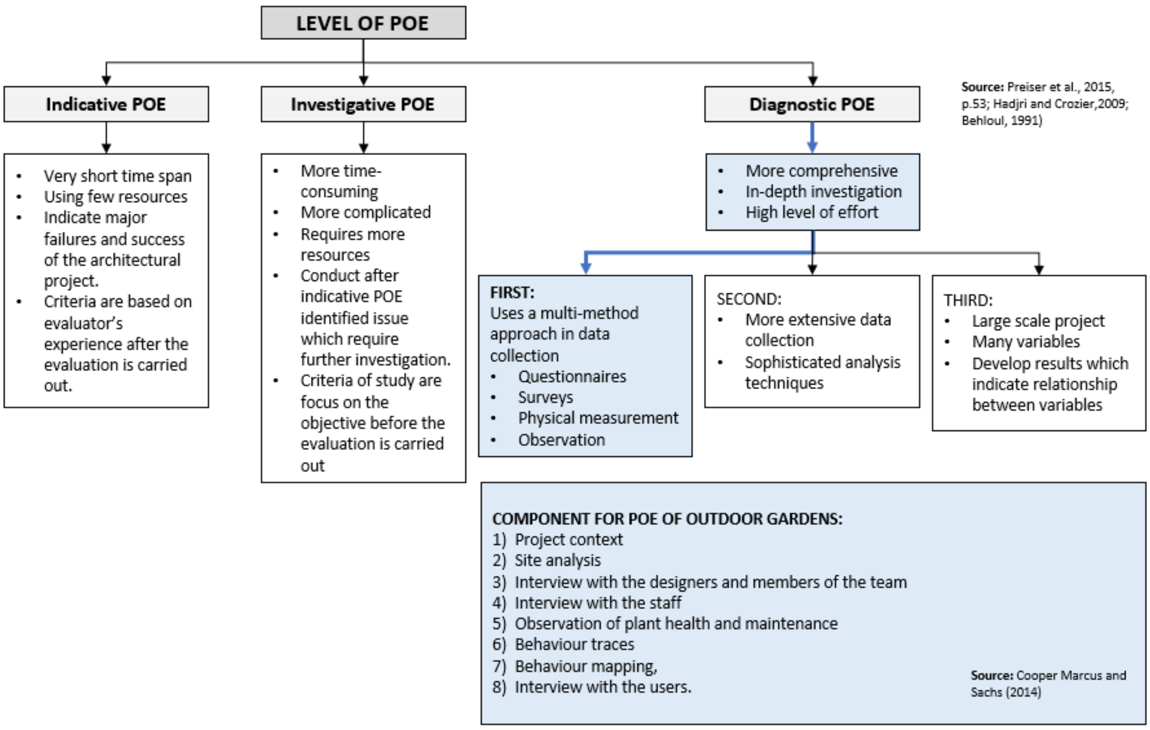


Figure 2.23: The three levels of POE
Source: Illustrated by Author based on Preiser et al. (2015, p.53), Hadjri and Crozier (2009), Behloul (1991) and Cooper Marcus and Sachs (2014).

Additionally, the present study also involved multiple fieldwork activities which can be categorised under a diagnostic POE as highlighted by Cooper Marcus and Sachs (2014); a diagnostic POE should include eight components: 1) Project context; 2) Site analysis; 3) Interviews with the designers and members of the team; 4) Interviews with the staff; 5) Observation of plant health and maintenance; 6) Behaviour traces; 7) Behaviour mapping; and 8) Interview with the users. Moreover, the evaluator should be an expert in landscape and have the skills necessary to conduct an evaluation. They should not be drawn from among those involved in designing the outdoor garden to avoid possible bias in the evaluation (Cooper Marcus and Sachs, 2013).

2.4.3.2 POE studies on the restorative effects of outdoor gardens in hospitals

Very little research on restorative gardens conducted in hospital courtyards focus on the different users groups (i.e. staff, patients and visitors). Two previous studies primarily focused on nursing staff in a regional healthcare hospital (Naderi and Shin, 2008), and parents of sick children in a paediatric hospital in the USA (Toone, 2008) (See Table 2.9) A recent study was conducted in a courtyard garden in a Malaysian hospital (Amat, 2017), but does not focus on different types of users. This study was an experimental study to assess the heart rate and blood pressure of cardiac survivor patients to compare the effects of outdoor exercise and indoor exercise. Hence, there still remains a paucity of research focused specifically on the restorative effect of different HCGs, particularly in the Malaysian hot humid climate. There are also no previous studies on the performance of different types of courtyard gardens in hospitals.

Table 2.9: A summary of the review on the findings of POE research in the courtyard gardens of paediatric hospitals

A POE RESEARCH CONDUCTED SPECIFICALLY IN THE <u>COURTYARD GARDENS</u> IN THE PAEDIATRIC HOSPITALS				
AUTHOR (YEAR)	**USERS GROUP**	**CASE STUDIES**	**METHODS AND NO OF CASE STUDIES**	**FINDINGS AND CRITICS**
Naderi and Shin (2008)	Staff (nurse)	1 courtyard garden in a regional healthcare setting in the USA	**Methods:** Survey Ecological site design **Sample:** 61 nurses **Case study:** 1 courtyard garden surrounded by a three-storey building	This is a pre and post-occupancy evaluation study, evaluating the outcome of design and staff satisfaction levels. **Findings:** • The staff highly appreciated the nature and privacy in the HCG. • A survey from the nurses also reported that the most significant limiting factors for them to use the courtyard space is weather conditions such as rain or too much sun and high temperature. • The outcome of the revised design met the satisfaction of most of the nursing staff with their restorative spatial experience in the retrofitted courtyard

			 Old HCG design  A proposal of new design	**Critic:** This study was only limited to the courtyard which was utilised by the staff and thus only gained feedback from the group of nursing staff; it ignored the needs and preferences of other users such as patients and visitors.
Toone (2008)	Parents of the sick children	1 courtyard garden in a paediatric hospital in the USA	**Methods:** Observational analysis Participant surveys Interview **Sample:** 27 parents **Case study:**  A newly built courtyard multi-level courtyard garden surrounded by a total of four floor levels.	This is a pre-post measure POE study to assess the stress level among the parents of the paediatric patients. **Findings:** • Parents perceived a higher reduction in stress levels when sitting in the HCG compared to the indoor waiting area. **Critic:** This study evidenced a very small sample size and did not include staff and visitors.

The majority of research on the POE of restorative gardens are mostly conducted in the various range of outdoor gardens (e.g. rooftop gardens, entry garden, terrace gardens and courtyard gardens) in various healthcare facilities: acute care hospital (Jiang et al., 2018; Sachs, 2017; Shukor, 2012; Davis, 2011; Asano et al., 2008; Naderi and Shin 2008; Cooper Marcus and Barnes, 1995); dementia care facilities (Shi et al., 2019; Guaita et al., 2011; Hernandez, 2007); and cancer centres (Van der Linden et al., 2016; Butterfield, 2014) and psychiatric centres (Belčáková et al. 2018; Erbino et al., 2015; Sachs, 1999).

The first prominent research into the POE of restorative gardens carried out an extensive observation of 24 gardens in 19 hospitals in the USA (Cooper Marcus and Barnes, 1995)

(See Table 2.10). Five gardens were evaluated for the assessment of users: feedback on their experiences and preferences of garden features using survey interviews with patients, staff and visitors. However, it can be argued that there was **no assessment of the non-users and no interviews with the designers** which is highlighted by Cooper Marcus and Sachs (2014) as an important aspect to be studied for a successful diagnostic POE.

Another POE of restorative gardens was carried out in five acute care hospitals in Denmark which found that the location, surroundings and facilities are important factors that influenced the perceived restorative score (Shukor, 2012). A major criticism of Shukor’s work is that the proposed Common Design Recommendation (CDR) tool, included **some components that are lacking and missing** which are identified in the current study. This tool only focused on the location and view, accessibility, layout and space, seating arrangement, planting, design details and practical services and did not include wayfinding, signage, the choice of pathway, the design of the wall enclosure, orientation and aspect ratio, all of which have been determined as important aspects for outdoor gardens (See Chapter 8). Moreover, environmental aspects, safety and maintenance were not examined in the proposed **CDR tool as it concentrated highly on the landscape design.**

Additionally, several researchers carried out a diagnostic POE employing several methods: i) an indicative evaluation using GATE audit tools developed by Sachs (2017) (See Table 2.10), ii) a semi-structured focus group with the staff; iii) on-site observation and behaviour mapping; and iv) an interview with the two landscape architects (carried out prior to the POE) to evaluate six gardens in two hospitals in the USA (Jiang et al.,2018). Based on the GATE score, all six gardens received a high score for the planting consideration, aesthetics and maintenance. Whereas the gardens that received a lower GATE score indicated lack of tables, water features, insufficient lighting, wayfinding and other facilities. This study also suggested that the location and the views are important factors in hospital garden design. In terms of the usability, this study found that locating the gardens close to the building entrance and traffic hubs resulted in a higher occupancy level (Jiang et al.,2018).

Nevertheless, one criticism of much of this research is the possibility of bias in data reporting because the data are solely based on the responses of the focused group respondents (n=21), mostly from among the staff and not involving the actual users of the gardens (i.e. patients, visitors). Moreover, a drawback of this previous research is that **no field measurement was conducted** to assess the outdoor thermal comfort in the gardens which is one of the methods utilised in the current study for further investigation to enhance the environmental aspects of the HCG design.

Table 2.10: A summary of the review on the findings of POE restorative gardens in healthcare facilities

RESEARCH ON POE RESTORATIVE GARDENS IN THE ACUTE CARE FACILITIES				
AUTHOR (YEAR)	**USERS GROUP**	**CASE STUDIES**	**METHODS AND NO OF CASE STUDIES**	**FINDINGS AND CRITICS**
Jiang et al. (2018)	Patients Staff Visitors	2 general hospitals in the USA 13 gardens (courtyard gardens, dining gardens)	**Methods:** Semi structured focus group with the staff (n=21) Interview with the landscape architects (n=2) On-site observation Behaviour mapping **Case studies:** Out of 13 gardens, 6 gardens were evaluated.	This research evaluated the quality of outdoor gardens in the two-case study hospitals in the USA using the GATE audit tools developed by Sachs (2017). **Findings:** • All 6 gardens showed a higher GATE-score in terms of the planting consideration, aesthetics and maintenance. The gardens that received a lower GATE score lacked tables, water features, insufficient lighting, wayfinding and other facilities. • A high amount of the green coverage and the hierarchical landscape realms contributed to stress reduction in the medical facilities. • Location and view are important aspects in the garden design. • This study found that the location of the gardens close to the building entrance and traffic hubs resulted in higher occupancy levels.
Sachs (2017)	Patients Staff Visitors	11 gardens in 8 hospitals in the USA.	**Methods:** **Evaluation by H-GET** tools developed in this study (pilot testing) – (online and paper pencil tools) **Total sample survey:** Staff (n=855) Patient/Visitors (n=96) **Total usable survey:** Staff: (n=729) Visitors: (n=95) 81.3% (online survey) **Interview** with the stakeholders (n=10) (e.g. landscape architect, staff, facility manager) Observation Behaviour mapping **Case studies:** 11 gardens in 8 hospitals in the USA.	This study evaluated the gardens in 8 hospitals by using the H-Get tool adapted from the previous studies and proposed new evaluation toolkit GATE tools. **Findings:** • Staff used the space more than patient and visitors and they preferred to spent time in the gardens during the lunch time. • Garden that allows people to pass through or function to linked between two indoor area are found to have more activity. • The garden is well used when it is physically and visually accessible to the hospital users. **Critics:** There is a possible bias in data reporting due to majority of the survey were conducted by online and the sample are mostly among the staff and visitors. Some of them are not the actual users on-site and evaluate the gardens based on their previous experience whilst there. No systematic on-site observation and behavior mapping were conducted. The mapping is conducted by different evaluators, which tend to lead to a bias in data reporting because the consistency of the data collection protocol is crucial to ensure its reliability.
Shukor (2012)	Patients Staff Visitors	5 hospitals in Denmark (5 gardens)	**Methods:** **Survey questionnaire** Staff (n=183) Patients (n=149) Visitors (n=131) **Semi structured interview** Staff (n=15)	This study developed a CDR evaluation tool and utilised it in the evaluation of the gardens. **Findings:** • This study found that the location, surroundings and facilities are the factors that contribute highly to a high percentage of restorative score in the green outdoor environment (GOE). • Staff are found to be the main garden users compared to patients and visitors.

			Case studies: 5 different types of gardens in 5 hospitals	• They mostly favoured the natural elements in the gardens (e.g. fresh air, sunshine and vegetation). • The most frequent activities recorded included smoking, having lunch and sitting and relaxing.
Cooper Marcus and Barnes (1995)	Patients Staff Visitors	19 hospitals in California, USA. (24 gardens)	**Methods:** Visual analysis Behavioural observations, Survey interviews Staff (n=59) Patients (n=26) Visitors (n=15) **Case studies:** 24 gardens were observed. In depth evaluation carried out in 5 hospitals.	The first prominent POE study in the research field. **Findings:** • The staff used the gardens more than the patients and visitors. • This study concluded that nearly all respondents (i.e. patients, staff, and visitors) reported a positive outcome on their ability to cope with stress because of their use of the hospital garden. • Patients reported that they felt better and evidenced a better tolerance for their medical procedures • Family members and friends of patients reported that they felt that the gardens provided relief from stress during their hospital visits.

2.4.3.3 Previous research on restorative gardens in Malaysian hospitals

Similarly, in the Malaysian context there is little research focusing specifically on courtyard design in Malaysian public hospitals (See Table 2.11). Most studies have focused on the general type of outdoor environment in a hospital with an additional focus on ill children (Samad and Abd.Rahim, 2014; Said et al., 2005; Shukor, 2007) again lacking feedback from the different user groups (patients, staff, visitors) which is the focus of this current research. Another study by (Amat (2017), as explained in the previous section, was an experimental study on cardiac patients to assess heart rate and blood pressure after conducting outdoor and indoor exercise.

Although some studies conducted in an outdoor garden in hospitals in Malaysia have claimed to utilise different types of users (Adnan, 2016; Ibrahim and Jer, 2014) these studies are not specifically focused on the different types of courtyard gardens in a Malaysian hospital that were built after 1998, and do not systematically evaluate the HCGs using a multiple methods approach or provide a holistic framework for the HCG. The research by Adnan (2016) is arguably biased in terms of the reporting data because the method is based on the response from a self-reporting survey with different users albeit dominated by the hospital staff compared to the visitors and patients. Moreover, no daily observation study was systematically done to clarify who the actual site users were. As will be examined in Chapter 6, Section 6.4, the current findings showed a disagreement with this study. Nevertheless, this study was only conducted in one case study hospital which led to a bias in reporting the data of the selected hospital. Similarly, a study by Ibrahim and Jer, (2014) also showed a possible bias in reporting the results because it was based on the researchers' observations and did not involve any feedback from the users.

Therefore, an evaluation of HCGs in Malaysian public hospitals is pertinent to be conducted to evaluate the performance of the different HCGs typology. Although it was found to be the common design practice by the architects to include the courtyard garden in the hospital planning since the 1970s, no systematic evaluation on different types of HCGs has been conducted so far. In fact, it was also found in the current study that this courtyard building typology is still be implemented in recent and newly built hospitals, as will be discussed in Section 7.71.

Table 2.11: Summary of the review of POE restorative outdoor gardens in Malaysian hospitals

RESEARCH ON RESTORATIVE GARDENS IN MALAYSIAN HOSPITALS				
AUTHOR (YEAR)	**USERS GROUP**	**CASE STUDIES**	**METHODS AND NO OF CASE STUDIES**	**FINDINGS AND CRITICS**
Adnan (2016)	Patients Staff Visitors	19	**Methods:** Questionnaire Survey: Staff (n=230), Visitors (n=156), Patients (n=178), Other (n=36). Interview with staff (n=40) 19 gardens in one hospital. (Rooftop garden, terrace gardens and courtyard garden)	The garden evaluation was carried out based on the CDR tools developed by Shukor (2012) which is based on the case studies in Denmark. This study found that the staff reported as the main group who used the gardens, followed by visitors and patients. **Critic:** There is a bias in data reporting due to the use of a self-reported survey among the majority of the staff who were not on site. No observation was carried out to clarify who were the actual users on site.
Ibrahim and Jer (2014)	Patients Staff Visitors	2	**Methods:** Informal interview Observation Outdoor garden in two small district hospitals (built before 1998). **2 case studies:** (Open type garden & courtyard garden) **Sample:** NA	Based on the observation, the study reported that visibility, accessibility, quietness and comfortable condition significantly influenced garden usage.. **Critic:** The results are based on the researchers' observations and does not included users' responses which tended to bias the findings. No statistical analysis was conducted.
(Shukor, 2007)	Paediatric patients	NA	**Methods:** Interview with the mothers (n=58) of Down Syndrome children Behaviour observation	This study suggested that a garden for Downs Syndrome children should provide a sense of security, a space for social interaction and facilitate easy supervision. **Critic:** This study was specifically focused to provide a garden recommendation for Downs Syndrome children and not the HCG for different user groups.
Said *et al.*, (2005)	Paediatric patients	2	**Methods:** Interview with the mother (n=320) of the children	This study found that 94% of the mothers (n=360) reported that their ill children preferred to spend time in the outdoor garden rather than remain in the wards.

			Behaviour observation **2 case studies:** 2 open type gardens next to the paediatric wards in two hospitals.	**Critic:** This study only focused on the perceptions of the paediatric patients. This study did not assess feedback from the experience of the staff and visitors.

2.4.3.4 Methods used in previous research on restorative gardens in a healthcare facilities

As explained in Section 2.4.3.1, a diagnostic POE in the landscape studies involves the use of various methods including a study of the project context, site analysis, interviews with the designers and members of the team, interviews with the staff, observations of plant health and maintenance, behaviour traces, behaviour mapping and interviews with the users to form a comprehensive and in-depth evaluation of the subject of the research area (Cooper Marcus and Sachs, 2014). However, it can be argued that the field measurement to assess the actual microclimates in the outdoor gardens are not included within the methods used in the POE restorative garden research (See Table 2.12 and Table 2.13). This method is crucial to assess users' perceptions of outdoor comfort in the HCG to enhance microclimatic performance, especially in the courtyard building typology of a hot humid climate (Almhafdy et al., 2013, Makaremi et al., 2012, Kubota et al., 2017). None of the studies in Malaysia and very few in other regions carried out interviews with architects (e.g. Van der Linden et al., 2016; Butterfield, 2014). Another study in the US and Oregon interviewed the landscape architect but did not involve the architect and no surveys or interviews with the patients group occurred (Jiang et al., 2018; Sachs, 2017).

Several methods have been utilised by previous studies in different types of outdoor gardens (e.g. rooftop garden, entry garden, courtyard garden and plaza) in healthcare facilities and **few studies were conducted specifically in the courtyard garden** (e.g. Toone, 2008; Naderi and Shin, 2008). Most of these researches employed the survey questionnaire method to gain feedback from the users, and very few studies conducted interviews with the users and non-users and designers. Furthermore, **none of these studies conducted field measurements of the actual air temperature, wind flow and humidity level**. In the current study, multiple methods were utilised with the aim to enhance the evaluation process of the HCG through a sophisticated data collection process and analysis process to ensure an accurate prediction of the performance of the studied area. Further justification of the selection of the methods of the current study is set out in Section 3.3.

Table 2.12: A summary of the review on the methods used in previous studies of outdoor gardens in acute care hospitals

Types of healthcare facilities			ACUTE CARE HOSPITAL								
Author (Date)			**Author (2020)**	Jiang et al. (2018)	Adnan (2016)	Sachs (2017)	Shukor (2012)	Davis (2011)	Asano et al. (2008)	Naderi and Shin (2008)	Cooper Marcus and Barnes (1995)
	Countries		Malaysia	USA	Malaysia	USA	Denmark	USA	Japan	USA	USA
	Courtyard gardens		✓		✓	✓			✓	✓	
	Rooftop gardens			✓	✓	✓	✓	✓	✓		✓
	Open type gardens					✓	✓		✓		✓
	Entry garden					✓	✓		✓		✓
	Viewing garden				✓						✓
	Cafeteria terrace					✓					
	Observed gardens		13	13	19	11	5	1	9	1	24
	Evaluated gardens		3	6	NA	8	5	1	9	1	4
	No. of site studies		3	2	1	8	5	1	1	1	24
METHODS USED IN THE STUDY	OBSERVATION	Project context	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Site analysis	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Behaviour traces	✓	✓					✓		
		Behaviour mapping	✓	✓		✓		✓	✓	✓	
		Occupancy count	✓						✓		
		Video-based observation	✓								
		Direct observation	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Field notes (sketches)	✓		✓			✓			
	SURVEY INTERVIEW	Patients	✓ (n=16)						✓	✓ (n=99)	✓ (n=26)
		Visitors	✓ (n=84)							✓ (n=35)	✓ (n=15)
		Staff	✓ (n=20)								✓ (n=59)
		Non-users	✓ (n=135)								
	SURVEY (Paper / Online)	Patients			✓ (n=178)		✓ (n=149)	✓			
		Visitors			✓ (n=156)	✓ (n=95)	✓ (n=131)	✓			
		Staff			✓ (n=230)	✓ (n=729)	✓ (n=183)	✓		✓ (n=389)	
		Others			✓ (n=36)						
		Non-Users									
	INTERVIEW	Architect	✓ (n=2)								
		Landscape architect	✓ (n=2)			✓		✓			
		Facility manager				✓					
		Staff		✓ (n=21) Focus group	✓ (n=40)	✓	✓ (n=15)				
		Patient									
		Visitors									
	DESIGN BRIEF		✓	✓							
	FIELD MEASUREMENT		✓								

Table 2.13: A summary of a review on the methods used in the previous study of outdoor gardens in paediatric hospitals, dementia care centres, cancer centres and psychiatric care centres.

Types of healthcare facilities			PAEDIATRIC HOSPITAL			DEMENTIA CARE		CANCER CENTRE		PSYCHIATRIC CENTRE	
Author (Date)			Reeve et al. (2017)	Pasha (2013)	Toone (2008)	Shi et al. (2019)	Hernandez (2007)	Van der linden et al. (2016)	Butterfield (2014)	(Belčáková et al. 2018)	Sachs (1999)
	Countries		Australia	USA	USA	China	USA	UK	UK	Slovakia	Canada
	Courtyard gardens				✓		✓	✓	✓	✓	✓
	Rooftop gardens		✓	✓		✓		✓			
	Open type gardens		✓	✓		✓	✓	✓	✓	✓	✓
	Entry garden		✓	✓			✓	✓	✓	✓	
	Viewing garden		✓					✓	✓		
	Cafeteria terrace		✓	✓				✓	✓		
	Observed gardens		13	5	1	2	2	10	4	1	3
	Evaluated gardens		4	5	1	2	2	10	4	1	3
	No. of site studies		1	3	1	2	2	10	4	1	3
METHODS USED IN THE STUDY	OBSERVATION	Project context	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Site analysis	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Behaviour traces									
		Behaviour mapping				✓	✓				
		Occupancy count				✓					
		Video-based observation									
		Direct observation	✓		✓	✓	✓		✓	✓	✓
		Field notes (sketches)	✓	✓		✓	✓		✓		✓
	SURVEY INTERVIEW	Patients/ Residents				✓ (n=37)					
		Visitors / families			✓ (n=27)						
		Staff				✓ (n=25)					
		Non-users		✓							
	SURVEY (Paper / Online)	Patients								✓ (n=19)	
		Visitors / families		✓ (n=76)						✓ (n=17)	
		Staff		✓ (n=70)						✓ (n=41)	
		Non-Users							✓ (online)		
	INTERVIEW	Architect					✓ (n=5)	✓ (n=5)	✓ (n=4)		✓ (n=1)
		Landscape architect		✓							
		Admin Staff		✓		✓	✓ (n=28)				✓ (n=2)
		Staff							✓ (n=57)		
		Co-founder						✓	✓		
		Key gardener							✓		
		Patient/ Residents						✓	✓ (n=67)		✓ (n=1)
		Visitors / families					✓ (n=12)		✓ (n=14)		✓ (n=1)
	Visitors' diaries		✓								
	Logbook								✓		
	DESIGN BRIEF							✓	✓		
	FIELD MEASUREMENT										

2.4.4 Theoretical background underpinning the concept of restorative environments

A restorative environment refers to a setting that is capable to ‘promote (rather than merely permit)’ restoration and recovery from the mental fatigue of a daily task and excessive demands, and leads to positive outcomes including positive moods, reduced stress levels, the renewal of cognitive functions as well as improving psychological well-being (Hartig, 2004, p.273-274). As described previously, a lot of empirical and scientific research has revealed the benefits of interaction with nature to foster restoration from stress and the positive effect it can have on health outcome in either healthcare settings (Ulrich, 1984; Verderber and Reuman, 1987; Kim et al., 2009; Gonzalez et al., 2011) or non-healthcare settings (i.e. urban setting) (Ulrich, 1981; Ulrich et al., 1991; Thompson et al., 2012; Honold, et al., 2016).

The theory of restorative environments which is associated with the restorative process, health related effects and its benefits on human outcome gain from the interaction with nature is traditionally referred to as the “Biophilia” concept (Wilson, 1984). This suggests that human beings tend to develop a positive response to nature (Wilson, 1984). This theory has been discussed further by Ulrich (1984) suggesting that a positive response also includes the restoration of the psychological aspects based on the stress reduction (Stress Reduction Theory – SRT). Kaplan and Kaplan (1989) suggested that the positive response from nature improves the psychological restoration process through the recovery of direct attention (Attention Restorative Theory - ART). Several empirical researches have been done to support both SRT (Ulrich et al., 1991; Hartig and Staat, 2004) and ART (Berto, 2005; Staats et al., 2003).

2.4.4.1 Stress Reduction theory (SRT)

The basic principle of SRT suggests that the potential of natural environments in improving health outcomes are linked to the ability of the individual to cope with stress and foster restoration for positive psychological well-being (Ulrich, 1984, 1991). This theory which also known as the ‘theory of supportive gardens’ (Ulrich, 1999) suggests that a garden in a healthcare setting can function as a stress mitigation resource provided that this outdoor garden fosters: (1) a sense of control; (2) social support; (3) physical movement and exercise; and (4) access to natural distractions. The conceptual model of the Theory of Supportive Gardens by Ulrich (1999) covers the effects of outdoor gardens in the healthcare setting on health outcomes in which it comprises of four qualities that have the capability to foster certain restorative and coping resources that lead to stress reduction and improve health outcomes (See Figure 2.24).

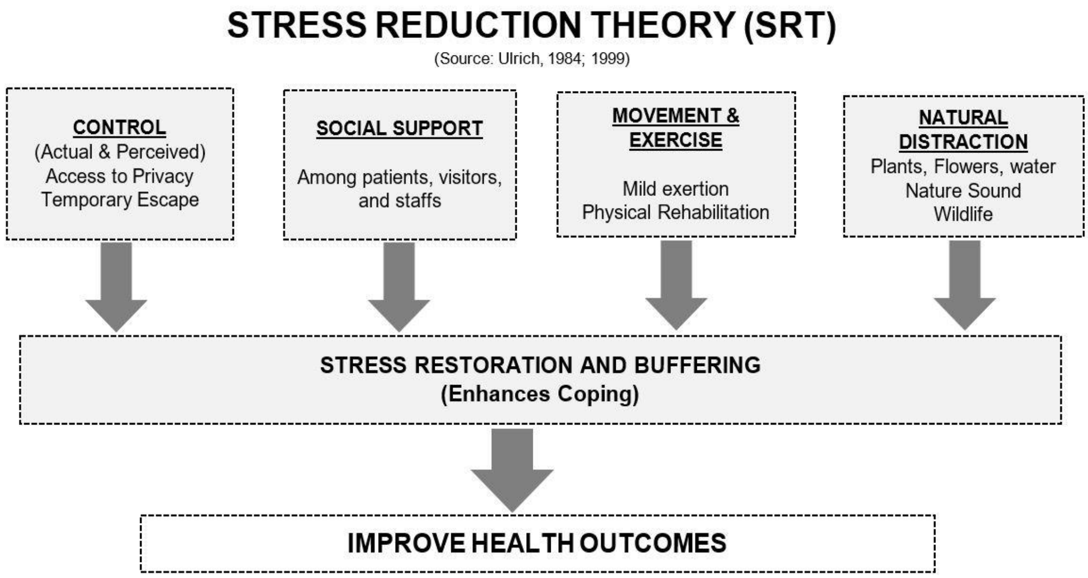


Figure 2.24: Conceptual model: Effect of garden on Health outcomes
Source: Ulrich (1999) and re-illustrated back by Author (2017).

i) Control

The first component of SRT is a sense of control. Individuals who feel a sense of control refer to people who can determine their actions and decisions that they take in certain situations and determine on what others do to them (Gatchel et al., 1989 cited in Ulrich, 1999). Research has shown that providing a sense of control can contribute to the reduction of stress levels and improve the ability to cope with stress in an individual (Evans and Cohen, 1987). People who feel a sense of control are found to be healthier compared to those who experience a lack of control (Evans and Cohen, 1987). SRT theory suggests that being in the garden or viewing nature through a window can provide a sense of control for patients, staff and visitors by having a temporary escape or being away from a stressful environment and situation. As such, it helps them to relieve their stress (Ulrich, 1999).

ii) Social support

The second component of SRT is social support, which refers to care, empathy and emotional, physical and material support that someone has received from other people (Ulrich, 1999). Ulrich (1999, p. 42) highlighted that people who received a higher level of social support experienced less stress compared to those who are often isolated and received low support from others. In addition, Cooper Marcus and Sachs (2014) described social support as also including expressing feelings to the people that they care about such as providing them with a sense of belonging to a group.

iii) Physical movement and Exercise

The third component of SRT is providing opportunity for physical movement and exercise. Ulrich (1999) emphasised that physical movement and exercise including mild movement can contribute to positive stress-reducing effects for the garden's users in the healthcare setting. There is an abundance of studies highlighting that physical movement and exercise provide both physical and emotional benefits for the perceivers (Norris et al., 1992; Blumenthal et al., 1999; Nabkasorn et al., 2006). For instance, a study conducted with an impaired older adult (e.g. patient with chronic lung diseases) reported a positive effect on the reduction on their stress level and a positive outcome in terms of their psychological change (Blumenthal et al., 1999). Further research conducted by Nabkasorn et al. (2006) also revealed that adolescent females with depressive symptoms who practiced jogging exercise reported less stress and lower levels of depression and stress hormones.

iv) Natural distraction

The fourth component of SRT is natural distraction (Ulrich, 1999). SRT theory suggests that a natural distraction such as viewing the trees, water, flowers, being in nature and listening to the sounds of nature can promote a positive emotional state in the perceiver (Ulrich, 1999). There is mounting evidence that viewing a natural scene (Ulrich 1984; Verderber and Reuman, 1987) and being in nature (Kim et al. 2009; Gonzalez et al. 2011) can promote restoration from stress for patients in a healthcare setting. In addition, several experimental control studies revealed that viewing nature can positively contribute to a stress-reducing effect in non-patient groups compared to viewing urban scenery (Ulrich, 1981; Ulrich et al., 1991). Moreover, further recent interventional studies have revealed that being in nature and viewing nature contributed to a lower level of stress hormone among the perceivers in a neighbourhood area (Thompson et al., 2012; Honold et al. 2016). Further studies also found that the sound of nature also promotes the restoration effect to its perceivers (Zhang et al., 2017; Payne, 2013; Jahncke et al., 2011; Alvarsson et al., 2010).

2.4.4.2 Attention Restorative Theory (ART)

Apart from Ulrich (1999) theory which focused more on the stress reduction in the healthcare setting (See Figure 2.25). ART suggested that the interaction with the natural environment can have positive effect in fostering recovery from the depleted directed attention capacity (Kaplan and Kaplan, 1989; Kaplan 1995). According to Kaplan and Kaplan (1989), ART focused on the two types of attentions that related to the human's brain function which include 'Direct Attention' and 'Indirect attention (Cooper Marcus and Sachs, 2014, p.28-29).

‘Direct attention’ refers to a prolonged concentration in performing a demanding or stressful task which indirectly disturbs the sensory stimuli that leads to mental fatigue. This theory suggests that the restoration process from a prolonged mental fatigue can come from ‘indirect attention’. Indirect attention is a state of mind that does not require effort to restore the mental fatigue in which (Kaplan and Kaplan, 1989; Kaplan, 1995) refer to the terms ‘soft fascination’ that facilitates mental restoration to manage anxieties and reduce stress. Kaplan and Kaplan (1989) asserted that the interaction with nature, whether directly or indirectly (by viewing or being in the garden), can contribute to positive well-being (Cooper Marcus and Sachs, 2014, p.28-29). ART characterises four basic properties for restorative settings which include: (1) Being away; (2) Extent; (3) Fascination; and (4) Compatibility.

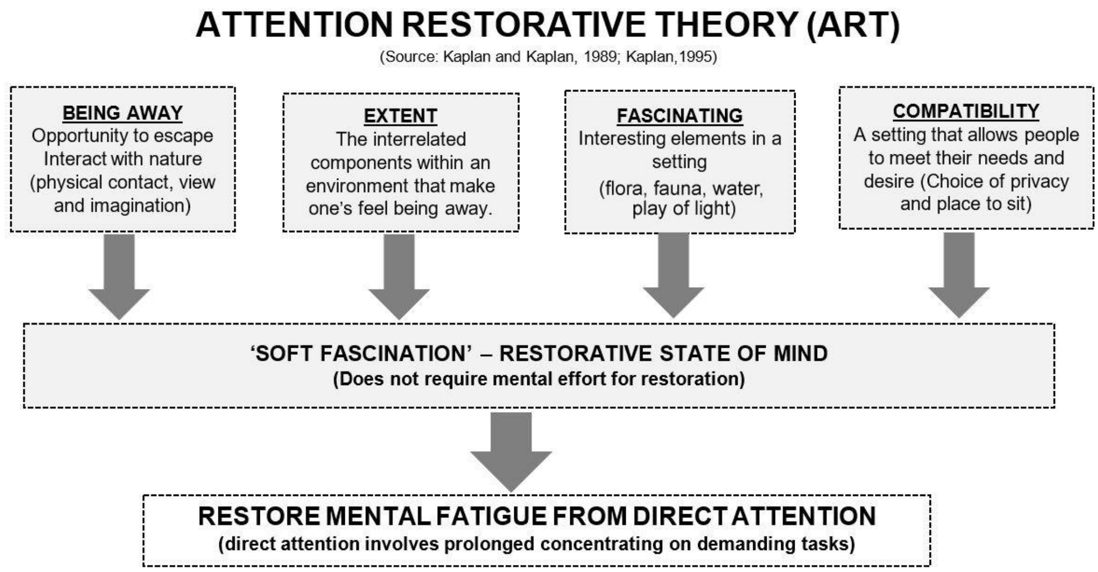


Figure 2.25: Conceptual model diagram: component of restorative environment
(Source: Kaplan and Kaplan, 1989; Kaplan 1995). Diagram is illustrated by Author (2017).

i) Being away

Being away refers to escaping from a stressful environment or situation or any source of mental fatigue. Apart from having physical contact with nature such as walking in a forest or garden, it also includes changes in visual terms, such as viewing nature or images of nature or imagining nature in one’s mind.

ii) Extent

Extent refers to the interrelated components within an environment that have all the elements that are related to one another to facilitates one’s mind to feel that they are away in which it engages their mind to foster restoration.

iii) Fascination

Fascination refers to the capability of a pleasant and aesthetical setting to hold one's mind without any mental effort. People not only tend to fascinate with the interesting things in a setting including the flora, fauna, water and the play of light but also through a process of thinking and imagining nature (Cooper Marcus and Sachs, 2014, p.28-29).

iv) Compatibility

Compatibility refers to the characteristics of the environment that have the capability to meet one's needs and inclination. For instance, the setting that allows one to have privacy and to fulfil their desire to be alone in that environment. Cooper Marcus and Sachs (2014) also described that incompatibility often happens when one's needs or desires to go outside and interact with nature are not met due to bad weather, inaccessible entrances as well as policy matters.

To sum up, both SRT and ART theory are the major focus in this study because these theories are focused on the interaction of people with nature and the effects of the natural environment in promoting restoration from stress and contributing to positive feelings through fascination and reflection. Ulrich (1999) suggested several components of the restorative environment in a healthcare setting that improved the ability to cope with stress and the emotional state of the perceiver. Additionally, Kaplan and Kaplan (1989) also highlighted several factors of restorative environments which resulted in the positive emotional responses and satisfaction of the perceivers. Thus, these theories will be used in this study as part of the formation of the framework of this study. Overall, the criteria for restorative environments are illustrated as in Figure 2.26.

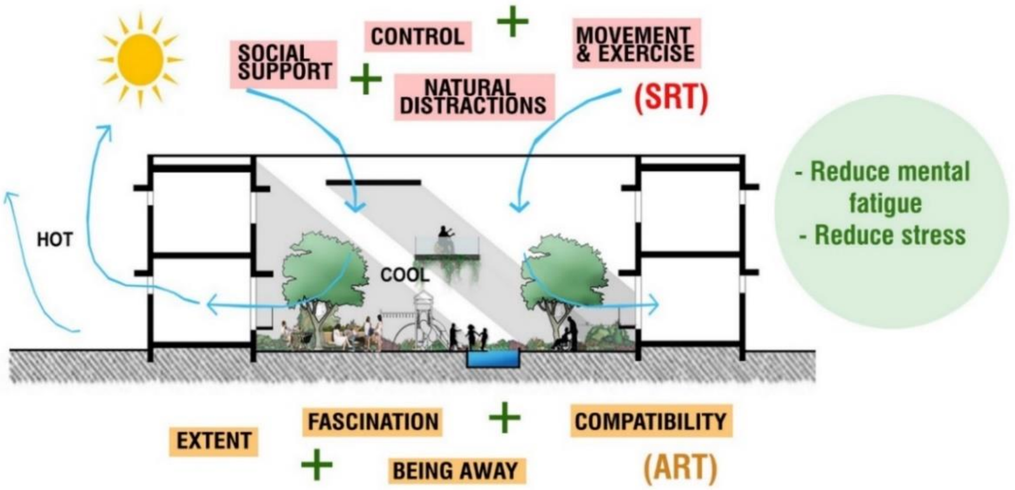


Figure 2.26: Illustration indicate the criteria for restorative environment for outdoor garden in hospital.
(Source: Author, 2017)

2.5 Summary

This chapter has reviewed the contextual and historical background of the study and highlighted the origin and significance of the integration of environmental and restorative roles in contemporary hospitals. This is useful for understanding the importance of this integration. It has also outlined the development and evolution of courtyard gardens in Malaysian public hospitals and the roles of the architect and landscape architect in the context of the current research. Further, this chapter has critically reviewed previous studies on both the environmental and restorative functions of courtyard gardens and presented the theories supporting the current study which are SRT and ART.

Overall, the chapter serves as a basis for understanding the contextual background of this study and the state of the art of the research field. It also acts as groundwork in identifying the research gap, the research methods utilised in POE restorative research and the theories underpinning this current research.

CHAPTER 3:

Methodology and research approach

3.1 Introduction

This chapter presents the methodology of the study which implemented a mixed methods and case study approach to achieve the main research aim and objectives. Next, the chapter outlines the four main research methods: i) Field investigation; ii) Survey interviews with users and non-users; iii) Participant observation; and iv) Interview with designers, followed by justification of the selected methods. The chapter subsequently explains the data collection process which included: desk study, exploratory survey study, case study selection, ethical approval and preparation of the research protocol, pilot study and preliminary study, and on-site fieldwork. The on-site fieldwork phase and its procedures are elaborated upon in detail in this chapter, and is categorised into: Phase 1: Site visit and visual analysis; Phase 2: Participant observation and on-site mapping, field measurement, survey interview with users and non-users; and Phase 3: Semi-structure interview with the architect and landscape architects. This chapter also outlines the study population and data sampling as well as the techniques of data analysis adopted for the purposes of this study.

3.2 A mixed method and case study design

For this study, a mixed methods and case study design was employed involving a combination of qualitative (personal views) and quantitative (statistical trends) data collection, in order to analyse and interpret both data sets to provide in-depth evidence for the case studies for comparative analysis (Creswell and Plano Clark, 2018, p.116). Adopting a mixed methods approach will facilitate further understanding of the prevalence of the phenomenon and responding to the research questions (Creswell, 2015, p.2); it has also been widely used in healthcare research (Östlund et al., 2011). A multiple cases study is examined together rather than individually to determine the reason(s) why certain phenomenon happens within each case study. This strengthens the findings and makes the research more robust than depending on a single case study (Yin, 2014, p.164). A close examination of each case by looking them from different perspectives is fundamental to achieving the research goal (Yin, 2014). Since this research required an in-depth understanding of the varying aspects of quality of three different case study HCGs, integration of both the objective and subjective data were necessary. In order to obtain relevant answers to the research questions, a diagnostic POE (a type of mixed methods approach) was utilised in this study as explained previously in Chapter 2, Section 2.4.3.4.

3.2.1 The methodological triangulation

The mixed methods approach is of further relevance to case study research as the **convergence of multiple sources of evidence** will allow the **triangulation of data** that can enhance the overall quality, reliability of the information and validity of the results (Creswell and Plano Clark, 2018; Flick, 2018, p.23). For the current study, the triangulation technique was used to compare and check the quantitative and qualitative results to determine whether they can be integrated to support each other and provide a more in-depth understanding on the phenomenon under study (Bryman, 2006). Figure 3.1 graphically illustrates the methodological triangulation of this study which employed multiple methods in data collection to achieve the research aim and objectives.

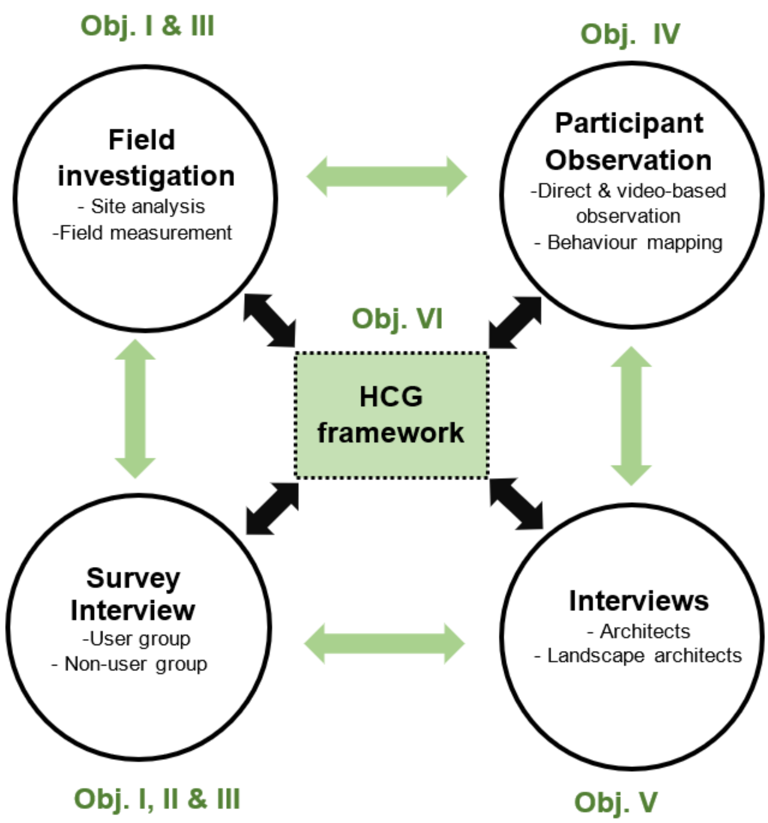


Figure 3.1: A methodological triangulation of the study.

3.2.2 A mixed methods case study design with a convergence approach

A **mixed methods case study with a convergent approach** (See Figure 3.2) was utilised in the current study (Creswell and Plano Clark, 2018, p.65). In the process of carrying out this method, some of the quantitative and qualitative data were collected concurrently, for example, participant observation and field measurement were conducted at the same time as the survey interviews with the HCG users (See section 3.4.6 for further explanation on the phase of data collection). The interviews with the designers were done off-site at a time convenient to the participants. Following that, a separate analysis was carried out for each qualitative and quantitative data of the three case study sites. Further, the results were merged to determine to what extent the results contradicted or related with each other. Finally, the findings were interpreted in order to address the research question.

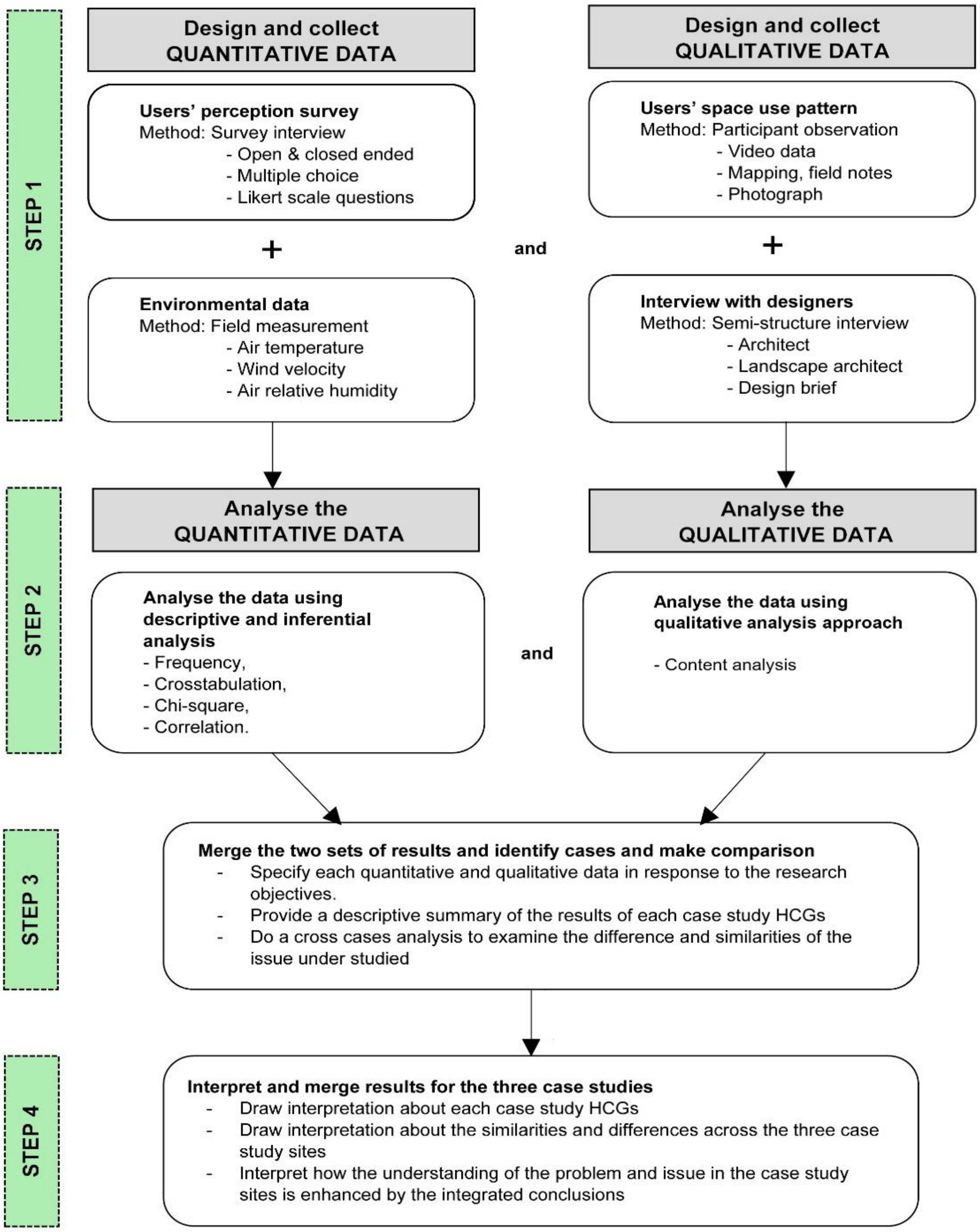


Figure 3.2: Flowchart of the mixed methods case study design with a convergence approach utilised in the current study

(Source: Author adapted from Creswell and Plano Clark, 2018, p.119)

3.3 Research methods and their justification

For this study, several methods were employed which include: **i) field investigation; ii) participant observation and behaviour mapping; iii) survey interview with users and non-users; and iv) interview with the architect and landscape architect.** These methods were utilised for this study due to the relevance of answering the research questions, and have been developed and improvised based on the methods used by previous researchers in POE restorative gardens in healthcare facilities (As discussed in Section 2.4.3.4).

3.3.1 Field Investigation: Site analysis and field measurement

The first method is the field investigation which includes: the site analysis and a field measurement. **A site analysis** is pertinent to be conducted particularly in case study research as it facilitates the process of identifying, exploring and evaluating the physical characteristics of the case study site. This method is fundamental in defining the limits and parameters of the study. Site visual analysis has been utilised by numerous researchers in the landscape field as part of observational studies (e.g. Jiang et al., 2018; Sachs, 2017; Adnan, 2016; Shukor, 2012; Davis, 2011; Asano et al., 2008; Naderi and Shin, 2008; Cooper Marcus and Barnes, 1995). Several important aspects require special attention in conducting the visual analysis which includes: (1) Mapping of the physical design features; (2) Circulation and orientation; (3) Views into and out of the garden; (4) Microclimates within the garden; (5) Sensory qualities; (6) Opportunities for social interaction; (7) Opportunities for privacy; and (8) Aesthetic and spatial elements (Cooper Marcus and Barnes, 1995). A field-based site investigation also involves a sensory exploration of the site including a site visit, taking photographs and making notes on the physical condition of the site (Reid, 2012).

In addition, **a field measurement** of the microclimatic conditions of the site were also conducted in this study. Previous research in a hot humid climate highlighted the importance of recording the microclimatic conditions of the site in order to assess users' perceptions on thermal comfort whilst in the outdoor garden (Ghaffarianhoseini et al., 2019; Kubota et al., 2017; Makaremi et al., 2012) and in the open space within an urban area (Sharmin and Steemers, 2018; Yang et al., 2013). Several important parameters of microclimatic conditions highlighted by previous researchers studying courtyard typology buildings include: the air temperature, air relative humidity, and wind velocity (e.g. wind direction and speed) (Ghaffarianhoseini et al., 2019; Kubota et al., 2017; Makaremi et al., 2012).

3.3.2 Participant observation and behavior mapping

The second method utilised in the current study is **participant observation** which involved direct and video-based observation. In general, effective participant observation requires the researcher to have skills to attend to details and an impeccable memory capacity that is necessary in taking note of the spatial arrangement of the site, the atmosphere and the overall activities happening within the spaces (e.g. the occurrences of the specific activities, the movement of the people in a scene and people's interactions within the site) (Spradley, 2016; Kawulich, 2005). Nonetheless, in some cases, memorising and recording multiple activities that occur at the same time can be quite a challenge. Cooper Marcus and Barnes (1995) acknowledged that several activities have been missed out during behavioural observation studies because the fluctuation of the activities that occurred at the sites could not be captured by the researchers solely based on direct observation.

Therefore, **video-based field observation** can be referred to as an effective solution to collect the data of the ongoing interactions between people in a specific context, suitable with the method's aims to overcome the limitation imposed by self-observation and therefore minimising the numbers of unrecorded activities. In addition, the solution of utilising video recording recording as a tool in conducting an observation of a particular scene also brings to light several advantages of the video (Jewitt, 2012, pp.5-8). In terms of durability, video data can be kept over a period of time, can be repeatedly viewed and the data can be revisited for further use and analysis in the future. Moreover, technical competencies in multi-tasking and handling the equipments are fundamental when carrying out observations using cameras or digital devices to avoid errors in the data collection process (Mason, 2018, p.177).

In addition to video recording, other data collection techniques including **on-site mapping and field notes**, were used as part of the observation techniques here to monitor on-site activities that were unnoticed during filming because of the unexpected barrier triggered during the fieldwork. Whyte and Whyte (1984) highlighted the importance of mapping the physical and social scene in the observational study. This step is very crucial as this study does not only involve mapping the layout of the site and the on-going activities happening on site but it also trains the researcher to better focus on the details of the on-going activities which will eventually provide a better understanding of the social relations within the scene. In the environmental behaviour research field, observation and behaviour mapping are well-established techniques that are useful in examining peoples' behaviours and interactions with the physical environment (Ng, 2016; Ittelson et al., 1970). In addition, **field notes** also act as a supplementary technique in the observation study. Furthermore, this technique also develop important skills and serve as training for the researcher to improve their memory capacity and observational skills (DeWalt and DeWalt, 2011, pp.87-89). This is done by constantly taking note of the details regarding the nature of on-site activities and the behaviour of people involved throughout the fieldwork.

3.3.3 Survey interview with the courtyard users and non-users

The third method is **interview survey with the users and non-users**. The survey interview of HCG users includes those sitting and spending time in the HCG. A survey interview with the users was planned and carried out to facilitate answering research questions 1, 2, 3, and 4. The survey interview method was deemed the most suitable method as it has a proven ability to provide valid data, as evidenced by several researchers in the landscape field who utilised the survey method to assess the quality of restorative outdoor gardens in healthcare facilities (Cooper Marcus and Barnes, 1995; Whitehouse et al., 2001; Said, 2005; Sherman et al., 2005; Shukor, 2012; Pasha, 2013).

Survey research is essential for this study in order to understand people's attitudes, trends, and opinions by studying a representative sample of the population; it also provides the necessary quantitative data as part of the case study evidence (Creswell, 2015). In addition, a survey research approach has two optional techniques for data collection: survey questionnaire and survey interview. A survey interview is also a part of a case study interview as the technique can be in the form of an open-ended survey (Yin, 2014, p.112). The type of questions are specifically designed to obtain the views and opinions of the respondents.

Furthermore, it is also important to note that this study also collected data from non-users to avoid bias in the sample selection. This issue has been singled out by Cooper Marcus and Barnes (1995) and Shukor (2012) regarding the importance of the perceptions of non-participants. Non-users' participation is necessary to avoid any bias in the process of data collection and subsequent reporting.

The photo elicitation technique was also utilised in the open-ended survey questions to enable users to provide an explanation on their perceptions and preferences of the landscape elements through the HCG photograph. This technique has been utilised by Butterfield (2014) in previous research of POE restorative gardens in which an interview using photo elicitation supplied the necessary opinion from the respondent about their feelings and perceptions of the outdoor garden in healthcare facilities.

3.3.4 Semi structured interview with the architects and landscape architects

The fourth method is a **semi-structured interview with architects and landscape architects.** The interview with the designers of the HCGs is one of the techniques that will be implemented to address the fifth research question. In this study, a semi-structured face-to-face interview will be used to interrogate the designers of the courtyard of the hospitals to examine their initial plan and matters that were taken into consideration in the process of designing the courtyard of the hospital. Yin (2014) highlighted that interviews are an important part of the case study evidence. Conducting interviews results in the ability to generate meaningful knowledge in understanding the issues studied; this involves several engaging tasks: observing, listening, and recording (Mason, 2018, p.125). A semi-structured interview is an interrogation method in which the questions are predetermined by the researcher (Yin, 2014).

The structure of the research however can be modified, and the designed question can also be removed or changed during the interview session as appropriate (Yin, 2014; Silverman, 2014). The flexibility given to researchers in handling and manipulating the questions allows more freedom of discussion when interacting with the interviewee to explore the relevant issues of the study. For example, several researchers conducted interviews with the designers including the architects and landscape architects involved in the garden design of healthcare facilities to understand their design intentions and gain insight into the design of the respective gardens (Jiang et al., 2018; Sachs, 1999; Naderi and Shin, 2008; Davis, 2011; Butterfield, 2014).

3.4 Process of data collection

The process of preparing and commencing data collection involved several stages. Initially, the research started with the preparation of the fieldwork which involved several stages: i) desk study on the literature review and secondary data; ii) Exploratory case study survey; iii) Case study selection; iv) Ethical approval and research protocol; and v) Pilot study (UK) and preliminary study (Malaysia) (See Figure 3.3). After improvement of the instruments and research protocol were made, the on-site data collection phase were carried out which divided into three phases: Phase 1: Site visit and visual analysis; Phase 2: Participant observation and on-site mapping, field measurement, survey interview with users and non-users; and Phase 3: Semi-structure interview with the architect and landscape architects. This is elaborated further in the following subsections.

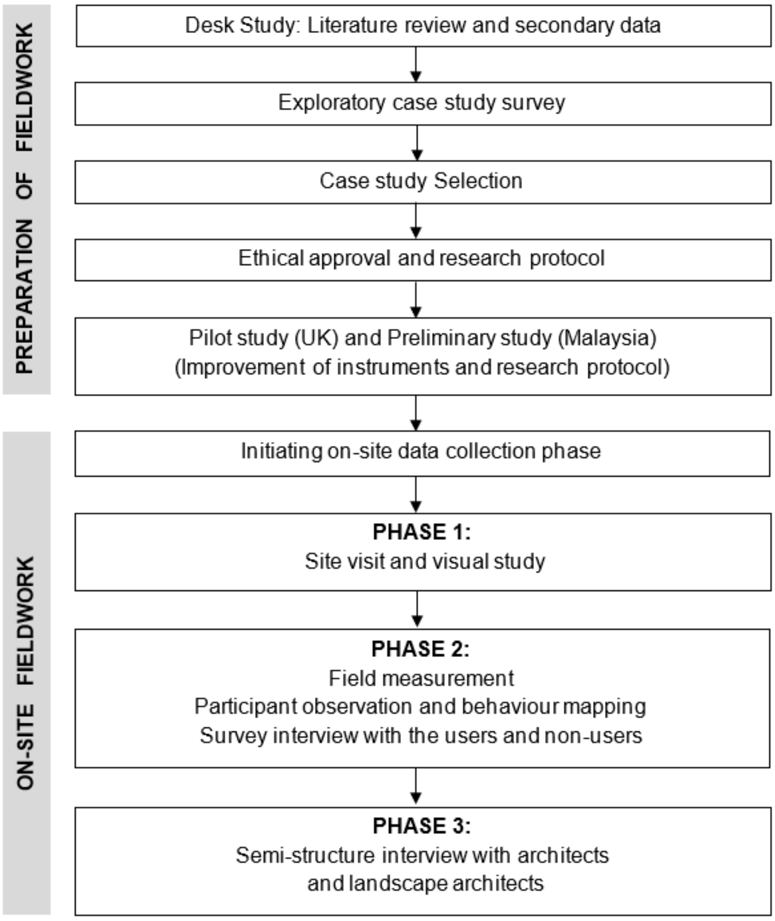


Figure 3.3: Flowchart of a data collection process

3.4.1 Desk Study: Literature review and secondary data

The first stage of the data collection included conducting a desk study comprised of a literature review and secondary data. Extant (past and recent) studies were critically reviewed to look at the research context, research gaps and methods of study used by previous researchers in related fields of study. This was carried out to build up an understanding of the issues pertaining to the provision of courtyard gardens in Malaysian hospitals and to find out what improvements can be made.

Moreover, understanding and critically reviewing the different methods used by previous researchers in similar studies facilitated establishing the research framework and methods for this study. The literature review ranged from building and environment, environmental psychology, environmental health and landscape studies. In addition to the desk study, secondary data from the MOH, including a list of all hospitals in Malaysia, were collected and reviewed to identify the potential case study hospitals designed with courtyard designs. Furthermore, architectural drawings from architects were collected for a preliminary spatial analysis of different types of courtyards and the type of functional spaces that are clustered around them.

3.4.2 Exploratory case study survey

During this stage, an exploratory survey was completed to explore a number of government hospitals in Malaysia which incorporated a courtyard in the hospital planning. A total of **142 government hospitals** in Malaysia including district hospitals, state general hospitals, national referral hospitals and special institutions had were studied to examine their overall layout and to identify the related characteristics that are necessary to this study (MOH, 2016). Based on the exploratory survey analysis, several hospitals built between 1990 and 1998 were determined to contain a similar type of open type courtyard which is not the focus of the current study. This type of open courtyard was excluded for the case study selection because it was an old type hospital, a low rise and a small-scale hospital which adapted the UK Nucleus hospital template (See Appendix 7). Moreover, these hospitals were built by the contractor through a turnkey project and managed by the PWD. As such, no landscape architects were employed to design the hospital garden.

After examining the HCG typology in 142 hospitals, the researcher limited the selection of the case study to **10 government funded public hospitals** in Malaysia (See Appendix 8) with courtyard gardens that were built from 1998 in response to a new regulation (still in place) making gardens a compulsory component in the planning of the hospital (MOH, 2013 cited in Shukor, 2007). Furthermore, these hospitals were designed by private architects and landscape architects through a design and build procurement process, which is an important aspect for the current study to examine their design intentions and assumptions regarding HCG design and planning in Malaysia (this will be further discussed in Chapter7). Out of 10 potential case study hospitals, three case studies have been chosen according to the selection criteria which are listed and described further in the next section.

3.4.3 Case study selection

The selection of the case studies was based on **making sure that all types of closed courtyard gardens configurations are represented in the sample of hospitals.** Considering the feasibility of the case study sites, time constraints and budget, the research focus was restricted to the geographic area of **Peninsular Malaysia** and to **State Government hospitals** with the **number of beds ranging from 500 to 700.** This type of hospital was categorised as a State Specialist Hospital. The selection of the three case studies is geographically spread, ranging from the Northern, Central and Southern parts of Peninsular Malaysia. The three case study hospitals are: H1-hospital, H2-hospital and H3-hospital (See Figure 3.4).

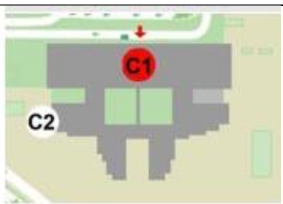
Figure 3.4: Location of the three case study hospitals: H1, H2 and H3.

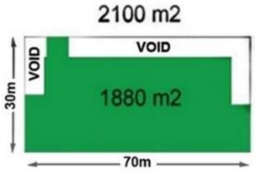
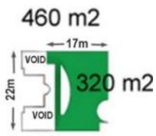
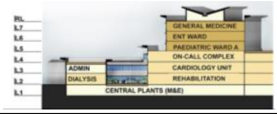
The case study hospitals have been selected according to the following criteria:

- Courtyard design configuration;
- Size and location of the courtyard within the building;
- Year of operation;
- Function of the spaces clustered around the courtyard; and
- Height of the wall surrounded the courtyard.

Table 3.1 presents a summary of the selection criteria for the three case study hospitals. Out of a total 13 HCGs in the three case study hospitals, three representative samples of the case study HCGs were selected (H1-C1, H2-C3 and H3-C2) based on several criteria: the accessibility; types of users; level of occupancy; feasibility for the subjective assessment study; the character of the sites; location and space function. These criteria will be elaborated further in Chapter 4.

Table 3.1: The matrixes and criteria selection for the case study hospitals

CASE STUDIES	H1- HOSPITAL	H2 - HOSPITAL	H3- HOSPITAL
Types of HCG	**A large central courtyard garden**	**An interlinked type courtyard garden**	**A clustered type courtyard garden**
Year of operation	2007	2005	2007
Site area	50.58 acres	60 acres	40 acres
Total floor area (hospital block)	105,417m²	129,000m²	77,940m²
No. of beds	704	620	550
Floor plan			
Total no. of HCGs	1 enclosed courtyard 1 semi-enclosed courtyard	4 enclosed courtyards 3 semi-enclosed courtyards	4 enclosed courtyards

<table>
<tr><th>Selected case study HCGs</th><th>H1-C1
</th><th>H2-C3
</th><th>H3-C2
</th></tr>
<tr><td>Total area of the case study</td><td>
</td><td>
</td><td>
</td></tr>
<tr><td>Height of the wall from the HCG ground</td><td>9 floors
</td><td>2, 3, 6 floors
</td><td>3 and 7 floors
</td></tr>
<tr><td>Location</td><td>• Level 2
• Main hospital street</td><td>Level 2
• Next to the main hospital street</td><td>Level 2
• Next to the main lobby</td></tr>
<tr><td>Space function</td><td>• Cafeteria
• Specialist clinic
• Auditorium
• Clinical research centre
• Visitors' centre
• A & E department
• Imaging department
• Forensic department</td><td>• Rehabilitation centre
• Dialysis centre</td><td>• Main lobby
• Specialist clinic
• Cafeteria
• O&G department
• Paediatric department
• Admission office
• Pharmacy unit</td></tr>
</table>

3.4.4 Ethical approval and preparation of study protocol

The UK pilot study and the actual study in Malaysia were carried out after obtaining an approval from the Research Ethics Committee of the School of Architecture in April 2017 (See Appendix 5). Approvals from the Medical research ethic committee (MREC) committee board under the Malaysian MOH, the Economic Planning Unit (EPU) committee board and the respective hospital directors were also obtained prior to starting the actual fieldwork (See Appendix 6). Preparation for the research protocols dealing with the ethical boards and discussion with the respective hospital directors were conducted prior to the commencement of the preliminary pilot study in H3 hospital and the fieldwork in all the three case study hospitals. Fieldwork was first conducted in the H3 hospital followed by H2 and H3 between January to March 2018 (i.e. H3-hospital received earlier approval from the hospital manager).

Additionally, the researcher also applied for approval from the MREC for two alternatives case study hospitals (H4 and H5) while waiting for confirmation for access approval from the H1 hospital managers. Approval for the alternatives hospitals was obtained in February 2018 (See Appendix 6). Following discussion with the deputy hospital manager explaining the research protocol, access clearance was obtained in March 2018 and the fieldwork carried out prior to gatekeeper approval. An extensive amount of time was involved in the process of getting approval from several bodies in Malaysia (e.g. MREC boards, EPU boards, the Clinical Research Centre (CRC) and the hospital managers).

3.4.5 Pilot study and preliminary study

A pilot study and a preliminary study were conducted prior to the actual fieldwork. The pilot study was conducted in the Firth Court building, Sheffield, in order to familiarise and check the practicality of the equipment for video-based observation (2 hours recording time) and to pilot test the survey questions. Several issue and problems were encountered in the pilot test of the video recording and an improvement in the techniques for video-recording and the survey questions were made (See Appendix 10).

A preliminary study was conducted at the H3 hospital with the aim to test all the methods utilised in the current study before the actual fieldwork were carried out. This included testing the practicality of the video-based observation (98 hours of recording time from 9 am to 5 pm) and the equipment for the field measurement as well as improving the survey technique and survey questions. Several improvements were made to the protocol for video-based observation, the technical issue of the field measurement, and enhancing the surveys questions and techniques of inquiry information from the participant (See Appendix 11).

3.4.6 Actual fieldwork phase and procedures

The data collection process was divided into three phases (See Figure 3.5).

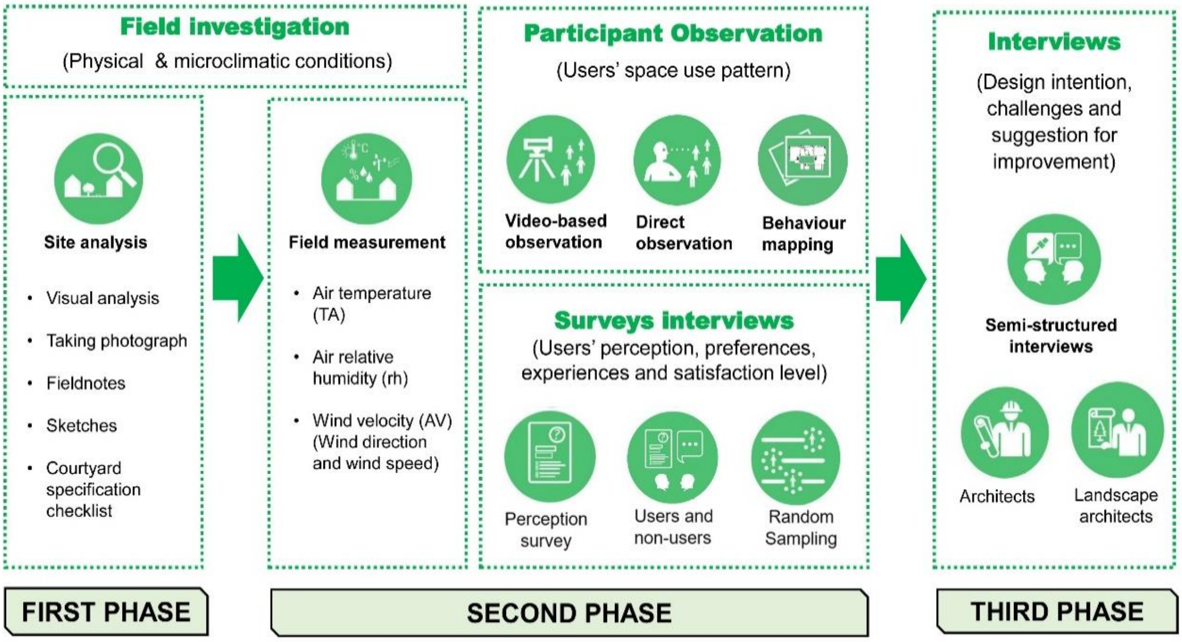


Figure 3.5: Fieldwork phase

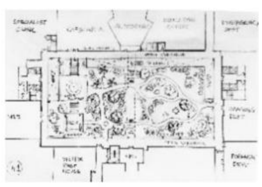
The first phase (Phase 1) is field investigation. In the second phase (Phase 2), the field measurement, participant observation and the video recording as well as the interview surveys were run simultaneously from 9 am to 5 pm for two weekends and two weekdays. The third phase (Phase 3) is the interviews with the designers.

3.4.6.1 Phase 1: Site visit and visual analysis

Phase 1 of the study focused on the initial fieldwork which involved the preparation of the technical procedures in each of the case study sites to ensure the practicality of the instrument to be used with the representative sample of the case study population. Therefore, several walkthrough observations and site analysis in all of the HCGs in the three hospitals were conducted in order to set the limits and parameters of the study. As explained earlier in Section 3.4.5, the H3 hospital was the first hospital visited, followed by H2 and H1 after obtaining access permission from the hospital manager. All 13 HCGs in the three case study hospitals (H1, H2 and H3) were observed in terms of usage, accessibility and the practicality to conduct the field measurement study, which should be taken into consideration before deciding the best representative case study HCG for an in-depth diagnostic POE.

During the site visit to all three sites, the procedures and protocols for video recording were discussed further with hospital management to ensure it followed the requirements set by the hospital and MREC ethical approval. Carrying out a site analysis provides the researchers with the ability to familiarise themselves with the sites (i.e. the space function, physical barriers on-site and hospital operation hours) to further plan fieldwork procedures including video-based observation, field measurement and survey interviews. Additionally, the physical conditions of the sites (e.g. aspect ratio (W/H), orientation, location and landscape features) were also observed and recorded in the checklist of HCG specifications (See Appendix 12). Field notes and sketches of the layout plan of all thirteen HCGs were also carried out during the fieldwork (See Table 3.2).

Table 3.2: Field notes and sketches during the on-site fieldwork

The researchers do sketches during the on-site fieldwork	Sample of sketches		
	H1-hospital	H2-hospital	H3-hospital
	 H1-C1	 H2-C3	 H3-C2

3.4.6.2 Phase 2: Participant observation and behaviour mapping

During the initial on-site fieldwork, an 8 hours observation (9 am to 5 pm) was carried out in all 13 HCGs in the three case study hospitals. Video-recording and field measurement were also conducted in these HCGs. However, after examining the initial results from the observation of all sites (e.g. level of occupancy, courtyard form, accessibility and physical features) (Discussed further in Chapter 4), and considering the time constraint and limitation of the resources, an in-depth investigation and data analysis were only conducted at three selected representative case study HCGs (H1-C1, H2-C3 and H3-C2).

i) The in-depth investigation at the three representative sample of HCGs

The fieldwork in the three representative HCG samples spanned approximately one week for each of three case study sites, from 9 am to 5 pm per day. Video recording and field measurement were conducted simultaneously during two weekends and two weekdays. It is important to note that, due to the extensive amount of time required to analyse the video data, only one weekday and one weekend daily data (a total of 16 hours in each case study HCG) were analysed and discussed further in the study.

Another two sets of daily video data in each case study HCGs were excluded due to time constraints. Further, some of the excluded data were the long raining hours which highly affected the normal pattern of on-site activities. Due to the limitations of time, budget restrictions for accommodation and travel expenses as well as the short period of access permission granted in each of the case study sites, video recording and field measurement could not be rescheduled to obtain another set of data (i.e. the data without the raining time). However, an in-depth analysis of a total of 48 hours observation in all three sites, and additional information related to users' activities gathered from the survey interviews with the HCG users, achieved research objective 2 (See Chapter 6, Section 6.4).

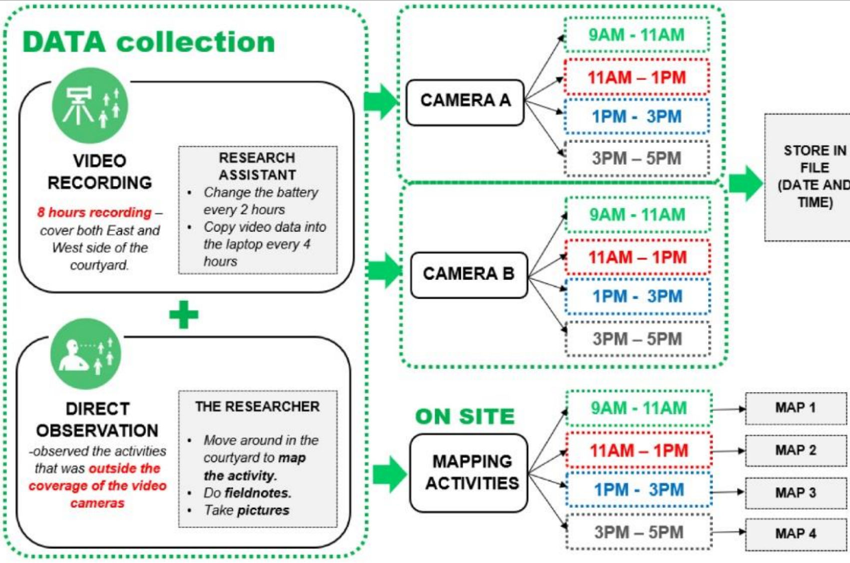
ii) Procedure of the video-based observation and direct observation.

Both video-based observation and direct observation were utilised in the current study to ensure robust and accurate observational data. The purpose of the participant observation was to investigate the space use pattern among the different types of users: patients, staff and visitors. The users' observations were conducted during a total period of two weekdays and two weekend days listed as follows: 9 am-11 am (2 hours), 11 am-1 am (2 hours), 1 pm-3 pm (2 hours) and 3 pm-5 pm (2 hours). During the study, two video cameras fixed on a tripod were placed at the corner of the courtyard area to capture the whole scene of the users' activities in the courtyard (See Table 3.3). These video cameras were run simultaneously at similar recording time of a total 8 hours per day. At the same time, direct-observation and mapping of the hidden activities (out of video coverage areas) were conducted by the researcher. These also included activities such as taking photographs and fieldnotes.

Table 3.3: The procedures of the direct and video-based observation

Equipment 1

Equipment 2



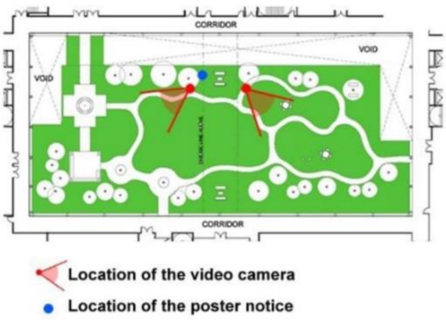
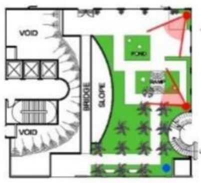
Equipment 1:

A video camera fixed on a tripod located at the corner of the HCG (i.e. where it could not be directly seen by the users)
Additional equipment: Eight lithium batteries, two 32GB memory cards.

Equipment 2:

A poster notice was placed in the HCG to inform HCG users that they have been video recorded for the purpose of the current study. The researcher's contact number was also provided in case they wanted to make further inquiries about the research.

Location of the video cameras in the representative HCGs

H1-C1	H2-C3	H3-C2
		

It is important to note that the investigator needs to be on-site at all times and this was discussed and agreed with the hospital manager to ensure the safety of the research equipment. One research assistant was hired and trained to safeguard the video camera and to ensure the workability of the video observation throughout the fieldwork. The task of the research assistant included changing the battery (at two hour intervals) and transferring the video data onto the laptop (at four hour intervals) to ensure the effectiveness of the video cameras in capturing the on-site activities.

iii) Ethical concern of the video-based observation and direct observation.

Concerning the ethical issues in video recording, the researchers notified the HCG users via a poster notice which was placed in the HCG regarding their participation that they have been video recorded for the purpose of the current study. Moreover, the video cameras were placed at a certain distance from the subjects, in order to prevent unintentionally capturing identifiable images of the participants and thus preserving their anonymity (Wiles et al., 2008). Additionally, snapshots of the video data used in the current study were masked and blurred to protect the identity of the HCG users.

iv) On-site behaviour mapping

For the H1-C1, which is four times larger than the other case study sites, some of the area in H1-C1 (at the centre and periphery of the HCG, behind the large trees and column) could not be captured by the video cameras (See Figure 3.6). Therefore, the hidden users' activities which lay outside the coverage of the video camera were mapped manually by the researcher. Each symbol representing the activities were mapped onto the floor plan printed on A4 paper (at two hour intervals) according to different types of users (patient, staff and visitors). The graphical symbol of activities used in the on-site mapping were adopted from Goličnik and Ward Thompson (2010) (See Table 3.4).

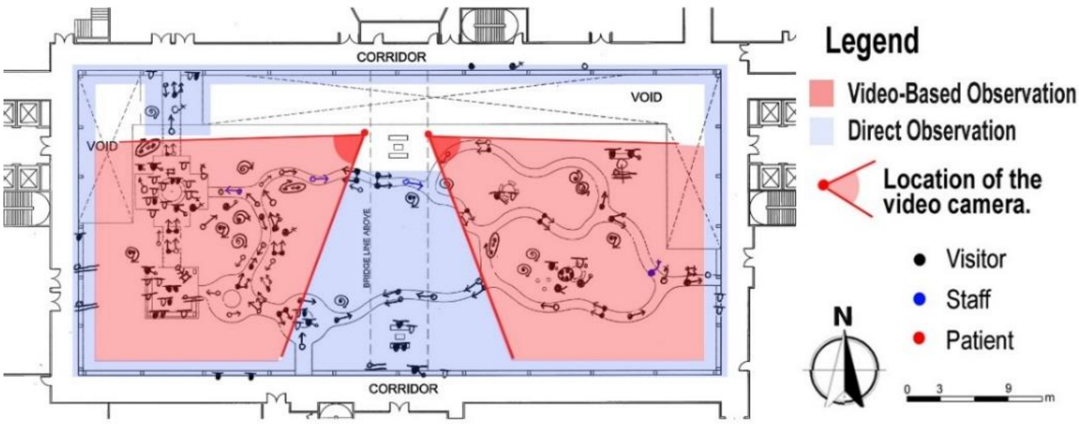


Figure 3.6: The area for video-based observation and direct observation carried out in H1-C1

Additionally, the photo of the activities (i.e. recorded with the date and time) were also taken during the direct observation for further references during the analysis stage. The process of analysis and integration of the on-site mapping and Geographic Information System (GIS) mapping techniques and analysis were explained further in the following Section 3.6.3.

Table 3.4: Graphical symbol of users' activities used in behaviour mapping

m	f	Activity	m	f	Activity	m	f	Activity
		1. Sitting			11. Walking around			21. Standing - Look around
		2. Sitting on a bench			12. Walking-pass through			22. Standing and use a phone
		3. Sitting around a table			13. Walking with a child			23. Standing and holding a baby
		4. Sitting and use a phone			14. Walking and holding a baby			24. Laying down on a bench
		5. Sitting and sleeping on a bench			15. Walking in pair			25. Laying down under the tree
		6. Sitting in pair			16. Walking in group			26. Reading book / newspaper
		7. Sitting in group (>2 people)			17. Walking with a pram			27. Eating and/or drinking
		8. Sitting on a wheelchair			18. Walking and use a phone			28. Playing
		9. Sitting and holding a baby			19. Walking with a wheelchair user			29. Playing in pair
		10.Sitting with a child			20. Standing			30. Playing in group (>2 people)

(*Source: Author, 2018 adopted from Golicnik and Ward Thompson, 2010)*

3.4.6.3 Phase 2: Field measurement

Additionally, in Phase 2, the field measurement were carried out simultaneously during the survey interview with the HCG users and video recording. The environmental data in the HCG is fundamental in order to further compare the microclimatic conditions between the three case study HCGs (See Section 6.2.1). The reason for this was to examine the association between the users' perceptions of thermal comfort in the HCG with the microclimatic conditions of the case study sites (See Section 6.2.2). The Aercus WS3083 Professional Wireless Weather Station was used to record air temperature (TA), air relative humidity (rh), and wind velocity (AV) (e.g. wind speed and wind direction). It was fixed on a tripod 1.1m above the ground in the HCG. It also was set to record every 15 min between 9.00am and 5.00pm over a period of two weekdays and two weekends. Additionally, a portable environmental meter was used to record TA and rh around the participants. The measured data was recorded on the survey paper preceding the survey interview with the HCG users (See Figure 3.7).

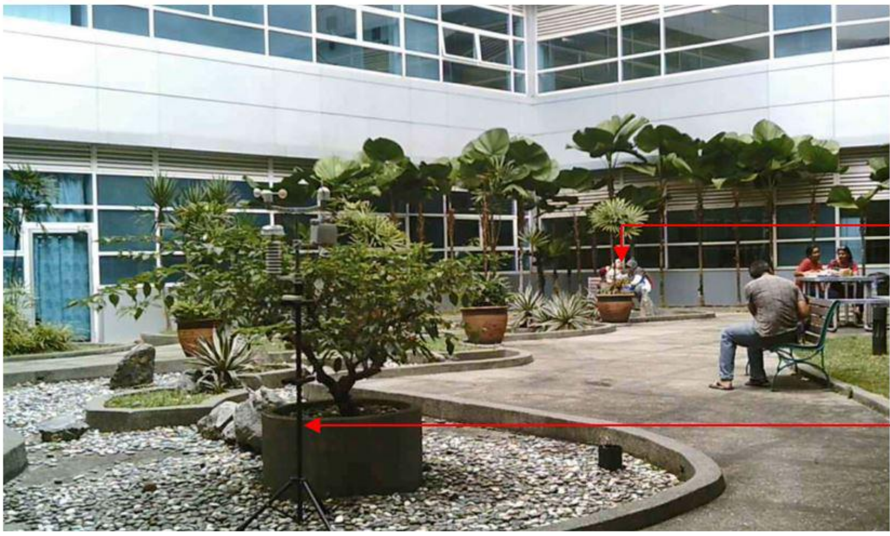


Figure 3.7: The location of the Aercus WS3083 Weather Station in H2-C3

Prior to the fieldwork, the researcher also approached two universities in Malaysia to borrow additional HOBO loggers for the research. However, due to the limited sources of funding to pay for the lending fee from the respective Universities, the research was limited to using only the equipment borrowed from the University of Sheffield and the supervisor, and used the researcher's own funding to buy the weather station. Table 3.5 shows four types of equipment used in the study. It also describes the number of equipment, functions, types of data measurement, sensitivity, resolution, sources of equipment and references based on the previous study. A detailed specification of equipment used in this study can be found in Appendix 15.

Table 3.5: The equipment used to record the environmental parameter of the site.

A portable environmental meter	**Data-loggers (HOBO-U12-012).**	**Aercus WS3083 Professional Wireless Weather Station**	**Data-loggers (HOBO-UA-002-64)**
			
No of equipment: 2	**No of equipment:** 2	**No of equipment:** 1	**No of equipment:** 3
Function: It was used to record the air temperature and air relative humidity **around the area participants sit** in the HCG.	**Function:** It was used to record a **backup measurement data** in case any error of the data from the weather station or other Hobo lodgers.	**Function:** It was used to record the **environmental data in the HCG** (e.g. air temperature, air relative humidity and wind velocity).	**Function:** It was used to record the **air temperature in the HCG** and **outside the hospital.**
Location: It was placed next to the respondents to measure the temperature and humidity preceding the survey interview. 	**Location:** It was attached onto the tripod of the weather meter station at 1.1m above the ground level. 	**Location:** It was placed at the centre of the HCG, fixed on a tripod at height 1.1m from the ground 	**Location:** **In the HCG:** It was mounted onto the tripod of the weather station at 1.1m **Outside the hospital:** It was mounted on a small tree located outside the hospital building (1.3m above the ground level). See Figure 3.8 for a location of the Hobo loggers in the H2-C3 and outside of the H2 hospital. See Figure 3.9 for a location of the equipment in all case study sites.

It can measure: - Air temperature (TA) - Relative humidity (rh) - Sound (dB) - Light (Lux)	**It can measure:** - Air temperature (TA) - Air relative humidity (rh)	**It can measure:** - Air temperature (TA) - Relative humidity (rh) - Wind speed - Wind direction - Rain level	**It can measure:** - Air temperature (TA) - Light intensity
Measurement range: Temperature: -20°C to +750°C (-4°F to +1382°F) Humidity: 25% to 95% RH	**Measurement range:** Temperature: -20° to 70°C (-4° to 158°F) Humidity: 5% to 95% RH	**Measurement range:** Temperature: -40°C to +60°C Humidity: 10% to 99% Wind: 0 - 160 kph	**Measurement range:** Temperature: -20° to 70°C (-4° to 158°F) Light: 0 to 320,000 lux (0 to 30,000 lumens/ft2)
Sensitivity: It has a fast measurement rate (1.5 times per second). It has score professional application for professional use.	**Sensitivity:** It provides 12-bit resolution measurements for detecting greater variability in recorded data, and stores 43,000 measurements.	**Sensitivity:** It can be used to record indoor and outdoor environmental data. It is water resistant. Waterproof level: IPX3	**Sensitivity:** It can be used indoor, outdoor, and underwater environment (Water resistant). It can store 51,000 measurements of 10-bit readings.
Resolution: Temperature: 0.1°C/ 1°C, 0.1°F / 1°F	**Resolution:** Temperature: 0.03°C at 25°C (0.05°F at 77°F) RH: 0.05%	**Resolution:** Temperature: 0.1°C	**Resolution:** Temperature: 0.14°C at 25°C (0.25°F at 77°F)
References: Zhang (2007) – A similar equipment was used to record the environmental data (e.g. light level, noise level, temperature and humidity) preceding the survey with users in office building.	**References:** Jamaludin (2014) – A similar logger was used to record indoor climatic measurements in the student bedroom. Palma (2015) - A similar logger was used to measure temperature and humidity in the lobby of an educational building.	**References:** Geoghegan et al. (2014) – A similar type of AERCUS WS3083 weather station was used to record environmental data of an outdoor area. Almhafdy et al. (2014) - A data logger weather station named PortLog was used to measure environmental data in the HCG.	References: Blumroeder et al. (2019) and Chaput and Gajewski (2014) – A similar logger was used to measure daily outdoor air temperature (it was mounted on a small tree). Sibley (2018)- A similar logger was used to measure light level in Hammam (Public bath). It was installed on the wall.
Source of equipment: The School of Architecture, University of Sheffield		**Source of equipment:** Researchers' own funding	**Source of equipment:** Supervisor

i) Location of the equipment in the HCG and outside the hospital

Additionally, the air temperature inside and outside the hospital area were also recorded using the Data-loggers. It is vital that the air temperature outside the hospital is compared with the air temperature inside the HCG to examine whether the courtyard has a significant impact in mitigating air temperature in the HCG (Discussed further in Chapter 6, Section 6.2.1.4). It should be noted that the data measurement outside the hospital is only an additional data point that helped to strengthen the findings. The main objective of this study is essentially to focus on the assessment of the microclimate and users' thermal comfort in the HCG.

For the data measurement in the HCG, the loggers (HOBO-U12-012 and HOBO-UA-002-64) were mounted onto the tripod of the Weather Meter Station at 1.1m above the ground level (recorded every 15 min between 9.00am and 5.00pm) (See Figure 3.8). The HOBO-U12-O12 was used as a back-up measurement in case there was an error in HOBO-UA-002-64.

Regarding the data measurement outside the hospital, initially the researcher planned to mount the HOBO-UA-002-64 on the wall at the entrance of the hospital. However, due to security concerns regarding the placing of such equipment in the public area and the lack of research assistants to monitor the equipment throughout the day, the researchers subsequently decided to mounted the Hobo loggers on a small tree (1.3 metres above the ground level) outside the hospital building. The main reason for this location (at a secluded place away from the high traffic zone area) was to ensure the safety of the equipment while researchers carried out fieldwork in the HCG. Similar standard procedures were used in the selection of the location of the hobo logger inside and outside the hospital in all the three sites (See Figure 3.9). Some previous studies also used a similar technique to measure daily air temperatures by mounting the hobo loggers onto small trees (e.g. Blumroeder et al., 2019; Chaput and Gajewski, 2014) (See Appendix 15, on page 502).

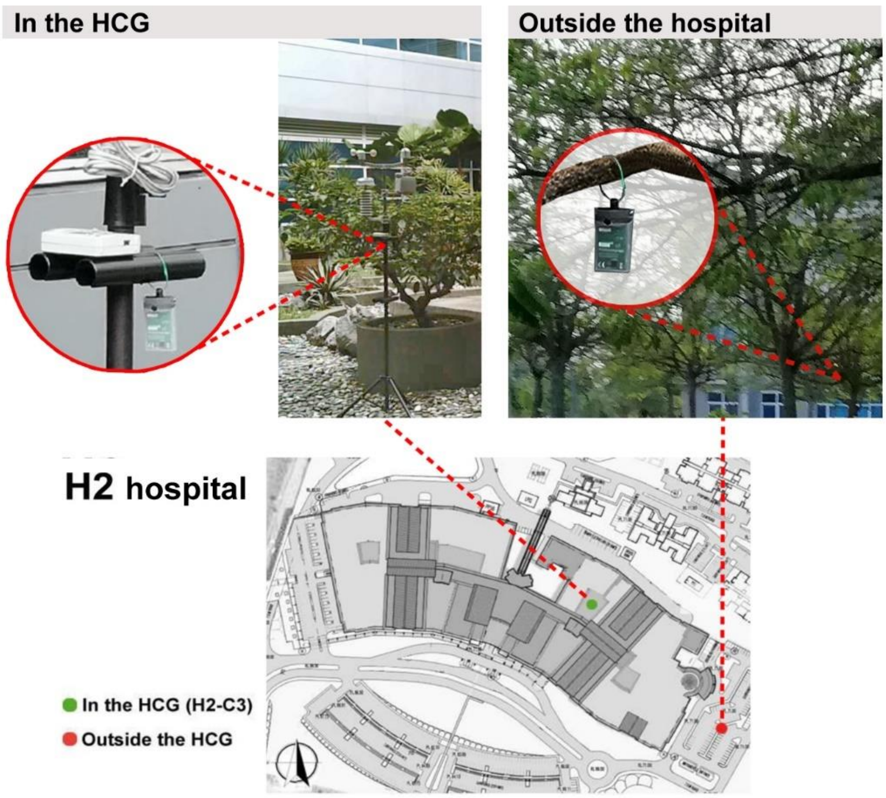


Figure 3.8: The location of Hobo logger UA-002-64 placed in the H2-C3 and outside the H2 hospital

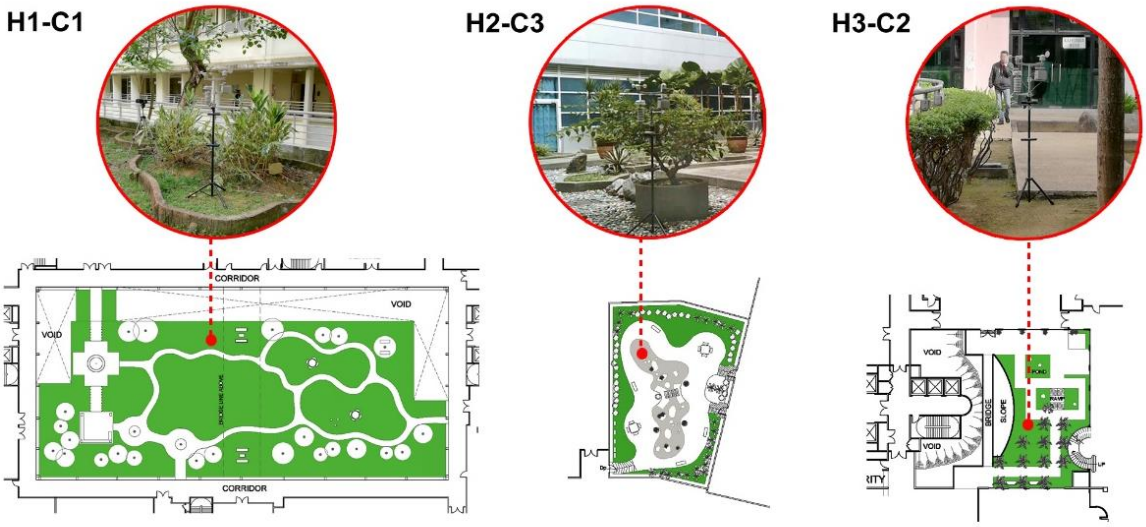


Figure 3.9: The location of Aercus WS3083 Professional Wireless Weather Station and Hobo loggers in the HCGs

ii) Testing and calibration of the instruments

Besides, it is also important to calibrate each instrument used in the fieldwork before deploying on site to ensure that previously used equipment has no technical issues and/or changes in their accuracy due to the wear and tear of the instruments. All equipment was tested to check for accuracy in accordance to the manufacturer's specifications. Before the actual fieldwork, all the instruments were tested and placed in the same area with the same climatic conditions (at an outdoor area) to check the workability of the sensors and compare the readings of all the instruments in order to minimise any measurement uncertainty. Each instrument was programmed with the same date and time, same interval time (15 minutes) and same measurement units for both air temperature (ºC) and relative humidity (%). The results of the readings for temperature and relative humidity were checked and compared across the different data from each instrument. The results showed very small differences in the readings of all the sensors. The small variation of the reading does not affect the quality of the data because the data measurements remained within manufacturer accuracy specifications (See Appendix 15 for detailed specification of each piece of equipment).

3.4.6.4 Phase 2: Survey interview with the users and non-users

In Phase 2, a survey interview with a total of 120 users in all three sites (H1-C1 (N=46); H2-C3 (N=36); and H3-C2 (N=38) were carried out to examine their perceptions, experiences, preferences and levels of satisfaction with the HCG (See Figure 3.10). The survey interviews with the HCG users were conducted simultaneously during the field measurement and video-recording.

Figure 3.10: Survey interview with the HCG user (patient) in the H2-C3

It is important to note that the researcher interviewed the HCG users and observed their activities in the HCG. Participants included patients, staff and visitors who were sitting and spending time in the HCG and have provided consent and were willing to participate in the study. Those who were simply passing by and who were in a state of stress were not approached. The duration of this survey was approximately 10-20 minutes. Additionally, two research assistants were also appointed to carry out a survey interview with users and non-users while the main researcher carried out survey interviews with the HCG users. They were briefed on the procedure of the survey interview and trained before the fieldwork commenced to ensure the consistency and accuracy of the data collection procedures. The technique of sampling and demographic data for the users and non-users group will be explained further in Section 3.5.

i) Development of survey questionnaire

It is crucial for any new survey questions to be pretested on a few pilot participants to identify any ambiguities and weaknesses in the survey and make improvements prior to commencement of the actual fieldwork (van Teijlingen and Hundley, 2018). The first pilot test was conducted in a Firth court building with 10 respondents to ensure the questions asked in the survey were not overly ambitious and further were clearly understood by the respondents (See Appendix 10). Several improvements and amendments were subsequently incorporated in the revised questionnaire. Prior to the actual fieldwork in Malaysia, a preliminary study was also carried out to pretest the survey with the actual pilot respondents (10 HCG users and 10 non-users) to detect any problems commonly encountered during the survey interview and to ensure the consistency and efficiency of the whole survey process (Collins, 2003). Further explanation on the improvement of the survey questions is explained in detail in Appendix 11. Several improvements were also made to the final survey questions after discussion and review by experts in the field to check for consistency and agreement during the development of the survey questions to ensure valid, unbiased and reliable results (Ikart, 2019).

ii) Content of survey interview with the non-users

The survey questionnaire for the courtyard users was adapted and developed by referring to surveys previously utilised in the landscape field (e.g. Shukor, 2012; Whitehouse et al., 2001; Cooper Marcus and Barnes, 1995) and the outdoor thermal comfort field (e.g. (Sharmin and Steemers, 2018; Nikolopoulou and Lykoudis, 2006) as the basis of developing the survey instruments. In particular, the survey was structured with four sections with the intent to achieve research objectives 1, 2, 3, and 4 of this current research (See Table 3.6). The survey questions with the HCG users can be seen in Appendix 1.

Table 3.6: The section in the survey questions with the HCG users linking to the research objectives and section in the thesis

Section in the survey question	Types of question	Research objectives	Section in the thesis
Section 1: PERCEPTION			
• Likes and dislikes about the HCG and suggestions for improvement	Open ended	**Obj.1:** To examine the positive and negative aspects of the design and planning of the selected case study HCGs.	Section 5.2
• Perception of outdoor thermal comfort, humidity and wind flow (TSV, HSV and WSV)	7-point ASHRAE scale	**Obj. 3:** To assess microclimatic conditions in the HCG and users' perceptions of outdoor thermal comfort.	Section 6.2.2
• Preference of outdoor thermal comfort (TPV)	3-Point McIntyre Scale		
Section 2: PREFERENCES			
• Users' perceptions of the importance of landscape elements	5-point Likert Scale	**Obj. 2:** To evaluate users' perceptions, preferences and satisfaction levels with the overall design and planning of the selected HCGs	Section 5.4.1
• Users' preferences of the HCG images	Multiple choice & open ended		Section 5.4.2
• Users' perceptions of environmental design	5-point Likert Scale		Section 6.3
Section 3: EXPERIENCES & ACTIVITIES			
• Users' activities, duration of time spent in the HCG	Multiple choice	**Obj. 4:** To investigate the activities, users' space use pattern and their experience in the selected case study HCGs.	Section 6.4.5
• Users' experience in the HCG	5-point Likert Scale		
Section 4: SATISFACTION LEVEL			
• Users' satisfaction with the quality of Courtyard design.	5-point Likert Scale	**Obj. 2:** To evaluate users' perceptions, preferences and satisfaction levels with the overall design and planning of the selected HCGs	Section 5.3
• Rating of overall performance of the HCG	5-point rating Scale		

iii) Content of survey interview with the non-users

A survey interview with the non-users was also carried out with the non-users group (e.g. those who were sitting and waiting in the lobby area of the hospitals). It is important to note that the survey with the non-users is not the main focus of the study and some data were excluded from this thesis. The main purpose of the non-user survey is to examine the factors that influence non-utilisation of the HCGs and to reduce bias in data reporting which otherwise would only focus on the perceptions of HCG users as explained earlier in Section 3.3.3.

Thus, the focus of this study is on the HCG users. However, due to time constraints, only non-user data that supports and strengthens the findings were analysed and presented here. For instance: i) perception of the visibility of the HCG among the non-users group (As discussed in Section 5.3.2, see also Figure 5.24) and; ii) factors that discourage them to use the HCG (As presented in Section 6.5.4). The survey questions for non-users can be found in Appendix 2.

3.4.6.5 Phase 3: Semi-structured interview with the designers

The semi-structured interviews with the **two architects and two landscape architects (N=4)** were conducted at their offices. The rationale for these face-to-face interviews is to investigate their design intentions, challenges and suggestions for improvements in future case study HCGs in response to research objective 5 (Refer to Chapter 7 for the results and discussion of the interviews). For H1 hospital, the architect and landscape architect were interviewed in February and March 2018, respectively. Additionally, the H2 and H3 Architects (i.e. the same person from the same company) and the H2-landscape architect were also interviewed in February 2018. However, the H3-landscape architect was not reachable, and no information could be traced and provided from the respective design team. Nevertheless, with the available interview data and the secondary data (architectural design brief), research objective 5 was still achieved.

Before the interview started, all interviewees were given participant information sheets for them to read and retain as a copy. The purpose of the study was also explained to them. After signing the consent form, the interview session was conducted in English and followed the structure of the designated interview questions (See Appendix 3). The photograph of the current state of the respective HCG sites were also used during the discussion with the architect and landscape architect. Each interview took approximately one hour to complete.

3.5 Study population and data sampling

3.5.1 Sampling techniques for the users and non-users' group

A simple random sampling was used for the selection of the representative sample for both the HCG users and non-users' groups in each representative case study HCG (H1-C1, H2-C3 and H3-C2). Thus, all members of the population had the equal probability of being chosen during the sampling process.

It is important to note that the sample for the users group was strictly based on the representative sample of the population in each HCG sites. The highest number of samples obtained was from the visitors group, followed by staff then patients in the HCG (See Table 3.7). This was based on the actual representative population of the HCG users which was evidenced from the daily observations in the HCGs (See Section 6.4). Within each case study HCGs site, the visitors, patients and staff who were sitting in the HCG were interviewed at random. Those who were in distressed and passers-by were not interviewed.

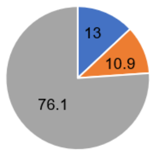
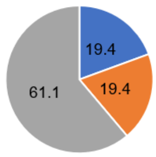
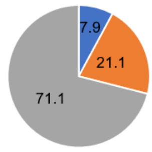
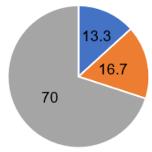
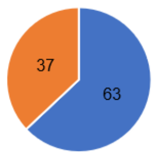
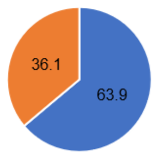
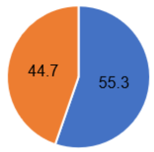
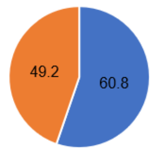
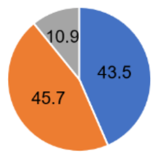
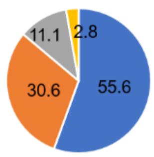
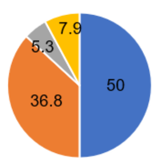
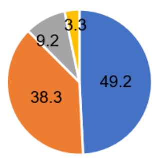
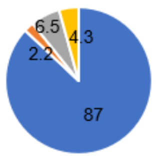
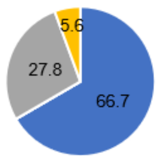
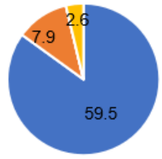
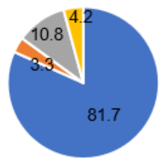
Similarly, a simple random sampling was also used for the non-users group. Non-users were randomly selected from among those outside the boundaries of the HCG (e.g. those sitting and waiting in the lobby area of the hospitals). The purpose here was to specifically interrogate the perceptions of the patients, staff and visitors who were waiting in the lobby to examine what factors had discouraged their visitation to the HCG. Those outside the hospital entrance and in the wards were not interviewed for non-users group.

3.5.2 A demographic data of the users group in the selected HCGs

A total of **120 respondents among the users group** from all three sites were participated in the survey interviews: H1-C1 (N=46); H2-C3 (N=36); and H3-C2 (N=38) (See Table 3.7). The ranges of types of user groups are almost identical in all three sites: the visitors are the highest group compared to staff and patients which is in agreement with the findings from the daily observations of the current study (See Section 6.4).

Similarly, the percentage of female users was higher than for male users across different sites. Moreover, over half of the total respondent in each case study sites were among a young age group (18-35 years old) and nearly one-third of a middle age group (36-55 years old). The remaining groups were among the older age group (55-64 years old) and senior age group (65 years old and older). Regarding the types of ethnicity among the HCG users, Malay represented the highest sample across the different sites followed by Indian, Chinese and others.

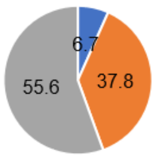
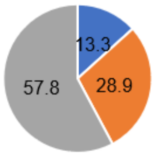
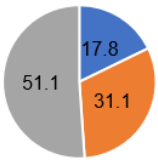
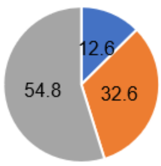
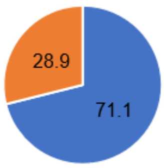
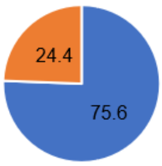
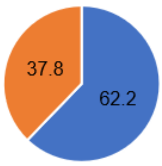
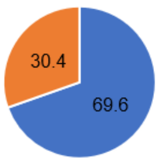
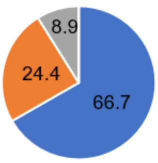
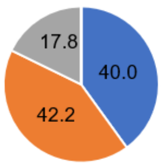
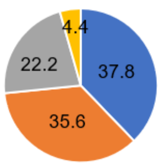
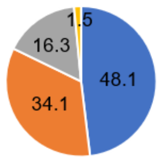
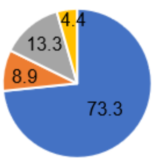
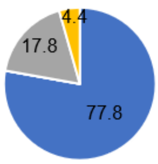
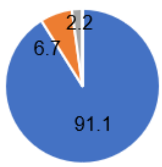
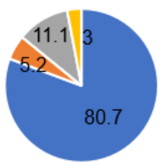
Table 3.7: Demographic data of the users group in each representative HCG

HCG USERS	**H1-C1 N=46 (38%)**		**H2-C3 N=36 (30%)**		**H3-C2 N=38 (32%)**		**TOTAL N=120 (100%)**	
TYPES OF USERS								
Patient	13.0%	(n=6)	19.4%	(n=7)	7.9%	(n=3)	13.3%	(n=16)
Staff	10.9%	(n=5)	19.4%	(n=7)	21.1%	(n=8)	16.7%	(n=20)
Visitor	76.1%	(n=35)	61.1%	(n=22)	71.1%	(n=27)	70.0%	(n=84)
GENDER								
Female	63%	(n=29)	63.9%	(n=23)	55.3%	(n=21)	60.8%	(n=73)
Male	37%	(n=17)	36.1%	(n=17)	44.7%	(n=17)	39.2%	(n=47)
AGE GROUP								
Young age group (18-35 years old)	43.5%	(n=20)	55.6%	(n=20)	50%	(n=19)	49.2%	(n=59)
Middle age group (36-55 years old)	45.7%	(n=21)	30.6%	(n=11)	36.8%	(n=14)	38.3%	(n=46)
Older age group (55-64 years old)	10.9%	(n=5)	11.1%	(n=4)	5.3%	(n=2)	9.2%	(n=11)
Senior age group (65 years old and older)	0.0%	(n=0)	2.8%	(n=1)	7.9%	(n=3)	3.3%	(n=4)
ETHNICITY								
Malay	87.0%	(n=40)	66.7%	(n=24)	89.5%	(n=34)	81.7%	(n=98)
Chinese	2.2%	(n=1)	0.0%	(n=0)	7.9%	(n=3)	3.3%	(n=4)
Indian	6.5%	(n=3)	27.8%	(n=10)	0.0%	(n=0)	10.8%	(n=13)
Other	4.3%	(n=2)	5.6%	(n=2)	2.6%	(n=1)	4.2%	(n=5)

3.5.3 A demographic data of the non-users group in the selected HCGs

A total of **135 respondents among the non-users group** from all three case study hospitals were participated in the survey interviews: H1-hospital (N=45); H2-hospital (N=45); and H3-hospital (N=45) (See Table 3.8). This sample group were randomly selected among those who were sitting in the lobby or clinic waiting areas. As with the users group, the visitors represent the highest sample followed by staff and patients. Again similar to the users group, the female sample among the non-users group was higher than for males in all case study hospitals. The sample among the young age group (18-35 years old) in both H2 and H3 are almost identical, while in H1-hospital it was slightly two times higher than that evidenced in the H3-hospital. Regarding ethnicity, Malay was again the highest sample across the different sites followed by Indian, Chinese and others.

Table 3.8: Demographic data of the non-users group in each representative HCG

NON-USERS	**H1-HOSPITAL N=45 (33.3%)**		**H2-HOSPITAL N=45 (33.3%)**		**H3-HOSPITAL N=45 (33.3%)**		**TOTAL N=135 (100%)**	
TYPES OF NON-USER								
Patient	6.7%	(n=3)	13.3%	(n=6)	17.8%	(n=8)	12.6%	(n=17)
Staff	37.8%	(n=17)	28.9%	(n=13)	31.1%	(n=14)	32.6%	(n=44)
Visitor	55.6%	(n=25)	57.8%	(n=26)	51.1%	(n=23)	54.8%	(n=74)
GENDER								
Female	71.1%	(n=32)	75.6%	(n=34)	75.6%	(n=28)	69.6%	(n=94)
Male	28.9%	(n=13)	24.4%	(n=11)	24.4%	(n=17)	30.4%	(n=41)
AGE GROUP								
Young age group (18-35 years old)	66.7%	(n=30)	40.0%	(n=18)	37.8%	(n=17)	48.1%	(n=65)
Middle age group (36-55 years old)	24.4%	(n=11)	42.2%	(n=19)	35.6%	(n=16)	34.1%	(n=46)
Older age group (55-64 years old)	8.9%	(n=4)	17.8%	(n=8)	22.2%	(n=10)	16.3%	(n=22)
Senior age group (65 years old and older)	0.0%	(n=0)	0.0%	(n=0)	4.4%	(n=2)	1.5%	(n=2)
ETHNICITY								
Malay	73.3%	(n=33)	77.8%	(n=41)	91.1%	(n=41)	80.7%	(n=109)
Chinese	8.9%	(n=4)	0.0%	(n=3)	6.7%	(n=3)	5.2%	(n=7)
Indian	13.3%	(n=6)	17.8%	(n=1)	2.2%	(n=1)	11.1%	(n=15)
Other	4.4%	(n=2)	4.4%	(n=0)	0.0%	(n=0)	3.0%	(n=4)

3.6 Techniques of data analysis

As explained earlier in Sections 3.2.1 and 3.4.6, the current study utilised multiple sources of data gathered from: i) field investigation (site analysis and field measurement); ii) participant observation (direct and video-based observation); ii) survey interview with users and non-users; and iv) interviews with the designers. After the data collection stage was completed, all the data were systematically organised and coded into two different files (quantitative data and qualitative data) and safely stored in a university google drive as backup.

For the current research, analysis of the multiple sources of data were run sequentially and separately for the different case study HCG sites. Starting with Case 1, then Case 2 and Case 3 (See Figure 3.11). At the first stage of data analysis, the researcher carefully examined all the different types of data for case 1 (H1-C1) to understand and familiarise themselves with all the different types of data. Data analysis was carried out sequentially for each different data, which included: i) analysing the video data; ii) mapping the users' activities using Arch GIS software; iii) running statistical analysis for the survey interview data including descriptive and inferential analysis using IBM SPPS statistics 2.1 software; and iv) transcribing, coding and analysing the interview data.

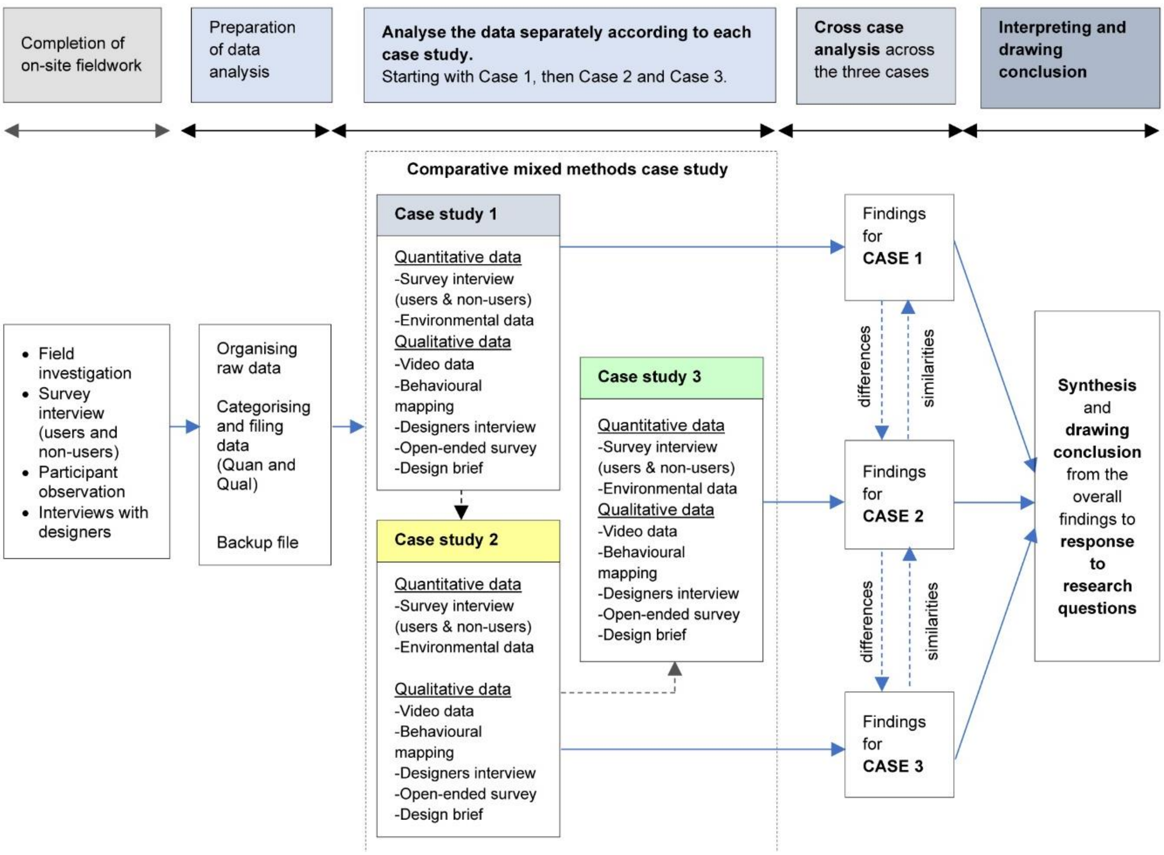


Figure 3.11: Diagram for a comparative mixed methods case study analysis for the current research

Subsequently, the analysis for the other two case study sites (H2-C3 and H3-C2) were carried out. The multiple sources of data were analysed sequentially for H2-C3 followed by H3-C2. Further, a cross-case analysis and synthesis between the three-case study HCGs was carried out to determine the similarities and differences across case study sites and synthesise the overall findings from the results of the three cases. The cross-case results and discussion from the multiple source of data is presented in Chapters 5, 6 and 7.

Finally, a cross-case conclusion from the overall findings of the presented results was carried out and this finding was formulated and specified into four important aspects of the HCG framework (As discussed in Chapter 8). Further, from the results of the overall findings of the current study, policy and practice implications were proposed (See Chapter 8). Further explanation of the data analysis for each of the different types of data will be explained in the following subsection.

3.6.1 Data analysis: Field investigation

The data from the field investigation are comprised of the courtyard specification checklist, photographs of the sites (site analysis), and the environmental data (field measurement). The images of the hospital floor plan that were captured during the site analysis were transferred onto a floor plan drawing using AutoCAD 2013 software which was used for further mapping analysis with GIS map system (ArcMap 10.4.1) (This is elaborated further in Section 3.6.3). From the CAD floor plan, the 3D illustration of the three sites were generated using Sketchup 2018 to visualise the different forms of the courtyard hospital for further comparison of their aspect ratios (i.e. height, width and length). The photo of the HCG related to the physical design, landscape features, types of seating, vegetation, maintenance and safety were categorised into a different file for a further triangulation process with the results from the interviews with the HCG users.

Additionally, the environmental data (e.g. air temperature, air humidity and wind flow) recorded by the Hobo-loggers and the Aercus WS3083 Weather Station were transferred onto computer using the HOBOware software and EasyWeather Plus software, respectively. Further, these data were imported into the Microsoft Excel and the SPSS IBM Statisticals 2.1 software for further analysis. A line graph visualising both the air temperature inside the HCG and outside the hospital were generated using Excel (Refer to Section 6.2.1.4). The environmental data in the SPSS statisticals software was used to run the correlation between the results from the survey interview on users' perceptions of outdoor thermal comfort. An inferential analysis was carried out using SPSS software to run a Pearson Correlation to examine the association between actual air temperature and

TSV (See Section 6.2.5). A boxplot and scatterplot were also generated using this software (Pallant, 2016, p.75-81).

3.6.2 Data analysis: Survey interviews with the HCG users

3.6.2.1 Statistical analysis of quantitative data

For the survey data, the demographic, closed-ended, multiple-choice, picture choice questions and Likert scale questions were all analysed using the SPSS IBM statisticals 2.1 software for the descriptive analysis: frequency analysis of each data for different case study sites and cross tabulation across the demographic data. Cross-tabulation is useful for the current subject of study because it provides information regarding the intersection between different variables (e.g. demographic data). Additionally, an inferential analysis, namely Chi-square and Contingency coefficient and Correlation analysis (i.e. Pearson and Spearman Correlation) were also carried out using the SPSS software. The details of each statistical analysis conducted in this study are shown in Table 3.9.

It is important to note that most of the graph (e.g. the bar chart, pie chart and line charts) were generated using Microsoft Excel; only the scatterplot and boxplot chart were generated using the SPSS software. Each different site used different colour coding throughout the whole thesis (i.e. H1-C1-blue, H2-C3-yellow and H3-C2-green) when generating the graph for comparison across the three different HCGs.

Table 3.9: The list of descriptive and inferential statistical analysis utilised in the current study

Aspect of study	Types of statistical analysis	Sample	Type of statistical test	Section in the chapter
Users' satisfaction levels with the design and planning of the HCG	Frequencies	Across different case study sites	Descriptive	Section 5.3 and Section 5.5.2
	Chi-square test Contingency coefficient	Across the whole sample (N=120)	Inferential	
Users' perceptions of the importance of landscape elements	Cross-tabulation (Demographic data)	Across the whole sample (N=120)	Descriptive	Section 5.4.1 and Section 5.5.3.1
	Chi-square test		Inferential	
Users' preferences of the HCG images	Frequencies Cross-tabulation	Across different case study sites	Descriptive	Section 5.4.2 and Section 5.5.3.2

Users perception of thermal comfort (TSV, HSV and WSV)	Frequencies Cross-tabulation	Across the different case study sites	Descriptive	Section 6.2.2
Association between the thermal responses with different case study sites	Chi-square test	Across different case study sites	Inferential	Section 6.2.3
Correlation between thermal responses votes	Spearman Rank correlation test	Across the whole sample (N=120)	Inferential	Section 6.2.4
Correlation between microclimatic conditions and thermal sensation votes (TSV)	The Pearson correlation	Across the whole sample (N=120)	Inferential	Section 6.2.5
Relationship between thermal sensation votes (TSV) with the gender, age group, time spent in the HCG.	Cross-tabulation Chi-square test	Across the whole sample (N=120)	Descriptive Inferential	Section 6.2.6
Users' perceptions of the importance of the environmental design	Frequencies Cross-tabulation	Across different case study sites	Descriptive	Section 6.3.1
Types of activities, time spent and frequency of visitations to the HCG	Frequencies Cross-tabulation	Across different case study sites	Descriptive	Section 6.4.5
Users' experiences and perceived restorative score in the case study HCG	Frequencies Cross-tabulation	Across different case study sites	Descriptive	Section 6.5.1 and Section 6.5.3

i) Chi-square test

A statistical significance study using a Chi-square test was conducted to test whether there was any significant association between two variables and whether the null hypothesis was true or false. This is also a way to check whether the two-variables examined in the contingency table are independent of each other in the population (Pallant, 2016).

The null hypothesis (Ho) for the Chi-square test assumes that there is no association between these two variables. The alternative hypothesis (Ha) is the assumption that there is a relationship between two variables. In the Chi-square analysis, the 'P-value' is used to check either to accept or reject the null hypothesis. If the 'P-value' is less than significance level ($p < 0.05$), it indicates strong evidence against the null hypothesis, so the null hypothesis is rejected. In other words, the null hypothesis will be rejected if there is at least 95% chance that the observed distribution is true which also means that there is a significant association between the two variables. On the other hand, if the ‘P-value’ is more than the significance level ($p > 0.05$), it shows weak evidence against the null hypothesis, so the null hypothesis is retained (or failed to be rejected). A null hypothesis cannot be rejected if there is only 5% that the observed distribution is true which also means that there is no significant association between the two variables.

ii) Contingency coefficient and crosstabs

Although the Chi-square test is used to examine whether there is a significant association between the two variables, the Chi-square test cannot measure the strength of the relationships between the two variables. Therefore, a contingency coefficient also known as Pearson’s Coefficient is used to measure the magnitude of the relationship of two variables. A contingency coefficient (C) is used to measure the extent of the association between several variables. The C is derived from the Chi-square test, and it is used to show the strength of the relationship of the two variables in which the value is between the range of 0 to 1. The C can never reach the value of 1. If C is near or equal to zero, it indicates that the variables are independent of each other, which also means that there is no relationship between the two variables (Pallant, 2016). On the other hand, if C is away from zero or nearer to one, it means a higher magnitude of the association between the two variables. Moreover, a contingency table known as a crosstabs or two ways table was used to summarise the association between two studied variables as indicated earlier in Table 3.9.

3.6.2.2 Content analysis of open ended survey questions

Content analysis is commonly used to analyse textual data involving a systematic process of coding, examining the meaning of text, developing categories or theme (Vaismoradi et al., 2016) and counting the frequencies (Silverman, 2014, p.109; Krippendorff, 2013b, p.189) Several textual data in the current study which used content analysis are included the data of users’ responses in the open ended questions, interview transcriptions and architectural briefs. Quantitative content analysis was used to analyse the open ended questions. Each of the responses of the users on what they ‘likes and dislikes about the HCG’ and ‘suggestion for improvement’ were first checked for content and coding and categorised based on similar theme using Microsoft Excel. Following that, the frequency count and the bar chart graph illustrating the frequency of responses in each HCG were generated using Microsoft Excel (As presented in Section 5.2). The analysis of the interview transcription and the architectural brief is discussed further in Section 3.6.4.

3.6.3 Data analysis: Participant observation

3.6.3.1 Mapping analysis of users' activities

Both data from the video recording and direct observation were used to analyse the users' space use patterns in the HCGs. This included the level of occupancy by different types of users and the frequency of activities in the different case study HCGs. Following completion of the on-site fieldwork, the video data and the on-site mapping data were combined into the GIS map system (ArcMap 10.4.1) for a mapping analysis. The on-site mapping data were combined with the video data for every two hourly observation period (e.g. 9 am-11 am, 11 am-1 pm, 1 pm-3 pm and 3 pm-5 pm) to form a complete set of daily 8 hour observation data (See Figure 3.12). Each of the video data from video cameras A and B were analysed sequentially from Case 1, Case 2 and Case 3.

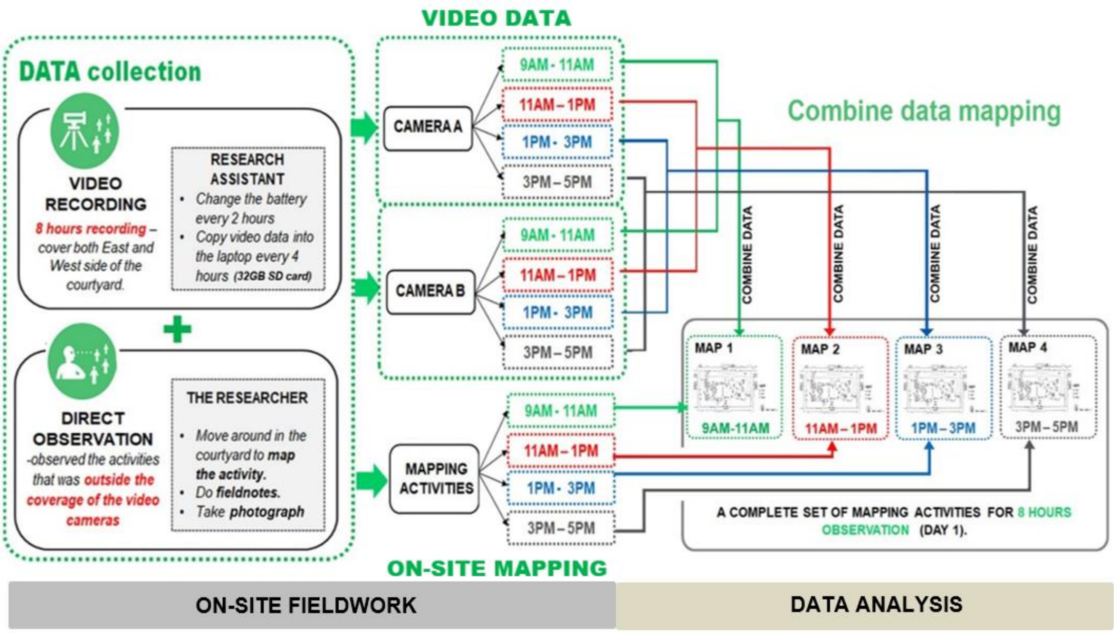


Figure 3.12: The flowchart of the data transfer for the video data and on-site mapping into the GIS system.

Several parameters were observed in the video data including the types of users, types of activities, gender and age group. All of the snapshots of daily activities based on the eight hours observation period (9 am to 5 pm) of both the video data A and B were transferred onto the table using Microsoft Word software (See Section 3.6.3.1). Further, the on-site mapping data (i.e. the activities which occurred outside the coverage of the video camera) during the fieldwork, were then digitally re-coded and re-mapped onto the GIS map system. Following that, the data of each user (e.g. the type of users, type of activities, gender and age group), based on the table snapshot video data (See Figure 3.13), were re-mapped onto the HCG floor plan and re-coded onto the GIS map system which completed the whole daily eight hours observation (one weekend day). Then, the data for the eight hours observation (one weekday) were mapped onto the same case study floor plan in the GIS map system. A similar step was also carried out for another eight hours observation on each weekday and weekend for the other case study sites. The frequency analysis and the graph (e.g. the bar chart and line chart) for the level of occupancy and the types of activities were generated using Microsoft excel (As presented in Section 6.4).

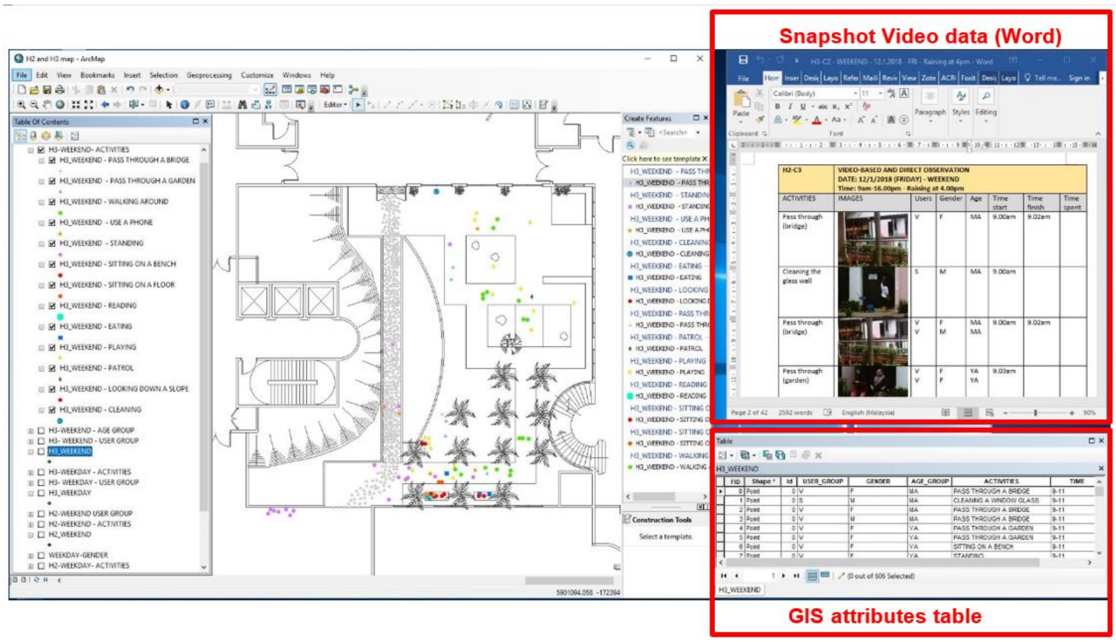


Figure 3.13: The process of transferring the snapshot video data into the attributed table and mapping activities onto the floor plan in the GIS map system

3.6.4 Data analysis: Semi-structured interviews with designers

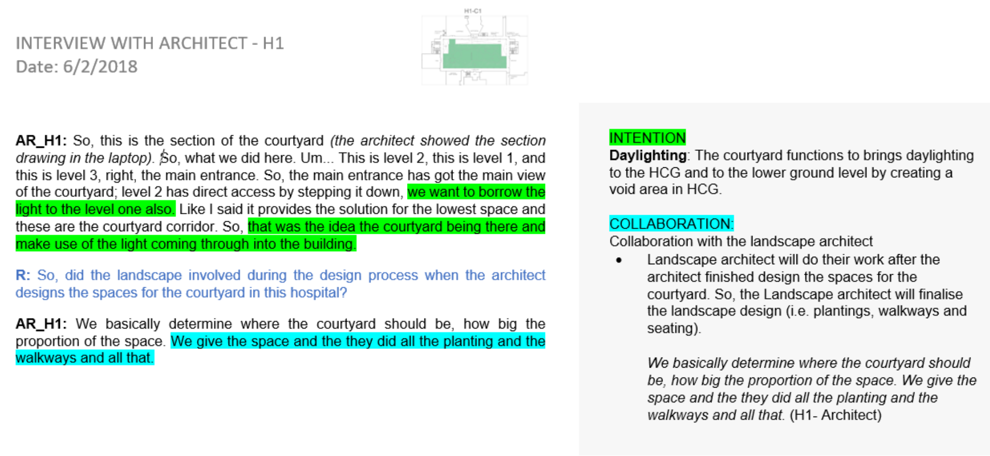
It is important to note that in response to research objective 5, both interview data with the designers and the architectural design brief were used in the data analysis process using a qualitative content analysis. Secondary data (architecture design briefs) was also analysed to support and strengthen the findings of the interview data. The techniques for data analysis for each type of data is presented below.

3.6.4.1 Content analysis of interview data

Before carrying out the analysis, the interviews with the architects and landscape architects were first transcribed. The transcriptions were then analysed using a qualitative content analysis technique which focused on examining the meaning of the text and drawing realistic conclusions from it (Erlingsson and Brysiewicz, 2017; Vaismoradi et al., 2016; Bengtsson, 2016). The transcriptions were coded and categorised according to several themes in order to explore the related subjects (See Table 3.10 and Figure 3.14). The coding process was carried out using Microsoft Word.

Table 3.10: Coding utilised in the content analysis of the interview data

Coding	Research subjects/ themes
DESIGN	Design development stage in the hospital project
COLLABORATION	Collaboration practice among the stakeholders
INTENTION	Design intentions
CHALLENGE	Challenges in the design development stage
SUGGESTION	Suggestions for future improvement.



INTERVIEW WITH ARCHITECT - H1
Date: 6/2/2018

AR_H1: So, this is the section of the courtyard *(the architect showed the section drawing in the laptop).* So, what we did here. Um... This is level 2, this is level 1, and this is level 3, right, the main entrance. So, the main entrance has got the main view of the courtyard; level 2 has direct access by stepping it down, we want to borrow the light to the level one also. Like I said it provides the solution for the lowest space and these are the courtyard corridor. So, that was the idea the courtyard being there and make use of the light coming through into the building.

R: So, did the landscape involved during the design process when the architect designs the spaces for the courtyard in this hospital?

AR_H1: We basically determine where the courtyard should be, how big the proportion of the space. We give the space and the they did all the planting and the walkways and all that.

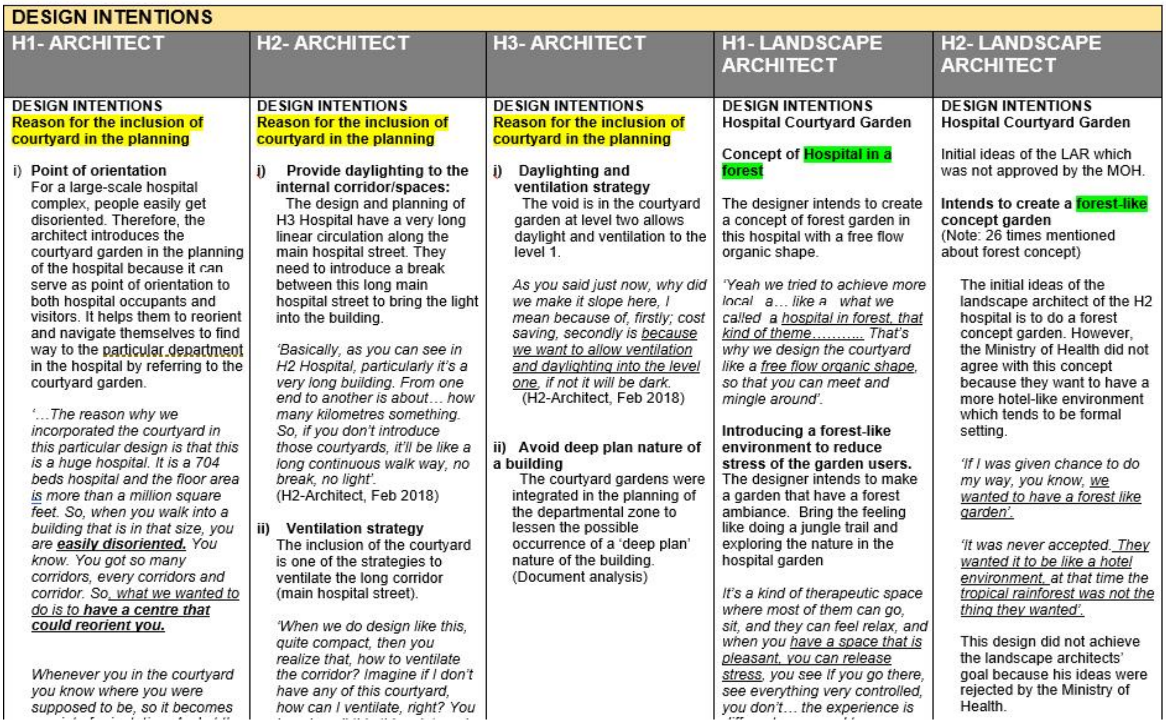
INTENTION
Daylighting: The courtyard functions to brings daylighting to the HCG and to the lower ground level by creating a void area in HCG.

COLLABORATION:
Collaboration with the landscape architect
- Landscape architect will do their work after the architect finished design the spaces for the courtyard. So, the Landscape architect will finalise the landscape design (i.e. plantings, walkways and seating).

  We basically determine where the courtyard should be, how big the proportion of the space. We give the space and the they did all the planting and the walkways and all that. (H1- Architect)

Figure 3.14: Sample of the coding of the interview data in the Word document

After all the coding process were completed, the key points of the interviews was highlighted and linked to similar themes. Subsequently, the data was then summarised and transferred onto a comparative table for comparison according to similar themes for each architects and landscape architects (See Figure 3.15).

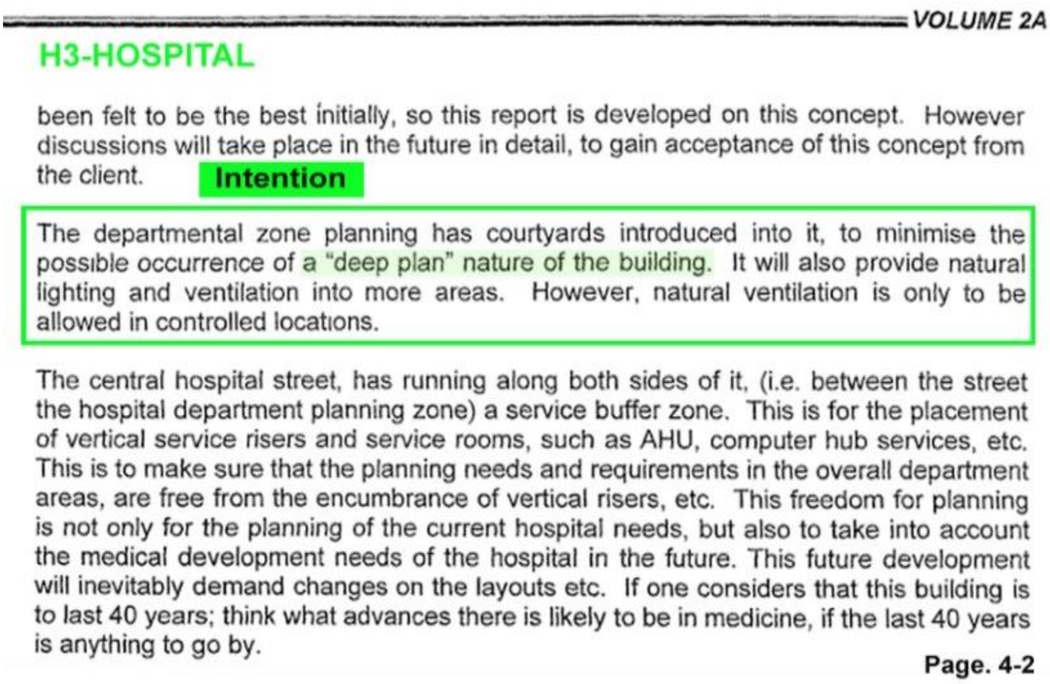


DESIGN INTENTIONS				
H1- ARCHITECT	**H2- ARCHITECT**	**H3- ARCHITECT**	**H1- LANDSCAPE ARCHITECT**	**H2- LANDSCAPE ARCHITECT**
DESIGN INTENTIONS **Reason for the inclusion of courtyard in the planning** i) **Point of orientation** For a large-scale hospital complex, people easily get disoriented. Therefore, the architect introduces the courtyard garden in the planning of the hospital because it can serve as point of orientation to both hospital occupants and visitors. It helps them to reorient and navigate themselves to find way to the particular department in the hospital by referring to the courtyard garden. *'…The reason why we incorporated the courtyard in this particular design is that this is a huge hospital. It is a 704 beds hospital and the floor area is more than a million square feet. So, when you walk into a building that is in that size, you are **easily disoriented.** You know. You got so many corridors, every corridors and corridor. So, what we wanted to do is to **have a centre that could reorient you.*** *Whenever you in the courtyard you know where you were supposed to be, so it becomes*	**DESIGN INTENTIONS** **Reason for the inclusion of courtyard in the planning** i) **Provide daylighting to the internal corridor/spaces:** The design and planning of H3 Hospital have a very long linear circulation along the main hospital street. They need to introduce a break between this long main hospital street to bring the light into the building. *'Basically, as you can see in H2 Hospital, particularly it's a very long building. From one end to another is about… how many kilometres something. So, if you don't introduce those courtyards, it'll be like a long continuous walk way, no break, no light'.* (H2-Architect, Feb 2018) ii) **Ventilation strategy** The inclusion of the courtyard is one of the strategies to ventilate the long corridor (main hospital street). *'When we do design like this, quite compact, then you realize that, how to ventilate the corridor? Imagine if I don't have any of this courtyard, how can I ventilate, right? You*	**DESIGN INTENTIONS** **Reason for the inclusion of courtyard in the planning** i) **Daylighting and ventilation strategy** The void is in the courtyard garden at level two allows daylight and ventilation to the level 1. *As you said just now, why did we make it slope here, I mean because of, firstly; cost saving, secondly is because we want to allow ventilation and daylighting into the level one, if not it will be dark.* (H2-Architect, Feb 2018) ii) **Avoid deep plan nature of a building** The courtyard gardens were integrated in the planning of the departmental zone to lessen the possible occurrence of a 'deep plan' nature of the building. (Document analysis)	**DESIGN INTENTIONS** **Hospital Courtyard Garden** **Concept of Hospital in a forest** The designer intends to create a concept of forest garden in this hospital with a free flow organic shape. *'Yeah we tried to achieve more local a… like a what we called a hospital in forest, that kind of theme……….. That's why we design the courtyard like a free flow organic shape, so that you can meet and mingle around'.* **Introducing a forest-like environment to reduce stress of the garden users.** The designer intends to make a garden that have a forest ambiance. Bring the feeling like doing a jungle trail and exploring the nature in the hospital garden *It's a kind of therapeutic space where most of them can go, sit, and they can feel relax, and when you have a space that is pleasant, you can release stress, you see If you go there, see everything very controlled, you don't… the experience is*	**DESIGN INTENTIONS** **Hospital Courtyard Garden** Initial ideas of the LAR which was not approved by the MOH. **Intends to create a forest-like concept garden** (Note: 26 times mentioned about forest concept) The initial ideas of the landscape architect of the H2 hospital is to do a forest concept garden. However, the Ministry of Health did not agree with this concept because they want to have a more hotel-like environment which tends to be formal setting. *'If I was given chance to do my way, you know, we wanted to have a forest like garden'.* *'It was never accepted. They wanted it to be like a hotel environment, at that time the tropical rainforest was not the thing they wanted'.* This design did not achieve the landscape architects' goal because his ideas were rejected by the Ministry of Health.

Figure 3.15: Sample of the comparative table of the key point of interview data across different architects and landscape architects

3.6.4.2 Content analysis of secondary data (Architectural design brief)

The secondary data, which is architectural design brief of the hospitals (i.e. received from the respective architects during the interview sessions), were also used and analysed using the content analysis technique (See Figure 3.16). The key point which related to the subject of study and theme were carefully examined and integrated with the interview data in a similar comparative table for further cross-case analysis and synthesis of the findings. The comparative table is useful to examine the pattern of answers and information related to different case study HCGs and to further investigate whether there are similarities or differences in the views of the different designers



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H3-HOSPITAL

been felt to be the best initially, so this report is developed on this concept. However discussions will take place in the future in detail, to gain acceptance of this concept from the client. **Intention**

The departmental zone planning has courtyards introduced into it, to minimise the possible occurrence of a "deep plan" nature of the building. It will also provide natural lighting and ventilation into more areas. However, natural ventilation is only to be allowed in controlled locations.

The central hospital street, has running along both sides of it, (i.e. between the street the hospital department planning zone) a service buffer zone. This is for the placement of vertical service risers and service rooms, such as AHU, computer hub services, etc. This is to make sure that the planning needs and requirements in the overall department areas, are free from the encumbrance of vertical risers, etc. This freedom for planning is not only for the planning of the current hospital needs, but also to take into account the medical development needs of the hospital in the future. This future development will inevitably demand changes on the layouts etc. If one considers that this building is to last 40 years; think what advances there is likely to be in medicine, if the last 40 years is anything to go by.

Page. 4-2

Figure 3.16: Part of the content in the architectural design brief highlighting a key point related to research subject
(Source: H3-Architect Sdn. Bhd)

The process of content analysis involved several stages, including: i) Design; ii) Collection; iii) Conversion; iv) Analysis; v) Interpretation (This is explained further in Section 7.1). The results and discussion of the interviews with both the architects and landscape architects related to the design and planning of the HCG will be set out in Chapter 7.

3.7 Summary

This chapter has presented the explanation and justification of the methods utilised in the current research. First, the chapter described the mixed methods and case study design approach which is utilised in the current study. This included an explanation on the methodological triangulation and mixed methods design with a convergence approach. Further, the chapter elaborated on the four research methods utilised in the current study, e.g. i) Field investigation; ii) Survey interviews with users and non-users; iii) Participant observation; and iv) Interview with designers). This was justified based on the previous literature review.

The research then described the process of data collection which started from the desk study, exploratory survey study, case study selection, ethical approval and preparation of the research protocol, pilot study and preliminary study and on-site fieldwork. The chapter also elaborated on the 3 phases of on-site fieldwork, namely: Phase 1: Site visit and visual analysis; Phase 2: Participant observation and on-site mapping, field measurement, survey interviews with users and non-users; and Phase 3: Semi-structured interviews with the architect and landscape architects. Each of the data collection procedures for each of these research methods were also presented in this chapter.

Additionally, this chapter presented the study population and the data sampling approach, including the sampling techniques and demographic data for the users and non-users' groups. Finally, the techniques of data analysis for the four research methods were explained in detail in this chapter to provide a clear understanding of how the data analysis was carried out. The case study context and descriptions and the explanation of the criteria that led to the selection of the three representative sample hospitals will be elaborated in the next chapter.

CHAPTER 4:

Case study selection, context and description

4.1 Introduction

This chapter presents information related to the context of the case study hospitals (H1, H2, H3) and a description of the three selected representative case study HCGs (H1-C1, H2-C3 and H3-C2). First, the chapter outlines the criteria of selection and elaborates on the process of selection regarding the three representative HCGs from a total of 13 HCGs in the representative case study hospitals. Further, this chapter elaborates on the character of each case study hospital including the site context and size by comparing the three representative hospitals. This chapter then describes the characteristics of each of the selected representative case study HCGs with a focus on the landscape character and the spatial arrangement of the HCGs. Finally, the chapter summarises several characteristics of the selected case study HCGs.

4.2 The criteria of selection of the three representative HCGs

As presented in Section 3.4.2, several processes were involved in the selection of the best representative case study sites for the current study. First, an exploratory survey was carried out involving 142 government hospitals in Malaysia. Second, the selection process was carried out and focused on the hospital courtyard typology in Peninsular Malaysia and excluding the old type nucleus hospital. Third, ten potential case study courtyard hospitals which were built after 1998 were selected, based on the observation that the hospitals were designed by both architects and landscape architects. Further, three representative case study hospitals (H1, H2 and H3 hospitals) were decided based on the 5 major criteria mentioned earlier in Section 3.4.3 including:

i) courtyard design configuration;
ii) the size and location of the courtyard within the building;
iii) the year of operation;
iv) the function of spaces clustered around the HCG; and
v) the height of the wall.

Subsequently, the site visits and field investigation were carried out in all 13 HCGs in all the three case study hospitals. Observation was carried out in these sites to ensure that the best three representative case study HCGs could be selected for further in-depth POE investigation. The selection of **the three representative case study HCGs** are based on the 6 following criteria:

- **i) accessibility (i.e. locked or unlocked door);**
- **ii) types of users;**
- **iii) level of occupancy;**
- **iv) feasibility for the subjective assessment study;**
- v) character of the sites (i.e. the availability softscape and hardscape); and
- vi) the location and space function.

The criteria of each HCG were presented in Table 4.1. It is important to note that the criteria of selection of the three representative case study HCGs are highly focused on **accessibility, utilisation by different types of users (patients, staff and visitors) and have a high level of occupancy**. Therefore, for the selection, several HCGs which were locked and not accessible, not utilised by all types of users, and with no occupancy were excluded from the selection. This included: H1-C2, H2-C5, H2-C6, H2-C, H3-C3, H3-C4.

Further, the screening for the case study selection looked at the feasibility for the subjective assessment for a survey interview. Case study H2-C1 and H2-C2 evidenced a very low occupancy due to the restricted access and location (secluded from the main lobby). Thus, it was not feasible for further in-depth investigation and survey interviews. In H2-C4, although occupancy was high, it was not feasible due to the high proportion of the sample from children and parents. The parents were mostly unavailable to participate in the survey interviews as they needed to supervise their children.

Additionally, H3-C1 was not locked and utilised by different types of users. However, this case study HCG was not selected because of the low occupancy level. Moreover, the function of the space had been changed into a dining area for the cafeteria and most of the activities observed were sitting, eating and passing though. Thus, this HCG was also not feasible for further on-site investigation and subjective assessment.

Table 4.1: Summary of criteria of selection of the three representative case study HCGs

Case study HCGs		Photo of the HCGs	The character of the sites		Easily accessible		Use by all types of users		Located at Ground floor (GF)		Space function	The level of occupancy		Feasibility for subjective assessment	
			Softscape	Hardscape											
H1	**H1-C1**		**80%**	**20%**	✓	**Unlocked**	✓	**P, S, V**	✓	**L2 (GF)**	Cafeteria, Clinic, Visitors centre A&E unit	✓	**High**	✓	**Feasible**
	H2-C2		70%	30%	**X**	Locked	**X**	P		L3	Rehabilitation centre	**X**	No	**X**	No users
H2	H2-C1		40%	60%	✓	Restricted	✓	P, S, V		L2 (GF)	A & E unit Labour & delivery unit	**X**	Low	**X**	Very few users
	H2-C2		30%	70%	✓	Restricted	✓	P, S, V		L2 (GF)	NICU unit	**X**	Low	**X**	Few users
	H2-C3		**60%**	**40%**	✓	**Unlocked**	✓	**P, S, V**	✓	**L2 (GF)**	Rehabilitation centre, Dialysis centre	✓	**High**	✓	**Feasible**
	H2-C4		20%	80%	✓	Unlocked	✓	P, S, V		L2 (GF)	Paediatric clinics	✓	High	**X**	Children interruptio n
	H2-C5		20%	80%	**X**	Locked	**X**	P		L5	Surgery theatre O&G wards	**X**	No	**X**	No users
	H2-C6		20%	80%	**X**	Locked	**X**	P		L5	Surgery theatre Paediatric wards	**X**	No	**X**	No users
	H2-C7		30%	70%	**X**	Locked	**X**	S		L7	General surgery wards	**X**	No	**X**	No users
H3	H3-C1		40%	60%	✓	Unlocked	✓	P, S, V		L2 (GF)	Cafeteria Rehabilitation centre	**X**	Low	**X**	Low users (Eating activities)
	H3-C2		**40%**	**60%**	✓	**Unlocked**	✓	**P, S, V**	✓	**L2 (GF)**	Lobby, Cafeteria Pharmacy, Clinics,	✓	**High**	✓	**Feasible**
	H3-C3		10%	90%	✓	Restricted	**X**	S		L3	Administration office	**X**	Low	**X**	Very few users
	H3-C4		70%	30%	✓	Restricted	**X**	P, S		L2 (GF)	Labour and delivery unit	**X**	Low	**X**	Very few users

L2 -Level 2
GF -Ground floor
P -Patient
S -Staff
V -Visitor

Finally, only three representative sample case study sites that evidenced comparable characteristics in terms of location, space functions, layout arrangement and landscape features (i.e. percentage of hardscape and softscape) were selected for further investigation (See Figure 4.1). The floor plan of each representative hospitals can be found in Appendix 9.

The selection of these comparative case study sites allows an in-depth investigation of the current performance of these HCGs in relation to their environmental and restorative functions in response to the main research question. The selection also enables a further examination of the different types of HCGs and how they impact the space use patterns of the different types of users. In addition, a comprehensive investigation of the issues and problems of each case study site was also carried out to explore the physical, environmental, social and operational aspects of the selected HCGs as discussed in Chapter 8, Section 8.3.

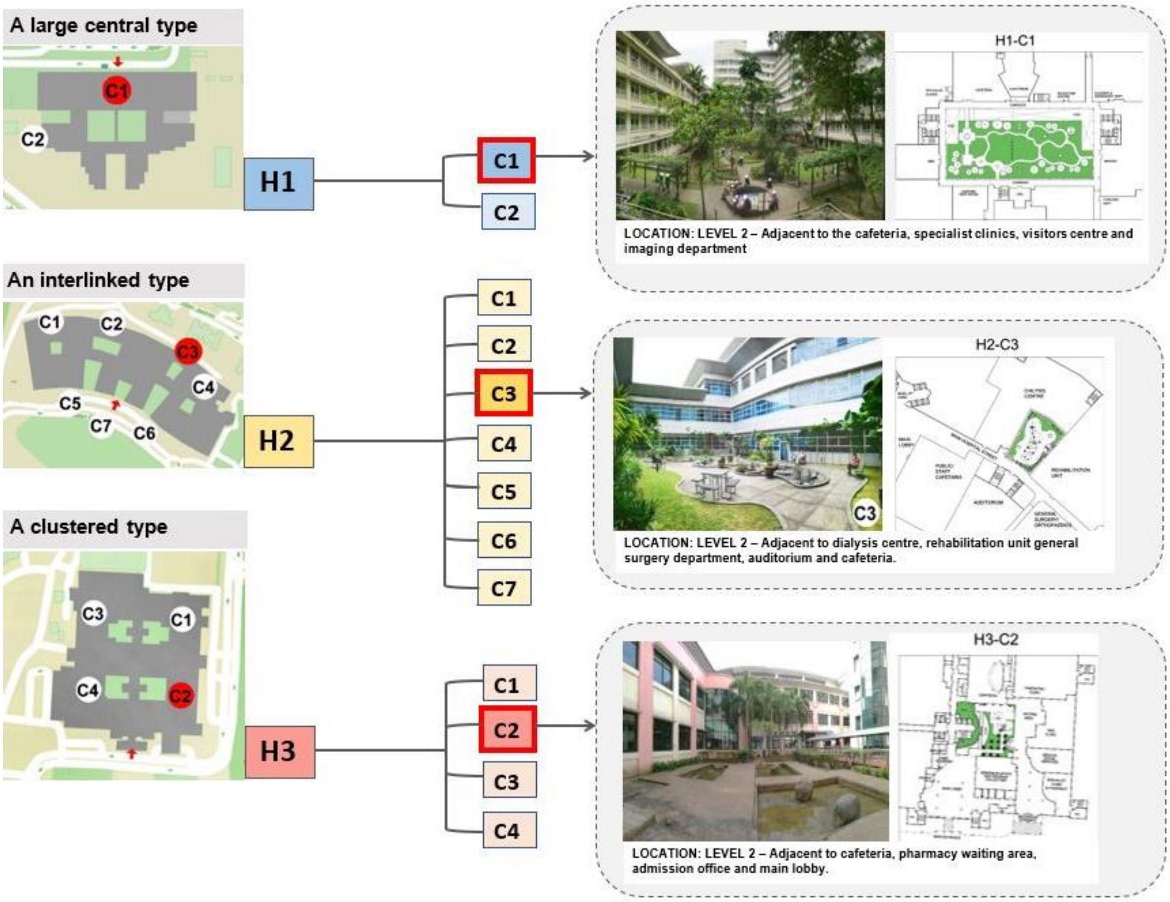

Figure 4.1: The selection of the representative case study HCGs: H1-C1, H2-C3 and H3-C2.

4.3 The context and description of the case study hospitals

4.3.1 Climatic context of the selected case study sites

Malaysia lies between the latitudes of 1º and 7º North and longitudes of 100º to 103º East with an area of 131,587 km² (Suhaila and Yusop, 2018). According to the Malaysian Meteorological Department (MMD) official website, Malaysia has an equatorial climate and is classified as a hot humid climate (tropical, warm weather, humid and rainy climates with no cool season).

All three case study sites are located on the West coast of Peninsular Malaysia as indicated in Figures 4.2 and 4.3. H1, H2 and H3 hospitals are in Johor Bharu (Southwest), Selangor (West) and Kedah (Northwest), respectively. Peninsular Malaysia has a uniformly high temperature and high humidity (Jamaludin, 2014; Ahmad, 2008) with relatively light winds and heavy rainfall throughout the year (Suhaila and Yusop, 2018). However, the climatic variations in Peninsular Malaysia is due to differences in altitude and exposure to the Southwest and Northeast wind (MMD, 2017a, p.29). Regarding the urban context and its impact on the microclimate, all the case study sites were located in suburban areas. There is a small variation in the landform because all the case study sites are situated in suburban areas of a similar altitude; thus, the climatic conditions will evidence only a little variation across the different sites.

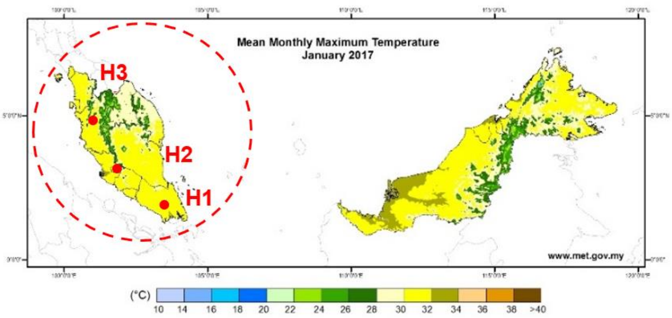

Figure 4.2: Mean monthly temperature in Malaysia, January 2017
Source: (Malaysian Meteorological Department, 2017)

The climatic conditions in Malaysia are discussed further below:

Temperature

Malaysia evidences a similar average temperature throughout the year with a uniform temperature range from 21ºC - 32ºC (Wong et al., 2009). Seasonal and temperature changes are comparatively small (Jamaludin, 2014; Ahmad, 2008). In Peninsular Malaysia, the annual difference in temperature is less than 2ºC except the East coast of Malaysia which is usually affected by the Siberian cold wind during the Northeast Monsoon (MMD, 2019). The highest average monthly temperature is recorded in April and May, whereas the lowest average temperature is recorded in December and January (Malaysian Meteorological Department, 2019).

Humidity

Malaysia also evidences high humidity. The average monthly humidity ranges from 10% to 90%, changing by place and month. In Peninsular Malaysia, the lowest relative humidity is often recorded in January and February, except for the East Coast which has the lowest humidity level in March (Malaysian Meteorological Department, 2019).

Solar radiation

Malaysia also receives a long period of solar radiation (5-7 hours of sunshine per day) the whole year round. Cloud cover can reduce the amount of sunlight received per day (Malaysian Meteorological Department, 2019).

Wind and rainfall

The surface climate in Malaysia is generally affected by two significant Monsoon seasons, namely the Southwest (SW) Monsoon (beginning in May and ending in August, 10-30 knots) and the Northeast (NE) Monsoon (beginning in November and ending in February, 15 knots) (MET, 2019). The NE Monsoon brings in more rainfall compared to the SW Monsoon, with an average annual rainfall of between 2,000mm and 4,000mm (Suhaila et al., 2010). Heavy monsoon rains and floods commonly occur in the East Coast of Peninsular Malaysia and Western Sarawak (MMD, 2017b). The case study sites are located at the Western edge of peninsular of Malaysia as indicated in Figure 4.3. The fieldwork activity was carried out from January 2018 until March 2018 during the NE Monsoon. However, the fieldwork activity was not highly affected by heavy rain or flooding during this period.

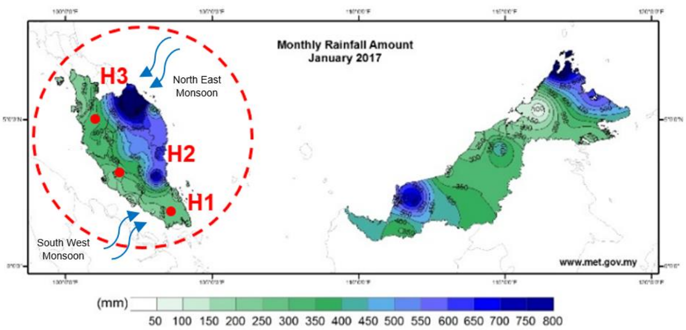

Figure 4.3: Monthly rainfall amount in Malaysia, January 2017
Source: Malaysian Meteorological Department (2017)

4.3.2 The site context of the H1, H2 and H3 hospital

H1 Hospital is a specialist public hospital located at Bandar Mount Austin, Johor, within proximity to Johor Bharu city centre. Figure 4.4 shows the overall view of the surrounding neighbourhood context around the hospital compound. The zone area includes 50% residential, 30% commercial, 10% industrial, and 10% educational zone. On the east side of the hospital lies a high-end commercial area (TESCO, AEON, IKEA shopping mall) and several shop lot areas (See Table 4.2). The residential zone encompasses the northern and eastern site of H1. Compared to a decade ago, more new development area including commercial and residential properties have been built. Prior to this, H1 hospital was surrounded by a rubber estate and palm estate. The architect who designed this hospital mentioned that the increasing number of new residential and commercial areas around the site slightly changed the microclimate within the region.

H2 Hospital is a specialist public hospital that serves as a teaching hospital for medical students from several universities. H2 was intentionally designed to achieve a unified, practical and efficient operating environment for staff and the training of doctors. H2 is located in a suburban area in close proximity to the University Putra Malaysia (UPM). Despite the development of a commercial, educational and residential zone around the neighbourhood context, some of the green areas at the south and north side, are still preserved to date (See Table 4.2). H2 aims to represent an image of Putrajaya and Cyberjaya (i.e. a modern city within the vicinity context) and an image of a world-class hospital with high-end technology and training. H2 was designed to connect via the bridge with the Medical teaching faculty at UPM on the west side of the hospital. At the north-side, H2 is linked via a bridge to the nurses' hostel. In terms of the visual view, H2 was also designed with a splendid view over the golf course located on the north-side.

H3 hospital is a replacement for an old hospital in the Kedah region to cater to the growing healthcare needs. This H3 hospital was operated in 2007 to support the health needs of the community which require a bigger and more comfortable hospital. H3 hospital is surrounded by a commercial area on the west side and various ranges of the residential zone (i.e. high-end residential and low-end residential) at the south and east side of the hospital site. Ample green areas are still preserved on the south side of the hospital context In addition, H3 is encompassed by the North-South Expressway which allows easy access to the hospital (See Table 4.2).

Table 4.2: The overall view and the neighbourhood context of the case study hospitals

H1-HOSPITAL	**H2-HOSPITAL**	**H3-HOSPITAL**
Year of operation: 2007 **Site area:** 50.58 acres **Floor area:** 105,417m²	**Year of operation::** 2005 **Site area:** 60 acres **Floor area:** 129,000m²	**Year of operation:** 2007 **Site area:** 40 acres **Floor area:** 77,940m²
		
Source: GDP Architects Sdn Bhd	*Source: University Putra Malaysia*	*Source: HSAH*
OVERALL VIEW		
		
Source: West D Zero. Retrieved from https://www.youtube.com/watch?v=3xj1xJ0RqM8 (March, 2019)	*Source: Retrieved from https://www.skyscrapercity.com/showthread.php?t=482937&page=27 (March, 2019)*	*Source: HSAH (2018)*
NEIGHBOURHOOD CONTEXT		
All the case study sites were all located in the suburban area. The sites was surrounded with a residential, commercial, industrial, and educational zone.		
		
Source: Retrieved from https://earth.google.com (March 2019)	*Source: Retrieved from https://earth.google.com (March 2019)*	*Source: Retrieved from https://earth.google.com (March 2019)*

4.3.3 The masterplan of H1, H2 and H3 hospital

H1 hospital was built on 50.58 acres of land and operated in 2007. It consists of ten floors with the capacity to accommodate 704 beds. The wards and other medical departments are organised around a central forested courtyard garden, thus providing a beautiful view of the garden. This hospital is also strategically located at the main road which allows easy access to the hospital. H1 encompasses the following: a six storey medical block, ten storey ward blocks and three residential quarters as indicated in the master planning of this hospital (See Figure 4.4).

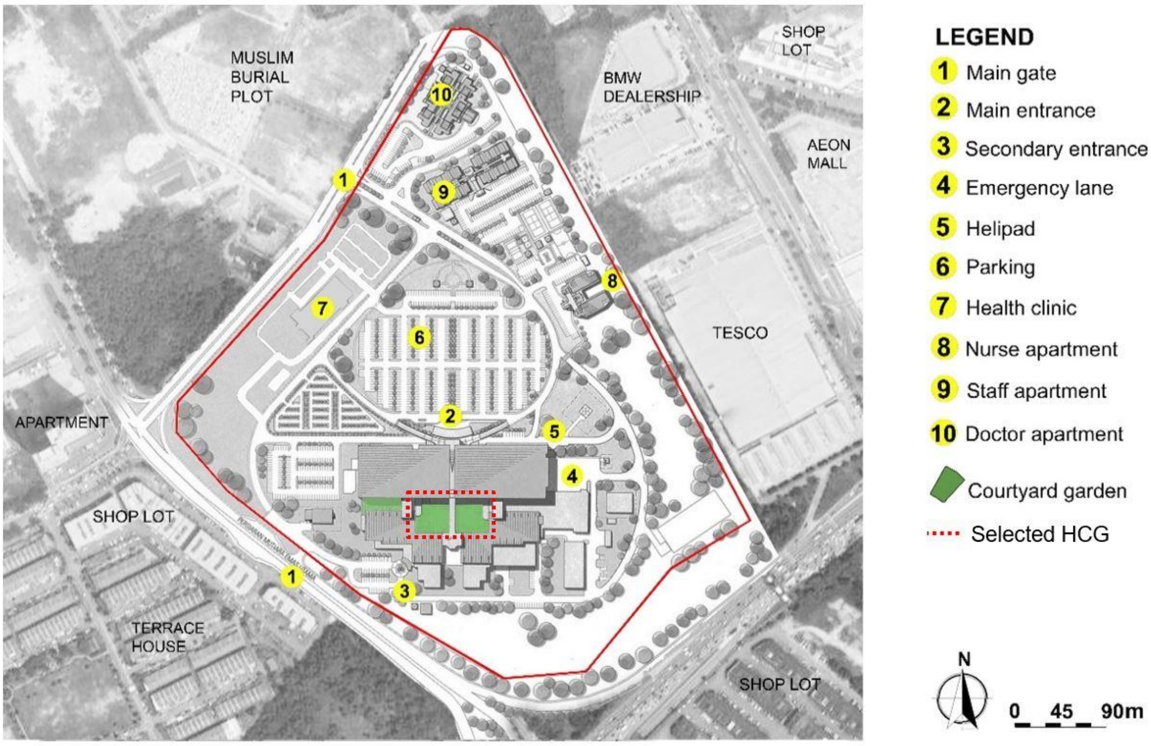

Figure 4.4: H1 hospital - Master plan
Source: GDP Architects. Sdn Bhd (Re-edited by Author, 2018).

H2 hospital was built on 60 acres of land and commenced the operation in 2005. It consists of the eight floors with the capacity to accommodate 620 beds, with the potential designed in for the future expansion of 1,000 beds. H2 planning introduced courtyard gardens to minimise the occurrence of the 'deep plan' nature of the building which could provide natural lighting and ventilation into the indoor spaces. The site plan of the hospital is elongated along a north-south orientation to minimise sunlight penetration from the east and west side of the hospital building. A simple horizontal circulation of this hospital was intentionally designed to facilitate the infrequent users from disorientation. There are three entry points which include:

(i) the south side entry point (i.e. the main entrance that connects to the main lobby),
(ii) the west side entry point (i.e. the drop off point to the A & E Department), and
(iii) the east side entry point (i.e. the outpatient entry point to the specialist clinics) (See Figure 4.5).

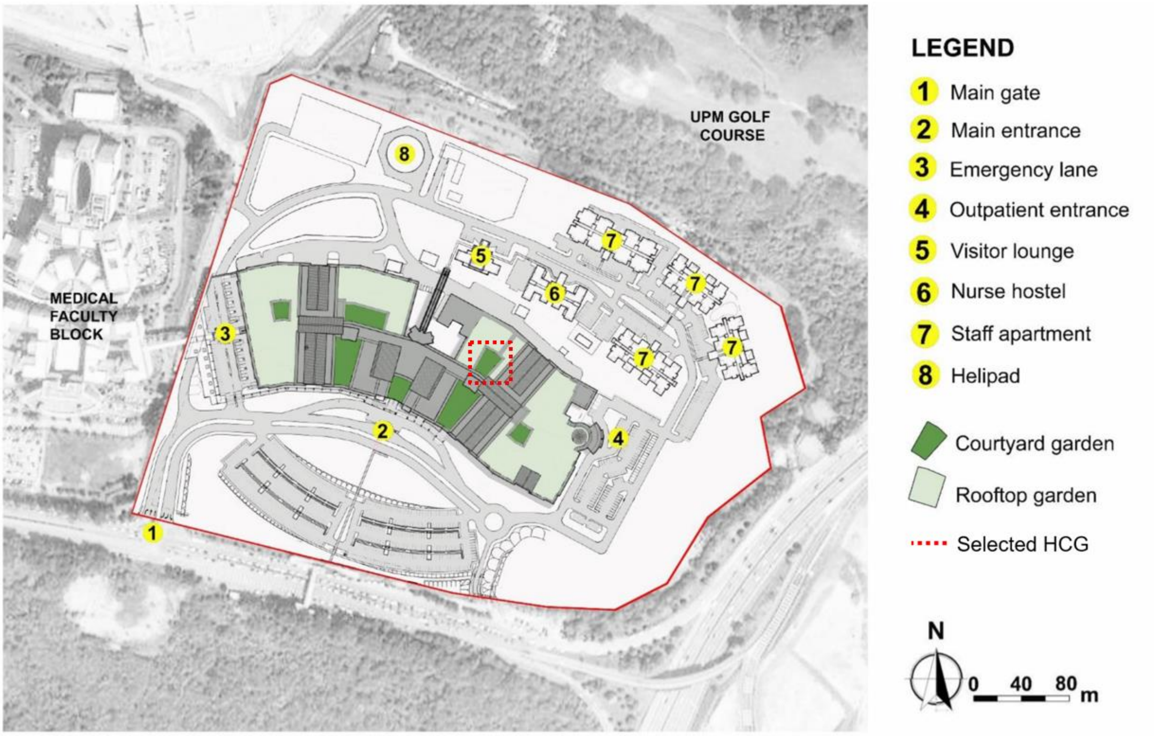

Figure 4.5: H2 hospital - Master plan
Source: H2 hospital Architect Sdn. Bhd (Re-edited by Author, 2018).

H3 hospital started operation in 2007. Built on an area of 40 acres, the **H3 hospital** equipped with 550 beds and was later expanded into 628 beds in January 2014 to offer secondary level care to the surrounding community of Kedah. The main building block of H3 hospital stands eight-storey height (See Figure 4.6). This hospital finished with the medical facilities, patients' wards, operating theatres, laboratories, examination and observation rooms which are located in a specific wing of the main hospital block. This H3 hospital block was also intentionally designed with courtyard gardens to bring fresh air and daylight into the indoor space and to avoid the 'deep plan nature' of a large building plan. There are also rooftop gardens provided in this hospital building.

Besides the main hospital blocks, other hospital building complexes within the facility included the visitor's lounge and catering was provided for the family members of the sick to rest comfortably between visiting hours. H3 hospital also housed a nursing training college to train nurses and student interns in the medical field. Apart from being medical facilities and a medical training centre, H3 hospital also integrated with living accommodation for its staff along a small stream within the hospital compound. For medical staff, a total of 182 apartments are available. A hostel for nurses with a total of 100 rooms and a student interns' hostels totaling of 180 rooms ensure the nurses and student interns have the ease of the accommodation.

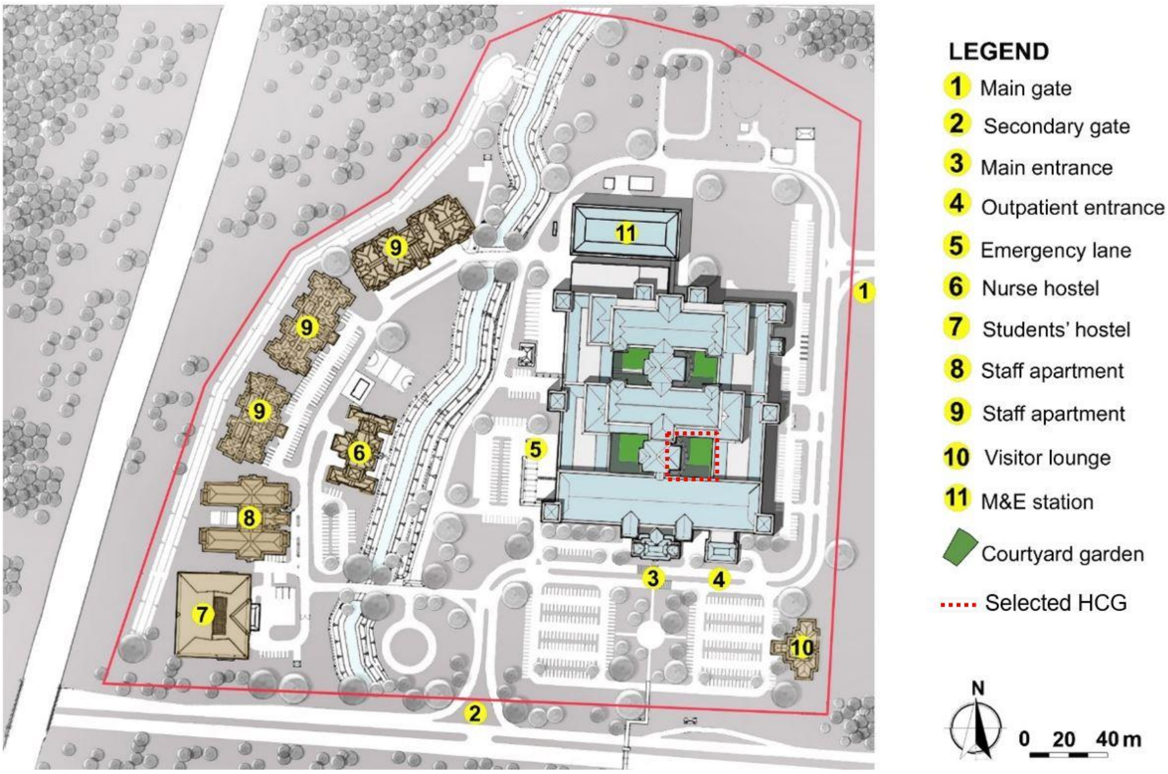

Figure 4.6: H3 hospital – Master plan
Source: Gabungan Architect Sdn. Bhd. (Re-edited by Author, 2018)

4.3.4 The floor plan and the circulation of the H1, H2 and H3 hospital

All of these 20th century hospitals were completed and became operational over a decade ago. These three hospitals include a number of HCGs that vary in their design planning: H1 (large central type), H2 (interlinked type), and H3 (clustered type). Both H2 and H3 have a rooftop garden whilst no rooftop garden was found in the planning of the H1 hospital. Among the three hospital, H1 hospital has the highest floor level (10 floors) followed by the H3 hospital (8 floors) and H2-hospital (7 floors) (See Table 4.3).

Regarding vertical zoning, all the three hospitals arranged and accommodated the lower level with supporting medical facilities (e.g. clinics, pharmacy, imaging, A& E unit) and services. All the wards were located on the upper floors. Moreover, all three hospitals evidenced a different arrangement of the hospital circulation; H1 - Radial circulation; H2 - Linear circulation and H3 - Compound circulation. All three HCGs (H1-C1, H2-C3 and H3-C2) were connected to the main hospital street. The H1 hospital circulation was organised around the HCG which allowed a high degree of visibility and accessibility to the sites compared to the H2 and H3 hospitals (See Table 4.3). This will be discussed further in analysis and discussion in Chapter 5.

Table 4.3: The floor plan and circulation of the H1, H2 and H3 hospitals

<table>
<tr><th>H1-HOSPITAL</th><th>H2-HOSPITAL</th><th>H3-HOSPITAL</th></tr>
<tr><td colspan="3">Floor plan and sectional perspectives</td></tr>
<tr>
<td>
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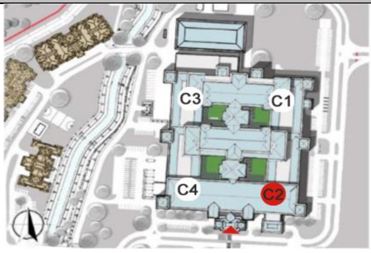
<td>
</td>
</tr>
<tr>
<td>Types of HCGs: A large central courtyard garden
Total HCGs: 2 types (Located at floors 2 & 3).
No roof top gardens.</td>
<td>Types of HCGs: An interlinked type courtyard garden
Total HCGs: 7 types (Located at floors 2, 5 & 6)
Have rooftop gardens.</td>
<td>Types of HCGs: A clustered type courtyard garden
Total HCGs: 4 types (Located at floors 2 & 3)
Have rooftop gardens.</td>
</tr>
<tr>
<td>No of beds: 704 beds
Total floor: Ten floors</td>
<td>No of beds: 620 beds
Total floor: Seven floors</td>
<td>No of beds:550 beds
Total floor: Eight floors</td>
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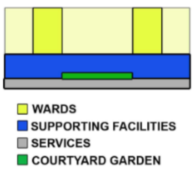
</tr>
<tr><td colspan="3">The vertical zoning</td></tr>
<tr>
<td>
</td>
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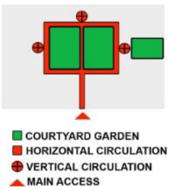
</tr>
<tr><td colspan="3">Types of spatial circulation</td></tr>
<tr><td>Radial circulation</td><td>Linear circulation</td><td>Compound circulation</td></tr>
<tr>
<td>
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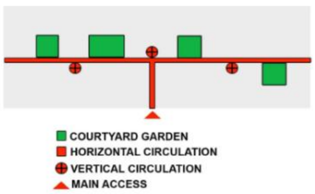
<td>
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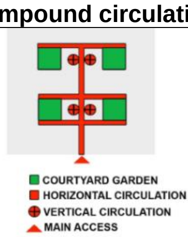
<td>
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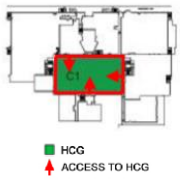
</tr>
<tr><td colspan="3">Circulation to the HCG</td></tr>
<tr>
<td>
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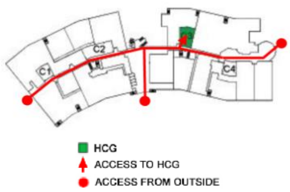
<td>
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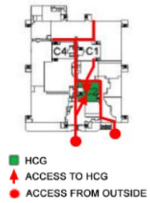
<td>
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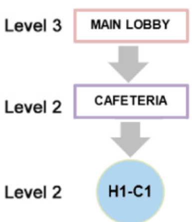
<td>
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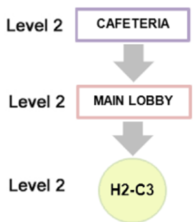
<td>
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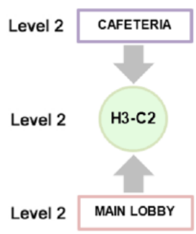
<td>
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4.3.5 Type of HCGs in the H1, H2 and H3 hospital

H1 hospital incorporates two HCGs, H1-C1 and H1-C2, located at level 2 and 3 of this hospital, respectively. H1-C1 is situated in the middle of the hospital planning which can be accessed from level 2. H1-C1 was selected as the case study because of the characteristics of the site, that it is a type of large central courtyard accessible to all types of users (i.e. patients, staff and visitors). H1-C2 was not chosen as a case study because of its different functional use and restricted access (patients only). Moreover, in the case study site, H1-C1 is located close to the cafeteria and main lobby which is similar to the other case studies situated at another hospital (H2-C3 and H3-C2). The character of the site and the landscape elements are different from the other case study sites which are worth studying on the characters of the case sites and the spatial quality. Figure 4.7 summarises some of the characteristics of both HCGs in H1.

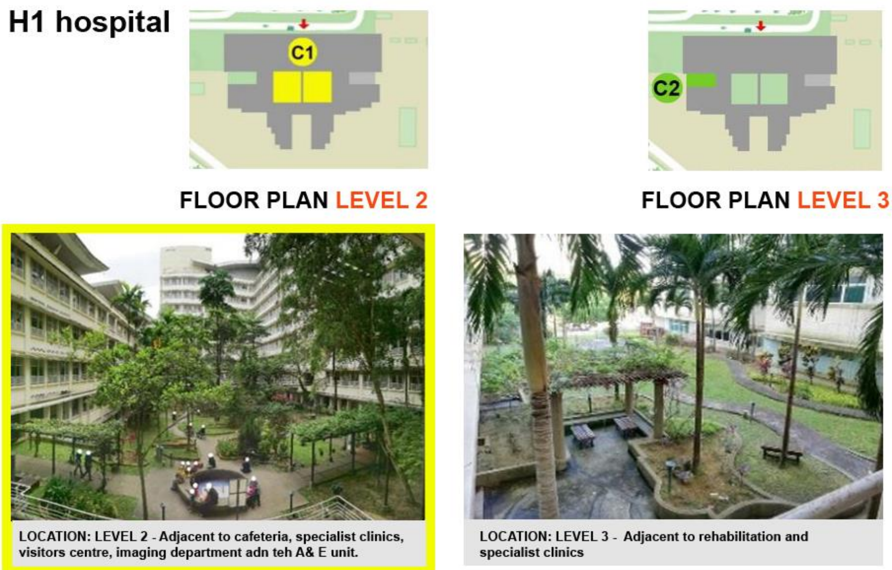


Figure 4.7: H1-hospital - Floor plan level 2 and level 3 indicating the location of courtyard H1-C1 and H1-C2 respectively

H2 hospital has seven HCGs which include four enclosed type courtyards located on level 2 (C1, C2, C3 and C4) and three semi-enclosed types of HCGs situated on levels 5 and 6 (C5, C5 and C6). Apart from the HCGs, this hospital is also equipped with several rooftop gardens that can be accessed on level 5. On level 2 of the hospital, there are four HCGs (H2-C1, H2-C2, H2-C3 and H2-C4) accessible to all types of users (i.e. patients, staff and visitors) (See Figure 4.8). H1-C1 is located adjacent to the labour and delivery room and A & E department. H2-C2 is located close to the milk kitchen and imaging department. H2-C3 is located adjacent to the dialysis centre, rehabilitation unit and cafeteria, and H2-C4 is located adjacent to the paediatric clinic, surgery clinic and ophthalmology clinic.

Figure 4.8: H2-hospital - Floor plan level 2 indicating the location of courtyard H2-C1, H2-C2, H2-C3 and H2-C4

Regarding usability, H1-C1 and H1-C2 are the least frequently used as they are located in a quiet secluded area on the east-side of the hospital compared to H2-C3 and H2-C4. Very few staff, patients and visitors were observed to spend time in H2-C1 and H2-C2 compared to H2-C3 and H2-C4. Apart from the HCGs which are located at level 2, there are three types of HCGs situated on level 5 and level 6 of H2. The HCGs are H2-C5, H2-C6 and H2-C7 (See Figure 4.9). Although these HCGs are mainly designed for patients who stay in the nearby wards, it is locked by the hospital management due to safety reasons. Thus, no activity by patients or staff were recorded and public access is restricted in this area.

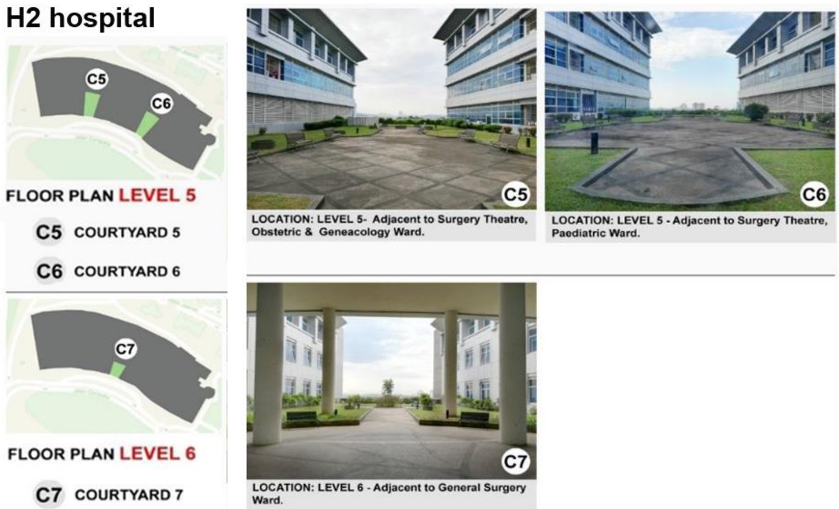


Figure 4.9: H2 hospital - Floor plan level 5 and 6 indicating H2-C5, H2-C6 and H2-C7

H3 hospital has four types of HCG which include: H3-C1, H3-C2, H3-C3 and H3-C4 (See Figure 4.10). H3-C1, H3-C2 and H3-C4 are on the same floor (Level 2), while H3-C3 is located on floor 3 of the hospital. H3-C1 is located on level 2 adjacent to the rehabilitation centre and cafeteria. It was initially designed to function as a garden for a rehabilitation program. It is equipped with a basketball court and equipment for conducting physical activities. However, today, this space has changed into an outdoor eating area for hospital users. The door that connected to the rehabilitation centre is locked to the public, and H3-C1 can only be accessed from the door attached to the cafeteria.

The second HCG is H3-C2 which also located next to the cafeteria and can be accessed from the main lobby and cafeteria. It is also located close to the specialist clinics and pharmacy area. The third HCG is H3-C3 is located adjacent to the management office. Sometimes it is used by the administration staff as a place for conducting events such as Eid festival or other administrative programs. The fourth HCG is the H3-C4 which is placed near to the labour room, imaging department and Neonatal Intensive Care Unit (NICU). Access to H3-C4 is restricted to the public and permitted only to staff. Some herb plants are planted in this HCG, however there was evidence of poor garden maintenance. Overall, the most frequently used HCG by the hospital users is H3-C2.

Figure 4.10: H3 hospital - Floor plan indicating the location of H3-C1, H3-C2, H3-C3 and H3-C4

4.4 The characteristics and descriptions of the three representative case study HCGs

As mentioned previously in Section 4.2, three representative case study HCGs were selected for in depth on-site investigation as well as for analysis and discussion for the current study. The following section describes the characteristics of each site.

4.4.1 Case study 1: H1-C1

4.4.1.1 Site plan

The total area of the HCG in H1-C1 is 2,100m² (70m X 30m) or 1,880m² excluding the void area. Implementing a 'Hospital in a forest' concept, a free flow organic shape was chosen for the landscape planning of H1-C1 to create a more informal and leisurely setting for social interaction open to all types of uses including patients, staff and visitors. H1-C1 is set on level 2 of H1 and is strategically located close to the cafeteria, visitors centre, specialist clinics and diagnostic treatment area. Besides the lift access, H1-C1 can be accessed via a grand staircase from the main lobby, down to the cafeteria to go to the courtyard garden at level 2 (See Figure 4.11).

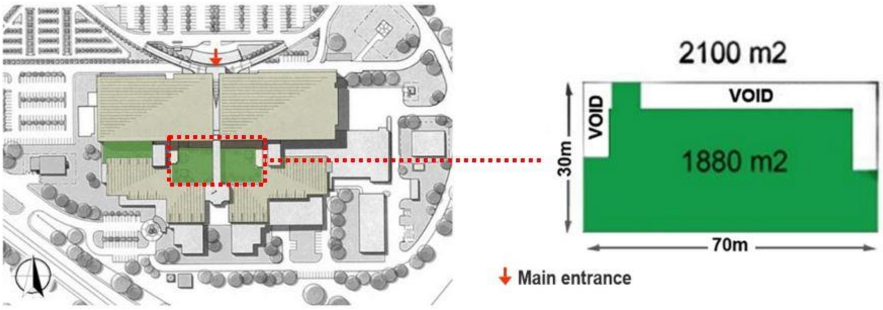


Figure 4.11: H1-C1- Site plan indicating the location of the case study site
(Source: GDP Architects. Sdn Bhd)

4.4.1.2 Space functions

The degree of openness and transparency can be seen between the indoor spaces of H1 and the semi-outdoor area of H1-C1. For instance, the glass walls of the cafeteria offer visual transparency to the hospital courtyard garden, permitting interaction between both the indoor and outdoor areas (Figure 4.12). The design of the hospital street running along the boundary of the courtyard garden provides not only physical access to the courtyard at level 2 but also visual access to the garden from the other floor levels, as well as from the bridge on level 3 that is suspended above and across the courtyard garden.

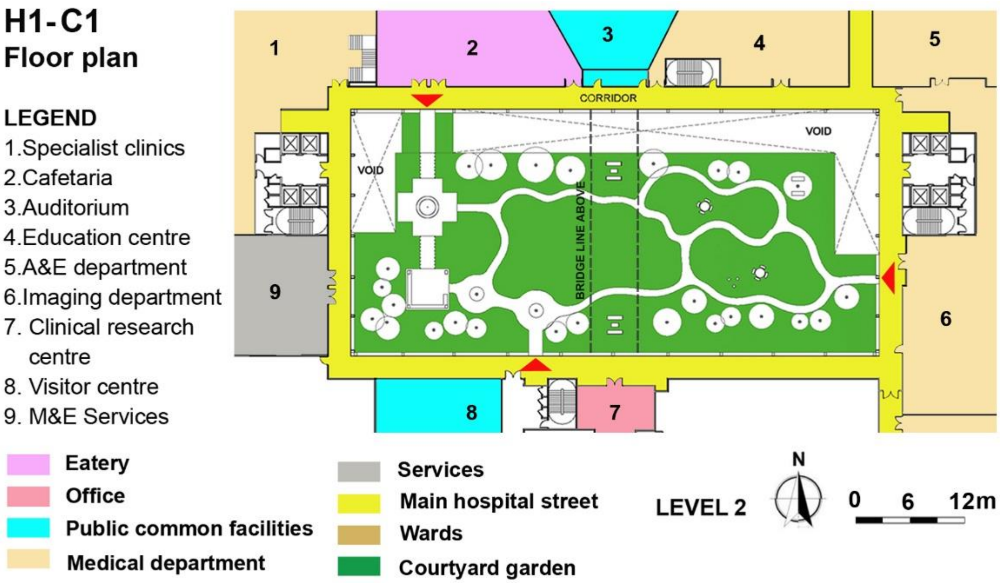


Figure 4.12: H1-C1 - HCG layout plan

On floor 2, H1-C1 is surrounded by an open corridor (main hospital street) that allows the breeze into the surrounding spaces. At the upper floor level, the building block is enclosed with fixed glazing, and powder coated ventilated screening wall (See Figure 4.13) This envelope is specially designed by the architect with the intention to allow a visual view of the surrounding nature as well as promote ventilation into the building. The height of the building on the northside is five floors lower than the other side of the building blocks (Height: 9 floors) from the ground level of H1-C1.

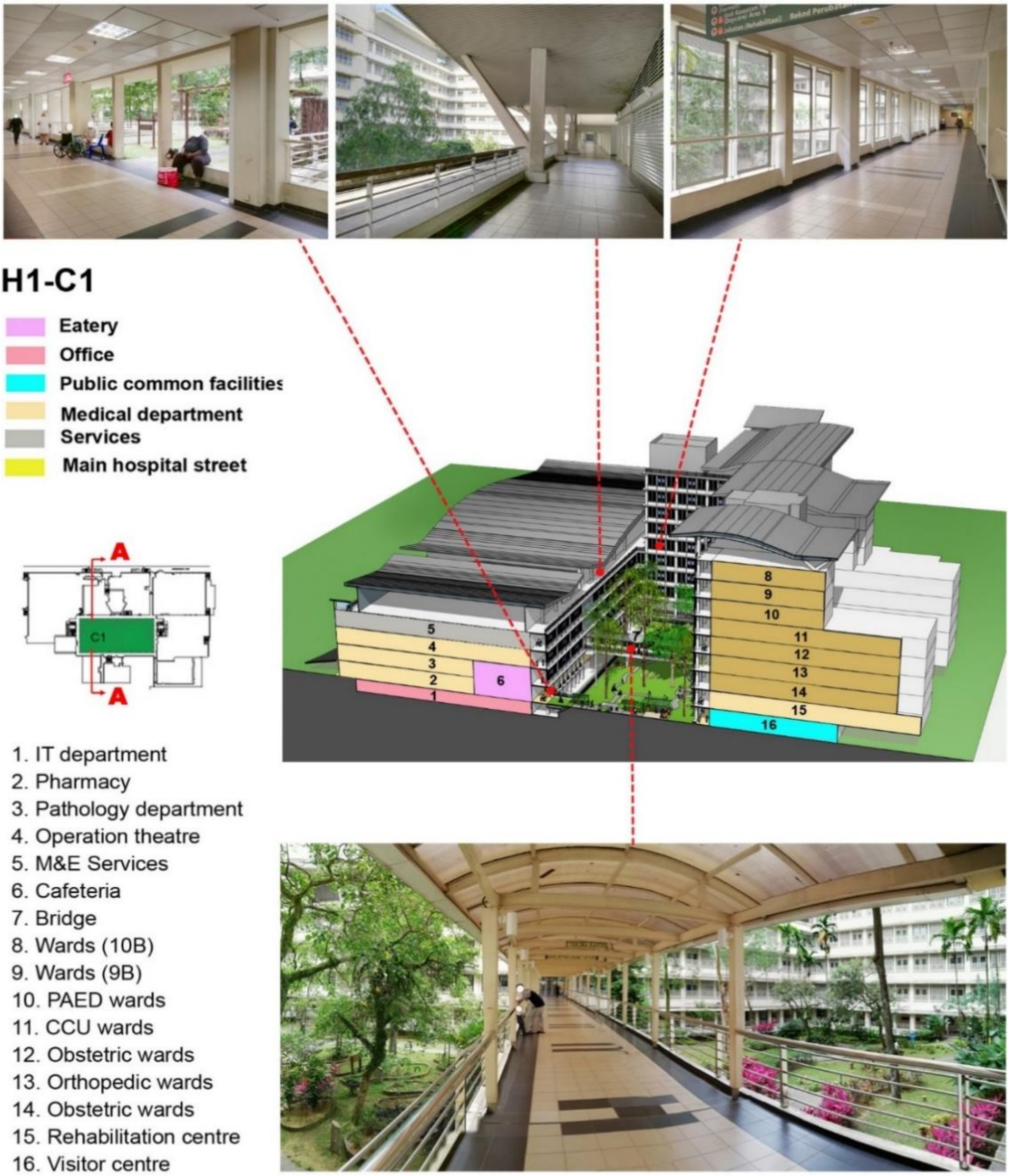


Figure 4.13: H1-C1 - Sectional perspectives and view from the bridge

4.4.1.3 Vegetation and seating area

H1-C1 has a wide range of plants including canopy trees, herbal medicinal plants, indigenous plants and native shrubs (See Figure 4.14). H1-C1 is surrounded by mature trees which were planted about a decade ago and now reach around six metres in height. These wide tree canopies shield sunlight penetration to the ground area as well as the building space around the courtyard compound. Despite generating a well-shaded area to the ground, it has drawbacks as it causes insufficient sunlight to reach some areas of the ground herb plants and native shrubs.

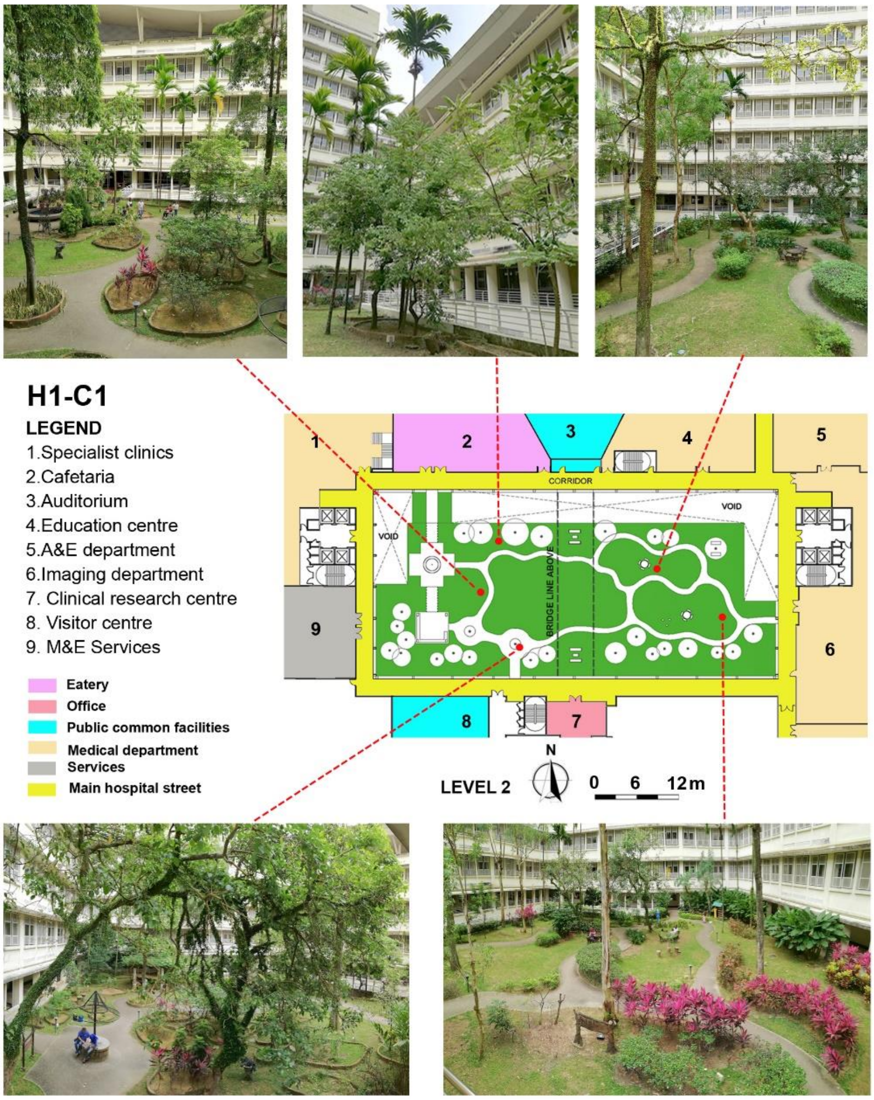


Figure 4.14: H1-C1 - Vegetation

Besides a variety of plantings, several options of seating are provided in H1-C1 including a mixture of seating arrangements: movable seating and fixed seating, individual and group seating, seating with a table, and shaded and unshaded seating. The seating facilities include: i) a concrete bench around the water fountain; ii) a pergola shaded seating, iii) a round concrete bench; iv) a wooden bench with a table; vi) a concrete bench with a round table; vii) a wooden bench under the shady tree; and viii) a fixed concrete bench around the periphery of the courtyard garden (See Figure 4.15). Also, H1-C1 is equipped with a water fountain intentionally designed as a focal point of this courtyard garden. However, it did not function during the period of fieldwork at H1.

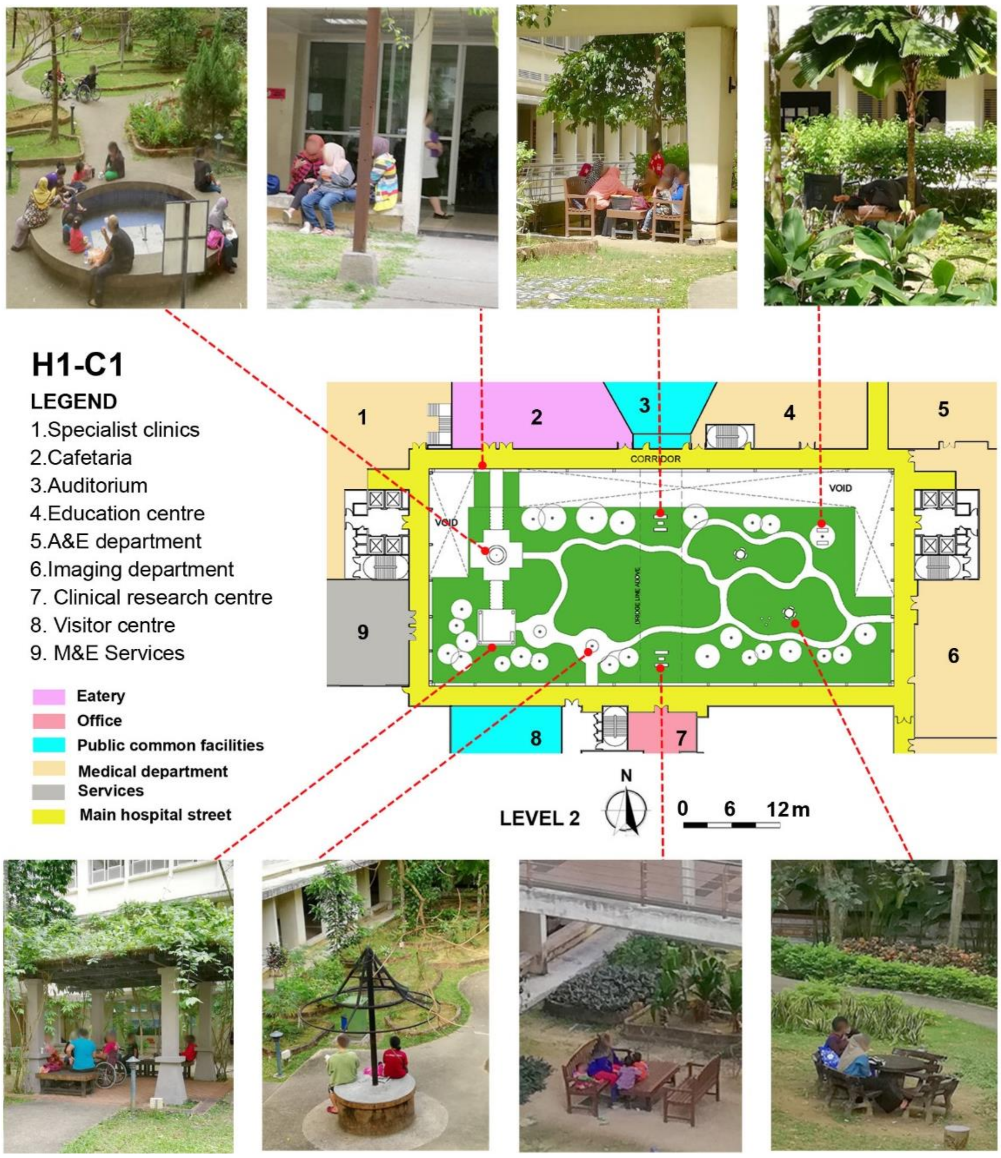


Figure 4.15: H1-C1- Seating area

4.4.2 Case study 2: H2-C3

4.4.2.1 Site plan

Figure 4.16 illustrates the site plan indicating the case study H3-C2. The size of H2-C3 is 427m², making it four times smaller than the H1-C1 courtyard. From the main lobby, H2-C3 can be accessed from the main hospital street that links to the courtyard garden H2-C3.

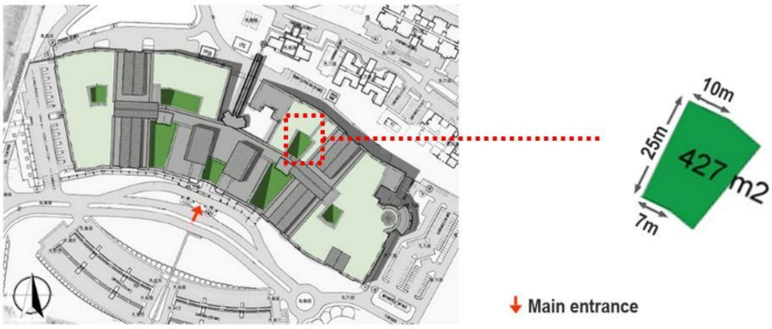


Figure 4.16: H2-C3 - Site plan indicating the location of the case study site

4.4.2.2 Space functions

H2-C3 is also located close to the public common facilities such as the prayer room and toilet which are connected via the main hospital street. However, the location of the cafeteria is slightly distant from H2-C3 which is located next to the main lobby. Regarding accessibility, there are three access doors to H2-C3. One entry is connected to the main hospital street which is commonly used by people to access this courtyard garden. Another two doors, attached to the rehabilitation centre, are often locked and only open when rehabilitation activity was held in H2-C3 (See Figure 4.17).

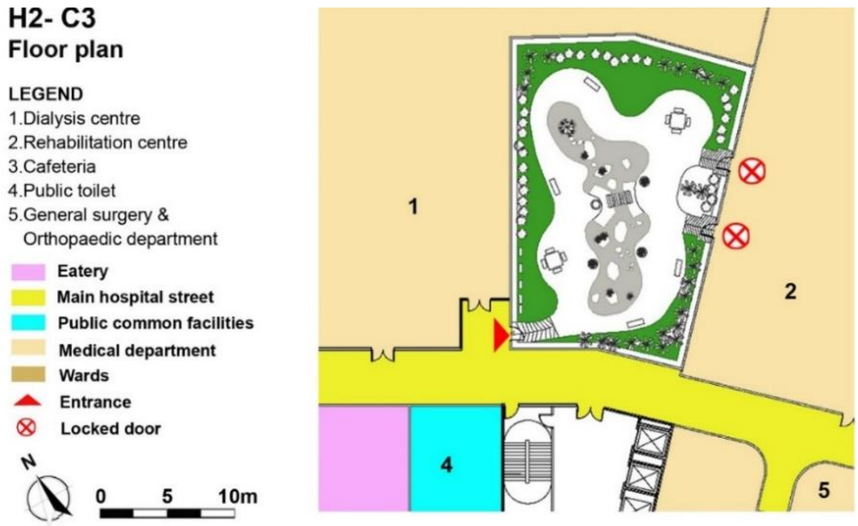


Figure 4.17: H2-C3 – HCG layout plan

Regarding accessibility, there are three access doors to H2-C3. One entry is connected to the main hospital street which is commonly used by people to access this courtyard garden. Another two doors, attached to the rehabilitation centre, are often locked and only open when rehabilitation activity was held in H2-C3. Based on the observation, the wall enclosure around H2-C3 is aluminium cladding and fixed window glazing. The windows around the periphery of H2-C3 are not opened because most of the spaces are air-conditioned except the main hospital street (corridor area). The height of the building wall at the north side and east side of H2-C3 is the lowest (i.e. two floor), while at the west side it is lower (i.e. third floor level) and the south side is the highest (i.e. seven floor level) from the ground level of H2-C3 (See Figure 4.18). In addition, the most frequent wind direction for H2-C3 comes from the north and north-east side.

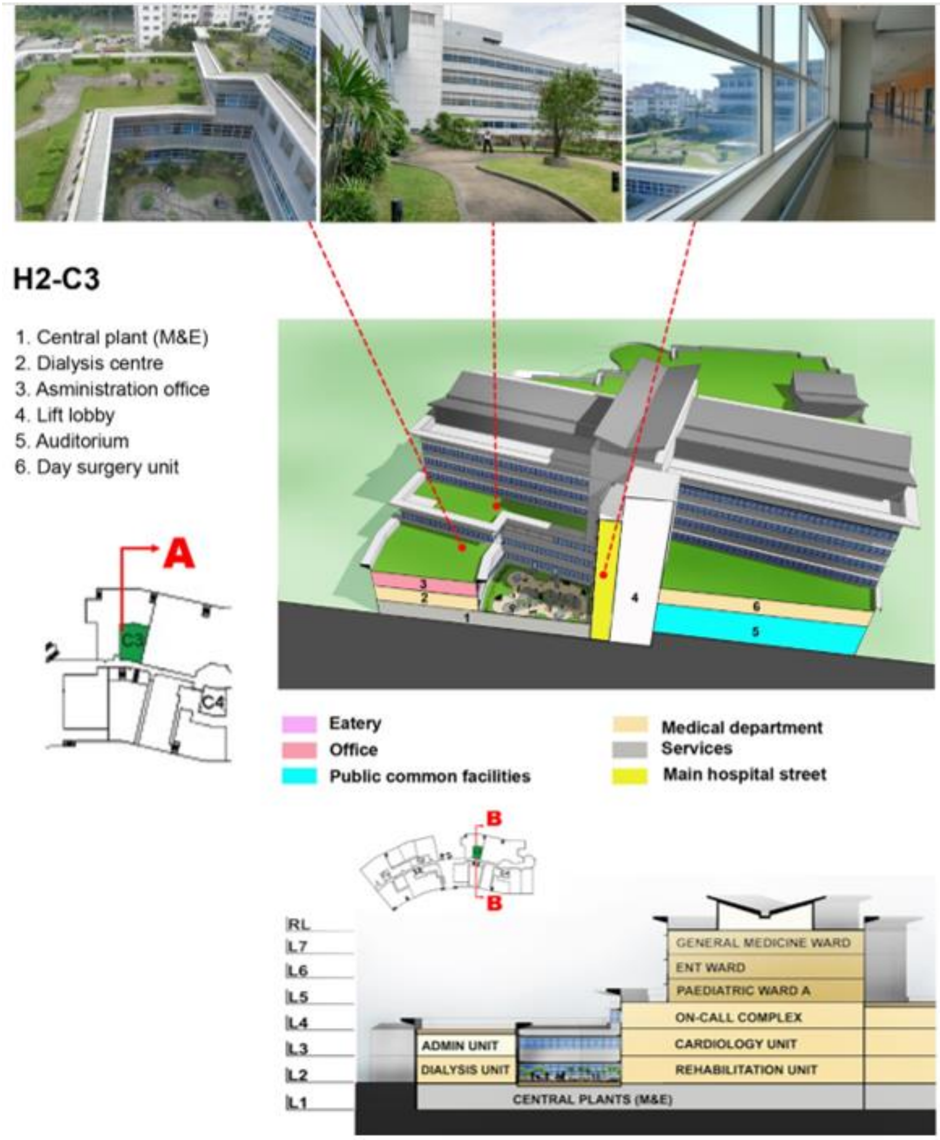


Figure 4.18: H2-C3 - Sectional perspectives and section B-B indicating the space functions

4.4.2.3 Vegetation and seating area

In H2-C3, there are two types of seating provided which included: i) a wooden bench, and ii) a square steel table and chair. Based on the observation, these seating facilities are well-used during the weekday by the hospital users including staff, patients and visitors compared to the weekend. Regarding the planting, some of the deciduous trees, potted plants and ground shrubs were planted and arranged around the H2-C3. Other landscape features included the stones and a wooden bridge that linked across a shallow pond (See Figure 4.19).

Figure 4.19: H2-C3 - Vegetation and seating area

4.4.3 Case Study 3: H3-C2

4.4.3.1 Site plan

Out of four enclosed type HCGs in H3 hospital, H3-C2 is selected as one of the case studies due to the several major criteria as mentioned earlier in Section 4.2. The size of H3-C2 garden is 460m² with the void area or 320m² excluding the void area (See Figure 4.20).

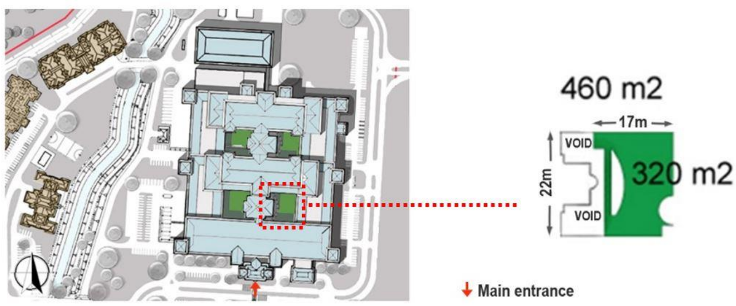


Figure 4.20: H3-C2 - Site plan

4.4.3.2 Space functions

In H3-C2, there is a small covered bridge that runs across the slope area linking the main lobby with the cafeteria. Despite its less frequent use during the day, many people use this bridge to pass through on their way to the cafeteria rather than using the uncovered pathway in the garden. Regarding access to H3-C2, there are two main access routes, from the main lobby and the cafeteria. There were four doors initially designed to connect this HCG with the cafeteria. However, only one door was opened during the day, and another three doors were locked by the hospital management (See Figure 4.21).

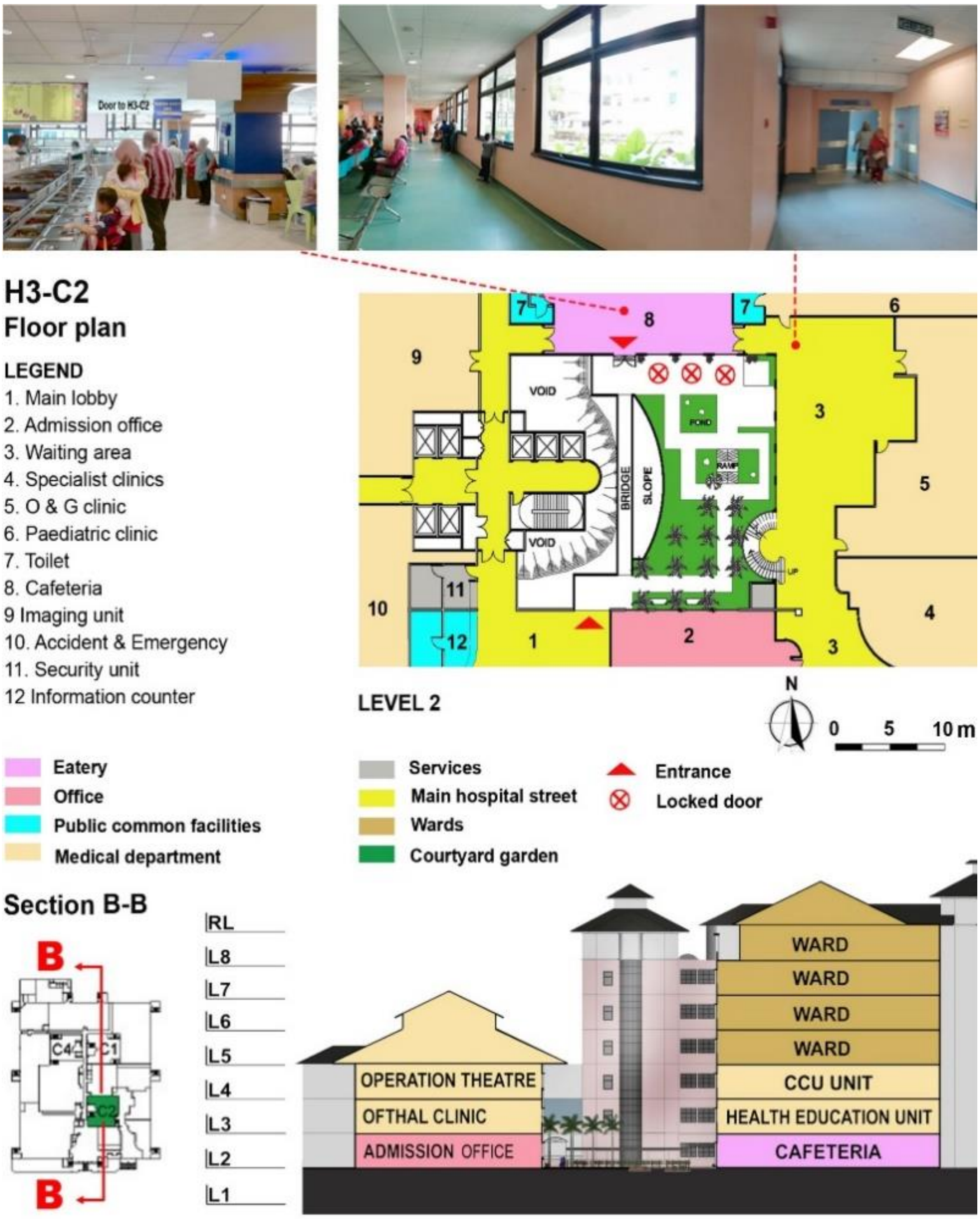


Figure 4.21: H3-C2 - Floor plan and section B-B

4.4.3.3 Vegetation and seating area

H3-C2 lacks the planting diversity of H1-C1. There are only some deciduous trees and small shrubs planted within this HCG. A palm tree was planted at the south side of H3-C2 which provides shade to the underneath seating area. However, H1-C1 has the least seating with only two wooden benches provided to cater to the 320m² courtyard garden space. In addition to the planting and seating, H2-C3 was designed with a shallow pond and some stones. It was initially designed with a small water fountain, but this was removed from the site due to maintenance issues (See Figure 4.22).

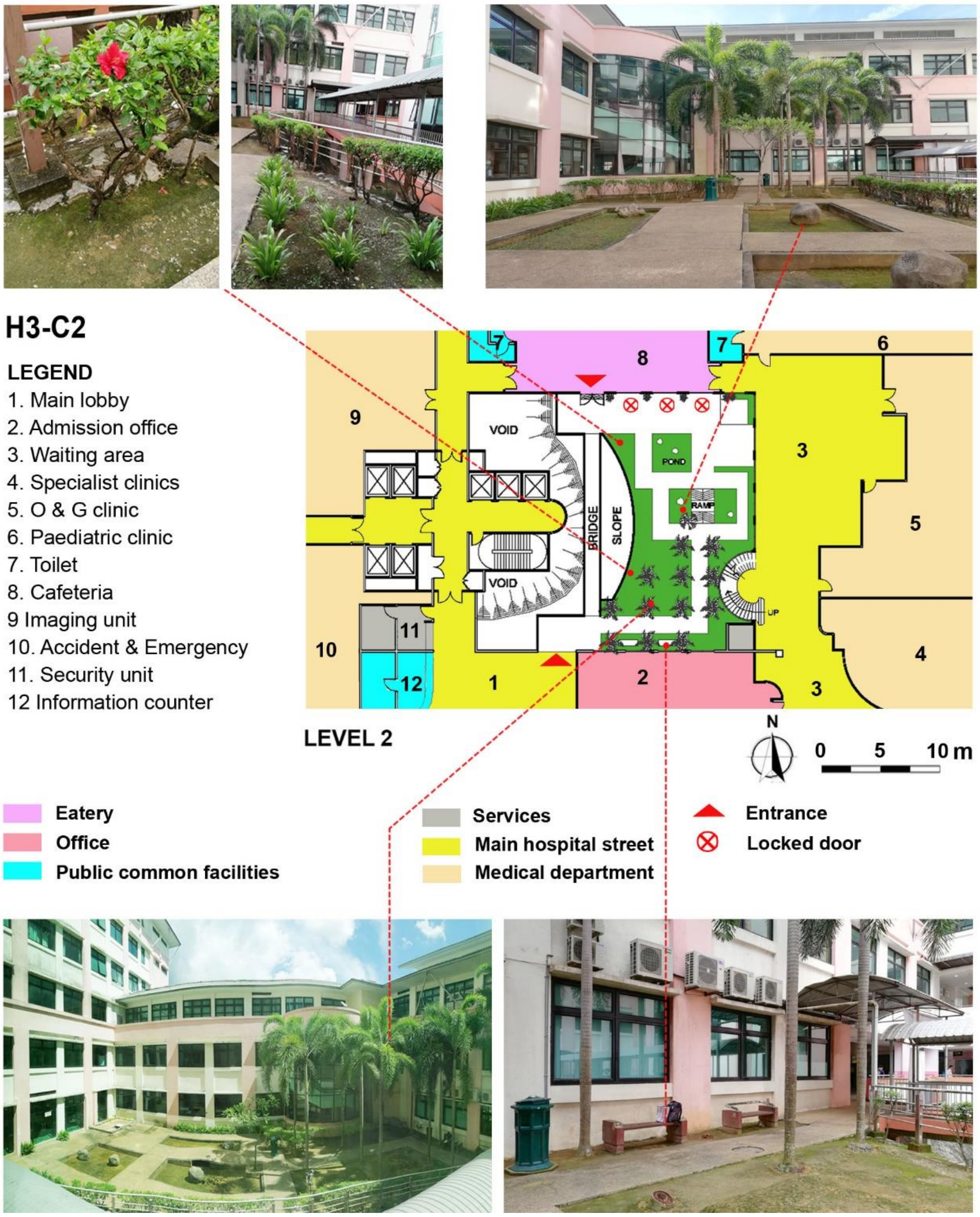


Figure 4.22: H3-C2 - Vegetation and seating area

4.5 Comparative summary of the characteristics of the representative case study HCGs

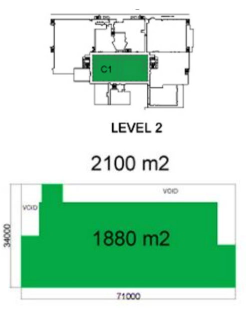
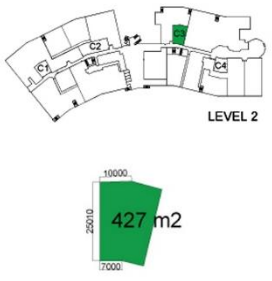
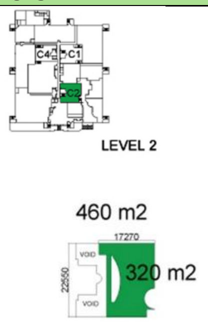
Based on an initial observation of the characteristics of the representative case study HCG sites, there were some similarities and differences in the characteristic of these sites which are useful to explore the issue of the sites in response to the main aims and research objectives of the current study. Several differences include: size, number of entrances, accessibility to the site, ratio of softscape and hardscape, variety of vegetation, types of seating areas, wall enclosure (e.g. types, colour, visual aesthetic, visibility level), and acoustic factors (See Table 4.4).

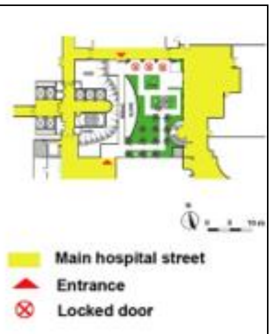
The three sites provided varying atmospheres that might impact on users' experiences whilst there due to the different hierarchies of greenery in these HCGs (i.e. the availability of a variety canopy tress and plantings) and facilities (i.e. seating, pavement). Hence, Sections 5.2 and 5.5.1 further explain and discuss the perceptions of the users on the positive and negative aspects of each of the representative HCGs.

Additionally, several importance aspects in the design and planning of the HCG which related to the users' satisfaction levels with accessibility (i.e. accessibility from the main entrances, number of entrances, access to a different department and accessibility for a wheelchair user), visibility, wayfinding, landscape elements and wall condition will be described and discussed further in Sections 5.3.1 and 5.5.2

The differences in the characteristic of the sites such as size, accessibility, visibility and different seating facilities were also compared to further examine of how these design characteristics influenced the space use pattern in the HCGs which will be discussed further in Chapter 6, Section 6.4.

Table 4.4: Comparative summary of the characteristics of the representative case study HCGs

Descriptions	H1-C1	H2-C3	H3-C2
Size			
	1,880m² (excluding the void area)	**427m²** (No void area)	**320m²** (excluding the void area)
Entrances	3 entry points	3 doors	1 entry point and 4 doors

Accessibility to the site		 All accessible	 1 door locked	 3 doors locked
Ratio softscape to hardscape		80:20	60:40	40:60
Provide variety of vegetations		70%	40%	30%
Availability of canopy trees		YES (60% coverage area)	NO	YES (20% coverage area)
Types of seating area		7 types of seating (50 pax)	2 types of seating (24 pax)	2 benches (4 pax)
Wall enclosure	Types of wall enclosure	Concrete wall. Fixed glazing and powder coated ventilated screening wall (i.e. upper floor enclosure)	Aluminium cladding Fixed glazing and openable window	Concrete wall Fixed glazing and openable top hung window
	The colour of the wall	Cream	Grey	White and peach colour
	Visibility from the adjacent spaces **Floor 2** (Ground level)	 Provide opening along the periphery of the HCG	 A standard type of top hung window	 A standard type of top hung window
	Upper floor	 Full height transparence screening wall	Similar type of windows used for the upper floor	Similar type of windows used for the upper floor
	Visual aesthetic	Have a black stain on the overhang coping 	No stain Well-maintained 	Have rust and black stain on the wall 
Acoustic factor. Presence of unwanted noise from the air condenser		Low 	Medium 	Medium 

4.6 Summary

This chapter has presented on the selection criteria of the representative case study HCGs which included: i) accessibility (i.e. locked or unlocked door); ii) types of users; iii) level of occupancy; iv) feasibility for the subjective assessment study; v) character of the sites (i.e. the availability of softscape and hardscape); and vi) location and space function. This chapter also comparatively elaborated on the context of the representative case study hospitals (H1, H2 and H3) which included the background, site area, neighbourhood context and master planning of the sites. Further, this chapter explained the characteristics of the selected three representative case study HCGs (H1-C1, H2-C3 and H3-C2), which included the site plan, space functions, vegetations and seating areas. Finally, the chapter summarised the characteristics of the representative case study sites.

CHAPTER 5:
Users' evaluation of the positive and negative aspects, perception of the landscape elements, preference of the HCG images and satisfaction levels with the HCG design

5.1 Introduction

Before proceeding to examine the environmental and social aspects, it is necessary to first investigate **the physical design and operational aspects of the HCG** in order to have a general understanding on how the HCG in each case study hospital is performing and functioning to date. The findings presented in this chapter are tailored to the **first research objective**:

- To examine the positive and negative aspects of the current conditions in the selected HCGs based on users' perspectives.

Moreover, the findings of this chapter also addressed the **second research objective**:

- To evaluate users' perceptions, preferences and satisfaction levels with the overall design and planning of the selected case study HCGs in Malaysian hospitals.

First, this chapter presents the results of the users' evaluations regarding the positive and negative aspects of the HCG as well as their suggestions for improvement of the HCG in response to the first research objective (Section 5.2).

Second, the chapter presents the findings regarding users' satisfaction levels with respect to the overall planning and performance of the HCG which includes five important variables (e.g. accessibility, visibility, wayfinding, landscape elements and wall conditions) in response to the second research objective (Section 5.3).

Third, the chapter presents the results of the users' perceptions on the importance of the landscape elements and their preference of the HCG images, also in response to the second research objective (Section 5.4). Following on, a detail discussion of these sections is presented in Section 5.5 and compared with the previous findings.

5.2 Users' evaluations of the positive and negative aspects of the HCG design

A total of 120 respondents in the three representative sites were randomly selected among those who were sitting in the HCG to participate in the survey interview; H1-C1(N=46), H2-C3 (N=36) and H3-C2 (N=38) (See Section 3.5.2 for a table setting out the demographic data of the participants). Further, a total of 246, 135, and 264 responses in all three sites were received for the positive aspects (likes about the HCG) the negative aspects (dislike about the HCG) and suggestion for improvement (See Appendix 17, Table 1 for detail number of responses and missing responses received in each case study site). As mentioned earlier in Section 3.4.6.4, (i), three types of open-ended questions were asked in examining the positive and negative aspects of the HCG, including: Question 6 and 7 asking what they like and dislike about the specific HCG, and Question 9 asking about their suggestion for improvement of the HCG (See Appendix 1).

Numerous previous research in the POE of restorative gardens in healthcare facilities (e.g. Sachs, 2017, p.309; Butterfield, 2014; Pasha, 2013; Asano et al., 2008; Cooper Marcus and Barnes, 1995) and the landscape research field (e.g. (Camacho-Cervantes et al., 2014; Refshauge et al., 2012) have utilised the 'liked and disliked' question format to interrogate the users' views of how they felt and perceived the gardens. The open-ended question was used in the current study to allow researchers to better understand users' true feelings about the HCG sites, or the issues that they wanted to express without being influenced by the researcher (Foddy, 2009, p.127; Reja et al., 2003). In contrast, close-ended questions do not allow the participants to truly express their opinions because they tend to simply answer the given selections of answers. It can also limit the researcher to obtain extra information about the HCG (Reja et al., 2003).

As described earlier in Subsection 3.6.2.2, quantitative content analysis was used to analyse the users' responses within each representative HCG. Written users' responses were coded into several themes and the frequency of responses and the graph were also calculated and generated in Microsoft Excel, respectively. Several categories of thematic criteria of evaluation were generated based on users' responses which include: i) Positive aspects (e.g. physical design, microclimatic conditions, experiences and activities); ii) Negative aspects (e.g. physical design and maintenance) and suggestions for improvement (e.g. Landscape elements, maintenance, new facilities and HCG planning) (See Appendix 17, Table 2). The results of the users' responses on the positive aspects, negative aspects and their suggestions for improvement are presented below, starting with

H1-C1, then H2-C3 and H3-C2. A detailed table of the frequencies of responses regarding the positive and negative aspects of the HCG is provided in Appendix 17, Tables 3 and 4. Following on, a comparative cross case analysis is presented Section 5.2.4 and discussed further in Section 5.5.1.

5.2.1 Case study 1: H1-C1

As described in Section 4.4.1, H1-C1 is much larger in size compared to the other case study sites. H1-C1 has a total floor area of 2,100m² which is more than the double that of the other HCGs: H2-C3 (427m²) and H3-C2 (460m²). H1-C1 is located on the second level of the hospital and occupies a central position in the layout of the hospital. It can be viewed directly from the bridge and lobby areas situated on level 3. As the main hospital circulation is arranged around H1-C1, it can also be viewed directly from the upper floor levels via the openings along the corridors. Due to its large size, it can accommodate a variety of seating facilities and plantings including a range of canopy trees, green shrubs and herb plants (See Figure 5.1). The overall ratio between the softscape and hardscape of this HCG is 70:30. Moreover, H1-C1 also provides access to the HCG that linked the main hospital street with the HCG.

Figure 5.1: Images of H1-C1

5.2.1.1 Positive aspects of H1-C1

Based on open-ended survey questions, the most frequently mentioned positive aspects about H1-C1 concerned the physical design (42%), followed by the microclimatic conditions (31%), experience of the space (15%) and the activities that can take place in the space (12%) (See Figure 5.2).

In terms of the physical design, the most frequently mentioned positive attributes that were liked by the respondents include the amount of the greenery (43.5%, n=20) and the pleasant view in the H1-C1 (32.6%, n=15). Some of the respondents mentioned that they liked the variety of seating areas in the H1-C1 (13%, n=6), the spacious size of the H1-C1 (6.5%, n=3), the cleanliness of the space (6.5%, n=3). Only one respondent (6.5%) mentioned that he liked the location of the HCG close to the cafeteria.

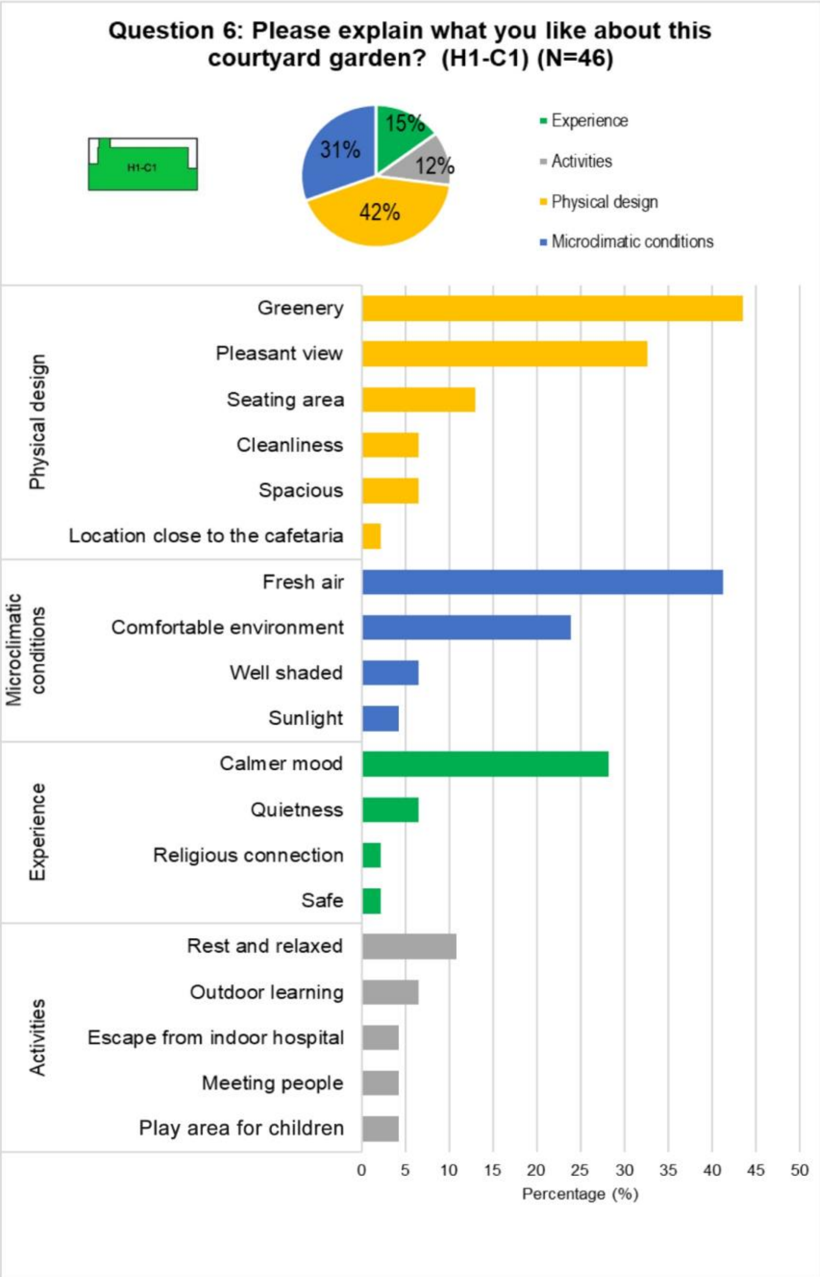


Figure 5.2: Percentage of liked response regarding H1-C1

The second most frequent positive response received by the respondents in H1-C1 regards the microclimatic conditions of the HCG. More than 40% of the respondent mentioned that they liked the fresh air in the HCG and 23.9% respondents (n=11) mentioned that they liked the comfortable environment in the HCG. Three respondents (6.5%) described that they liked the well-shaded are in the HCG and two respondents mentioned that they liked the exposure to morning sunlight into the HCG (4.3%).

The third most frequent mentioned response is related to users' experiences of the HCG. They mentioned that they liked the calm environment (28.2%, n=13), and quietness in the HCG (6.5%, n=3) compared to the indoor hospital area. Few respondents mentioned about feeling safe being in the HCG (2.2%, n=1) and feeling more connected to God when looking at the trees in the HCG (2.2%, n=1).

Moreover, the fourth most frequent mentioned response concerned the types of activities carried out in the HCG. Some of the respondents mentioned they liked the HCG because it offers them a place to rest and relax (10.8%, n=5), escape from the indoor hospital (4.3%, n=2) and the opportunity to meet other people in the HCG (4.3%, n=2). Those who bring children with them to the hospital, mentioned they that liked this HCG as it offered a play area for their children while they visited family members on the wards (4.3%, n=2) and outdoor educational learning for children where they can learn about the herb plants in the HCG (6.5%, n=3).

5.2.1.2 Negative aspects of H1-C1

When asked about their dislikes regarding H1-C1, about half of the respondents (54%) criticised its poor level of maintenance, and 46% of the respondents criticised some of its physical design aspects (See Figure 5.3)

In terms of maintenance, some of the respondent explained that they were unsatisfied with the unrepaired water fountain which had not functioned for some time (26.1%, n=12). Moreover, they also criticised the level of cleanliness of the HCG, such as fallen leaves on the ground (13%, n=6) and the presence of crows (associated with dirty areas) in the HCG (2.2%, n=1). Other responses regarding garden maintenance included unfertilised plants (lacking nutrients to grow properly) (4.3%, n=2), uncut grass (4.3%, n=2), and unrepaired planting labels (2.2%, n=1). One respondent was concerned about safety in the HCG and mentioned an exposed electric cable in the water fountain area that could be of danger to children if they played with and touched the electric cable (2.2%, n=1).

Furthermore, respondents also tended to criticise some of the physical design aspects in the HCG such as the lack of seating area (13%, n=5) and the lack of a sheltered seating area with a covered roof to be used during sunny and rainy days (4.3%, n=2). In terms of planting, they criticised the lack of flowering plants (8.7%, n=4), herb plants (2.2%, n=1) and fruit trees (2.2%, n=1). They also mentioned that H1-C1 looked like a forest and did not look like a garden (2.2%, n=1). Moreover, the respondent who were the parent visiting the hospital with their children criticised the lack of facilities for children such as the presence of a playground in the HCG (8.7%, n=4). Only one respondent complained about the lack of accessibility to the HCG from the lobby area.

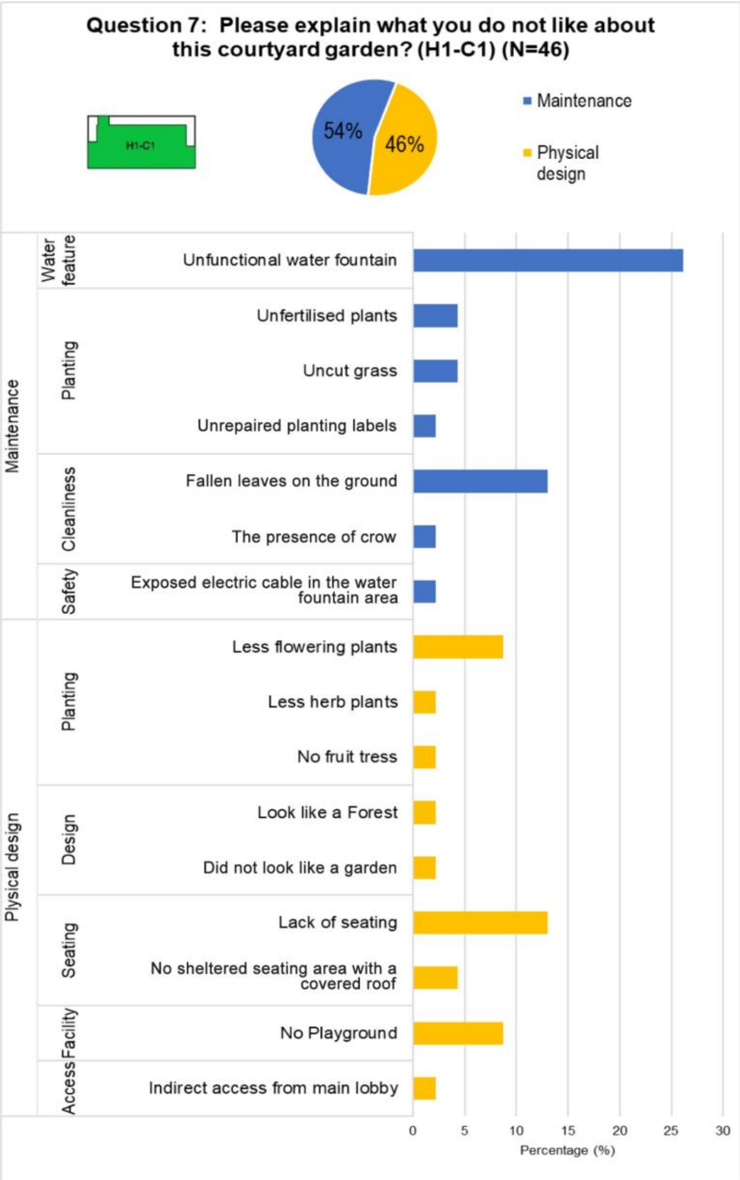


Figure 5.3: Percentage of disliked response regarding H1-C1

5.2.1.3 Suggestions for improvements in H1-C1

The respondents in H1-C1 were also asked if there were any changes that they would like to suggest or add to the HCG. Out of a total of 46 respondents in H1-C1, the majority (93.5%, n=43) suggested some changes to the HCG. A minority (6.5%, n=3) of respondents did not want to comment (See Figure 5.4).

The most frequently mentioned suggestions by respondents related to the hard and soft landscape elements of the HCG (52.2%, n=47). More than half of the respondents suggested adding more seating areas (56.5%, n=26) and a sheltered seating area with a roof (13.0%, n=6). Also, respondents mentioned that it would be better if more scented flowering plants were planted in the HCG to make it look more attractive and induce a cheerful mood with pleasant fragrances in the HCG (21.7%, n=10). They also suggested adding more varieties of planting in the HCG (10.8%, n=10).

The second most frequent mentioned suggestion concerned improvement to be made to the upkeep and the maintenance of the HCG (37%, n=31), such as the need to repair the broken water fountain (30.4%, n=14). Other less frequently mentioned suggestions included the need for watering and fertilising the plants (6.5%, n=3) as well as repairing the plant labels (4.3%, n=2). Other specific suggestions are as follows:

- i) Collecting the fallen leaves on the ground in the HCG;
- ii) Pruning the trees;
- iii) Removing plants with sharp edges;
- iv) Maintaining cleanliness such as cleaning up the fallen leaves;
- v) Removing broken benches and replacing them with new ones;
- vi) Fixing the HCG information board;
- vii) Cementing the ground around the water pipe to prevent the accumulation of muddy surfaces;
- viii) Repainting the faded exterior wall around the HCG;
- ix) Fixing the exposed electrical cable that can pose a danger to children;
- x) Adding a wire mesh around the water fountain to avoid children from falling into the water fountain pool;
- xi) Relocating the pest control trap to a suitable place and away from seating areas;
- xii) Adding more trash bins closer to seating areas; and
- xiii) Getting rid of the crows from the HCG to maintain the cleanliness in the HCG (e.g. removing bird droppings).

Other suggestions made mainly by the parents with children included the need to add a playground in the HCG (13.0%, n=6). Children have to stay in the HCG when their parents visit the High Dependency Ward (HDW) and maternity wards as hospital regulations do not permit children to visit these particular wards. Introducing a Wi-Fi area and displaying rules for the use of the HCG are two further suggestions mentioned by respondents.

Out of the 46 respondents, two mentioned the need to change the layout of the HCG and add more exciting features. Improving access to the HCG from the main lobby and planting flower beds near the entrance of the HCG were also suggested as actions that could make the HCG more welcoming.

Figure 5.4: Percentage of responses regarding the suggestion for changes and improvement in the HCG

5.2.2 Case study 2: H2-C3

As previously described in Section 4.4.2, H2-C3 is an enclosed courtyard garden located on the hospital ground floor level that can be accessed from the main hospital corridors. H2-C3 is five times smaller in size (427m²) compared to H1-C1 (2,100m²: including the void area). Only a few plants were found in this courtyard ranging from small trees, to potted plants and shrubs. This is due to the limited floor area of H2-C3 and its floor which consists of concrete slab, resulting in a reduced variety of plantings and seating facilities compared to H1-C1.

However, despite its smaller size, H2-C3 does provide a variety of seating facilities compared to the third case study site, H3-C2. H2-C3 has three access doors. However, only one of the doors was accessible during the day as the other doors were only unlocked when a rehabilitation program occurred in the HCG. The overall ratio of softscape and hardscape of H2-C3 is 40:60, significantly lower than that of H1-C1. The design features of the HCG are very different to the other case study HCGs as this is an enclosed walled courtyard with an aluminium cladding wall rather than a concrete wall (See Figure 5.5).

Figure 5.5: Images of H2-C3

5.2.2.1 Positive aspects of H2-C3

Several positive comments were obtained from an open-ended questions with the HCG users including physical design (44%, n=32), followed by the experience it provides (26%, n=19), activities if facilitates (18%, n=13) and its microclimatic conditions (12%, n=9) (See Figure 5.6). The most frequently mentioned response regarding respondents liking the HCG is related to the physical design of the HCG. A high proportion of the respondents in H2-C3 mentioned that they liked its pleasant view (47%, n=15), the greenery (19.4%, n=7) and its cleanliness (16.7%, n=6). Some of the respondents liked the seating area provided in the HCG (8.3%, n=3), the garden layout (9.3%, n=3) and its close location to the dialysis centre (2.8%, n=1).

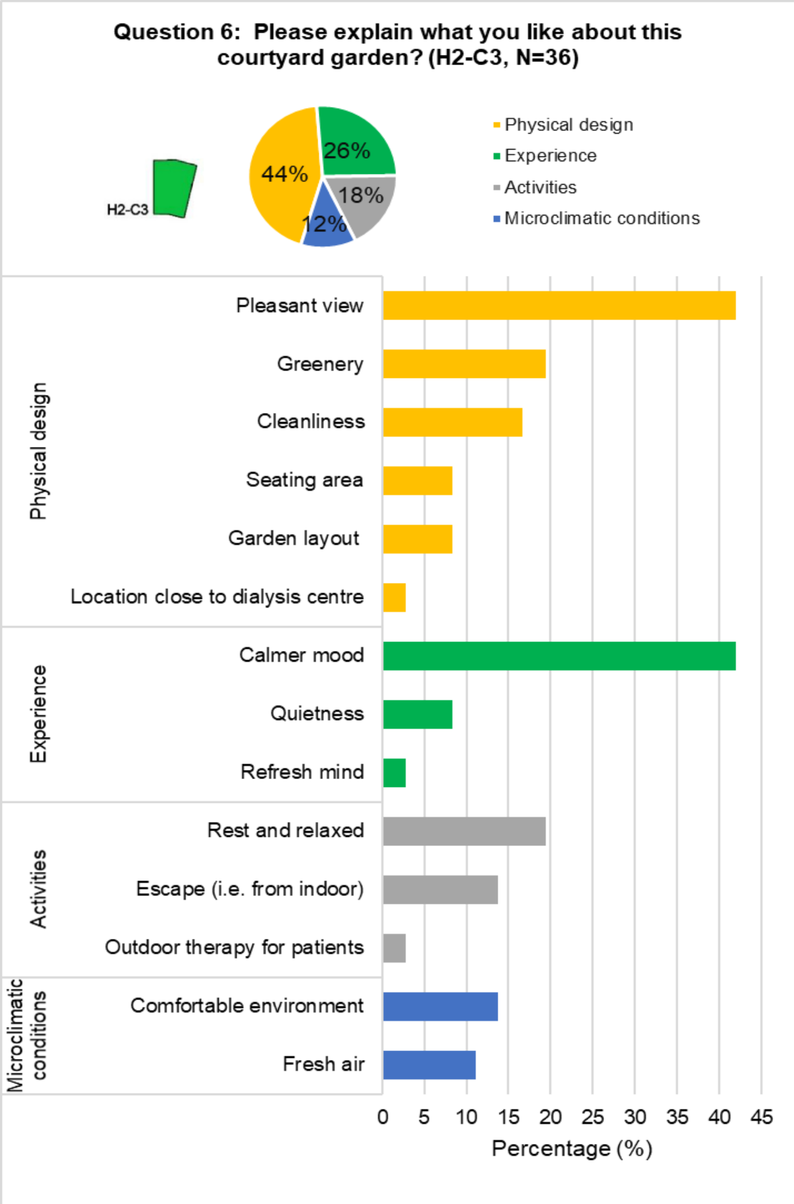


Figure 5.6: Percentage of liked response regarding H2-C3

The second most frequently mentioned positive aspect of H2-C3 is the experience it provides. Almost half (42%) of respondents mentioned that they liked the feeling of calmness when spending time in the HCG. Other respondents mentioned the quietness of the space (8.3%, n=3), and the opportunity to refresh one's mind (2.8%, n=1). Respondents also mentioned that they liked the HCG because it provided an alternative place for them to rest and relax (19.4%, n=7) and escape from the indoor hospital space to have contact with an outdoor environment (13.8%, n=5). In addition, one female staff mentioned that she liked this HCG because it offered a place for conducting outdoor therapy for patient rehabilitation. The least mentioned positive aspects are related to the comfortable microclimatic conditions in the HCG (13.8, n=5) and access to fresh air (11.1%, n=4).

5.2.2.2 Negative aspects of H2-C3

When asked about their dislikes regarding H2-C3, out of 38 responses one-third of the respondents (71%, n=22) complained about its physical design and level of maintenance (29%, n=27) (See Figure 5.7).

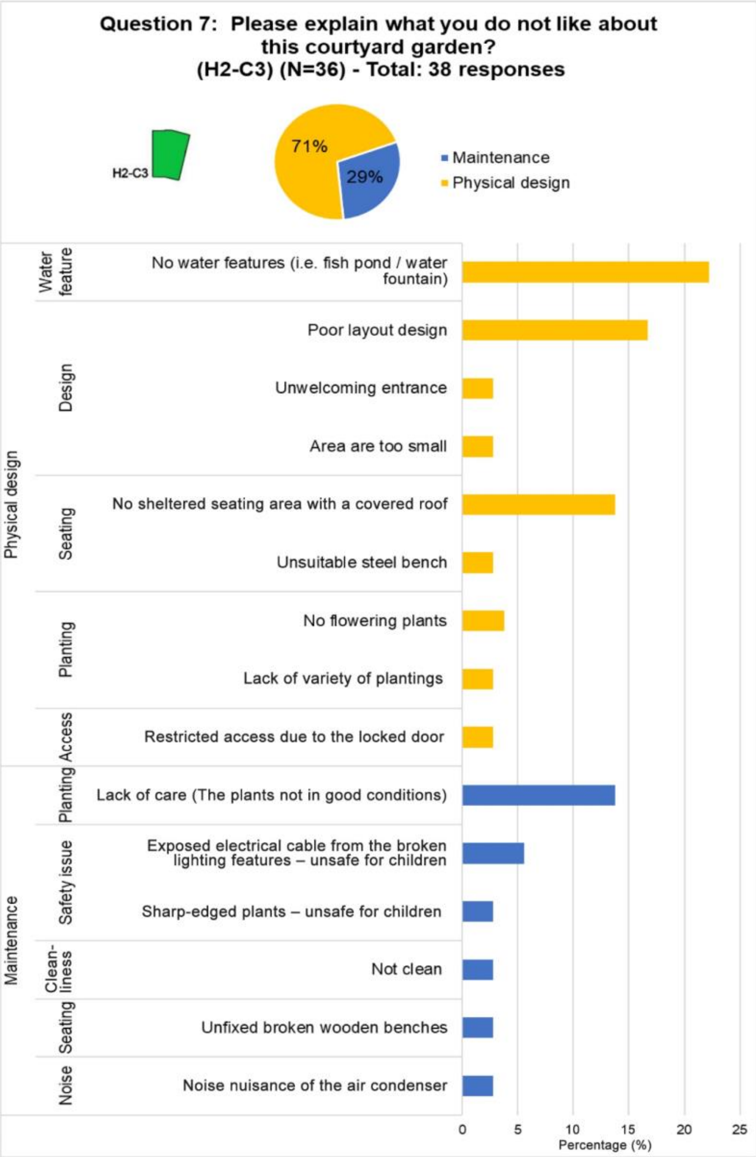


Figure 5.7: Percentage of disliked response regarding H2-C3

The most frequent disliked aspects was related to the absence of water features (i.e. water fountain or fishpond) in H2-C3 (22.2%, n=8), its poor layout design (16.7%, n=6) and the absence of a shaded seating area or seating with a covered roof in the HCG (13.8%, n=5). Other less frequently mentioned complaints included the small size of the courtyard garden (2.8%, n=1), the unsuitable and uncomfortable steel bench (2.8%, n=1), the unwelcoming HCG entrance (2.8%, n=1) and its restricted access due to the locked door attached to the rehabilitation centre (2.8%, n=1).

The second most frequently mentioned complaint was the level of maintenance of the courtyard. Respondents criticised the maintenance in H2-C3 which was perceived as of a much lower standard than that of H1-C1. Some respondents criticised that the plants in H2-C3 were in a neglected and poor condition (13.8%, n=5). Other respondents complained about the exposed electrical cable from the broken lighting features that might pose a danger to the children who played around in the HCG (5.6%, n=2), whereas one respondent criticised the placement of sharp-edged plants (again deemed unsafe for children). Other disliked features included the level of cleanliness (2.8%, n=1), the broken wooden bench (2.8%, n=1) and the noise nuisance of the air condenser placed in the HCG (2.8%, n=1).

5.2.2.3 Suggestions for improvements in H2-C3

When respondents in H2-C3 were asked what changes they would like to suggest for H2-C3, more than 80% (86.1%, n=31) made some suggestions whereas only a small proportion of respondents (13.9%, n=5) did not specify any changes at all (See Figure 5.8). Out of all respondents (100%, n=36), more than 80% suggested improvements with the remainder (13.9%, n=5) not specifying any changes in the HCG.

The most frequently mentioned suggestion was related to its landscape features including the hardscape and softscape in the HCG (50%, n=37). Most suggestions related to the hardscape features in the HCG and included the need to add more shaded seating areas (25%, n=9), more seating areas (16.7%, n=6), replace existing broken seats with more durable versions (13.8%, n=5), more colourful seating areas (2.8%, n=1), replace the existing pavement to a non-slip type paving (2.8%, n=1) and rearrange the existing decorative stones to make it look more attractive (2.8%, n=1). Suggestions about the soft landscape included the need to add more variety in terms of planted vegetation (5.6%, n=2), green grass (5.6%, n=2), canopy trees (5.6%, n=2), colourful trees (2.8%, n=1) and shrubs (2.8%, n=1).

The second most frequent suggestion related to the need for additional facilities into the HCG (27%, n=20) such as water features with a small fishpond or water fountain (30.6%, n=11), a drinking water dispensers (5.6%, n=1), trash bins (2.8, n=1), equipment for exercise and outdoor therapy (2.8%, n=1), a garden swing (2.8%, n=1), a reflexology pavement (2.8%, n=1), a proper tap water for washing hands (2.8%, n=1), a mechanical fan (2.8%, n=1) and a mini library (2.8%, n=1).

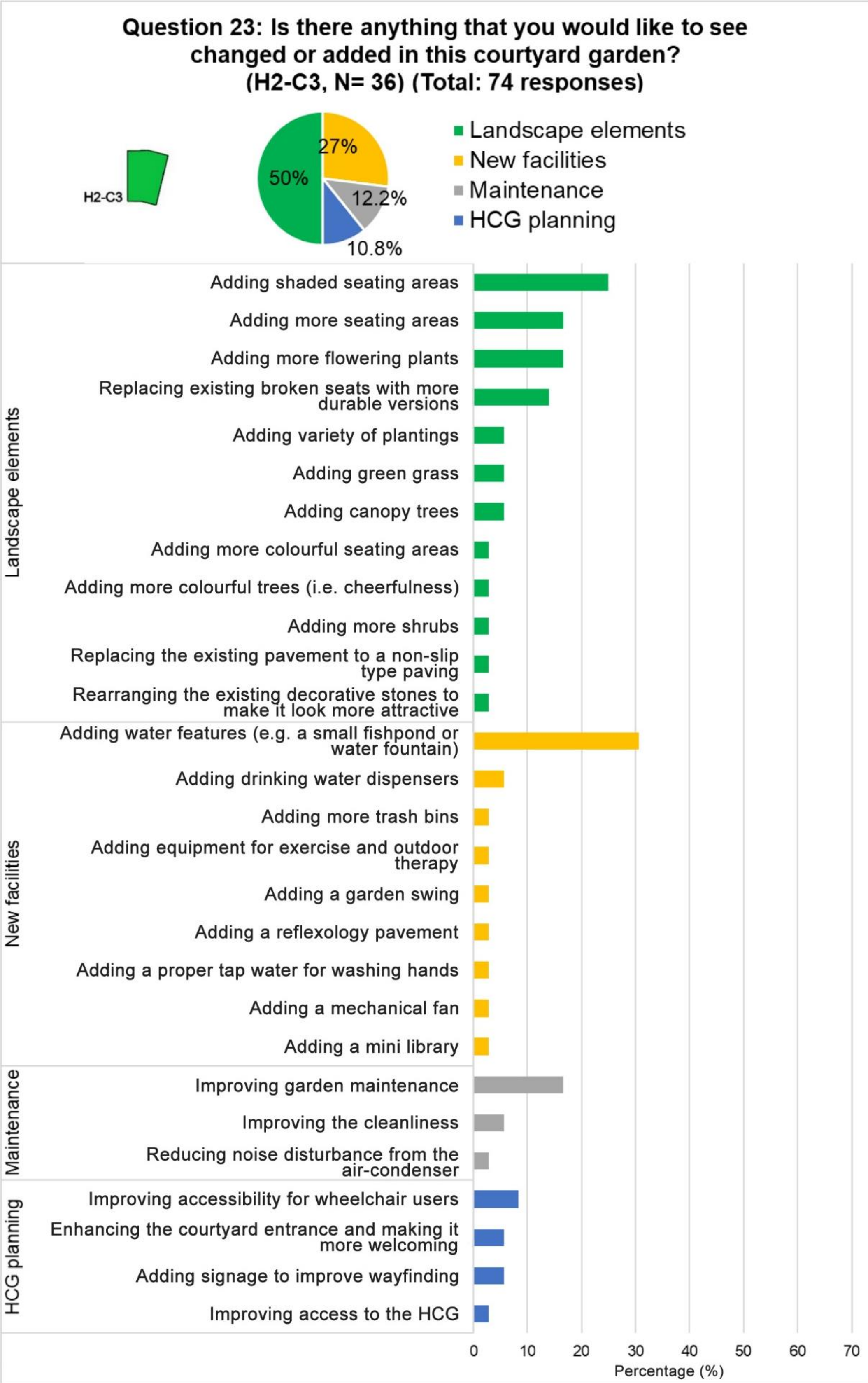


Figure 5.8: Suggestion for changes and improvement in H2-C3

The third most frequent suggestion for H3-C2 related to its maintenance (12.2%, n=9). Respondents provided general suggestions to improve garden maintenance (16.7%, n=6), improve its cleanliness (5.6%, n=2) and reduce noise disturbance from the air-condenser (2.8%, n=1). Other suggestions for improving the H3-C2 courtyard related to its layout (10.8%, n=8) which included improving accessibility for wheelchair users (8.3%, n=3), enhancing the courtyard entrance and making it more welcoming (5.6%, n=2), adding signage to improve wayfinding (5.6%, n=2) and improve access to the HCG from the main lobby (2.8%, n=1).

5.2.3 Case study 3: H3-C2

H3-C2 is the smallest HCG. Nevertheless, the actual size of H3-C2, excluding the void area is 320m² which is smaller than H2-C3 (427m²). However, due to the overall space of H3-C2 including the void area (460m²), it is larger than H2-C3 (427m²), although it does make H3-C2 looks more spacious than H2-C3 as reported by some of the respondent in H3-C2. In terms of planting and seating facilities, H3-C2 has less variety of planting and lack of seating area compared to H1-C1 and H2-C3. Only some areas of the HCG were planted with palm trees that provided some shade (See Figure 5.9).

Figure 5.9: Images of H3-C2

Other parts of H3-C2 are exposed to sunlight due to lack of shade canopy plants in the HCG compared to H1-C1 which has a variety of canopy trees to provide shade to the ground. Another design feature in H3-C2 is a covered walkway linking the main lobby and the cafeteria which is often used by hospital users during the day to pass through to go to the cafeteria.

5.2.3.1 Positive aspects of the H3-C2

Respondent positive comments about H3-C2 indicated that almost half of respondents (47%, n=27) mentioned the physical design. Almost a third of respondents (31%, n=18) mentioned the types of experiences the HCG provides, while a smaller proportion mentioned the comfortable microclimatic conditions in the HCG (19%, n=11). The least frequently mentioned aspect (3.4%, n=2) was related to the types of activities that can be carried out in the HCG. A total of 58 responses were received from a total of 38 respondents who participated in the survey interviews (See Figure 5.10).

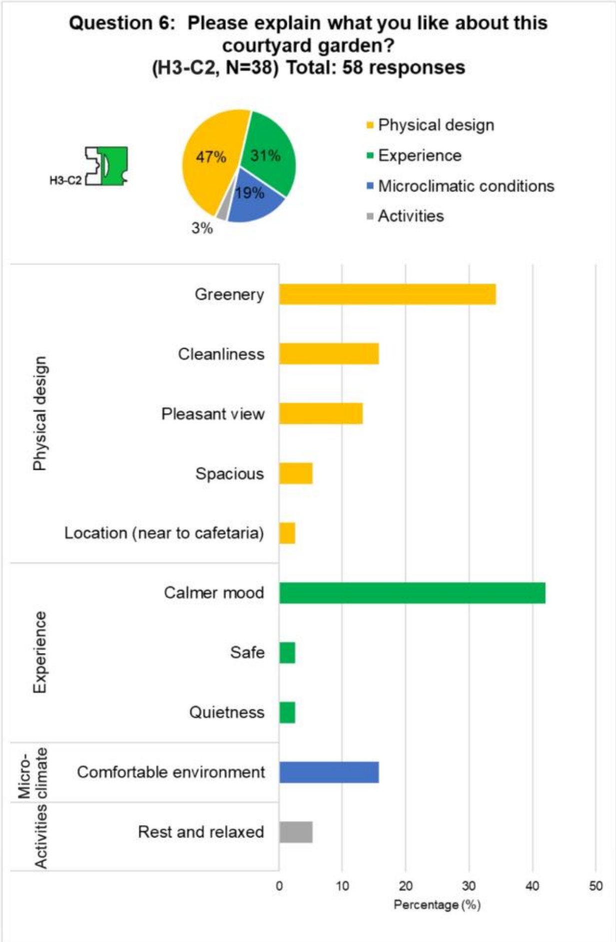


Figure 5.10: Percentage of liked response regarding the H3-C2

Firstly, the physical design aspects most frequently mentioned by the respondents in H3-C2 regard the greenery in the HCG (34.2%, n=13). Respondents in H3-C2 also mentioned that they liked the cleanliness of the HCG (15.9%, n=6). Surprisingly, a smaller number of respondents indicated that they liked the pleasant view in H3-C2 (13.2%, n=5) compared to H1-C1 (32.6%, n=15) and H2-C3 (47%, n=15). As H3-C2 is larger than H2-C3, it was no surprise that some respondents mentioned that they liked H3-C2 because it looks spacious (5.3%, n=2). One of the respondents also liked the connection between the courtyard garden and the cafeteria.

The next most frequently liked aspects in H3-C2 is the experience it provides. Respondents mentioned that they felt calmer when spending time in the HCG (42.1%, n=16). Two respondents mentioned they felt safe in the HCG and enjoyed its quietness. Moreover, respondents appreciated feeling comfortable when spending time in the HCG (15.8%, n=6).

The least frequently mentioned aspect is related to the activities in the HCG. Only two respondents (5.3%) mentioned that they liked the H3-C2 because they could rest and relax while waiting for family members with appointment in the clinics.

5.2.3.2 Negative aspects of H3-C2

Regarding negative comments about H3-C2, a total of 51 responses were received. The physical design aspect (54.9%, n=28) and maintenance (45.1%, n=23) were the two aspects highlighted the most by respondents. Out of 38 respondents, only four respondents did not provide any comments (See Figure 5.11).

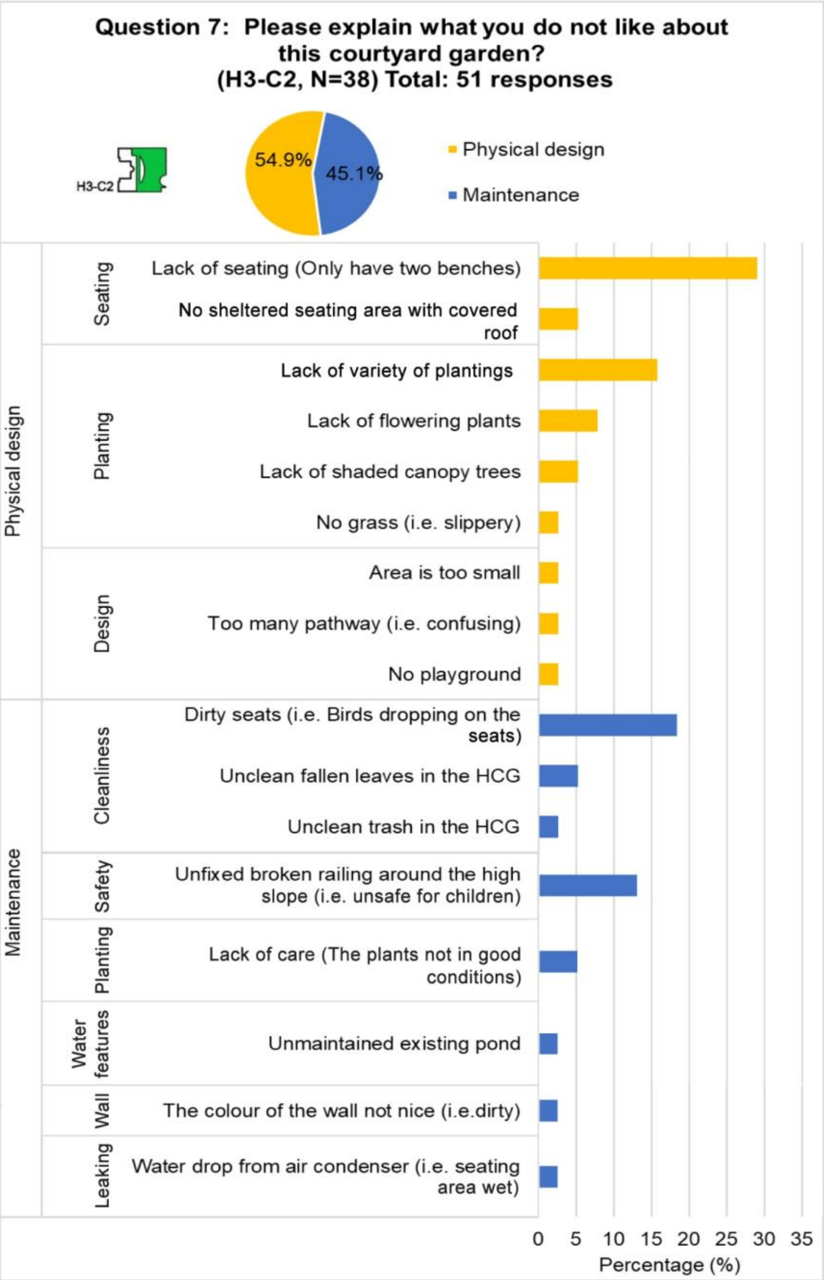


Figure 5.11: Percentage of disliked response regarding H3-C2

The first most frequently mentioned aspect regarding physical design was the lack of seating in H3-C2 (29%, n=11). There are only two benches in H3-C2, and they are not in good condition. Another complaint was the absence of a shaded seating area in the HCG. The next most frequently disliked feature was the soft landscape of the HCG. This included the lack of variety of planting in the HCG (15.8%, n=6), flowering plants (7.9%, n=3) and no canopy trees (5.3%, n=2). Moreover, one respondent complained about the bare ground surface in the HCG which he described as slippery and not safe for children to play.

Although some of the respondents mentioned that they liked H3-C2 because of its spaciousness, when asked about their dislike, one respondent complained that it was too small. Moreover, one of the respondents also criticised that H3-C2 has too many pathways which is very confusing. One of the respondents also criticised the absence of playground facilities for children to play in the HCG while waiting for their parents to visit family members in the wards or attending an appointment in the clinic.

The maintenance of the HCG was the second most frequent complaint (45.1%, n=23). The poor level of cleanliness in the HCG, especially the seating area, the poor state of benches in the HCG and the bird droppings left on the seats for some time have been mentioned by the respondent (18.4%, n=10). They also criticised the dead leaves and trash on the floor (7.9%, n=3).

The third most frequent complaint is related to safety issues in the HCG. Some respondents complained about the improper design of railing around the slopping area in the HCG (13.3%, n=5) which did not meet safety requirements as the gap between the balustrades are too wide which can pose a danger to children. Another complaint regarded the plantings in which two respondents mentioned that the HCG suffers from a lack of care. Concerns included that the plants needed to be better captivated and fertilised to maintain the plants' life. They also complained regarding the unmaintained existing pond, the dirty wall, and leakage from the air-conditioning condenser, which caused the seating area to be wet.

5.2.3.3 Suggestions for improvements in H3-C2

When asked about their preference regarding any changes that they wanted to add to improve H3-C2, all respondents (N=38) provided some suggestions. Out of a total of 100 responses received, most are related to landscape elements (62%, n=62), maintenance (19%, n=19), new facilities (15%, n=15) and HCG planning (4%, n=4) (See Figure 5.12).

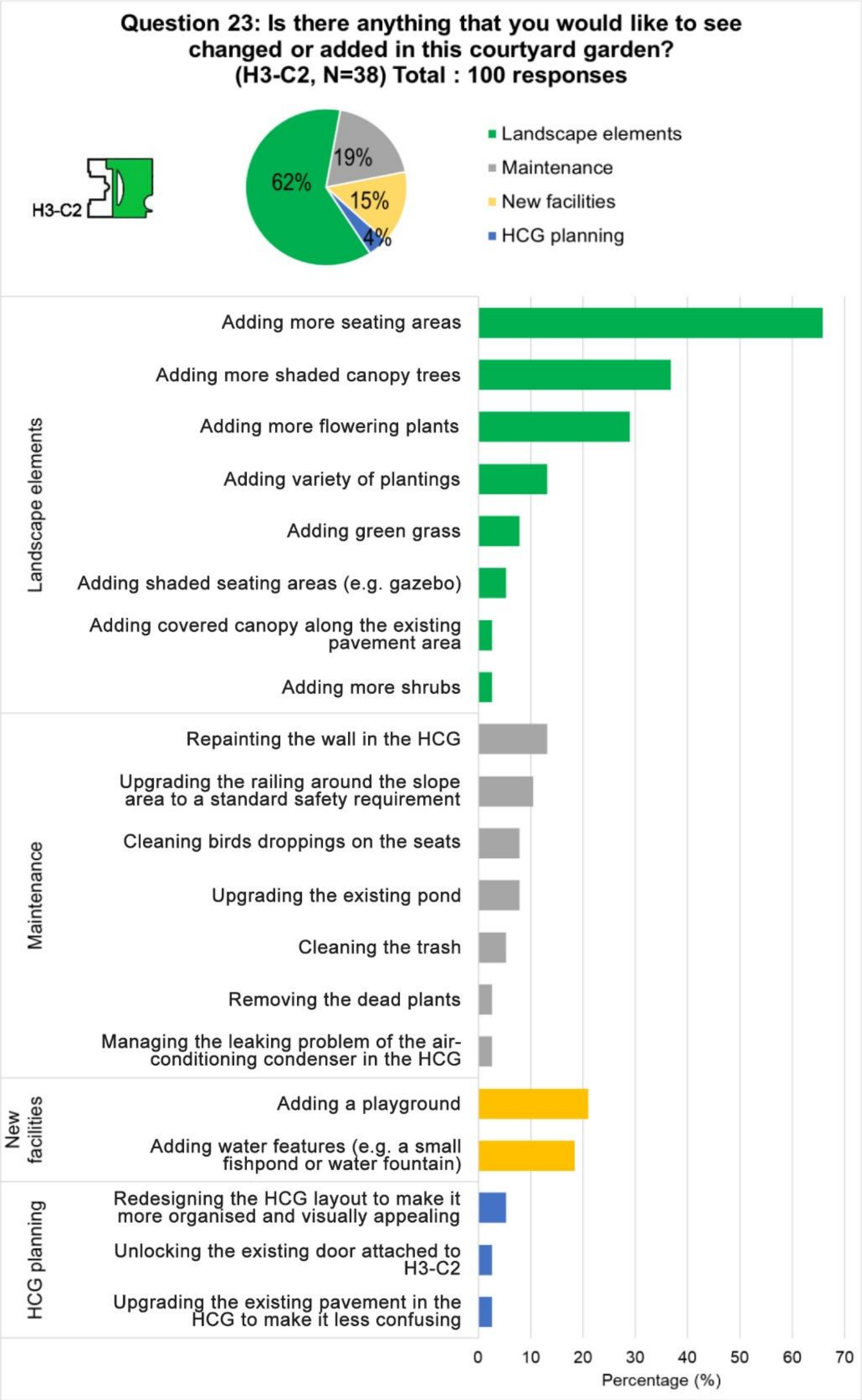


Figure 5.12: Percentage of response on the suggestion for improvement in H3-C2

Similar to the other case study sites, the most frequent suggestion is related to the landscape elements including the hardscape and softscape in H3-C2 (62%). More than half of respondents suggested adding more seating areas (65.8, n=25). Other suggestions included adding a sheltered seating area such as a 'gazebo' to provide shade and a covered canopy along the existing pavement area in H3-C2 to allow people to use it during sunny or rainy days. The other most frequent suggestions related to the soft landscape such as adding more canopy trees in the HCG (36.8%, n=14), more flowering plants to enhance the beauty of the HCG (29%, n=11), various types of plantings (13.2%, n=5) and shrubs (2.6%, n=1).

The second most frequent suggestions is related to maintenance (19%, n=19) which included repainting the wall in the HCG (13.2%, n=5) because of the presence of stain and rust on the wall that caused an unpleasant view in the HCG and upgrading the railing around the slope area in the HCG to standard safety requirements to ensure the safety of the children (10%, n=4). Other suggestions included cleaning birds droppings on the seats (7.9%, n=3), upgrading the existing pond (7.9%, n=3), cleaning the trash (5.3%, n=2), removing the dead plants (2.6%, n=1) and managing the leaking problem of the air-conditioning condenser in the HCG (2.6%, n=1).

The third most frequent suggestions are related to the need of additional facilities in H3-C2 such as adding a playground (21%, n=8) and water features in the HCG (18%, n=7). Other suggestion related to the HCG planning included the need to redesign the HCG layout to make it more organised and visually appealing (5.3%, n=2), upgrade the existing pavement in the HCG to make it less confusing and unlocking the existing door attached to H3-C2 (2.6%, n=1).

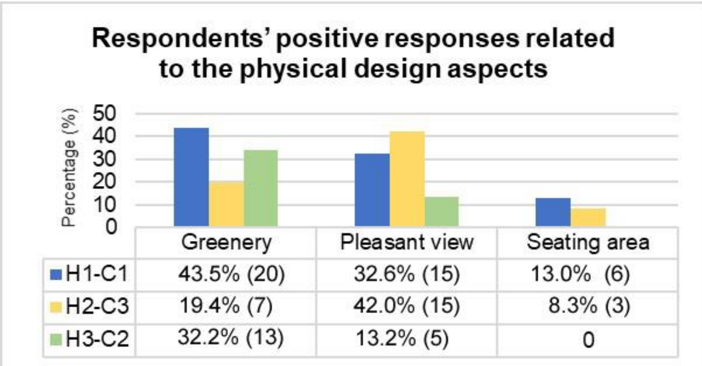
5.2.4 Comparative analysis of the positive and negatives aspects of the HCG from users' perspectives

Based on the data of open ended questions, the results of this study revealed and provided insight into the views of the respondents on the positive and negatives aspects as well as their suggestions for improvements in the representative HCGs. The present study revealed several aspects that were highlighted the most by the respondents in the three case study sites which are the physical design and operational aspects. Other aspects included environmental and social aspects (See Appendix 17, Table 3 and 4 for detailed tables of the users' comments on the positive and negative aspects of the HCG). It is important to note that the discussion of **the environmental and social aspects is discussed further in Chapter 6** based on other types of data (e.g. environmental data and users' perceptions surveys of thermal comfort in the HCG).

5.2.4.1 Physical design

When asked about what they liked about the respective HCGs, the most frequent comment collected from all three case study sites was **the greenery and the pleasant views** in the

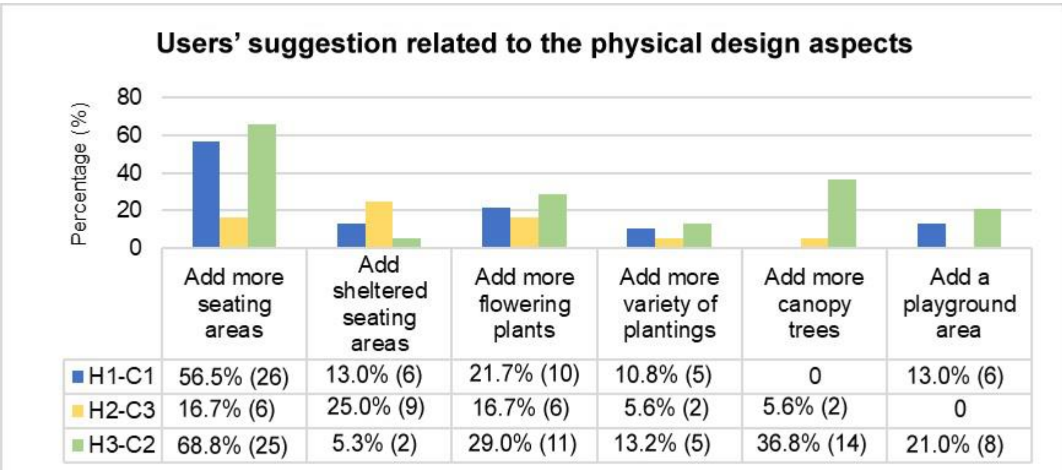
HCG (See Figure 5.13). A higher percentage of the respondents in H1-C1 (43.5%) and H3-C2 (34.2%) provided a positive response related to **the greenery** in the HCGs than H2-C3 (19.4%). The concurrent suggestions in the three case study sites showed a strong desire for a well-designed soft landscape such as additional types of planting with a variety of sizes and heights as well as scented flowering plants (See Figure 5.13). The results also showed that the **pleasant views** in the HCG received a higher positive response among the respondent in H2-C3 (42%, n=15) compared to H1-C1 (32.5%) and H2-C3 (13.2%). They expressed their preference regarding the pleasant views as they could contribute to a more positive mood and encourage them to spend time there more often.



	Greenery	Pleasant view	Seating area
H1-C1	43.5% (20)	32.6% (15)	13.0% (6)
H2-C3	19.4% (7)	42.0% (15)	8.3% (3)
H3-C2	32.2% (13)	13.2% (5)	0

Figure 5.13: Respondents' positive responses related to the physical design aspects

While both respondents in H1-C1 and H2-C3 expressed their like regarding the **seating facilities** in the HCGs, a high proportion of respondents in H3-C2 expressed their dislike regarding seating facilities in the HCG and suggested that more improvement be made in the HCG. The higher number of negative responses regarding seating in H3-C2 explained that lack of seating was the major problem in H3-C2 compared to H1-C1 and H2-C3. The majority of respondent in all three case study sites suggested adding more variety of seating facilities and sheltered seating in the HCG (See Figure 5.14).



	Add more seating areas	Add sheltered seating areas	Add more flowering plants	Add more variety of plantings	Add more canopy trees	Add a playground area
H1-C1	56.5% (26)	13.0% (6)	21.7% (10)	10.8% (5)	0	13.0% (6)
H2-C3	16.7% (6)	25.0% (9)	16.7% (6)	5.6% (2)	5.6% (2)	0
H3-C2	68.8% (25)	5.3% (2)	29.0% (11)	13.2% (5)	36.8% (14)	21.0% (8)

Figure 5.14: Users' suggestion related to the physical design aspects

5.2.4.2 Operational

The upkeep and maintenance issue the hardscape and softscape in the HCG received a higher negative response from the respondents in H1-C1 (54%) compared to H2-C3 (29%) and H3-C2 (45.1%). Some respondents in all three case study sites mentioned that the **HCG is the lack of care.** The responses were related to the **dissatisfaction with the plantings** associated with untrimmed grass, unfertilised plants and unrepaired planting labels as reported in H1-C1. Moreover, the **wall condition** in H3-C2 was mentioned by one respondent. The presence of a black stain and rust on the wall around the HCG area caused an unpleasant view in the HCG. The reason why none of the respondents in H1-C1 mentioned the wall condition could be because of the large size of the HCG that makes the presence of the black stain on the wall around the H1-C1 unrealised. Moreover, the big trees in the HCG may also block the views onto the unpleasant look of black stains on the wall of H1-C1. None of the respondents mentioned dislike about the wall condition in H2-C3. This could be because of the aluminium cladding material in H2-C3 that makes it look more pleasant due to no appearance of black stains on the wall. Despite the issue of lack of seating area, they also mentioned dirty seating in H3-C2 (18.4%, n=10).

The suggestions related to the maintenance aspects differed across the three-case studies (See Figure 5.15). Suggestions that were frequently mentioned by the respondents included fixing the broken water features in H1-C1, reducing the noise nuisance from the air condenser in H2-C3 and repainting the wall and cleaning the bird droppings on seats in H3-C2 in order to make the HCG environment more attractive and soothing. Some suggestions **to improve the safety in the HCG**, such as the exposed electrical cable in both H1-C1 and H2-C3 and upgrade the existing railing in H3-C2 to standard safety requirements. This study suggests that **upkeep, maintenance and safety are crucial issues** that need to be taken into consideration by the hospital managers and designers because it can impact on its usage and users' experiences in the HCG.

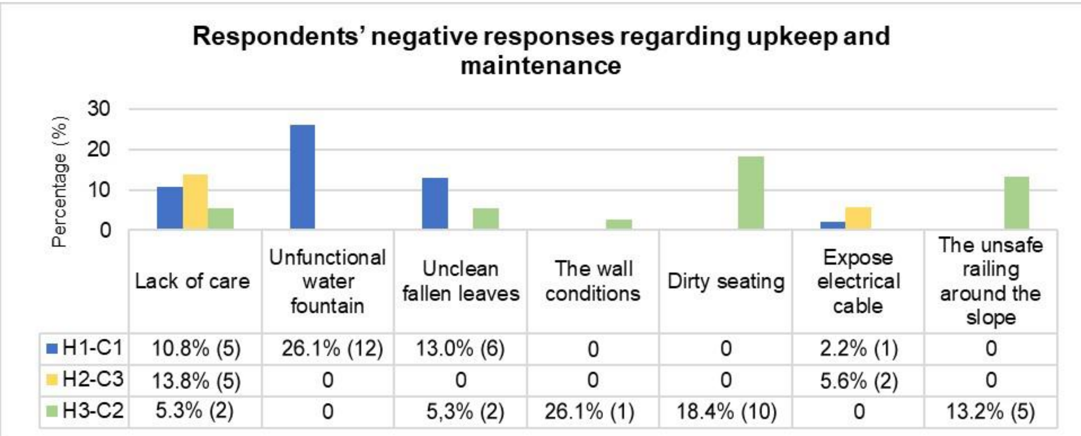
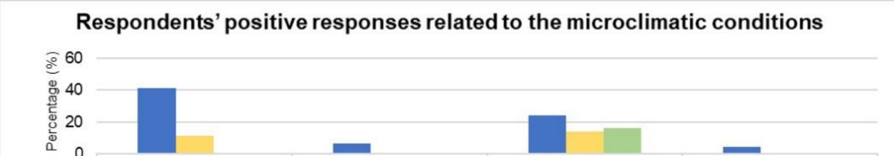


Figure 5.15: Respondents' negative responses regarding upkeep and maintenance

5.2.4.3 Environmental

The present results showed that a comfortable microclimate included enjoying the fresh air, shaded areas and morning sunlight in the HCG was expressed by the majority of respondents in H1-C1 compared to the other case study sites (See Figure 5.16). The findings suggested that there is a relationship between the different characters of the HCG with their microclimatic conditions. Moreover, the amount of greenery, the existence of shaded canopy trees and the floor ratio of the courtyard could possibly be some of the attributes that contribute to a comfortable environment in the HCGs. **The discussion regarding the environmental aspect and its attributes and how users felt regarding the microclimatic conditions in the HCG** will be elaborated further in Chapter 6.

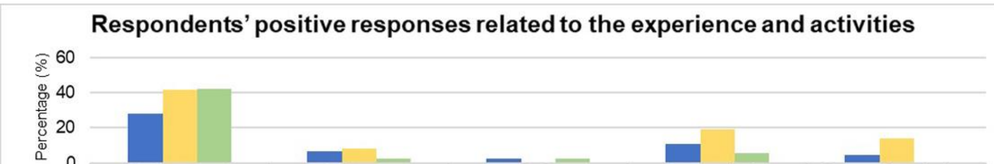


	Fresh air	Well shaded	Comfortable environment	Sunlight
H1-C1	41.3% (19)	6.5% (3)	23.9% (11)	4.3% (2)
H2-C3	11.1% (4)	0	13.8% (5)	0
H3-C2	0	0	15.8% (6)	0

Figure 5.16: Respondents' positive responses related to the microclimatic conditions

5.2.4.4 Social

The concurrent positive comments mentioned by the respondents in all three case study sites include that they liked the calm and quiet environment in the HCG. This explained the benefits of the inclusion of the HCG in the hospital that can contribute to a calmer mood and positive feeling among users (See Figure 5.17). The fact that the HCG is a walled garden means that it creates a quiet environment that help users to feel safer in it, which was appreciated by some of the respondents in the three sites. Respondents in all three case study sites mentioned that they liked to spend time in the HCG because it facilitated activities such as sitting and relaxing, and further provided an opportunity to escape from the indoor areas of the hospitals. **The social aspects including the activities by different type of users and their experience in the HCG** will be further examined in Chapter 6 based on the different set of data from the survey interviews.



	Calmer mood	Quietness	Safe	Rest and relax	Escape from indoor
	EXPERIENCE			ACTIVITIES	
H1-C1	28.2% (13)	6.5% (3)	2.2% (1)	10.8% (5)	4.3% (2)
H2-C3	42.0% (15)	8.3% (3)	0	19.4% (7)	13.8% (5)
H3-C2	42.2% (16)	2.6% (1)	2.6% (2)	5.3% (2)	0

Figure 5.17: Respondents' positive responses related to the experience and activities

5.3 Users' satisfaction levels with the design and planning of the HCG

The previous section discussed and evaluated the disliked and liked, as well as suggestions for HCG improvement (e.g. landscape elements, safety and maintenance). This section elaborates more on how satisfied the users were with the overall HCG layout and planning and the overall performance of the HCG. This will cover a range of aspects related to the physical design factors including accessibility, visibility, wayfinding, landscape elements and wall conditions of the HCGs. For this section, the results were also based on the interview surveys with HCG users using the 5-point Likert scale questions which ranged from very dissatisfied to very satisfied (See Question 21, in Appendix 1). A total of 120 respondents in the three representative HCGs (H1-C1 (n=46); H2-C3 (n=36); H3-C2 (n=38)) were analysed further in this study. The sample included 70% visitors (n=84), 16.7% staff (n=20), and 13.3% patients (n=16) with 60.8% (n=73) female and 39.2% (n=47) male (See Section 3.5.2). There were no missing responses recorded for this question.

As described earlier in Section 3.6.2.1, SPSS statistical software was used to run a descriptive (e.g. frequency analysis) and inferential analysis (e.g. Chi-square test, Contingency coefficient and crosstabulation). Microsoft Excel was used to generate the graph. A frequency analysis was used to compare the differences in the frequency of responses across the three representative case study HCGs to examine users' satisfaction levels on HCG design which is presented from Section 5.3.1 to Section 5.3.5. Further, an inferential analysis was carried out across the whole sample (N=120) to examine the relationship and the strength between the variables of the physical design factors with the overall satisfaction level of the planning and performance of the HCGs (See Section 5.3.6 and 5.3.7).

5.3.1 Accessibility

Several aspects of accessibility were asked in the surveys using a 5-point Likert scale question. These included satisfaction with the:

- accessibility from the main entrance to the HCG;
- number of entrances in the HCG;
- accessibility to a different department in the HCG; and
- accessibility to a wheelchair user.

5.3.1.1 Accessibility from the main entrance to the HCG

Regarding the accessibility from the main entrance to the HCG, the study revealed that more than two-thirds of the respondents in all case study sites (H1-C1 (78.3%; n=36), H2-C3 (66.7%, n=24) and H3-C2 (81.6%, n=31) were either satisfied or very satisfied (See Figure 5.18). Those who expressed their dissatisfaction with accessibility from the main entrance to the HCG is slightly lower in all three case study sites (H1-C1 (17.4%; n=8), H2-C3 (16.7%, n=6) and H3-C2 (7.9%, n=3). This suggested that a majority of the respondents did not encounter any difficulty to access and direct their way from the main hospital entrance to the respective HCG.

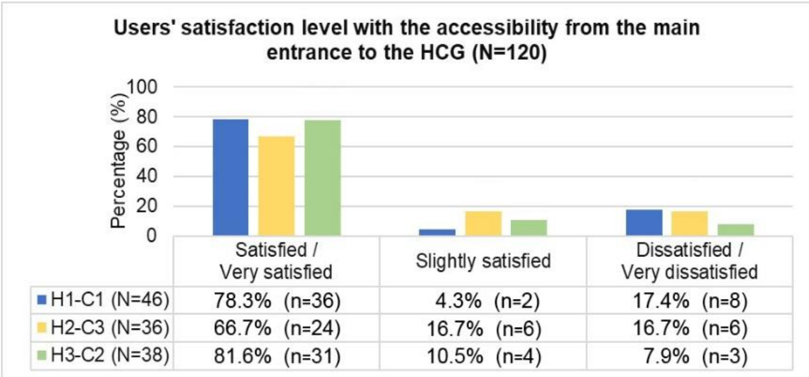


Figure 5.18: Users' satisfaction levels with accessibility from the main entrance to the HCG

H3-C2 has a lower percentage of response of dissatisfaction compared to the other two case studies. Based on the observation, H3-C2 provided the best options in terms of closeness of the HCG with the main entrance because the users could directly access the HCG from the main entrance and lobby that were located at the same level with the HCG. However, in H1-C1, the users have to go down via the stairs to the cafeteria to the HCG (i.e. located on level 2) or use the provided lift to go down to the HCG from the main lobby (i.e. located on level 3) (As illustrated earlier in Table 4.3, Section 4.3.4). As mentioned earlier in Section 5.2.1.2, some respondents indicated that they disliked the HCG because of the indirect access and from the main lobby to the H1-C1, which increased the walking distance to the HCG. For H2-C3, the location was not close to the main lobby, thus the hospital users needed to take a long walk along the corridor and from the main lobby to get to this HCG. The longer the walking distance to the HCG could increase the dissatisfaction to go to the HCG, especially mobility users.

5.3.1.2 Number of entrances in the HCG

The respondents were also asked regarding their satisfaction levels with the numbers of entrances in the HCG. More than 80% of respondents in H1-C1 were either satisfied or very satisfied with the number of entrances in the HCG which is slightly higher than H3-C2

(65.8%, n=25) and H2-C3 (41.7%, n=15) (See Figure 5.19). Surprisingly, a higher number of respondents expressed their dissatisfaction with the number of entrances in H2-C3 compared to the other two case study sites. This study suggests that the number of entrances might influence users' satisfaction with access to the HCG. Some respondents expressed dislike regarding the restriction of access in H2-C3 due to locked doors attached to the rehabilitation centre (See Section 5.2.2.2). The H3-C2 has limited access to the HCG (only has one access door) compared to the other case study HCGs which evidence multiple entrances.

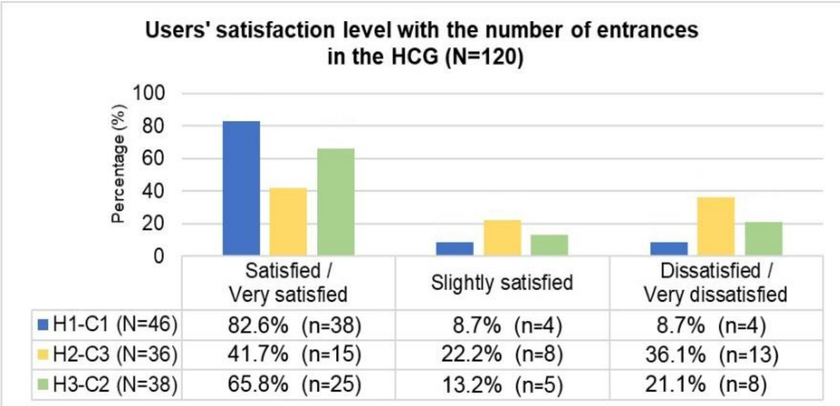


Figure 5.19: Users' satisfaction levels with the number of entrances in the HCG

5.3.1.3 Accessibility to a different department in the HCG

In addition, the study also inferred that the number of entrances to the HCG might influence the easy access to other departments via the HCG. This inference is furthered supported by the fact that over 80% of respondents were either satisfied or very satisfied with the accessibility to different departments via the HCG that the H2-C3 (33.3%, n=12) and H3-C2 (63.2%, n=24) (See Figure 5.20). It was no surprise that more users in the H2-C3 expressed dissatisfaction with the access to the different department via the HCG as it only has one access door open throughout the day (See Table 5.1).

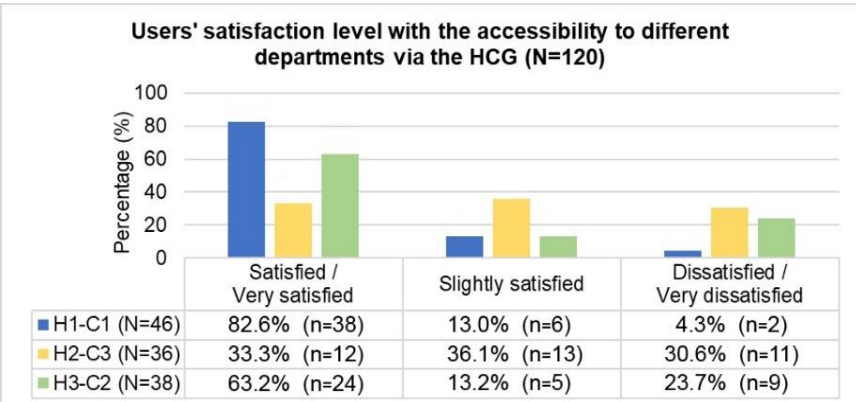
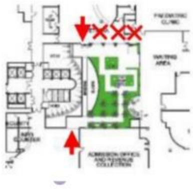


Figure 5.20: Users' satisfaction levels with the accessibility to different departments via the HCG

Table 5.1: Access to the HCGs

Description	H1-C1	H2-C3	H3-C2
Accessibility	 90%	 30%	 50%
Number of entrances	3 main entrances to access the HCG 	Only one door opens to the public 	Two entrances to the HCG 
Images	Entrance close to the cafeteria 	Entrance to the HCG attached to the main hospital street 	Entrance attached to the cafeteria 
	Entrance close to the visitors' centre 	The doors attached to the rehabilitation centre are often locked 	3 glass doors were locked by the hospital management 
	The entrance close to the imaging and A&E departments 		Entrance attached to the main lobby 

5.3.1.4 Accessibility to a wheelchair user

Further, the study also found that 80.4% and 71.1% of the respondents in the H1-C1 and H3-C2 were either satisfied or very satisfied with the access for wheelchair users respectively. A higher percentage of response of dissatisfaction with access for wheelchair users (47.2%, n=17) was found in H2-C3 which suggests that the uneven level at the entry point of H2-C3 has refrained wheelchair users from visiting this HCG (See Figure 5.21). More than 70% of the respondents H1-C1 and H3-C2) expressed their satisfaction with wheelchair access in the HCG could be because these HCGs provided a flat and even walkway allowing easy access for a wheelchair user and those with walking aids (See Table 5.2)

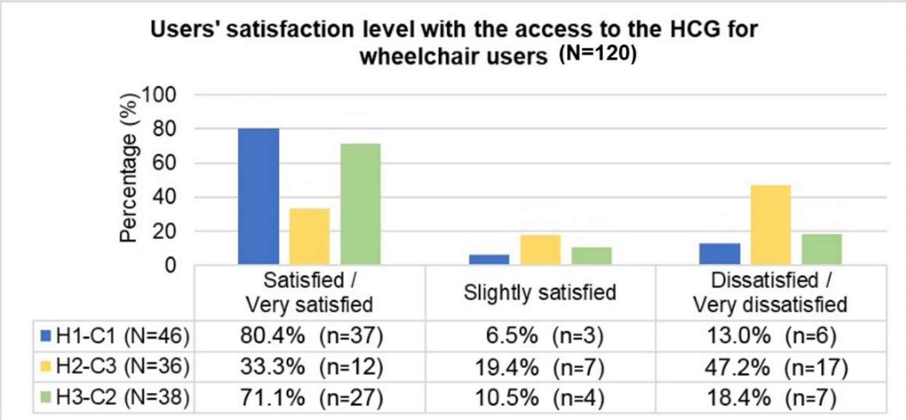


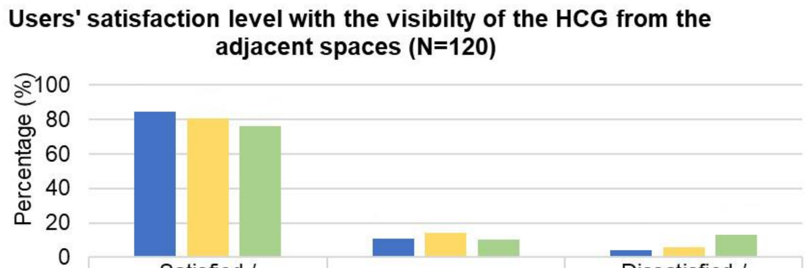
Figure 5.21: Users' satisfaction levels with access to the HCG for wheelchair users

Table 5.2: Access for wheelchair users

Description	H1-C1	H2-C3	H3-C2
Wheelchair access	H1 +ve	H2 -ve	H3 -ve
	• This HCG provides excellent access for wheelchair users • They were observed spending time around the garden with a friend and family members	• The 100mm drop at the entrance door caused difficulty for wheelchair users to visit the HCG • No wheelchair users spent time in the HCG	• The wheelchair users use the bridge to get to the cafeteria • No wheelchair users spent time in the HCG
Images			
Entry point	H1 +ve	H2 -ve	H3 +ve
	The entryway is wide with easy access	The access door is too heavy and not easy to open for wheelchairs and mobility aid people	The entryway is wide with easy access

5.3.2 Visibility

Additionally, the HCG users were also asked regarding their satisfaction with the visibility of the HCG from the adjacent spaces. Based on the survey interviews with a total of 120 respondents in all three case study sites, a majority of respondent in H1-C1 (84.8%, n=39) and H3-C2 (76.3%, n=29) were either satisfied or very satisfied with the visibility of the HCG from the adjacent spaces (See Figure 5.22). It was expected that H2-C3 would evidence less satisfaction compared to H1-C1 and H3-C2 because the location of H3-C2 is far from the cafeteria and main lobby and it was not visible directly from the adjacent spaces (i.e. the curtains were often used throughout the day). Surprisingly, the results showed that a higher number of respondents in H2-C3 expressed their satisfaction levels with the visibility of H2-C3 from the adjacent spaces (94.4%, n=34).



	Satisfied / Very satisfied	Slightly satisfied	Dissatisfied / Very Dissatisfied
H1-C1 (N=46)	84.8% (n=39)	10.9% (n=5)	4.3% (n=2)
H2-C3 (N=36)	80.6% (n=29)	13.9% (n=5)	5.6% (n=2)
H3-C2 (N=38)	76.3% (n=29)	10.5% (n=4)	13.2% (n=5)

Figure 5.22: Users' satisfaction levels with the visibility of the HCG from the adjacent spaces

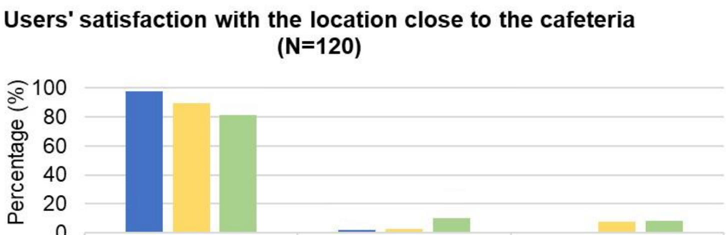
Furthermore, the results of H3-C2 showed that (13.2%, n=5) expressed their dissatisfaction regarding the visibility of the HCG from the adjacent space which is higher than evidenced for the other two case study sites. The reason why more users' expressed dissatisfaction in H3-C2 compared to the other case study sites could be because of the barrier in place. For example, visual access from the cafeteria to the H3-C2 was blocked by the food serving area (See Table 5.3).

Another possible reason could be because the size of the windows around the wall enclosure of H2-C3 are slightly smaller compared to H1-C1 and H3-C2. Moreover, this study also suggests that there is a possible bias in the results as more respondents tended to vote for either satisfied or very satisfied, as most of the respondents were familiar with this HCG and have frequently visited and know the existence of the respective HCG compared to those who were first time visitors to this hospital.

Table 5.3: Visibility from the cafeteria.

Description	H1-C1	H2-C3	H3-C2
Percentage of visibility	70%	NA – Not visible from the cafeteria	40%
Visibility from the cafeteria to the HCG			
Description	The full-height glass window in the cafeteria enhance visibility to the HCG	Users need to pass through a lengthy hospital street that links the cafeteria which is located close to the main lobby to the HCG	The serving counter in the cafeteria blocked the view to the HCG

In addition, over 80% of the respondents in all three case study sites mentioned that they were either satisfied or very satisfied with the location close to the cafeteria (See Figure 5.23). The cafeteria is the main common area where most of the hospital visitors frequently visit the space. Therefore, this study suggests that being located in close proximity to the cafeteria is one of the factors that can increase the visibility of the HCG. More people are aware of the existence of the HCG that is close to the cafeteria than the HCGs placed further away from the cafeteria.



	Satisfied / Very satisfied	Slightly satisfied	Dissatisfied / Very dissatisfied
H1-C1 (N=46)	97.8% (n=45)	2.2% (n=1)	0.0% (n=0)
H2-C3 (N=36)	89.5% (n=19)	2.6% (n=10)	7.9% (n=7)
H3-C2 (N=38)	81.7% (n=34)	10.0% (n=1)	8.3% (n=3)

Figure 5.23: Users' satisfaction with the location close to the cafeteria

To further investigate this issue, and avoid bias in presenting the results, evidence from the survey interviews with a total of 135 non-users groups in all three case study HCGs were discussed. This group of non-users were randomly sampled among those outside the boundaries of the HCG (e.g. those sitting and waiting in the lobby area of the hospitals). The sample included: 54% visitors, 32.6% staff and 12.6% patients. (See Section 3.5.3, for demographic data for non-users group). They were asked regarding their familiarity with the HCG, whether they knew the existence of the representative HCG or not.

This study found that from a total of 45 respondents in each of the case study HCGs who were interviewed, the majority of respondent in H1-C1 (93%, n=42) and H3-C2 (84.4%, n=38) answered that they knew about this HCG. In contrast, a slightly smaller number of respondents in H2-C3 mentioned that they knew about H2-C3 (55.6%, n=25) (See Figure 5.24). This could be because H2-C3 is located a bit far from the main lobby in which it is less visible. The H1-C1 and H3-C2 were located close to the main lobby and this increased their visibility to those coming from the main entrance of the hospital. Therefore, this study suggests that the location of the HCG which is close to the main entrance and visible from the main lobby increased the visibility of the HCG, in which it can direct people to go to the HCG without depending on sign directions (See Table 5.4).

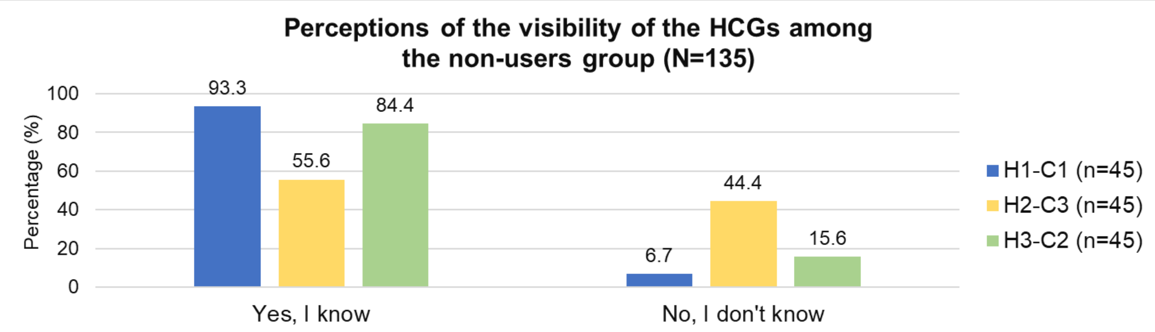
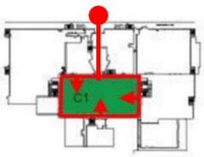
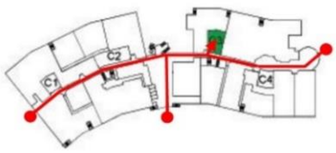
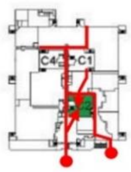


Figure 5.24: Perception of the visibility of the HCGs among the non-user group

Table 5.4: The hospital circulation from the main entrance to the HCG

Description	H1-C1	H2-C3	H3-C2
Circulation to the HCG			

5.3.3 Wayfinding

Apart from accessibility and visibility in the HCG, respondents were also asked regarding their satisfaction with the wayfinding to the HCG. More than half of respondents (58.3%, n=21) expressed their dissatisfaction with the wayfinding to H2-C3 (See Figure 5.25). A possible explanation of these results may be due to the location of H3-C2 which is located slightly away from the main entrance and the main lobby. The reason why more people mentioned that they are either satisfied or very satisfied regarding the wayfinding to H1-C1 and H3-C2 could be because of its location (at the centre of the hospital and close to the main lobby as well as highly access zone areas such as the cafeteria).

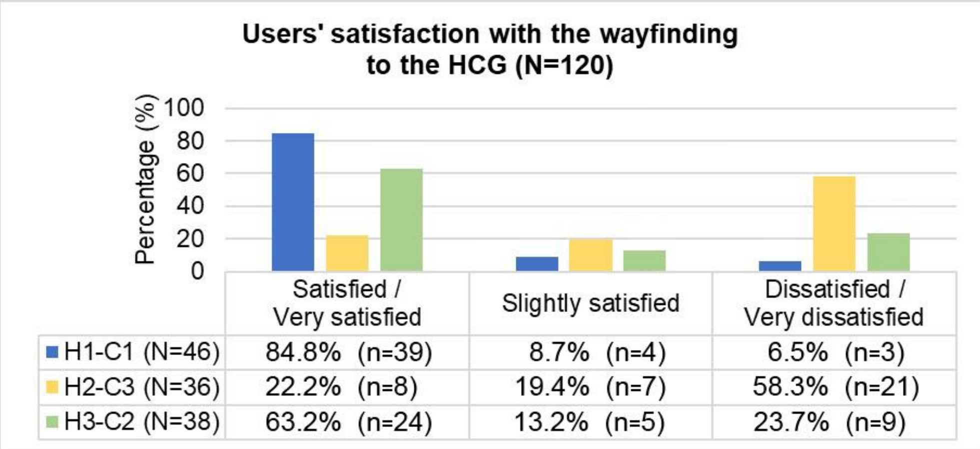


Figure 5.25: Users' satisfaction levels with the wayfinding in the HCG

Another possible reason why more respondents in H1-C1 expressed satisfaction with the wayfinding is possibly because directional signage was provided in this hospital, whereas in the other two case study hospitals no directional signage was provided to direct people to the HCG (See Table 5.5). Although directional signage can enhance the wayfinding to the HCG, however, this study suggests that a more significant factor that leads to better wayfinding is the location of the HCG within the hospital planning. H1-C1 is located at the centre of the hospital planning and visible to those who have first entered the building. Due to the awareness of its existence at the very first stage, first-time visitors or patients can easily find their way to the HCG without depending on directional signage.

Table 5.5: Signage provided in the HCG to enhance wayfinding

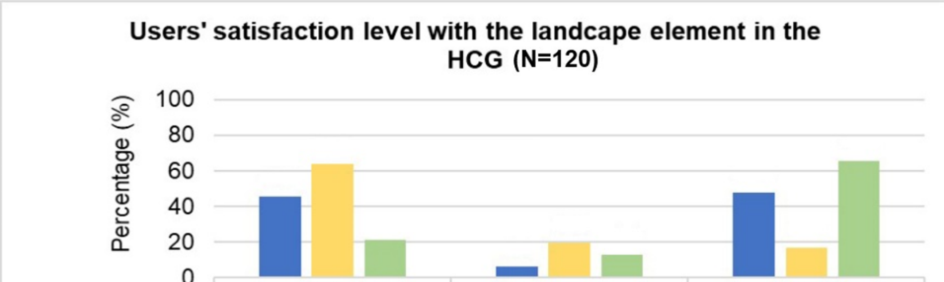
HCG	DIRECTIONAL SIGNAGE	MAP SIGNAGE	LOCATION SIGNAGE
H1-C1	The signage indicates the HCG mounted on the wall at the staircase area. However, the font is too small and less visible to other impaired and mobility users 	X	Signage provided to indicate the name of the HCG: 'Taman Harmoni' (Peace garden). However, the signage is located on the slope area, making it less visible to hospital users. 
H2-C3	X	X	X
H3-C2	X	X	X

X : No HCG signage provided
Directional signage : Signage indicates the direction to go to the HCG
Map signage : Signage indicates the floor plan and location of the HCG
Location signage : Signage which shows the name of the HCG

5.3.4 Landscape elements

Landscape elements were mentioned many times by respondents when asked about their likes regarding the HCG as previously evidenced in Section 5.2.4. This study expected that the lush and variety of landscape elements provided in H1-C1 compared to the other case study sites would contribute to higher satisfaction of the HCG with the landscape elements. Surprisingly, the findings show that even though H2-C3 has only few types of planting and seating areas in the HCG, it has the highest response from the users who expressed their satisfaction levels with the landscape elements (63.9%, n=23) compared to the other two case study sites (See Figure 5.26). The possible reason why more users in both H1-C1 and H3-C2 expressed dissatisfaction regarding the landscape elements in these HCGs compared to H2-C3 is due to the maintenance aspect of the landscape elements in this HCG.

More respondents in both H1-C1 and H3-C2 expressed their dislike on the maintenance aspects compared to H3-C2 (See Section 5.2.4.2). In H1-C1, the respondents criticised the HCG in terms of landscape elements such as the unfunctional water fountain, lack of flowering and herbs plants, unfertilised plantings, uncut grass, unclean fallen leaves, unrepaired planting labels and broken wooden seating area. In H3-C2, respondents were concerned and unhappy with the lack of seating, and lack of choice of plantings and flowering plants. This study infers that low garden maintenance can significantly decrease the degree of satisfaction of the landscape elements in the HCG.



	Satisfied / Very satisfied	Slightly satisfied	Dissatisfied / Very dissatisfied
H1-C1 (N=46)	45.7% (n=21)	6.5% (n=3)	47.8% (n=22)
H2-C3 (N=36)	63.9% (n=23)	19.4% (n=7)	16.7% (n=6)
H3-C2 (N=38)	21.0% (n=8)	13.2% (n=5)	65.8% (n=25)

Figure 5.26: Users' satisfaction levels regarding the landscape elements in the HCG

5.3.5 Wall condition

Finally, the results showed that a higher number of respondents expressed their dissatisfaction with the wall conditions in the H1-C1 (41.3%, n=19) and H3-C2 (57.9%, n=22) (See Figure 5.27). In addition, over 40% of the respondent in H1-C1 and H3-C2 were either dissatisfied or very dissatisfied with the wall condition in the HCG. The possible reason for these results could be due to the **overall appearance of the wall that affected the aesthetical view of the HCG.** The H2-C3 wall used a type of aluminium cladding which made the wall look much better than a faded and rusted concrete wall.

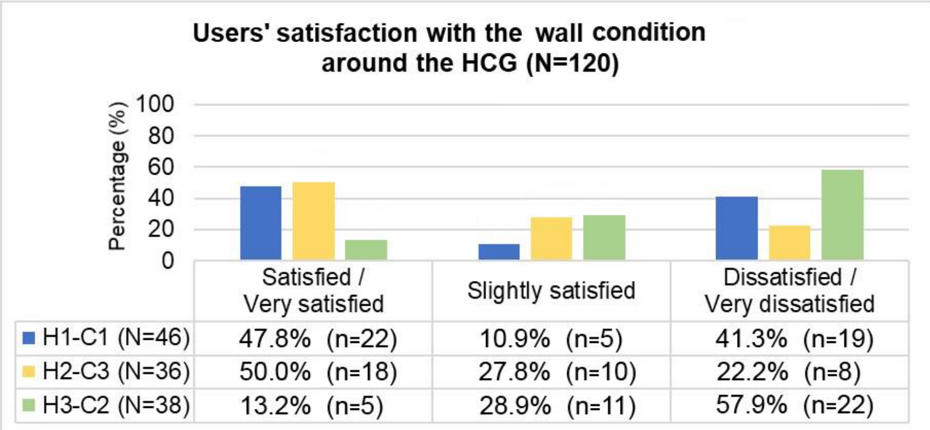


Figure 5.27: Users' satisfaction with the wall condition around the HCG

This result was supported by the findings on the disliked aspect of the HCG, whereas some of the respondents in H1-C1 and H3-C2 criticised the faded colour of the concrete wall and **the presence of the black stain and rust on the wall of the HCG** (See Section 5.2.3.2). Moreover, they suggested that the wall around the HCG be painted to a bright and cheerful colour to improve the appearance of the wall around the HCG. Therefore, this study suggests that the overall appearance of the wall or the overall look around the HCG contributed to the total satisfaction of the planning and performance of the HCG.

5.3.6 Users' satisfaction levels with the overall planning and performance of the HCG

Following on, the data from the survey interviews on the degree of user satisfaction with the overall planning and performance of the HCG were analyse using a SPSS software for both the descriptive and inferential analysis, as described earlier in Section 3.6.2.1. A frequency analysis was carried out across a total whole sample of the respondents in the three representative HCGs (N=120). The users were asked using a 5-point Likert scale questions on the overall planning and performance of the HCG (See Questions 21 and 22, in Appendix 1).

Despite the number of deficiencies in the physical design factors in each of the HCGs themselves (As previously discussed in earlier Sections 5.3.1 to 5.3.4), the overall recorded satisfaction on the overall planning from the three case study HCGs was somewhat positive. Whereas more than half of the respondents (63%, n=75) were either satisfied or very satisfied with the overall planning of the HCGs, the respondents who expressed their dissatisfaction was slightly lower (19%, n=23) (See Figure 5.28 (a)).

Nevertheless, the results of the overall rating performance showed that a majority of the respondents in all three case study sites tended to rate the HCG as good (47%, n=56). More than 30% of respondents in all three case study sites voted the HCG as either fair or poor, whilst a small percentage of respondents (19%, n=23) voted for either very good or excellent (See Figure 5.28 (b)).

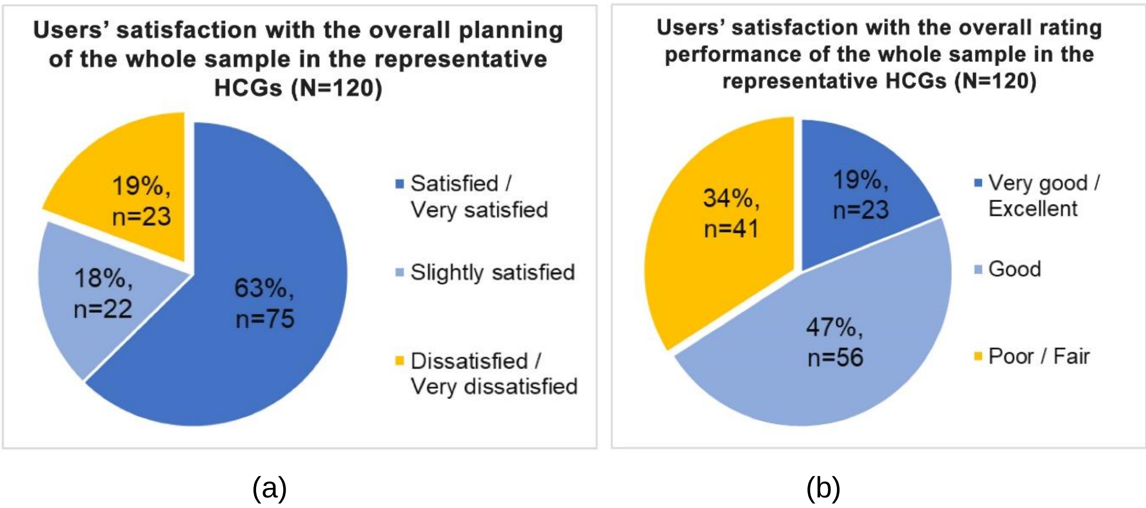


Figure 5.28: (a) Users' satisfaction levels with the overall planning of the HCGs, (b) Overall rating performance of the HCGs

The results on the users' satisfaction levels on the overall planning of the HCGs showed that over 70% of the respondent in H1-C1 (n=34) and 65% of the respondents in the H2-C3 (n=24) reported that they were either satisfied or very satisfied. The number of respondents who expressed their dissatisfaction on the overall planning in the H3-C2 (34.2%, n=13) is higher than the H1-C1 (17.3%, n=8) and H2-C3 (5.6%, n=2) (See Figure 5.29).

In terms of the overall rating of the HCG performances, the results showed a slightly higher percentage of response in H2-C3 who voted the HCG as 'good' compared to the other case study sites. In contrast, more respondents tended to vote for good, very good and excellent in both H1-C1 and H3-C2, and almost half of the respondents in the H3-C2 tended to vote for either fair or poor (See Figure 5.30).

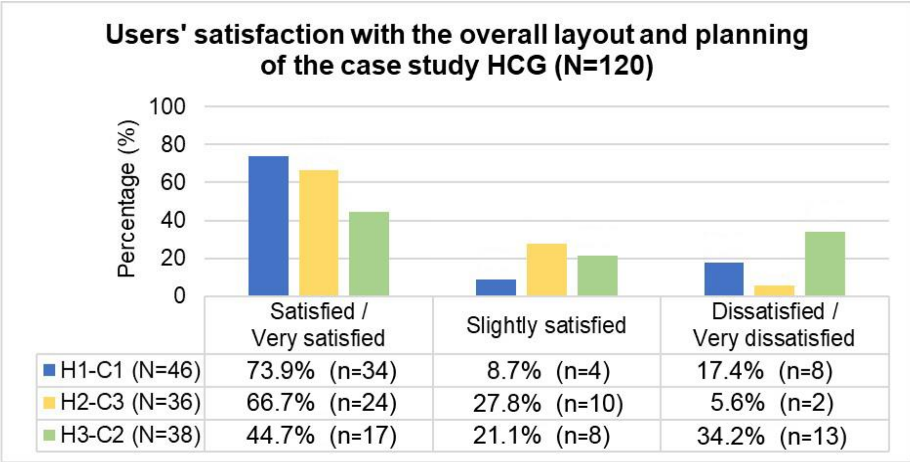


Figure 5.29: Degree of users' satisfaction with the overall planning of each of the case study HCGs

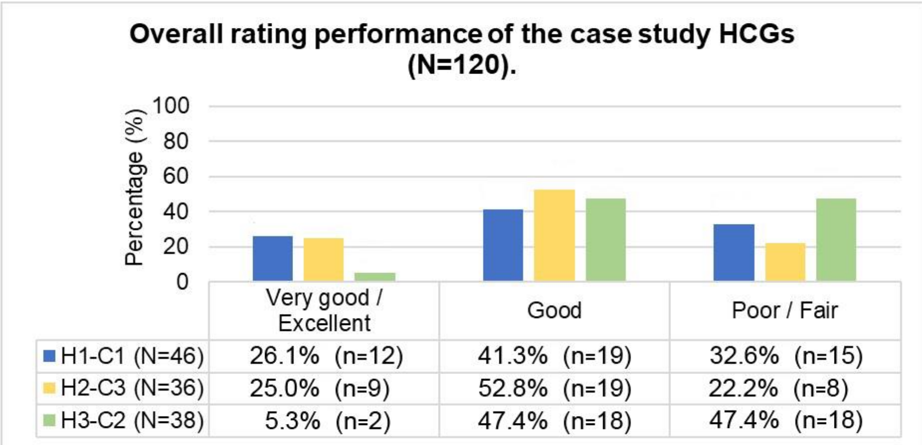


Figure 5.30: Overall rating performance of the case study HCGs

5.3.7 Factors related with the overall planning of the HCG.

As explained earlier, a Chi-square analysis was used to explore the relationship between nine physical design variables with the record of users' satisfaction on overall planning of the HCG. These variables are included: 1) landscape elements; 2) wall condition; 3) access from the main entrance to the HCG; 4) visibility; 5) number of entrances; 6) Wayfinding; 7) access to different department; 8) access for a wheelchair user and 9)location close to the cafeteria. These variables were tested to examine which attributes of the physical design factors of the HCG have either direct, indirect or no relationship with the users' satisfaction with the overall planning of the HCG.

A contingency coefficient was also used to measure the strength of the relationships between the two variables. The results of factors that are closely related, slightly related and not related to the satisfaction of the overall planning of the HCG are summarise in the following subsection in Table 5.6, Table 5.7 and Table 5.8 in the following subsections.

The selection was made based on the value of the significance level (p < .05) (Chi-square analysis) and the strength of the association (C value that is closer to 1) (Contingency coefficient) as explained earlier in Section 3.2.2.1, (i) Chi-square test (ii) Contingency coefficient and crosstab. See Appendix 18 for a detail Chi-square results and a cross-tabulation table.

5.3.7.1 Factors closely related with the overall planning of the HCG

Based on the results of the Chi-square test, the factors that are closely related to the users' satisfaction with the overall planning of the HCG include:

a) Landscape elements
b) Wall condition
c) Access from the main entrance to the HCG
d) Visibility

Table 5.6: Factors closely related to the satisfaction of the overall planning of the HCG

Factor related		Significance p	Contingency C	Interpretation
CLOSELY RELATED	**(p < 0.01) (.40 < C < .50)**			
	Landscape element	p < .000	C = .442	**p < .01: Significant** Respondents who were satisfied with the landscape element express satisfaction with the overall layout and planning of the HCG
	Wall condition	p < .000	C = .429	**p < .01: Significant** Dissatisfaction with the wall condition contributed to lower satisfaction with the overall layout and planning of the HCG
	Access from the main entrance to the HCG	p < .000	C = .393	**p < .01: Significant** Access from the main entrance contributed to higher satisfaction with the overall layout and planning of the HCG
	Visibility	p < .000	C = .382	**p < .01: Significant** Those who were satisfied with the visibility of the HCG tended to express their satisfaction with the overall layout and planning of the HCG

a. ***The landscape elements***

The landscape elements in the HCG was one of the most strongly related factors to the overall records of users' satisfaction regarding the layout and planning of the HCG (p < 0.01, C= .44). Those who express dissatisfaction with the landscape elements in the HCG had higher dissatisfaction with the overall layout and planning of the HCG. The highest proportion of dissatisfied respondents, as mentioned previously, was from H3-C2 (65.8%) and H1-C1 (47.8%), where patients were mostly unsatisfied with the landscape elements in the HCG (Section 5.3.4).

b. Wall condition around the HCG

Surprisingly, it was found that those who expressed dissatisfaction with the wall condition around the HCG were dissatisfied with the overall layout and planning of the HCG ($p < 0.01$, $C = .429$). More than half of the respondents in H3-C2 reported that they were dissatisfied or very dissatisfied (57.9%) with the wall condition around the HCG, and 41.3% of respondent expressed dissatisfaction to the wall condition in H1-C1. The possible reason could be due to the presence of a black and rusty stain on the wall of the case study H1-C1 and H3-C2 sites that seemed to influence users' satisfaction on the overall layout and planning of the HCG (Section 5.3.5).

c. Accessibility from the main entrance to the HCG

Accessibility from the main entrance to the HCG has been found as one of the factors that closely related to the users' satisfaction levels to the overall layout and planning of the HCG ($p < .001$, $C = .393$). More than half of the respondents in H1-C1 (78.3%), H2-C3 (66.7) and H3-C2 (81.6%) are satisfied or very satisfied with the accessibility from the main entrance to the HCG (Section 5.3.1.1).

d. Visibility of the HCG

It was also found that the visibility of the HCG was closely related to the users' satisfaction levels with the overall layout and planning of the HCG ($p < 0.01$, $C = .382$). There is a significant relationship between the visibility of the HCG with the overall layout and planning of the HCG. Most of the respondents who expressed their satisfaction with the visibility of the HCG were found to have a higher satisfaction level with the overall layout and planning of the HCG. More than 70% of the respondents in all three case study HCGs were either satisfied or very satisfied with the visibility of the HCG (Section 5.3.2).

5.3.7.2 Factors related with the overall layout and planning of the HCG

Several factors that are found to be related to the degree of satisfaction with the overall layout and planning of the HCG include:

a) Number of entrances
b) Wayfinding
c) Access to different departments

Table 5.7: Factors related to the satisfaction of the overall planning of the HCG

Factor related		Significance p	Contingency C	Interpretation
RELATED	**(p < 0.05, .30 < C < .40)**			
	Number of entrances	p < .022	C = .295	**p < .05: Significant** Multiple entrances in the HCG contributed to higher satisfaction with the overall layout and planning of the HCG
	Wayfinding	p < .030	C = .286	**p < .05: Significant** Those who were satisfied with the wayfinding in the HCG are satisfied with the overall layout and planning of the HCG
	Access to the different departments	p < .033	C = .283	**p < .05: Significant** Satisfaction with access to the different departments in the HCG contributed to higher satisfaction with the overall layout and planning of the HCG

a. Number of entrances

Satisfaction with the number of entries was found to be significantly related to the degree of satisfaction with the overall layout and planning of the HCG but with different magnitudes. The respondents who were found to have a higher degree of satisfaction with the overall layout and planning of the HCG expressed high satisfaction with the number of entrances in the HCG ($p < 0.05$, $C = .295$). A higher dissatisfaction with the number of entrances in H2-C3 (i.e. only has one door opened during the time) was found compared to H1-C1 and H3-C2 (i.e. these HCGs has several entries) (Section 5.3.1.2).

b. Wayfinding

Satisfaction with the wayfinding to the HCG was found to be significantly related to the degree of satisfaction with the overall layout and planning of the HCG ($p < 0.05$, $C = .286$). Most of those who were either dissatisfied or very dissatisfied (58.3%) with the wayfinding in the HCG were from H2-C3 compared to the other case studies H1-C1 (6.5%) and H2-C3 (23.7%). The location of H1-C1 and H3-C2, which are close to the main lobby, could be one of the reasons that make users perceive better wayfinding in this case study compared to H2-C3, as mentioned earlier (Section 5.3.3).

c. Access to different departments

Satisfaction with the accessibility to various departments via the HCG contributed to the degree of users' satisfaction with the overall quality of the HCG ($p < 0.05$, $C = .283$). Although the relationship between access to different departments with the degree of satisfaction with the overall layout and planning of the HCG was found to be statistically significant, the magnitude of relationship was found to be a moderate one ($C = .28$) rather than being particularly strong. The results showed that the majority of those who were unsatisfied with access to different departments via the HCG was the respondents from H2-C3 (30.6%). Only 23.7% and 4.3% of the respondents in H3-C2 and H1-C1 expressed dissatisfaction with the access to different departments via the HCG, respectively (Section 5.3.1.3).

5.3.7.3 Factors non-related with the overall layout and planning of the HCG

Contrary to what would have been expected, neither the access for a wheelchair user and location to the cafeteria were found to be significantly associated statistically with the degree of satisfaction with the overall layout and planning of the HCG (See Table 5.8).

Table 5.8: Factors non-related to the satisfaction of the overall planning of the HCG

Factor related		Significance p	Contingency C	Interpretation
NOT RELATED	**($p > 0.01$, $C < .20$)**			
	Access for a wheelchair user	$p < .410$	$= .179$	**P > .05: Not significant** Degree of satisfaction with access for a wheelchair user has no association with the dissatisfaction of the overall layout and planning of the HCG
	Location close to the cafeteria	$p < .848$	$C = .106$	**P > .05: Not significant** A higher degree of satisfaction with the location of the cafeteria did not contribute to higher satisfaction of the overall layout and planning of the HCG

a) Access for a wheelchair user

Whereas the access for a wheelchair user is expected to be positively contributed to the degree of satisfaction with the overall layout and planning of the HCG, the result did not turn to be so ($p > 0.05$, $C = .179$). It could be argued that this is because the HCG users are not among those who are a wheelchair user, so the results could have a possibility of bias among them. Nevertheless, the results found that a higher percentage of respondents in H2-C3 (47.2%) were dissatisfied with the access for a wheelchair user to the HCG compared to other case study HCGs with only 13.0% and 18.4 % in H1-C1 and H3-C2, respectively (Section 5.3.1.4).

b) Location close to a cafeteria

Another important factor, whether a location is close to a cafeteria, that was expected to be related to the degree of satisfaction with the overall quality of layout and planning did not turn out to be so. The finding of this study indicated that a location close to a cafeteria is not statistically significant ($p > 0.05$, $C = .106$) and no association was found between the location close to the cafeteria and the degree of satisfaction with the overall layout and planning of the HCG. Based on the results, more than 80% of the respondents in all three case study sites were either satisfied or very satisfied with the location of the HCG close to the cafeteria (Section 5.3.2).

5.3.8 Factors related to the users' satisfaction levels with the HCG overall performance.

Having presented the findings on the factors related to the overall planning of the HCG as well as the strength of the association, further Chi-square tests were carried out to examine the association between these nine variables with the overall rating performance of the HCGs. The results showed that only two of the factors were found to be closely related to the overall rating performance of the HCG which are the landscape elements and the wall condition (See Table 5.9). The visual appearance of healthy plants and cleanliness of wall condition around the HCG could be the possible reasons that influenced users' satisfaction with the overall performance of the HCG.

Table 5.9: Factors related to the overall rating performance of the HCG

Factor related		Significance p	Contingency C	Interpretation
FAIRLY CLOSELY RELATED	Landscape element	p < .000	C = .394	**p < .01: Significant** Respondents who were satisfied with the landscape element expressed satisfaction with the overall layout and planning of the HCG
	Wall condition	p < .004	C = .339	**p < .01: Significant** Dissatisfaction with the wall condition contributed to lower satisfaction with the overall layout and planning of the HCG

5.4 Users' perceptions of the landscape elements in the HCG and preference of the HCG images.

The results for this section were also based on the survey interview with a total sample of HCG users in all representative sites (N=120). The sample included 70% visitors (n=84), 16.7% staff (n=20), and 13.3% patients (n=16) with 60.8% (n=73) female and 39.2% (n=47) male. Out of 120 respondents, 49.2% of the respondents were from the young age group, 38.3% from the middle age group. The remaining groups were from the older age group (9.2%) and senior age group (3.3%). Regarding the types of ethnicity, Malay (81.7%) represented the highest sample across the different sites followed by Indian (10.8%), Chinese (4.2%) and others (3.3%) (See Section 3.5.2). For this section both descriptive and inferential analysis were used as described earlier in Section 3.6.2.1.

5.4.1 Users' perceptions of the importance of landscape elements in the HCG

The data for this section was based on a survey using a 5-point Likert scale which ranged from very important to not important (See Question 12, in Appendix 1). This was used to examine users' perceptions on the different landscape elements in the HCG such as water fountains, green plants, sitting areas, flowering shrubs and pedestrian walkways. The assessment of such features in the HCG is essential to know whether there is any significant difference between the perceived importance of landscape elements within the sample of each of the case study HCGs or vice versa. Further, a relationship between different types of users, gender and age with the perceived importance of landscape elements in the HCG was also statistically analysed using a Chi-square test (See Section 5.4.1.1).

Throughout the detailed survey with the willing respondents in all the three case study HCGs (N=120 respondents), the majority of the HCG users reported that all landscape elements including the water fountain, green plants, seating area, flowering plants, pedestrian walkways and green grass were considered as either important or very important. The results revealed that there are no significant differences across the three case study HCGs, H1-C1 (n=46), H2-C3 (n=38) and H3-C2 (n=36) as majority of the respondents in each of the case study sites reported that all those landscape elements were either important or very important (See Figure 5.31).

Nevertheless, there was variation in the percentage of the responses that perceived the importance of the water fountain. The results showed that nearly 20% of the respondents in each case study HCG thought the water fountain as either of little importance or not important to them. As mentioned in the previous section on the safety factor, those who answered either of little importance or not important were those concerned about their child that might fall into the water fountain. The possible reason why the water fountain is likely to be less important to some respondents is because of their concern regarding the health aspect. Low maintenance could also attract mosquitoes breeding in stagnant water.

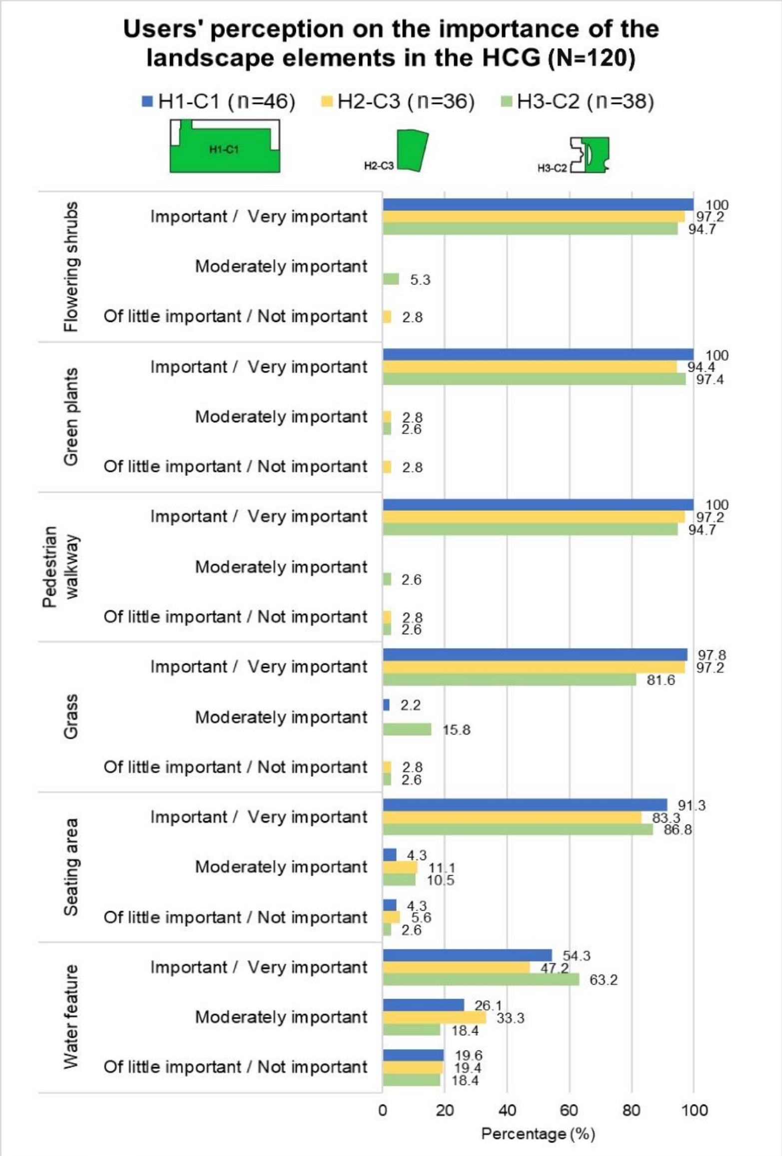


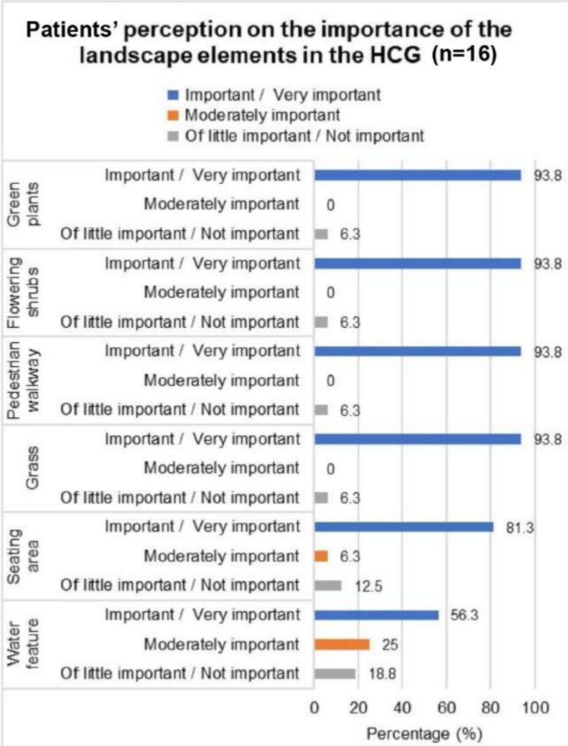
Figure 5.31: Percentage of users' perceptions on the importance of the landscape elements in each case study HCG

Moreover, the result also showed a similar percentage of those who perceived it as 'important' and 'less important' across different types of user groups (See Table 5.15). The green plants, flowering plants, pedestrian walkway was highly rated as either important or very important followed by seating and water feature.

Table 5.15: Perceptions of the importance of landscape elements in the HCG between the three different user groups

N=120

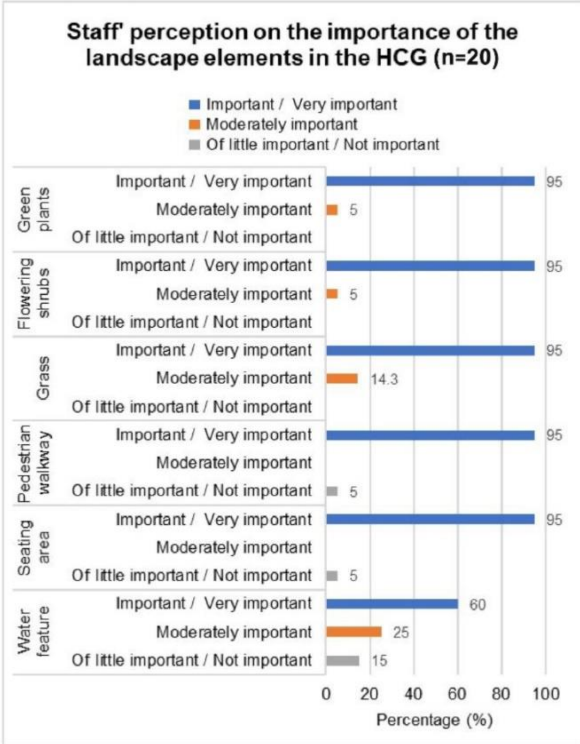
Patients (n=16)



Ranking:

1. Green plants
2. Flowering shrubs
3. Pedestrian walkway
4. Grass
5. Seating area
6. Water feature

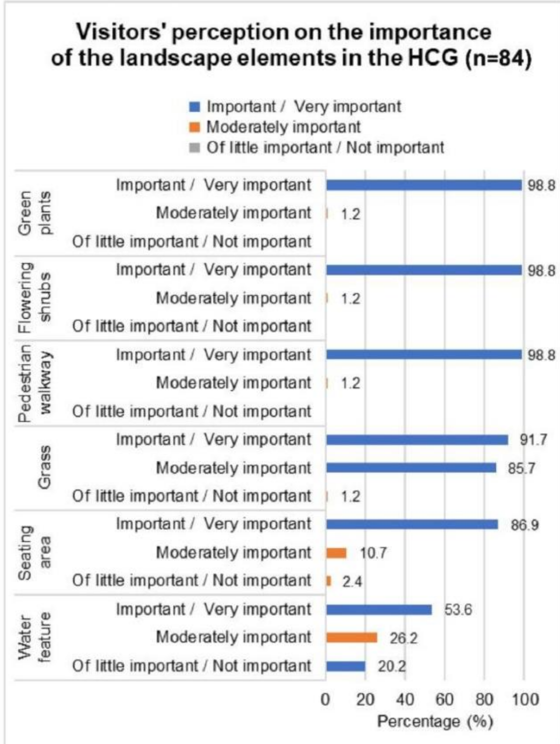
Staff (n=20)



Ranking:

1. Green plants
2. Flowering shrubs
3. Grass
4. Pedestrian walkway
5. Seating area
6. Water feature

Visitors (n=84)



Ranking:

1. Green plants
2. Flowering shrubs
3. Pedestrian walkway
4. Grass
5. Seating area
6. Water feature

5.4.1.1 Relationship between demographic characteristics with the perceived importance of landscape elements

The results were further examined using a cross-tabulation test to identify if there is an association between the perceived importance of landscape elements with the socio-demographic characteristic of the HCG users. The graph percentage of the cross-tabulation and results of the Chi-square test are shown below (See Appendix 19 for the cross-tabulation table).

i) Water feature

The results found that there was no significant association between types of users (X^2 =0.37, p=.985), gender (X^2 =2.6, p=.270), age group (X^2 =6.10, p=.412), and ethnicity (X^2 =6.08, p=.414) with the perceived importance of the water feature (See Figure 5.32). About one-third of the patients, staff and visitors thought water feature as either of little importance or not important. More than half of male respondents (63.8%) thought the water feature as either important or very important compared to only half of the female respondents (49.3%). The results also showed that more than 15% of both female and male respondents did not perceive the water feature as important. More than 80% of the older age group perceived the water feature as either important or very important compared to the middle age groups (45.7%). In terms of ethnicity, more than 20% of respondents of Malay, Chinese and Indian ethnicity thought that the water feature was an unimportant landscape element in the HCG.

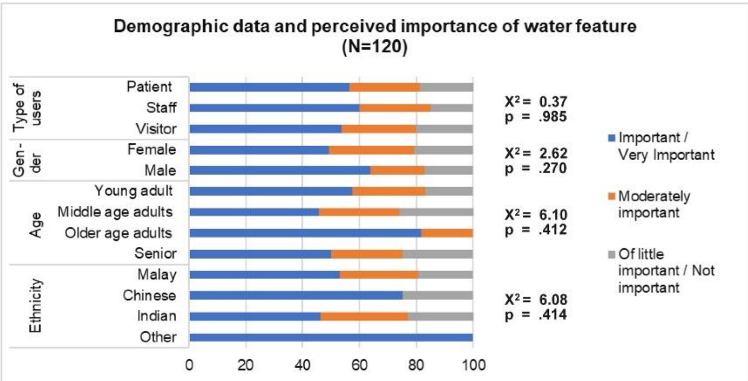


Figure 5.32: Percentage of demographic data by perceived importance of water feature

ii) Green plants

There was no significant difference between different types of users (X^2 =8.26, p=.082), gender (X^2 =1.98, p=.371), age group (X^2 =4.28, p=.639) and ethnicity (X^2 =8.72, p=.190) with the perceived importance of the green plants. More than 90% of respondents of different types of users viewed green plants as either important or very important (See Figure 5.33). While all male respondents thought of the green plants as either important or very important, only (1.4%, n=1) of female respondents did not think green plant as important landscape elements. Regarding ethnicity, all Chinese perceived green plants as either important. However, (7.7%, n=2) of the Indian group thought that the green plants were of little importance or not important. Nevertheless, it should be noted that the actual number of Chinese and Indian respondents was relatively small compared to Malay.

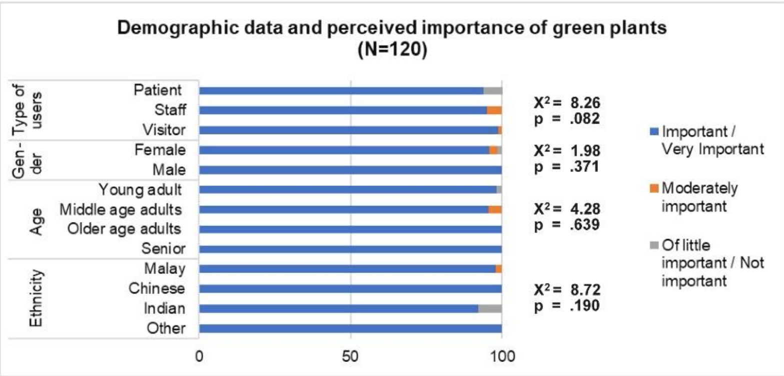


Figure 5.33: Percentage of demographic data by perceived importance of green plants

iii) Seating area

Further analysis was conducted to explore if there was any significant difference found between demographic characteristics with the perceived importance of seating area in the HCGs. The results showed that there was no association found based on the Chi-square test between types of users (X^2 =5.87, p=.209), gender (X^2 =.005, p=.998), age group (X^2 =6.14, p=.408) and ethnicity (X^2 =7.02, p=.319) with the perceived importance of the seating area (See Figure 5.34). Although no significant relationship was found between them, several interesting comparisons could be made. For example, although the majority of the respondents of different age groups perceived the seating area as either important or very important, surprisingly, some respondents from the senior group (25%, n=1), middle age adults (12.2%, n=1) and young adults (35.1%, n=3) did not think of the seating area as an important part of landscape element.

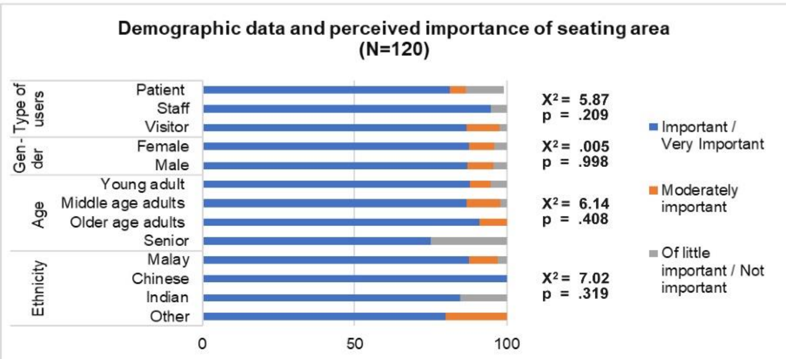


Figure 5.34: Percentage of demographic data by perceived importance of seating area

iv) Flowering shrubs

No significant relationship was found between different types of users (X^2 =8.29, p=.082), gender (X^2 =.743, p=.690), age group (X^2 =4.28, p=.639) and ethnicity (X^2 =8.72, p=.190) with the perceived importance of the flowering shrubs. There was little variation for comparison between different demographic data because a majority of the respondents highly perceived flowering shrubs as either important or very important. Out of 120 respondents, only one Indian patient thought flowering shrubs as of little importance (See Figure 5.35).

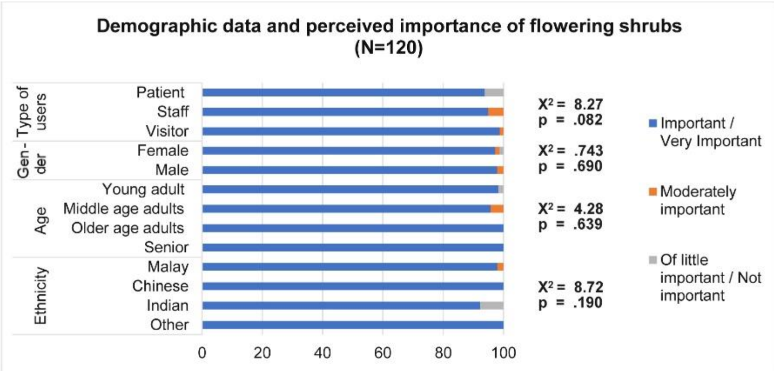


Figure 5.35: Percentage of demographic data by perceived importance of flowering shrubs

v) Pedestrian walkway

Another landscape element that was asked among the respondents regarded the importance of the pedestrian walkway. The result also showed that there was no significant association between the different types of user group (X^2 =5.23, p=.265), gender (X^2 =.743, p=.265), age group (X^2 =3.69, p=.718) and ethnicity (X^2 =3.49, p=.745) with the perceived importance of the pedestrian walkway. While the majority of respondents (n=120) perceived the pedestrian walkways as either important or very important landscape elements in the HCG, only one Indian patient and one Malay staff from the young adult group perceived pedestrian walkways as of little importance (See Figure 5.36).

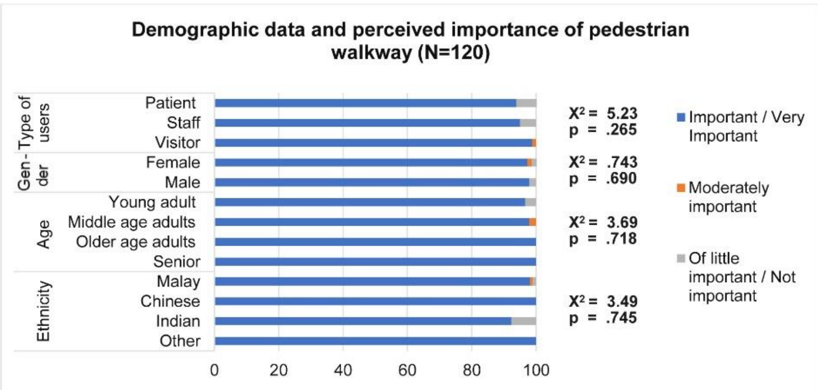


Figure 5.36: Percentage of demographic data by perceived importance of pedestrian walkway

vi) Grass

Lastly, the results also revealed that there was no relationship found between the different types of user group (X^2 = 8.26, p=.082), gender (X^2 =1.98, p=.371), age group (X^2 = 4.28, p= .639) and ethnicity (X^2 = 8.72, p= .190) with the perceived importance of the grass. Out of 120 respondents, only one Indian patient and one Malay visitor thought of the grass as of little importance to them (See Figure 5.37).

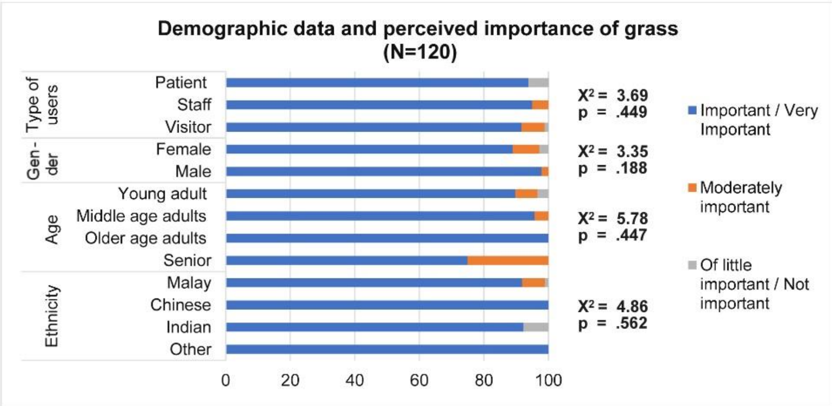


Figure 5.37: Percentage of demographic data by perceived importance of grass

5.4.2 Users' preference of the HCG images

Users' perceptions on the landscape elements revealed that there was no significant relationship between the landscape elements (e.g. the water features, green plants, seating area, flowering shrubs, pedestrian walkway and grass) with the demographic data (e.g. types of users, age, gender, and ethnicity). This section elaborates on users' preferences of the HCG images, which will further inform their choices related to the landscape elements shown in the photos. The selection of these photos based on a similar classification of character of the garden which is informal and naturalistic (Twedt et al., 2016). Moreover, the variation of photos was based on visual properties and qualities in each of the images (e.g. degree of canopy closure, variety of vegetations and landscape features) as a representation of the whole setting of a designed garden.

Data analysis was run across a total sample of 120 respondents in all of the representative HCGs (H1-C1 (N=46); H2-C3 (N=36); and (H3-C2 (N=38)), as explained earlier in Section 3.5.2. Two types of survey questions using a photo-elicitation technique asked the respondent to select the most preferred image and provide a reason for their selection **(**See Questions 14 and 15, in Appendix 1). Both questions have multiple-choice and open-ended type questions. For the multiple-choice question, the data of the whole sample were analysed using frequency analysis in SPSS software. Further, the open-ended questions (e.g. responses related to the reason for the selection of the HCG images) were coded and grouped and categorised according to similar theme and subtheme. Subsequently, the frequency of the users' responses was calculated, and the graph generated using Microsoft Excel.

5.4.2.1 Users' preferences of the three HCG images (Question 14)

The first question asked them to choose one of the images of the courtyard gardens that they liked the most out of the three images portrayed in the survey questions and provide a reason for their choice of selection. The results showed that a majority of the respondents in all three case study sites (N=120) choose image B (69%, n=83). The second favourite image among the respondents was image A (23%, n=27). The least preferred image was image A (8%, n=10) (See Figure 5.38).

5.4.2.1.1 Relationship between demographic characteristics with the preference of the HCG images (Question 14)

Based on the Chi-square test, the results showed that there was a significant relationship between types of users (X^2 =16.12, p=.003), age group (X^2 =15.93, p=.014), and ethnicity (X^2 =15.4, p=.017), with the preferences of the HCG images ($p > .005$) (See Figure 5.38). However, there was no significant difference found between the preferences of the HCG images with gender.

Types of users were found to have the most statistically significant relationship with the preference of the HCG images (X^2 =16.12, p=.003). Based on Figure 5-33, it was shown that image B was the most preferred among different patients, staff and visitors. However, image A was preferable among hospital employees compared to patients and visitors. A majority of the comments among the staff were that image A looked more spacious, clean and well-maintained, whereas more than 70% of the visitors (72.6%, n=61) preferred image B than the other two images. When asked why they choose image B, they responded that it looked more pleasant and calmer than the other photos. Another reason mostly mentioned by visitors was that image B had a water feature, a variety and choice of planting, seating and a spacious walkway. In contrast, a few patients preferred image C because they appreciated the greenery, the flowering plants and the spacious walkway portrayed.

From the analysis, gender had no significant association with the preference of the HCG images (X^2 =3.76, p=.152). Image B is the most preferred image among both genders, followed by image C and A. A significant relationship was found between different age groups with the preferences of the HCG images (X^2 =15.93, p=.014). An interesting variation of responses across age groups showed that none of the older age group (55 years old and older) and senior age group (65 years and older) choose image A. The majority of other age group users preferred image B, all senior age adults preferred image C, compared to other images (See Figure 5.38). The senior age group choose image C because the environment in image C looked calm and pleasant. Besides, they mentioned that they liked the spacious look of image C, and the greenery as well as the flowering plants in this image.

In terms of ethnicity, it was found that a significant relationship was found between ethnicity and the preference of the HCG images (X^2 =15.4, p=.017). The majority of Malay and Indian participants preferred image B more than the other two images with 72.4% and 61.5%, respectively. Although the Chinese group was more likely to prefer image B, and all the other groups (minorities and expatriate) preferred images A and C, it should be noted that the actual number for these respondents was small.

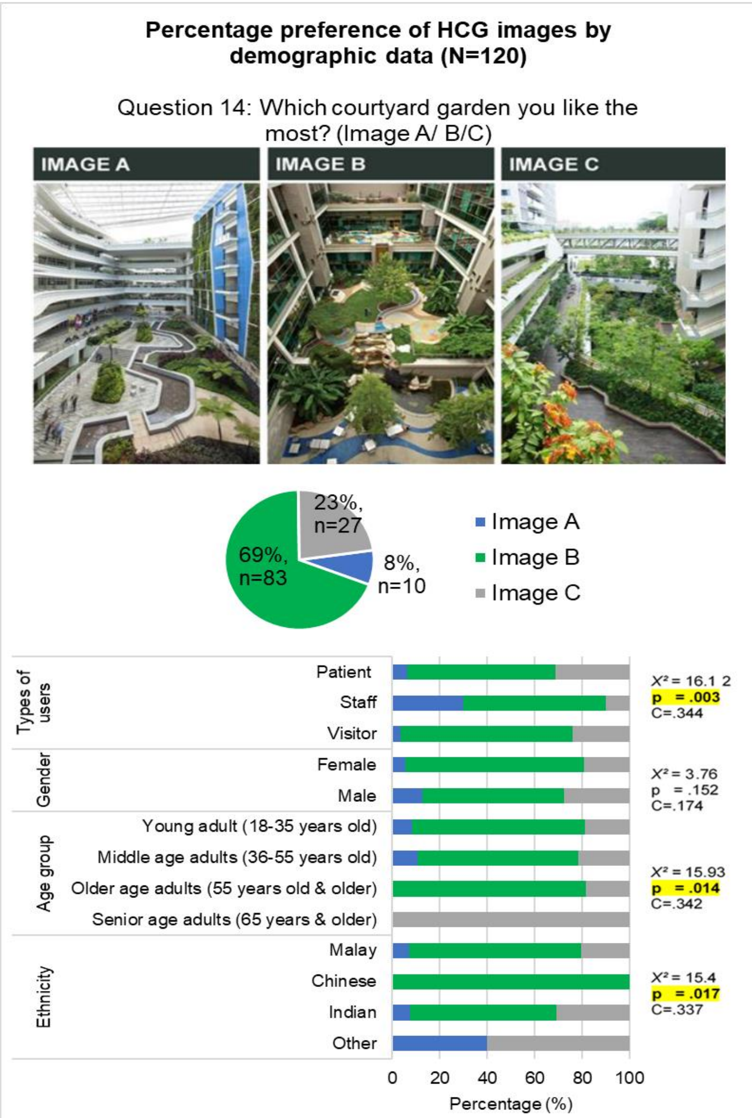


Figure 5.38: Percentage of users' preferences of HCG images by demographic data

5.4.2.1.2 Reason for the selection of the HCG images (Question 14)

Further explanation was asked from among the respondents regarding their reason for the selection of the HCG image. From a total of 120 respondents in all three case study sites, a total of 276 responses were received. Image B received the highest responses from the respondents (74%, n=206). Less than a fifth of all responses received related to image A (19%, n=53) and image C (7%, n=20). Overall, most comments related to these images were related to the landscape elements (48%, n=135) and atmosphere (35%, n=74). Only 13% of the comments were related to planning (n=60) and 4% related to maintenance (n=10) (See Figure 5.39).

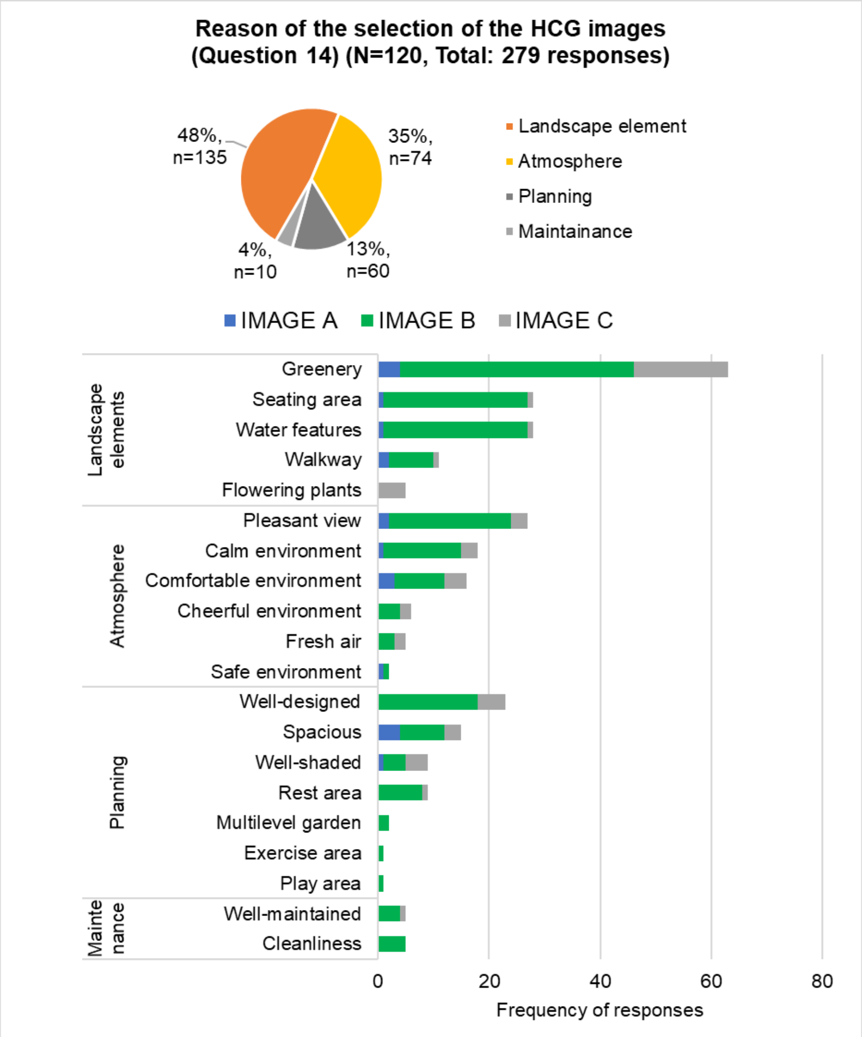


Figure 5.39: Frequency of responses of the reason for selection of the HCG images

The most frequent comments among those who selected image B (Green colour) was because of the landscape element of the HCG. Specifically, this included a variety of planting (greenery) (n=42), the choice of the seating area (n=26), water features (n=26) and walkway (n=8). Another frequent response mentioned among those who choose Image B was because of atmosphere of the HCG including the pleasant view in the HCG (n=22), and calm environment (n=18). Some responses mentioned that image B looked comfortable (n=9) and more cheerful (n=4) compared to the other images.

Furthermore, those who selected image B (Green colour) did so because they liked the planning aspects of the HCG. More than 70% mentioned that the layout of the HCG in image B was well-designed (i.e. it balanced the hardscape and softscape, with a right combination of the landscape elements and adequate facilities). Moreover, some of them mentioned that they liked image B because of the spaciousness of the HCG (n=8) and the multilevel garden design (n=2). Besides that, they stated that the HCG in image B provided a rest area (n=8), an exercise area (n=1) and the play area (n=1) for children to play. Lastly, they mentioned that image B look well-maintained (n=4) and clean (n=5).

In contrast, exceptionally few choose image C (grey colour) and image A (Blue colour). In terms of the landscape elements, those who selected image C explained that they liked the greenery (n=17), flowering plants (n=5) and spacious walkway in the HCG (n=1). In terms of the atmosphere, some of them mentioned that they liked the pleasant view (n=3), the calm environment (n=3) and comfortable environment (n=4) in the HCG. They favoured image C more than the other images because of its spaciousness (n=3) and the feeling of fresh air (n=2) in the HCG.

Only 8% (n=10) from a total of 120 respondents selected image C. It is the least preferred image among the respondents out of the three HCGs. Out of 279 responses, only 7% (n=20) of the responses received related to this image. Most of the comments related to the landscape elements and atmosphere, but very few and no comments were related to planning and maintenance, respectively.

5.4.2.2 Users' preferences of the six HCG images (Question 15)

In addition to Question 14, which asked respondents regarding their preference of the HCG images, another set of questions (Question 15) was used. This asked the respondents to choose the images that they liked the most out of six images of the landscape element in the HCG. This present study intends to further investigate their preferences of the landscape elements in the HCG and recheck whether there was a similar or different trend in the percentage of responses of users' preferences of courtyard garden images between Question 14 and Question 15.

Figure 5.40 presented the percentage of responses regarding the preferences of the courtyard garden images among a total of 120 respondents. The results showed that out of the six images, **more than half of respondents preferred image 2** (60%, n=72). The next most preferred image was image 3 (48%, n=57). Image 5 (38%, n=46) was the third most preferable among respondents followed by image 4 (32%, n=38) and image 6 (30%, n=36). The least preferable image was image 1 with only 23% of the respondents (n=27) who chose this image.

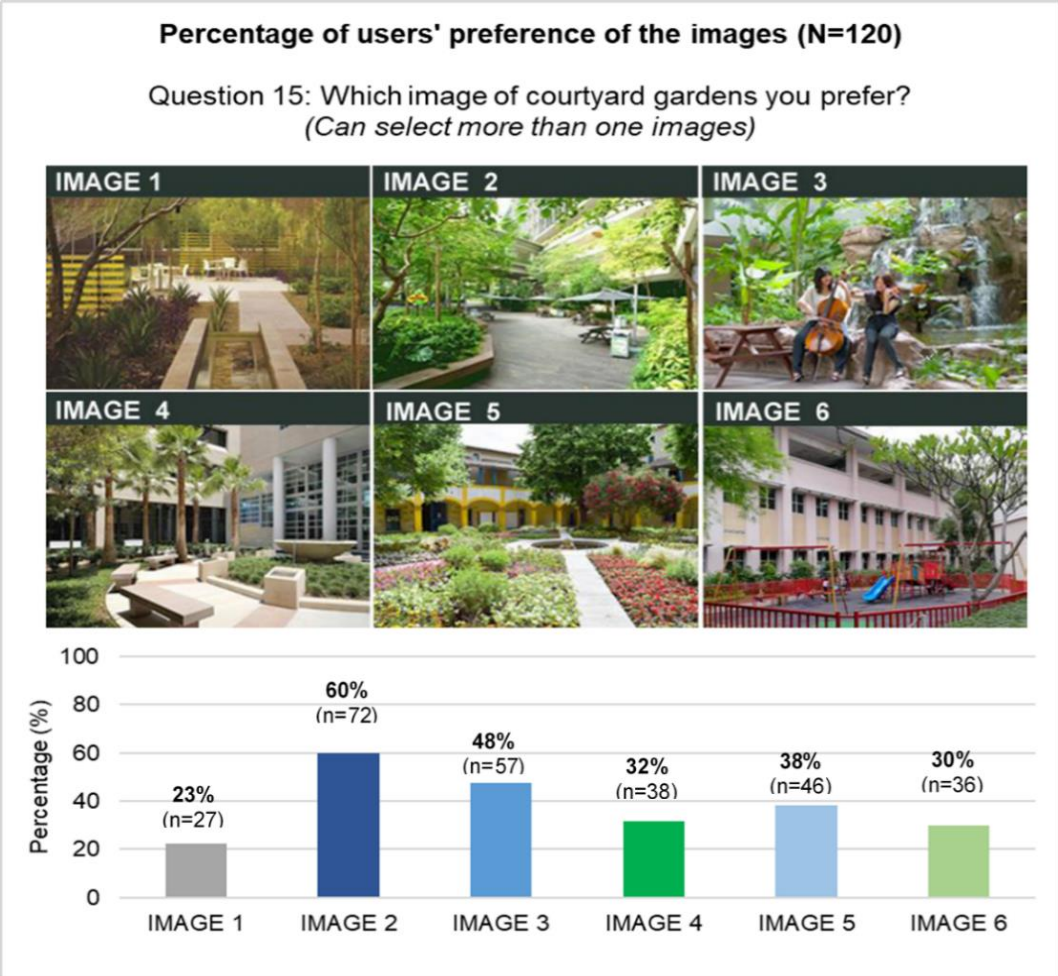


Figure 5.40: Percentage of users' preferences of the images (6 selections)

5.4.2.2.1 Relationship between demographic characteristics with preference of the HCG images (Question 15)

The results of a cross-tabulation of users' preferences of courtyard garden images (Question 15) by demographic data was presented in Figure 5.41. Based on the Chi-square test, a significant relationship was found between the preference of image 6 (Question 15) with gender (X^2 = 4.33, p=.037, C=187), preference of image 4 with age group: (X^2 = 9.74, p=.021, C=.274) and preference of image 2 with ethnicity: (X^2 = 6.06, p=.015, C=.219) (See Table 5.10) (A detail cross-tabulation table can be found in Appendix 20, Table 4).

Table 5.10: A significant relationship between the selected image with gender, age group and ethnicity

Demographic data		N	%	The image that was found to have a significant relationship with demographic data	
Gender	Female	**27**	**75.0**		$X^2 = 4.33$ **p=.037** C=.187
	Male	9	25.0		
Age group	Young age group (18-35 years old)	**15**	**39.5**		$X^2 = 9.74$ **p=.021** C=.274
	Middle-age group (36-55 years old)	14	36.8		
	Older age group (55-64 years old)	8	21.1		
	Senior age group (65 years & older)	1	2.6		
Ethnicity	Malay	**62**	**86.1**		$X^2 = 6.06$ **p=.015** C=.219
	Chinese	2	2.8		
	Indian	4	5.6		
	Other	**4**	**80.0**		

This study found that there was no significant relationship between the types of users (i.e. patients, staff and visitors) with all six images. However, there were several interesting comparisons to be made. Overall, it showed that more than 70% of the visitors preferred images 2, 3 and 4 compared to the other HCG images. In contrast, more staff choose images 6 and 4 and the patient group was more interested in images 1 and 5 (See Figure 5.41). Although the results could not be generalised because the sample of respondents among the group of the patients (n=16) and staff (n=20) was smaller compared to the visitors (n=84), it is still comparable to examine the variation of the selection of the images within each group.

A Chi-square test between gender with the six images revealed that only **image 6 has a significant relationship with gender** (X^2 = 4.33, p=.037, C=187). From the cross-tabulation test shown in Figure 5.41, a higher percentage of female respondents preferred image 6 compared to male respondents. Moreover, the results showed that female respondents were likely to choose images 6, 3 and 2, whereas male respondents preferred images 1, 4 and 5 more.

A further analysis was conducted to explore if the respondents of different age groups had a relationship with the preference of the six images. The Chi-square test results revealed that out of the six images, only **image 4 has a significant relationship with age groups** (X^2 = 9.74, p=.021, C=.274). The results showed that a higher percentage of young adults (18-35 years old) and middle-aged adults (36-55 years old) preferred image 4 compared to the older age adults (55-64 years old) and senior age adults (65 years and older). Whereas the older age group preferred images 4 and 5 compared to the other images, image 1 was the most preferred among senior age adults (See Figure 5.41)..

Lastly, this study found that there was **a significant relationship between ethnicity with image 2**: (X^2 = 6.06, p=.015, C=.219). A higher percentage among Malay (86.1%) and other groups (minorities and expatriate) (80%) preferred image 2 compared to the Chinese (2.8%) and Indian groups (5.6%). Whereas images 3 and 5 were preferable among Indians, the Malay group were likely to select images 2 and 4. Nevertheless, it should be noted that the number of respondents for Indian, Chinese and other groups was smaller than for Malay respondents (See Figure 5.41).

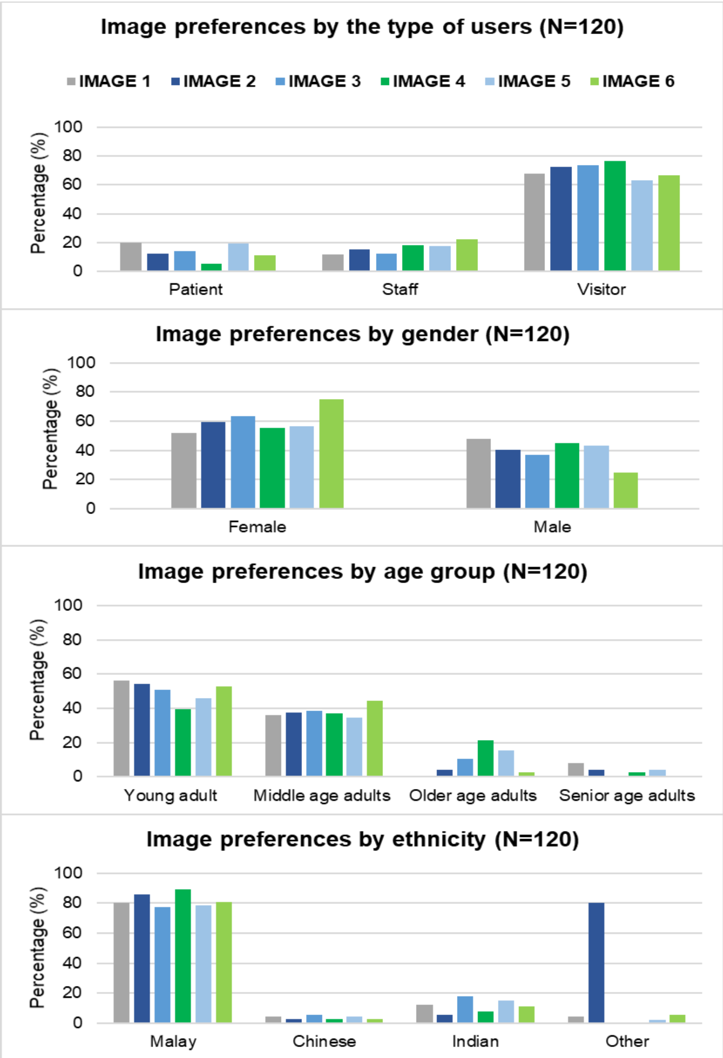


Figure 5.41: Users' preference of images by demographic data

5.4.2.2.2 Reason for the selection of the HCG images (Question 15)

Apart from Question 14 which asked respondents to choose one out of three images, the following Question 15 asked respondents to choose more than one image out of six images and provide a reason for those selections. Several themes emerged from the responses related to the reason for the selection of images which included **landscape element, atmosphere, planning and maintenance** (See Figure 5.42).

Out of the total of 511 responses received from all the respondents in all three case study sites (N=120), **the most frequent comments received related to the images was landscape elements** (39%, n=210 responses). The second most frequent response was atmosphere (36%, n=183 responses), followed by planning (21%, n=108 responses) and maintenance (4%, n=19 responses).

As mentioned earlier in Section 5.4.2.2, the results showed that out of the six images, **image 2** was **the most preferred image** among the respondents (60% of the total of 120 respondents), followed by image 3 (48%), image 5 (38%), image 4 (32%), image 6 (30%) and image 1 (23%). The most frequent responses related to the particular HCG images included: the greenery (30 responses - image 2), the water features (44 responses - image 3), the flowering plants (32 responses - image 5), the seating area (14 responses - image 4), the play area (32 responses - image 6) and well-shaded (8 responses - image 1) (See Appendix 20).

Based on the percentage of votes for each image and reason of the selection of images 2, 3, 5 and 4, the results showed that the pattern of preferences are highly concentrated to the landscape elements such as the greenery, water features, flowering plants and seating area. Additionally, the presence of facilities such as a play area are one of the frequency responses received on the reason of the selection of Image 6. Moreover, the atmosphere of the HCG influenced the selection of the images, such as the calm, comfortable, pleasant view and well-shaded area (See Figure 5.42).

This implies that **landscape elements, adequate facilities (i.e. play area and rest area), comfortable and calm atmosphere as well as well-shaded** areas are fundamental aspects that need to be considered when designing the HCG as determined in the current study. Further discussion in relation to the previous findings is presented in Section 5.5.3.2.

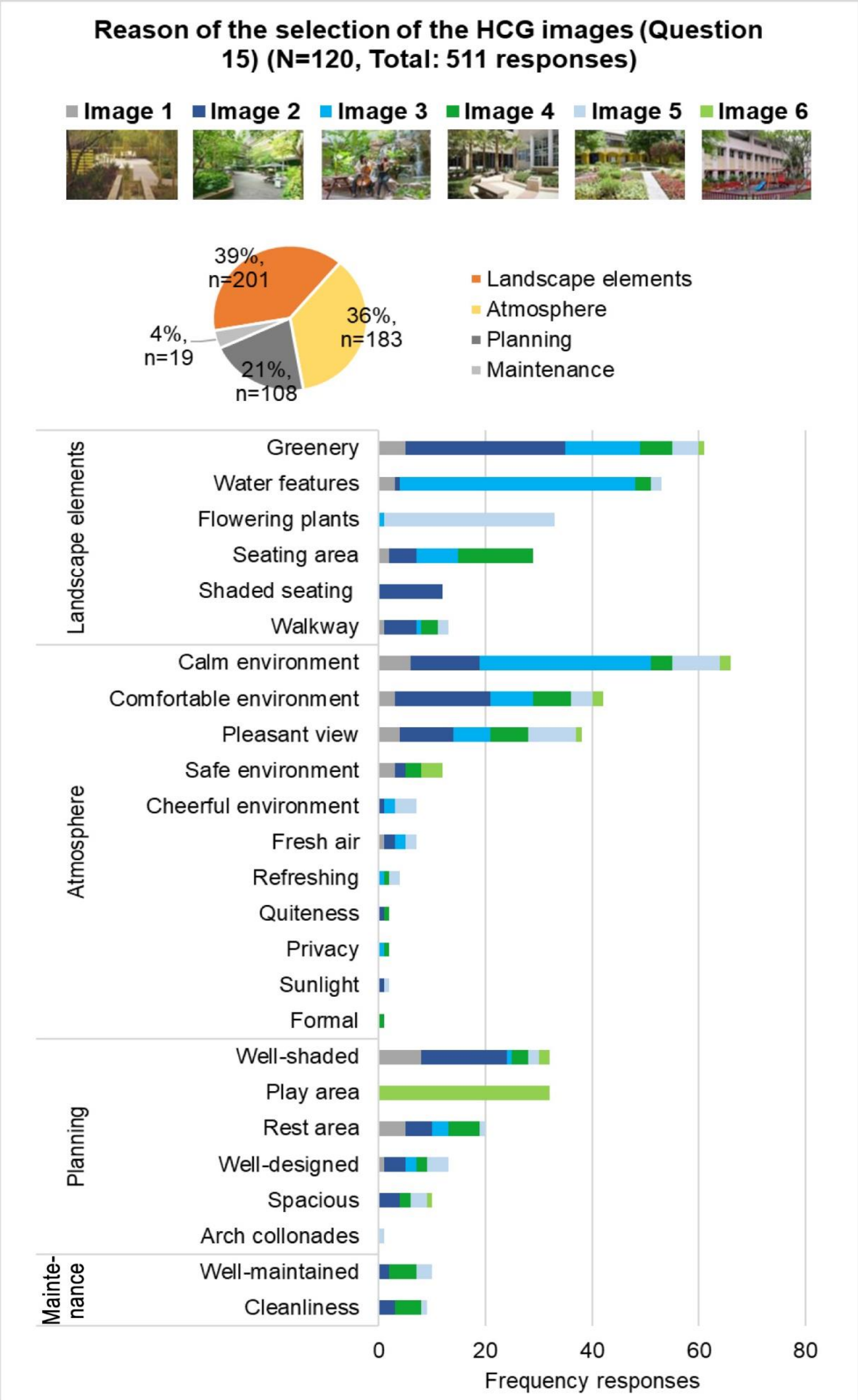


Figure 5.42: Frequency of responses of the image preferences (Question 15)

5.5 Discussion and comparison of the results with the findings of the previous studies

Having presented the various findings related to the users' evaluation of the positive and negative aspects of the HCGs, users' perceptions on the importance of the landscape elements as well as users' preferences of the HCG images, this section will discuss the results of the present study. In particular, this will examine whether it confirms or contradicts with previous studies. The discussion will consider in sequence the research findings as described in the earlier sections. Photographs and diagrams are also used to support the argument of this section. The results of this chapter are tailored to **Objective 1 and 2** as mentioned earlier in Section 5.1.

5.5.1 Users' evaluations of the positive and negative aspects of the HCG design

For this section, the research questions put forward for discussion are:

i) What are the positive and negative aspects of the HCG design?

ii) How can the existing HCG be improved from the users' perspectives?

The evaluation of the physical design aspects of the HCG identified design aspects and issues that are both similar and varied across the three case study sites. When asked about the liked of the HCG, most of the **positive responses** are received related to the: i) **physical design;** ii) **environmental** (i.e. microclimatic conditions); and iii) **social aspects** (i.e. use and experience). Conversely, when asked about disliked, the **negative comments** which most highlighted by the respondents related to the: **i) maintenance; and ii) physical design**.

5.5.1.1 Positive and Negative aspects of the HCG

a. Physical design

<u>Greenery</u>

When asked about their like, a similar and frequent response received from the respondents of the three case study sites related to the preference of **the greenery** of the HCG. A higher response regarding the greenery in H1-C1, followed by H3-C2 and H2-C3. The possible reason for this could be because of the natural-looking scenery and richness of plant species in H1-C1 compared to the other case study sites which has a more formal ambience and lack of variety of plantings (See Table 5.11). Moreover, users' comments appeared to suggest that the HCG should provide a multisensory experience by increasing the variety choice of planting such as **flowering plants and herbs plants** in the HCG. The current finding appears to reinforce earlier studies which found that people generally preferred viewing scenes of nature compared to the view of the urban content scene (Twedt et al., 2016; Carrus et al., 2015; Ulrich et al., 1991). For example, people prefer walking in the places which are dominated by nature (i.e. forest or garden) rather than walking in the urban or built environment (Grazuleviciene et al., 2015; Song et al., 2015; Takayama et al., 2014; Park et al., 2010).

Table 5.11: Different types of planting in the HCG

Description	H1-C1	H2-C3	H3-C2
Size	 2,100m²	H2  320m²	H3  427m²
Canopies	Have a variety of canopy trees	No canopy trees	Shady palm trees
Variety of planting	 - Have a variety of trees and shrubs	 - Less variety of trees and shrubs. - Potted plants	 - Have the least variety in type of trees and shrubs

Pleasant view

Surprisingly, H1-C1 was expected to receive more response regarding the **pleasant view** in the HCG due to its luxurious greenery, variety of planting and seating facilities. However, when asked about their liked, more respondents frequently mentioned the pleasant view in H2-C3, compared to the other case study HCG, which has more comments regarding hygiene and maintenance issues. It appears that the respondents favoured the greenery and visual aesthetic in the HCG which reinforced the findings of earlier studies suggesting that a high green coverage rate and range of landscape realms as well as pleasant scenery encouraged visual interaction between users and the outside nature of a healthcare garden (Jiang et al., 2018; Reeve et al., 2017).

The current study suggested that although people appreciated the lush greenery in the HCG, cleanliness and maintenance in the HCG can affect the visual aesthetic and spatial experience in the HCG. The HCG is a type of enclosed garden surrounded by the building walls. The spatial experience of an enclosed courtyard garden differed from an open type garden such as a rooftop garden or semi-enclosed courtyard garden. Thus, an outward view of the surrounding environment within the HCG is vital as it effected users' perceptions of the HCG as a pleasant view or vice versa.

Seating area

Another most prevailing response related to the physical design in the HCG is the **seating area.** When asked about their liked, respondents in both H1-C1 and H2-C3 mentioned about the seating facilities in the HCG. Surprisingly, no respondent mentioned that they favoured the seating in H3-C2; instead, more respondents disliked issues such as the lack of a seating area and the dirty benches which caused a decrease in their physical usage. This finding corroborates with earlier studies that the inadequate and improper design of seating areas in the outdoor garden of a hospital may influence the number of people visiting and spending time in the garden (Jiang et al., 2018; Pasha, 2013; Whitehouse et al., 2001).

The responses from the users appeared to reinforce the findings from earlier studies on the importance to provide an adequate, comfortable and well-designed seating area facing beautiful scenery which can promote its usage and enhance perceived of restorativeness (Ulrich et al., 2019; Jiang et al., 2018; Reeve et al., 2017; Nejati et al., 2016; Adnan, 2016; Cooper Marcus and Sachs, 2013; Shukor et al., 2012). As evidenced in the present study, most of the hospital users predominately visited the HCG to find a place to sit and rest. This current study suggests that providing a variety of seating facilities that allows users to sit either in pairs or groups, fixed or movable seating, and under sun or shade, can enhance their spatial experience in the HCG and encourage them to stay outside longer. Moreover, it gives options for people to choose to look for privacy or socialise with other people while being there.

Spaciousness and 'fish-bowl' effect

Whereas some respondent mentioned that they liked H1-C1 (2,100m^2) and H3-C2 (460 m^2) because of the sense of **spaciousness** in the HCGs, other respondents mentioned that they disliked H2-C3 (427m^2) and H3-C2 (460m^2) because of the small size of these HCGs. This finding suggests that the perception of spaciousness is subjective and varies from user to user. Although the HCG was dominated with canopies, plantings and a diversity of features, due to its large size, users could still feel the sense of spaciousness in the HCG. However, if a small HCG was improperly designed with a diversity of canopies and landscape features, it will only make the space feel small and crowded. Nevertheless, earlier studies have revealed that the openness and outward view of the surroundings of outdoor gardens enhanced the users experience and they perceived it as spacious, even though the gardens may be twice their size (Said, 2003b).

Several earlier studies have also highlighted that a small courtyard garden with a lack of screening plants could possibly cause the **'fish-bowl' effect** (the feeling of being observed by others) and reduce their sense of privacy whilst being there (Jiang et al., 2018; Pasha and Shepley, 2013; Naderi and Shin, 2008; Cooper Marcus, 2007). However, none of the respondents in the present case study sites mentioned that they felt that they were observed by other people from inside the hospitals.

For H1-C1, none of the users reported regarding the ‘fish-bowl’ effect due to the spaciousness of the site, the presence of canopies and the pergola seating structure that buffered the view from the indoor hospital and provided privacy to the HCG users. Although some respondents mentioned that H2-C3 and H3-C2 were small, none of them commented about the ‘fish-bowl’ experience while being there. The reason could be because the plantings around the periphery screen the window. Further, the location of the seating does not directly face the windows of the HCG. This is in accordance with the earlier findings suggesting that the provision of buffer plantings around the window and overhead structures can be used to limit the direct view from the adjacent space and upper floor to enhance privacy and reduce the ‘fish-bowl’ effect in the courtyard garden (Browning, 2010; Sachs, 1999).

b. Operational

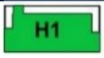
i) The care of planting

When asked about what to improve, many respondents in all three case study sites suggested to add more variety of planting and add more flowering plants and herb plants. They also suggested repairing the planting labels, fertilising the plants and removing dead plants as well as fallen leaves from the sites. This study suggests that poor planting maintenance could have an effect on the visual appearance of the HCG and reduce the garden experience among HCG users. This finding is consistent with earlier research which highlighted that abundant greenery and better garden maintenance significantly improved users’ experiences in the outdoor garden of healthcare facilities (Uwajeh, 2018; Butterfield, 2014; Davis, 2011, Cooper Marcus and Barnes, 1995). Moreover, it appears that on-going maintenance in captivating and keeping the plantings in the HCG is vital to ensure that the visual appearance of the HCG looked fresher and inviting to the users. Subsequently, it could attract more people to visit and encourage engagement with the HCG.

ii) Maintenance and cleanliness

More negative responses received from respondents regarding **cleanliness and maintenance** in both H1-C1 and H3-C2 compared to H2-C3 as previously described in section 5.3. The current study found that cleanliness and maintenance affected user satisfaction with the performance of the HCG (See Table 5.12). The current result is in agreement with previous findings that highlighted the importance of the cleanliness and maintenance aspects which affected user satisfaction with the hospital outdoor garden (van der Riet et al., 2017; Adnan, 2016; Ibrahim et al., 2015). A well-cared for garden makes the patients feel they are ‘in care’ and ‘looked after’, which in turn offers a psychological impact that goes beyond the physical environment (Barnes, 2014; Butterfield, 2014).

Table 5.12: Maintenance and cleanliness issues in the HCG

Description	H1-C1	H2-C3	H3-C2
		H2 	H3 
Unfixed seating facilities	 Broken wooden seating under pergola shaded area. They need to be restored	 The colour of seating facilities started to fade. They need to be painted to maintain their durability	 The provided benches in the HCG were too dirty to use (i.e. dirt from bird droppings)
Cleanliness	 The broken part of the seating area and signage were left unattended in the HCG	 The rubbish overflow during a peak day. A bigger dustbin is more appropriate	 The existing water pond has turned into stagnant and lifeless. The green algae growth on the ground surface
The visual appearance of the wall enclosure	 Black stains appeared on some part of the exterior wall	 No stains were found on the aluminium cladding wall. The type of material may influence the visual appearance of the wall	 The unpleasant view of the exterior wall with the stain on the wall
The visual appearance of the pavement	 Dull coloured pavement with a crack	 The pavement colour started to fade	 Black stain on the sidewalk

iii-Safety issue

Another important issue highlighted by respondents when asked about their dislike regarded the **safety issue** in the HCG. Based on the overall comments regarding safety in all case study sites, the visitors (i.e. parents) were those who responded the most regarding the physical and health safety of their children. As indicated in Table 5.13, several safety issues highlighted by the respondents from all the case study sites included:

i) the presence of the thorny plants (H2-C3);
ii) the slippery ground or pavement in the HCG (H3-C2);
iii) the wide gap between the railing which does not follow safety standards (H3-C2);
iv) the unsuitable location of a mouse control trap (H1-C1);
v) the danger of an exposed lighting cable H1-C1 and H2-C3); and
vi) the risk of children falling into the water fountain (H1-C1).

A restorative setting should be able to reduce the level of fear and remove the negative feeling while being in the outdoor garden and include the preferences of a safe and secure setting (Reeve et al., 2017). Most previous findings mentioned the importance of safety in the outdoor garden to ensure that users felt safe and secure whilst there (Lygum et al., 2013; Uwajeh, 2018; van der Riet et al., 2017; Jonveaux et al., 2013; Cooper Marcus and Sachs, 2013; Shukor, 2012; Said, 2003a).

As found in an earlier study, patients prioritised aspects of safety based on the design features, including the types of planting and decorative elements in the garden (Jonveaux et al., 2013). Several suggestions from existing research are related to the safety and security of the outdoor healthcare garden including providing adequate lighting in the garden during the night (Eckerling, 1996) and removing toxic and thorny plants from the garden (Pachana et al., 2003).

Moreover, it is also crucial to choose a proper material for pavements that can avoid creating a tripping hazard for elderly or frail people (Detweiler et al., 2008) and ensure the safety and hygiene of the equipment in the play environment for children (van der Riet et al., 2017). Thus, this study suggests that the perception of how safe the outdoor garden is varied among the respondents and upon different settings. Moreover, it appears that both physiological and psychological aspect of improving the safety and sense of security is vital as part of the HCG design.

Table 5.13: Safety issue in the HCG

Description	H1-C1	H2-C3	H3-C2
Sharps Plants and sharp edge rock.	Some herb plantings have a type of sharp plants	Sharp plants and sharp edged-rock poses a danger to a child if they are falling onto it 	NA - No presence of sharp plants in the HCG
Slippery ground	NA - No slippery ground	NA - No slippery ground	 Children almost fell near the sloppy area due to the slippery ground (Captured on video)
Railing do not follow standard safety	 Railing is properly designed and meets safety requirements	NA - No railing in the HCG	 The gap between the handrail is too wide and did not meet safety requirements
The unsuitable location of the mouse control trap	 - The mouse control traps should not be placed close to the seating area (unsafe for children)	NA	NA
Exposed electrical cable	 Exposed electrical cable in the unfunctional water fountain	 Exposed electrical cable from the broken lighting features	NA

c. Environmental

Another significant finding related to their preference of the HCG was in terms of the environmental aspects (i.e. microclimatic conditions) of the HCG. This showed that more positive responses were received from the respondents in H1-C1 compared to the other case study sites (See also Subsection 5.2.1.1). A majority of the comments indicated that they favoured the HCG because of the presence of the **fresh air, well-shaded area and comfortable environment** (i.e. felt cooler).

As highlighted in previous studies, trees and plants can reduce glare, provide sufficient shade and create a more comfortable microclimate in the outdoor garden of healthcare facilities (Shi et al., 2018; Pasha and Shepley, 2013; Naderi and Shin, 2008; Detweiler et al., 2008; Said et al., 2005; Cooper Marcus and Barnes, 1995). The rustling sound of the trees when a breeze passes through the leaves and the sound of the breeze stimulates users' experiences, inducing relaxation and calmness while in the outdoor garden (Browning, 2010; Said et al., 2007; Ulrich, 1999).

Moreover, the current study suggests that implementing more shaded seating areas and covered shelters in the HCG can increase the frequency of visits to the HCG because it can be used both during rainy or sunny days. The finding is concurrent with prior studies that the lack of shade in the HCG influenced the frequency and duration of visits amongst the majority of garden users (Reeve et al., 2017; Pasha and Shepley, 2013).

Conversely, another interesting response mentioned by HCG users was the preference of the morning sunlight in the HCG. They favoured having the warmth of sunshine on their skin. Subsequently, exposure to adequate morning sunlight helps the body to produce vitamin D which holds benefits for bone health, prevention of deadly cancers and cardiovascular disease (Holick, 2004).

It is important to note here that a more detailed finding on how the microclimatic conditions of the three-case study HCGs influenced the perception of thermal comfort of the HCG users is discussed further in Chapter 6.

d. Social

The social aspects (i.e. activities and experiences) were also found to be among their concerns regarding their preference of the HCG. Regarding activities, the frequent positive response received from all three case study sites was **a place for rest and relaxed**. A similar activity was mentioned in previous studies which found that hospital users visited the garden to sit and relax and find a place for respite to have a short period of rest in the garden (Reeve et al., 2017; Adnan, 2016; Shukor, 2012; Cooper Marcus and Barnes, 1995). Other previous studies reported that staff and adults preferred to sit and relax in the gardens while children tended to be more active and interacted with garden features (Pasha and Shepley, 2013; Sherman et al., 2005; Whitehouse et al., 2001). Moreover, a prior study suggested that an informal style of outdoor garden that has abundant vegetation provided a place for respite and reduced the state of stress among its users (Ulrich et al., 2019).

Despite their preferred activity, which is to rest and relax in the HCG, another significant response related to their preferences of the HCG was as **an alternative place to escape from indoor and meet people**. Based on these comments, this shows that the respondents also valued the HCG as a peaceful place for them to have a sense of ‘time out’ and seclusion from the congested waiting area in the hospital. These findings matched those mentioned in earlier studies, namely that the garden in a healthcare facilities enhanced the sense of being away from the indoor hospital and offered a place to socialise and interact with family, relatives or friends in a more relaxed environment compared to the sterile indoor hospital environment (Jiang et al., 2018; Reeve et al., 2017; Ibrahim et al., 2015; Davis, 2011; Pasha, 2013; Cooper Marcus and Barnes, 1995).

Another interesting finding related to their preference of the HCG was the opportunity to do **outdoor learning and play area for children.** The regulation of the hospital in Malaysia did not allow children to visit the high dependency and maternity wards. Therefore, either the mother or the father will wait in the HCG to allows their children to play around in the garden while waiting their family members visit their friend or relatives in the wards. Outdoor experience in the HCG will enable children to expand their learning experience and appreciation of nature surrounding them. Moreover, the presence of the herb gardens provides a variety of scent that can sharpen their sensory experience outdoors (Honig, 2019).

The current study found that the **playground** was among the suggestions mentioned by most of the parents who visited the case study hospitals. The playground benefited both the paediatric patients and children visiting the hospital because it allowed children to play and socialise with other children and enhanced their cognitive and developmental skills (Pasha and Shepley, 2013; Said and Abu Bakar, 2006; Sherman et al., 2005; Whitehouse et al., 2001). However, the sound of children screaming, and shouting may contribute to the noise and decrease the peacefulness and perceived tranquility in the outdoor garden. Thus, the current study suggests that the playground is a more appropriate to place close to the paediatric clinics or common waiting areas of healthcare settings rather than in the HCG which was initially designed to function as a peaceful garden, such as H1-C1.

Nevertheless, Watts et al., (2013) found that a majority of the respondents in their study felt more relaxed in the outdoor garden that had dominant natural sound sources and a reduction in mechanical noise, people sounds and children playing. Moreover, a similar study revealed that a larger open space has a higher percentage of tranquilly rating compared to a smaller open space. This present study suggests that the playground should be introduced at an appropriate location in a large-scale HCG rather than a small-scale HCG depending upon its intended functional purpose.

The current study also found that the staff liked the HCG because of the availability of space to do **physical therapy for patient (H2-C3).** During the fieldwork, more patients were observed to spend time in H3-C2 when a rehabilitation treatment program was being held. This activity was also mentioned in previous studies which suggested that the integration of therapy programs into garden use could improve garden visitation among patients (Pasha and Shepley, 2013; Davis, 2011; Whitehouse et al., 2001). Thompson Coon et al. (2011) highlighted the benefits of outdoor exercise on physical and mental well-being compared to indoor exercise. Moreover, a clinical observational study found that cardiac survivor patients more preferred to exercise in an outdoor setting than the indoor hospital and that their heart rate was significantly reduced after walking in the outdoor garden (Amat, 2017). Additionally, exercise in an outdoor setting can promote direct attention and social interaction among participants compared to indoor exercise (Rogerson et al., 2016).

In addition to the positive response related to the social aspects, is on their experience in the HCG. The frequent responses among respondents in the three case study sites was because **they felt calmer** in the HCG. This current study corroborates the findings of previous studies which found that garden users frequently felt calm, more relaxed and had a better mood while spending time in the HCGs (Reeve et al., 2017; Amat, 2017; Whitehouse et al., 2001; Cooper Marcus and Barnes, 1995). Moreover, a positive response received from respondents when asked about their likes was the **sense of quietness** in the HCG. This finding is consistent with previous studies which highlighted the importance of the quiet area as a place for reflection and privacy that also provided a more restorative function to garden users (Amat, 2017; Erbino et al., 2015; Guaita et al., 2011).

It should be noted that the present finding related to user activities and experience in the HCG presented in this section does not imply that these are the only predominant activities and experiences among the users in all three case study HCGs. Further findings based on the closed-ended survey questions and on-site observation related to activities and experiences in the HCG will be elaborated further in Chapter 6. Such a combination of multiple methods in data inquiries enhances the validity of the current results.

5.5.2 Users' satisfaction with the planning and performance of the HCG

The previous section discussed their likes and dislikes regarding the HCG design. In this section, the discussion is focused on their satisfaction regarding the overall planning and performance of the HCG. The research questions put forward for discussion in this section are:

i) How satisfied are users with the overall planning and performance of the HCG design?
ii) Which physical design attributes are related to the overall planning and performance of the HCG design?

The discussion covers several physical design attributes including: i) accessibility; ii) visibility; ii) wayfinding; iv) landscape elements; and vi) wall condition. The findings revealed that a lower percentage of respondents expressed their satisfaction with the overall planning of H3-C2 and H1-C1 compared to H2-C3. The possible reason could be because of their dissatisfaction with the level of maintenance and cleanliness in H3-C2 and H1-C1 compared to H2-C3. As evidenced previously in Section 5.2.2.2, fewer comments were received regarding the maintenance aspect in H2-C3 compared to the other case study HCG. Similarly, when asked about their satisfaction with the overall performance of the HCG, more respondent in H3-C2 and H1-C1 rated the HCG as either fair or poor compared to H2-C3.

This current study suggests that **greenery and pleasant view and garden maintenance profoundly influence users' satisfaction with the planning of the HCG**. This finding corroborates earlier studies that found that users are more interested in an aesthetical view of an outdoor garden, a combination of diverse plantings and design features (Reeve et al., 2017). Moreover, the beauty of the scenery in the outdoor garden induced an aesthetic appreciation of the garden because it provided an opportunity for visual stimulation and positive distraction from the unpleasant substances in the indoor hospital (Weerasuriya et al., 2018). Other studies have also placed emphasis on the importance of maintenance in the outdoor hospital garden to sustain its aesthetical appearance (van de Riet et al., 2017; Adnan, 2016; Ibrahim et al., 2015).

5.5.2.1 Factors closely related to the overall planning and performance of the HCG

The Chi-square test was used to check on the relationship between physical design attributes and degree of satisfaction with the overall planning and performance of the HCG. Out of nine attributes, seven attributes have a significant relationship with the degree of satisfaction with the overall HCG planning and two attributes have a significant association with the overall HCG performance (See Figure 5.43). The results showed that two factors that are closely related to both the degree of satisfaction with the overall planning and the overall performance of the HCG are:

i) the landscape elements, and

ii) wall condition

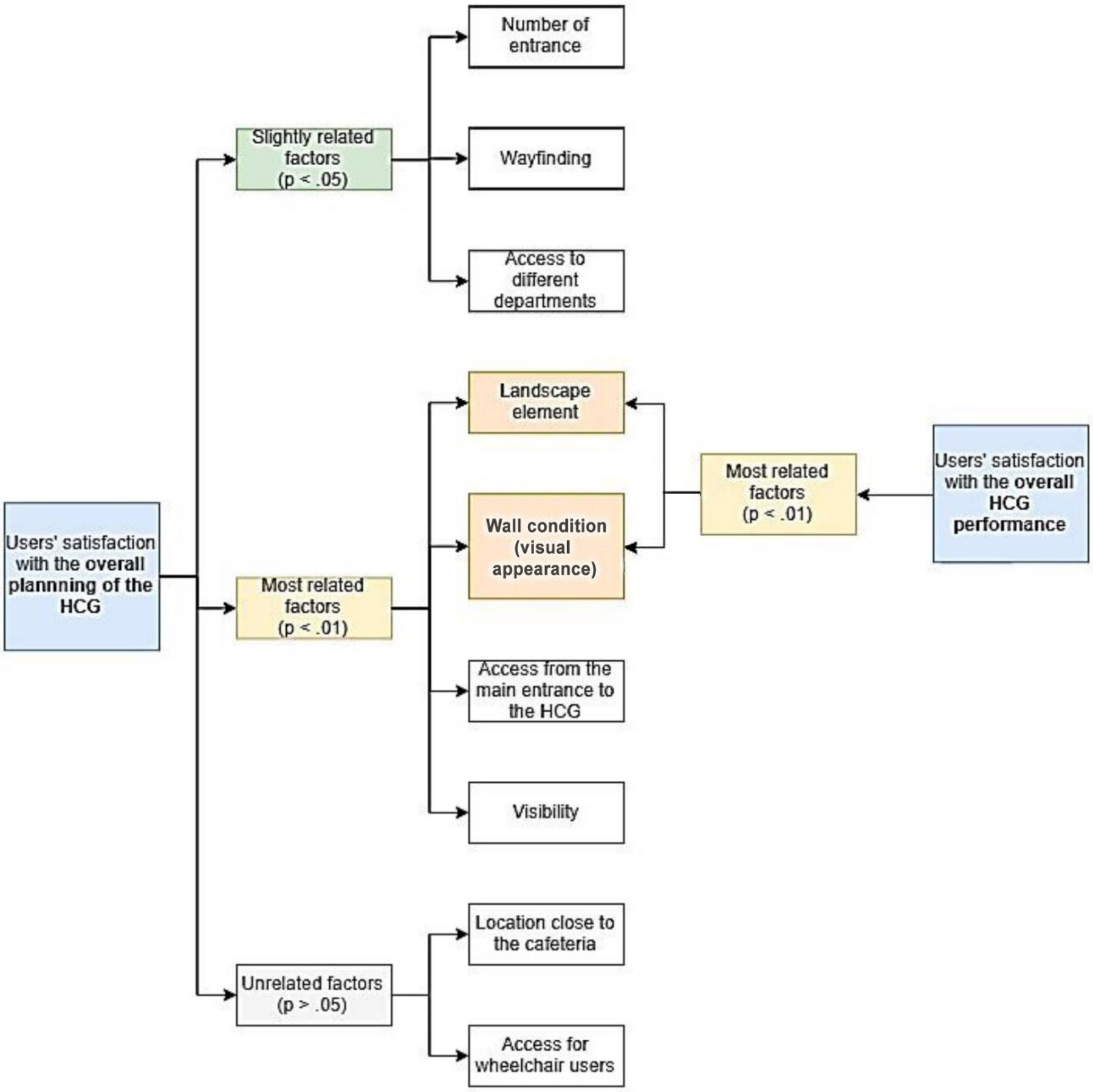


Figure 5.43: Factors related to the overall planning and performance of the HCG

5.5.2.2 Factors closely related to the overall planning of the HCG

The findings found that the most related factors with the overall planning of the HCG ($p < .01$) are the landscape element, wall condition, access from the main entrance to the HCG and visibility.

i) Landscape elements ($p=.000$, $C=.442$)

This study suggested that the presence of greenery and the variety of seating facilities and attractive features can contribute to a higher satisfaction level of the overall planning of the HCG if they are well-maintained and well-functioned. Previous studies reported that seating played an important design features which can influence garden usage (Reeve et al., 2017; Pasha, 2013; Whitehouse et al., 2001). Moreover, earlier studies highlighted that a well-maintained hospital garden that has a working water feature and well-maintained vegetation are more attractive and were perceived as being more restorative by the users (Pasha, 2013; Shukor, 2012; Naderi and Shin, 2008; Maller et al., 2006; Sherman et al., 2005; Cooper Marcus and Barnes, 1995). Moreover, recent studies found that spending time in outdoor gardens with an abundance of greenery were more effective in improving stress recovery among the family members of ICU patients compared to staying indoors (Ulrich et al., 2019).

ii) Wall condition ($p=.000$, $C=.429$)

As mentioned earlier in the section on the negative aspects of HCG design, a poor wall condition and unpleasant outward view of the wall enclosure around the HCG contributed to a lower satisfaction level of the planning and performance of the HCG. The findings showed that a higher number of respondents in both H1-C1 and H2-C3 expressed their dissatisfaction of the HCG wall condition compared to H2-C3. Respondents mentioned the faded wall condition and the presence of black stain and rust on the wall. The present study suggests that cleanliness of the wall around the HCG can induce an aesthetic experience of beauty as evidenced in H2-C3 as most are satisfied with the appearance of the wall.

To the best of this author's knowledge, the result regarding hygiene issues and the appearance of the wall around the HCG has not been previously described in the extant literature. However, a previous study highlighted the importance of visual stimuli and an attractive view in the outdoor garden that influenced aesthetical appreciation in the HCG and enhanced user's overall experience in the HCG (Reeve et al., 2017). For example, Reeve suggested that the presence of the grass green wall in the outdoor garden encouraged users to visit the garden; further, users found it to be an attractive feature that they can see and touch.

Another study found that decor, art, pleasant appearance and cleanliness evoked the feeling of being relaxed and comfortable among healthcare customers (Lee and Lin, 2011). Moreover, Ulrich (1984) reported that patient who had a view to a brick wall took more pain medication, had a more extended hospital stay and more negative comments on their nurse reported compared to those who had a view of nature. Imagine how these impact on patients' health while spending time in the HCG, which has unpleasant wall conditions such as black stain, rust or bird dropping. A clean environment in healthcare portrays that facilities are well-cared, which implies that a better quality of care and service is provided for the patients of that healthcare facility.

iii) Access from the main entrance to the HCG (p=.000, C=.393)

It was found that respondents of H1-C1 and H3-C2 were mostly satisfied as this HCG was located close to the main entrance and visible from the main lobby. This study suggests that the location of the HCG near to the main entrance facilitates access to the HCG and increases user satisfaction with the overall planning of the HCG. Although H2-C3 is located on the same floor level with the main entrance, however, its location quite far from the main entrance significantly influenced user satisfaction with the overall planning of the HCG. This is in accordance with previous studies that revealed that outdoor gardens which are located on the rooftop of the building, or in secluded place and far from the main entrance are rarely used and that users were mostly unaware of its existence (Jiang et al., 2018; Pasha and Shepley; 2013; Shackell and Walter, 2012; Shukor, 2012; Cooper Marcus and Barnes, 1995).

iv) Visibility (p=.000, C=.382)

This study found that lack of visibility (visual access and clear sightline) from the adjacent space and the location of the HCG which is far from the main entrance significantly affected users' awareness of the existence of the HCG, especially among first-time visitors. When the users group was asked, most of the respondent in all three-case studies were either satisfied or satisfied with the visibility to the HCG. There could be a possible bias in their responses because they were very well-acquainted with, and knew the location of, the HCG. However, when the same question was asked to the non-user group in H2-C3, they mentioned that they did not realise or were not even aware the existence of the HCG, while more respondents knew about the existence of H1-C1 and H3-C2. This is because of the location of H2-C3 which is far from the main entrance.

Therefore, this study suggests that the location of the HCG close to the main entrance and located at the centre of the hospital planning improved the visibility of the HCG and contributed to the satisfaction level with the overall planning of the HCG. This finding corroborates with previous research which found that the location of the HCG close to the main entrance significantly enhanced visibility to the HCG (Pasha and Shepley, 2013; Butterfield, 2014; Shackell and Walter, 2012; Shukor, 2012; Cooper Marcus, 2007). This current finding is reinforced by the results from observational studies which discovered that outdoor gardens located on the rooftop of the building and far from the main entrance were rarely used and that users were mostly unaware of its existence (Shukor, 2012).

Moreover, this study found that the design of the wall enclosure and window around the HCG influenced the visibility of the HCG from the adjacent space. It also reinforces previous findings, that the visibility of an outdoor garden from the indoor spaces influenced visitation levels among the staff and residents of healthcare facilities (Ulrich et al., 2018; Uwajeh, 2018; Jiang et al., 2018; Gonzalez and Kirkevold, 2016). The transparency of the window wall allowed the garden to be seen from indoors which serves to integrate and connect the outdoor with the indoor space (Jiang et al., 2017; Reeve et al., 2017; Shackell and Walter, 2012).

Numerous evidence has revealed that an outdoor garden which is visible from the indoor space impacts on the quality of work-life and job satisfaction among healthcare staff (Cordoza et al., 2018; Nejati et al., 2016; Pati et al., 2008). A view to nature can have positive impacts on patient health as revealed in earlier studies that patients took less pain medication and evidenced shorter durations of stay in hospital (Ulrich, 1984) and a reduction in aggressive behaviour (Ulrich et al., 2018). Additionally, a recent study revealed that visual access to an abundance of greenery in HCGs contributed significantly to stress reduction among the ICU patients' families (Ulrich et al., 2019).

5.5.2.3 Factors related to the overall planning of the HCG

i) Number of entrances (p=.022, C=.295)

This study found that multiple numbers of entrance or entryway to a HCG can significantly improve accessibility to the HCG. This is evidenced in both H1-C1 and H3-C2, both of which has more than one entrance which increased access to the HCG and allowed transition from one department to another via these entrances. The HCG which has more doors or entry points receive highly satisfied responses compared to HCGs with only one access door. There is little evidence highlighting the importance of providing several choices of entrances to the HCG in the previous literature, which typically emphasizes the importance of ensuring access to the hospital outdoor garden to increase user visitations (Jiang et al., 2018; (Cooper Marcus and Sachs, 2014; Pasha and Shepley, 2013; Whitehouse et al., 2001).

This study suggests that multiple entrances are relevant for the HCG which is designed for all types of users as evidenced in the present study. Moreover, multiple points of entry could prevent confusion and disorientation as well as shorten the walking distance to the outdoor garden exit point. The findings are in agreement with existing research which suggested that having more than one door eases access to the outdoor garden (Said et al., 2007). However, it is essential to note that the situation will be different in other settings, such as the psychiatric centre (Kalagi et al., 2018), dementia care centre (Detweiler et al., 2008) and cancer centre (Van der Linden et al., 2016; Butterfield, 2014) as some access restrictions are often considered necessary to ensure safety and ease the environmental complexity experienced by the patients and residents.

ii) Access to different departments (p=.030, C=.286)

This study found that access to different departments via the HCG was closely related to users' satisfaction with the overall planning of the HCG. It suggests that the number of entrances in the HCG allows easy access to different departments via the option of a pathway(s) provided in the HCGs. The ease of access to different departments via the HCG will subsequently increase user's visitation levels to the HCG as revealed in H1-C1. Previous studies have highlighted the importance of easy access to move around in the HCG or to another department via the HCG (Butterfield, 2014; Shackell and Walter, 2012; Davis, 2011; Naderi and Shin, 2008; Said et al., 2007).

Other previous studies have suggested that a welcoming entrance is crucial because it was the first impression when people arrived at the HCG because it can make users feel warm and invited (Van der Linden et al., 2016; Butterfield, 2014; Shackell and Walter, 2012; Shukor, 2012). A former study reported that visitors found it difficult to find the garden entrance on their first visit due to the lack of signage and no clearly visible door to access the outdoor garden (Butterfield, 2014). Moreover, the 'no exit' signage caused confusion among the hospital users as they thought they were not allowed to use the outdoor garden (Jiang et al., 2018). Nevertheless, recent studies have highlighted that having easy access and unlocked door(s) to the HCG encouraged visitation and a sense of control among patients (Ulrich et al., 2018). Perhaps they can enjoy the garden and find a place to socialise and seek privacy in which their safety is ensured in an enclosed hospital courtyard garden.

iii) Wayfinding (p=.033, C=.283)

The present study found that wayfinding was one of the factors that contributed to the overall satisfaction of HCG planning. It suggests that the location which is far from the high traffic zones such as the cafeteria and main lobby decreased users' satisfaction with the wayfinding as evidenced in the case study H2-C3. The results showed that 50% of the HCG users' expressed dissatisfaction with the wayfinding and had difficulty finding their way to H2-C3. The current finding reinforces earlier studies by Sivaji et al., (2015) which found that 60% of respondents thought that the current signage system in a similar case study, H2-C3 as ineffective and 54% responded that it as having either a bad or very bad signage system.

In contrast, the present study suggests that the provision of directional signage increased users' satisfaction with the wayfinding to the HCG. The results revealed that more than 80% were either satisfied or very satisfied with the wayfinding in H1-C1. Despite its location at the centre of the HCG and close to the high traffic zone area, it was the only case study site which provided directional signage to the HCG. The present finding corroborates with previous studies which suggested that signage and visual access to the HCG facilitate the wayfinding and guide people to the outdoor garden and increase its use (Alvaro et al., 2018; Potter, 2017; Passini et al., 2000).

However, directional signage might have been less preferred among visually impaired patients. In order to overcome this barrier, the sound of water features and wind chimes can be an option to facilitate wayfinding to the outdoor garden for visually impaired patients or visitors (Yucel, 2013; Ulrich, 1999). Wayfinding and spatial navigation enhances peoples experience and made people feel connected between the spaces in the hospital (Alvaro et al., 2018; Jiang and Verderber, 2017; Shamsuddin et al., 2016; Sivaji et al., 2015). Courtyard gardens or atriums provide vista and function as a landmark within the hospital building which helps to orient people and enhance spatial navigation in the hospital (Peavey, 2015; Adams et al., 2010).

Based on the present findings and literature review, the current study recommends that several aspects of HCG planning that contribute to easy wayfinding and increase users' satisfaction with the wayfinding to the HCG should include consideration of:

i) the location of the HCG at the centre of the hospital building;
ii) the location of the HCG close to the main entrance;
iii) the location of the HCG close to the high traffic zone area (e.g. main lobby, cafeteria and public common area);
iv) the provision of directional signage to the HCG; and
v) the HCG itself serve as a landmark

5.5.2.4 Factors not related to the overall planning of the HCG

i) Access for wheelchair users (p=.410, C=.179)

Contrary to expectation, the results from the Chi-square test showed that there was no relationship between access for a wheelchair user with the degree of satisfaction with the overall layout and planning of the HCG. The possible reason for this could be because of bias in the representative sample which included mostly non-wheelchair users who might not understand the importance of access for wheelchair users.

However, this study found that H2-C3 received a higher dissatisfaction among HCG users due to the split level at the entry door which was inaccessible to wheelchair users. Whereas, more users were satisfied with wheelchair access in both H1-C1 and H3-C2 because of the even and smooth surface of the HCG pavement. This evidence suggests an important finding on the needs of easy access for wheelchair users and other mobility and impaired users to the HCG. This is in accordance with previous research which suggested that wheelchair access was an important aspect to support patients visitation to the outdoor garden of healthcare facilities (Ulrich et al., 2019; Paraskevopoulou and Kamperi, 2018; Reeve et al., 2017; Ibrahim and Jer, 2014; Pasha, 2013; Whitehouse et al., 2001; Pasha, 2013; Cooper Marcus, 2007).

ii) Location close to the cafeteria (p=.410, C=.179)

Another unanticipated finding was the location close the cafeteria which was found to have no significant relationship with the overall planning and performance of the HCG. Nevertheless, a majority of respondents in all three case study sites expressed their satisfaction with the location close to the cafeteria. The possible reason for this could be because of the respondent's personal satisfaction with the location close to the cafeteria being based on their satisfaction on the location of the cafeteria of the respective case study site which is satisfying to them as they could not be able to compare it with the other case study sites. Moreover, they could also be possible biased in their response because they are not able to relate the impact of the location of the cafeteria with the overall HCG planning as they are mostly laymen and not professional designers who know about hospital planning.

Although the location of the HCG close to the cafeteria has no relationship to overall satisfaction with the HCG planning, this present study found that the location of the HCG close to the cafeteria significantly improved the visibility of the HCG. When asked in term of their visibility from the adjacent space, some respondents mentioned that they saw the HCG from the cafeteria, main lobby and main hospital street. This indicated the importance of the location close to the highly zone area (e.g. cafeteria) in enhancing HCG visibility. This is in accordance with previous studies that suggested the location of the outdoor garden should be close to the main entrance and the high traffic zone and well-used indoor spaces such as the cafeteria, main lobby or waiting area to enhance its visibility (Jiang et al., 2018; Adnan and Shukor, 2015; Pasha, 2013; Cooper Marcus and Barnes, 1995).

5.5.3 Users' perceptions of the importance of landscape elements and preferences of the HCG images.

Previous sections have discussed users' satisfaction with the planning and HCG performance and revealed that the landscape elements are the most related factors among the other physical design attributes. This section will further discuss this attribute (e.g. landscape elements) in detail. The research questions put forward for the discussion of this section are:

i) How did users perceive the importance of the landscape elements in the HCG?
ii) Which landscape elements are the most preferred and valuable by the HCG users?

5.5.3.1 Perception of the importance of landscape elements

First, the results from this study found that all six types of landscape elements were considered as either important or very important by most of the respondents. The results showed that there is a consistent result across different case study sites and different types of users (patients, staff and visitors). This study found that there was **no significant relationship between perceived importance of landscape elements with the types of users, gender, age group and ethnicity.**

Based on the highest percentage of degree of satisfaction regarding the landscape elements, **green plants, flowering shrubs, pedestrian walkway, grass and seating** were considered as either most important or important to the majority of respondents from all three case study sites as explained earlier in Section 5.4.1. This finding was reinforced from previous research which found that the landscape elements, especially **green plants, green lawn and colourful flowering plants**, are more preferred among the hospital users than the water feature (Amat, 2017; Adnan, 2016; Asano et al., 2008).

Moreover, the present study found that about one-fifth of respondents from all three case study sites thought that the **water feature** was either little important or not important to them. When informally asked why they thought so, they mentioned safety concerns for their children that might have fallen into the water features. Another concern mentioned by them regarded the possibility of mosquitoes breeding in the water if not well-maintained.

Nevertheless, although nearly 20% of the respondent in all the three case study HCGs thought that the water feature was either of little important or not important to them as describe earlier in Section 5.4.1, this does not mean that water features are not important elements for HCG. This is evidenced in the present study that 50% of the respondents of all three case study sites thought that water features are either important or very important to them. Numerous scholars have highlighted the importance of providing water features in healthcare gardens (Blaschke et al., 2018; Butterfield, 2014; Pasha, 2013; Davis, 2011; Whitehouse et al., 2001; Asano et al., 2008; Naderi and Shin, 2008; Cooper Marcus and Barnes, 1995). Moreover, hearing the sound of flowing water and providing a sense of relaxation and calm, and reduced stress and mental fatigue has greater perceived restorative potential (Zhao et al., 2018; Ma and Shu, 2018; Alvarsson et al., 2010).

This study found that **green lawn** was also considered as one of the important elements in the HCG with more than 80% of respondents from all three case study sites having voted it as either important or very important. This is in line with an earlier study which found that the preference of **green lawn, green trees and sunshine** encouraged users to spend time in the outdoor garden (Adnan, 2016). Several studies have suggested the importance of providing fresh green lawn in the outdoor garden for a better aesthetical appearance and to develop users visual stimulation (Amat, 2017; Adnan, 2016; Shukor, 2012; Davis, 2011; Asano et al., 2008; Said et al., 2005). Moreover, the green lawn is necessary in the HCG because it impacted on users' safety in the HCG. This is evidenced during an observation in the present case study (H3-C2), where children almost slipped down while walking in the HCG due to the slippery surface of a ground area without any turf.

5.5.3.2 Preferences of the courtyard gardens images

i) Preference of Image A / B / C (Question 14)

This study found that **the most preferred image was image B** which portrayed an informal or naturalistic type of garden with a good combination of landscape elements, followed by images C and A (As explained earlier in Section 5.4.2.1). When asked the reason of the selection of image B, the response frequently mentioned by them was the preference of the landscape elements portrayed in the HCG such as the variety of **the greenery, the presence of water features and variety of seating** (See Table 5.14). Another frequent response regarded the pleasant view and calm environment portrayed in image B.

Therefore, this study suggests that **a good-combination of natural and manmade elements in the HCG are vital as it influenced users' preferences of the HCG images in which they perceived it as visually appealing and restorative to them.** This is somewhat in accordance with previous studies which found that the presence of more natural elements such as water, grass, trees and flowering plants in an outdoor garden setting were perceived as more restorative compared to the setting which has less natural elements (Ulrich et al., 2019; Twedt et al., 2016; Carrus et al., 2015; Cooper Marcus and Sachs, 2014; Shukor, 2012). Twedt et al. (2016) suggested that an informal garden with more visually appealing and more natural elements was perceived as having a higher restorative potential than an informal garden with less visually appealing and less natural elements.

Table 5.14: Characteristics and preferences of the HCG images (Question 14)

Setting							
Classification of the image character		Informal Less naturalistic		Informal Most naturalistic		Informal Moderately naturalistic	
Manmade feature		70%		50%		40%	
Design features		Water feature Seating Walkway Green wall Covered roof		Water features Seating Walkway Play area Multi-level garden		No water features Flowers Walkway	
Percentage and frequency of responses		8%, n=10		69%, n=83		23%, n=27	
Total responses (N=120)		**IMAGE A**		**IMAGE B**		**IMAGE C**	
Total responses across all images	**f**	**Responses**	**f**	**Responses**	**f**	**Responses**	**f**
Greenery Water features Pleasant view	63 28 27	**Spacious** Greenery Comfortable	**4** 4 3	**Greenery** Water features Pleasant view	**42** 26 22	**Greenery** Well designed Flower	**17** 5 5

Moreover, this study found that **there was a significant relationship between preference of images and ethnic group**. The present study found that a majority of other ethnic groups (i.e. minorities and expatriates of a different culture) preferred image A and none of them preferred image B. Whereas, none of Chinese preferred image A and C, and a majority of Malay and Indian respondents preferred image B (See Table 1 in Appendix 20). This implies that there is a possibility that **users of a different culture may value design features differently compared to other cultures**, which influenced the variation of their responses. Nevertheless, the number of samples in each of the ethnicity groups was too small to generalise the finding. Thus, a promising avenue for future research is to test with a larger sample of each different ethnic group.

ii) Preference of Image 1 / 2 / 3 / 4 / 5 / 6 (Question 15)

Additionally, this study found that **Image 2** was the **most preferred image** across all different types of users (As explained earlier in Section 5.4.2.2). The most frequent response was because of their preferences of **the greenery** in image 2 (See Table 5.15). The finding of this section strengthens the findings of the previous questions which found that more respondents chose image B that portrayed more variety of greenery than the other images. This finding also reinforced previous studies, that the most preferred element for an outdoor garden in hospitals included natural elements such as trees, greenery, flowers, water features and benches (Ulrich et al., 2019; Twedt et al., 2016; Whitehouse et al., 2001; Cooper Marcus and Barnes, 1995).

Image 3 was the **second preferred image** among the respondents and the most frequent response was the preference of the water feature. Based on their responses, they related the **water features** portrayed in the HCG with a **calm environment**. This is aligned with an earlier study which determined water features as an important design feature for outdoor gardens because it can arouse a sense of pleasure and calm while being in the garden (Maller et al., 2006), and have higher perceived restorative potential (Shukor, 2012). Moreover, water features have a stress-reducing effect on people and serves as a positive distraction which can reduce distressed and negative feelings while spending time in the garden (Asano et al., 2008; Naderi and Shin, 2008; Ulrich et al., 2008; Whitehouse et al., 2001).The present study found that the **patient group** and **older age adults** (55-64 years old) preferred image 3 which portrayed **flowering plants**. The present finding differs from former research which found that shelter, benches and trees were among the landscape elements highly valued among the patient group (Chang and Chien, 2017).

In addition, **image 4**, showing a variety of seating areas, was preferred the most by the older age group (55-64 years old). **Image 6** was the most preferred image by the majority of females (usually mothers). The most frequent comments included that they liked the playground in the image because it offered a place for their child to play while waiting in the hospital. Finally, **image 1,** showing a well-shaded area, was favoured among the young adult group (18-35 years old) and the patient group (See Table 5.15).

Table 5.15: Characteristics and preferences of the HCG images (Question 15)

Images						
Informality	Informal		Informal		Formal	
Rank	**1**		**2**		**3**	
The most frequent response	**Responses**	**f**	**Responses**	**f**	**Responses**	**f**
	Greenery Comfortable Well-shade	**30** 18 16	**Water features** Calm Greener	**44** 32 1	**Flower** Pleasant view Calm	**32** 9 9
Images						
Informality	Formal		Formal		Formal	
Rank	**4**		**5**		**6**	
The most frequent response	**Responses**	**f**	**Responses**	**f**	**Responses**	**f**
	Seating Pleasant view Comfortable	**14** 7 7	**Play area** Safe Comfortable	**32** 4 2	**Well-shaded** Calm Rest area	**8** 6 5

Comparing both data on users perceptions of the importance of landscape elements and their preference of the HCG images, this study suggests that the landscape elements valued by the HCG users included **the greenery (e.g. tree canopies, green trees, green lawn, green shrubs,)** followed by **water features, flowering plants, seating area and play area.** Besides the landscape elements, this study found another aspect preferred by the users which was a **well-shaded area** in the HCG.

Overall, this study suggests that **an informal garden with an abundance of greenery, pleasant views, comfortable and have a great combination of hardscape and softscape in the HCG are vital parts in the HCG planning and valued by most of the HCG users.**

5.6 Summary

This chapter discussed on the results of the evaluation of the physical design and operational aspects of the HCG, and as such has provided insight into the needs and preferences of users. The information regarding the positive and negatives aspects of the HCG were gathered from the users (patients, staff and visitors) who use and experience the HCG, which mainly addressed research objective 1. Based on the open ended responses, this study revealed several aspects mentioned mostly by the users, namely the physical design and operational aspects. In terms of the physical design, the findings from this study revealed that the, pleasant views and variety of seating area were the main important aspects in HCG design as these was frequently mentioned by most of the users. The results from the survey interviews with the users also informed operational aspects such as garden maintenance and safety issues which need to be addressed by the respective hospital administrators to attain an improvement in HCG design.

In addition to the physical and operational aspects, the finding of the positive and negative aspects revealed that users expressed their desire for a comfortable environment in the HCG which suggested that microclimate conditions were also an important aspect of the HCG design. Not only that, the positive aspects of the HCG as an alternative place for them to be outdoors and meet people was frequently mentioned by respondents. This implied the importance of the HCG to cater for the social needs of their intended users. A detailed results and discussion concerning these two aspects, environmental and social, will be presented in the next chapter based on the primary data set to address research objective 3 and 4.

This chapter discussed some important contributions which provided insight into user satisfaction level with the planning and performance of the HCG which responded to research objective 2. Several aspects related to the physical design including landscape elements, wall condition, access from the main entrance, visibility and accessibility were studied. This provided useful findings on their overall satisfaction level and the performance of each particular HCG. Moreover, the Chi-square test statistical analysis among the whole studied sample (N=120) revealed four factors that were highly significant and closely related. These include landscape elements, wall condition, access from the main entrance and visibility. This finding is crucial because it provides a basis for the development of HCG design framework and guidelines which will be discussed in Chapter 8.

This chapter revealed an important finding related to users' perceptions and preferences of the HCG in response to research objective 2. The results from the survey interview revealed that there was no significant relationship between the perceived importance of landscape elements with the types of users, gender, age group and ethnicity. The research identified several landscape elements considered important by the majority of HCG users including green plants, flowering shrubs, pedestrian walkway, grass and seating. Surprisingly, water features was found to be of little important to some of the HCG users. Moreover, the findings of the most preferred HCG images based on photo elicitation during the survey interview revealed that the majority of the users expressed their desire towards the HCG that has abundant greenery and other landscape features such as flowers, seating areas, water features and walkway. This suggested an important finding on the needs and preferences of landscape elements that need to be taken into consideration by the designers in future HCG design.

CHAPTER 6:
Users' perceptions of outdoor thermal comfort and the environmental design, users' space use pattern, experience and perceived restorative score in the HCG

6.1 Introduction

This chapter presents the results and discusses the findings related to the environmental and social aspects of the HCG design. It is important to note that some of the findings in Section 5.5.1.1 also related to a number of environmental and social aspects. As mentioned earlier, some of the results related to the activities and experience in the HCG based on the open-ended questions will be cross-checked with the results from a close-ended survey and the observation results to validate and conclude the findings. The results and discussion presented in this chapter are associated with the **third research objective:**

- To examine the microclimatic conditions of the case study HCG and how they influence users' perceptions of thermal comfort.

Additionally, it also responds to the **fourth research objective:**

- To investigate the users' activities, users' space use pattern and their experience in the selected case study HCGs

The chapter divided into four important sections which presents the results on the:

i) microclimatic conditions of the case study sites and users' perceptions on the thermal comfort in the HCG;
ii) users' perceptions of the importance of environmental design;
iii) users' space use pattern in the selected case study HCG; and
iv) users' experience and perceived restorative scale while spending time in the HCG.

The chapter also provide an explanation and interpretation of the main findings and compare them with the findings in prior studies. This is to examine whether the current findings differ or support previous research and related to the relevant theory which contributes to the field of knowledge.

6.2 The microclimatic conditions of the case study HCGs and users' perceptions of thermal comfort in the HCG

This section presents the results collected from the field measurement and the survey interview which concentrated on the **environmental aspects** of the HCG. **The field measurement** was carried out simultaneously on the same day the survey interview and participant observation (i.e. video-based and direct observation) occurred (As mentioned earlier in Section 3.4.6). It was conducted for a total of 8 hours per day from 9 am to 5 pm between January and March 2018. It is important to note that Malaysia's climatic conditions typically evidence uniform average air temperatures and humidity with little variation throughout the year across Peninsular Malaysia as well as Sabah and Sarawak (Jamaludin, 2014; Ahmad, 2008). However, the amount of rainfall and wind direction differs during the monsoon period (Malaysian Meteorological Department, 2017, p.29). The AERCUS 3083 weather station was used to record the daily environmental data from 9 am to 5 pm (e.g. air temperature, air humidity and wind velocity). This weather station was fixed on a tripod at a height of 1.1 metres from the ground and placed at the centre of the HCG (See Section 3.4.6.3). Additionally, two data-loggers (HOBO-UA-002-64) were used to measure and compare the air temperature inside and outside the HCG. The environmental data was then exported into the Microsoft Excel and the SPSS software for further analysis as described earlier in Section 3.6.1.

For the **users' perceptions surveys** on thermal comfort, a 7-point ASHRAE scale and 3-point McIntyre scale was used for TSV and TPV, respectively. Further a 5-point scale question was used for users' perceptions on the WSV and humidity sensation votes HSV. A total of 120 HCG users who were sitting and spending time in the HCG were randomly selected to participate in the survey interviews (H1-C1 (N=46); H2-C3 (N=36); and H3-C2 (N=38) (See Section 3.5.2 for a demographic data). The survey data were analysed using both **the descriptive and inferential analysis** as described earlier in Section 3.6.2.1. The frequency analysis was used to examine differences in the users' TSVs across the different case study HCGs. Correlation analysis was used to assess the association between thermal responses votes and the relationship between microclimatic conditions and TSV. Additionally, a cross-tabulation and Chi-square test were used to analyse the relationship of TSV with gender, age group and time spent in the HCG.

First, this section presents on the results of the microclimatic conditions of the representative HCGs (Section 6.2.1). Further, it presents on the results of users' perceptions of thermal comfort in the selected HCGs, followed by the statistical analysis on the relationship of users' sensation responses with the actual microclimatic conditions (Section 6.2.2 to 6.2.6). Finally, this section presents the effect of orientation, courtyard ratio and vegetations on the microclimate conditions and outdoor thermal comfort of the HCG (Section 6.2.7).

6.2.1 The results of microclimatic conditions in the three case study HCGs

There are two purposes of measuring the microclimatic conditions in the case study HCGs:

- To compare microclimatic conditions (i.e. air temperature, humidity and the wind speed) in the three case study sites.
- To compare air temperature inside the HCG with the outside hospital.

The microclimatic conditions in each of the case study HCGs were recorded to examine how environmental factors such as air temperature (°C), air humidity (%) and wind speed (m/s) might influence how respondents perceived outdoor thermal comfort. A summary of the microclimatic conditions in the three case study sites included the maximum, minimum and average temperature of 3-4 days of measurements from 9 am to 5 pm each day is presented in Table 6.1.

Table 6.1: The data on the microclimatic conditions in the case study HCGs

H1-C1

Summary of the microclimatic conditions during survey days between 9.00 am to 5.00 pm - Average data of 4 days at H1-C1 (5, 8, 9 & 10/3/2018) (interval: 15 min)

Environmental data	Max	Min	Mean	SD
Air temperature, (ºC)	32.7	26.3	**29.4**	1.2
Relative humidity, (%)	90	50	**69**	6.85
Wind speed, (m/s) (Beaufort scale)	3.19 Light breeze	0.31 Light air	**1.3 Light air**	0.81 Light air

H2-C3

Summary of the microclimatic conditions during survey days between 9.00 am to 5.00 pm – Average data of 3 days at H2-C3 (23, 24 & 27/1/2018) (interval: 15 min)

Environmental data	Max	Min	Mean	SD
Air temperature, (ºC)	36.5	24.5	**30.2**	3.8
Relative humidity, (%)	91.3	45.6	**65.7**	14.5
Wind speed, (m/s) (Beaufort scale)	1.11 Light air	0.2 Calm	**0.1 Calm**	0.24 Calm

H3-C2

Summary of the microclimatic conditions during survey days between 9.00 am to 5.00 pm – Average data of 3 days at H3-C2 (11, 12/1/2018 & 18/3/2018) (interval: 15 min)

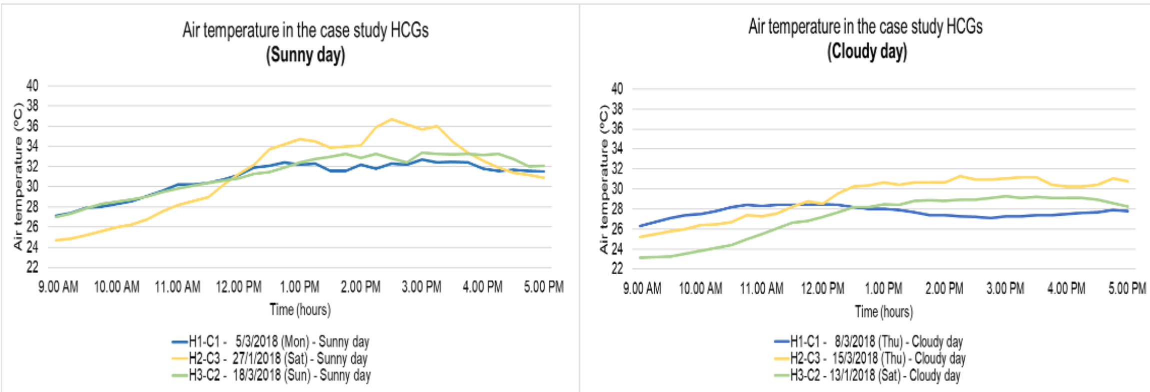
Environmental data	Max	Min	Mean	SD
Air temperature, (ºC)	31.4	24.4	**28.4**	2.1
Relative humidity, (%)	85.7	53.3	**69.3**	9.3
Wind speed, (m/s) (Beaufort scale)	1.23 Light air	0.31 **Calm**	**0.24 Calm**	0.3 Calm

The results of microclimatic conditions in each representative HCGs is presented below:

6.2.1.1 Air temperature (°C)

The results show little variation in average temperature between the three-case study sites: between **1°C to 2°C. The mean temperature in H3-C2 was the lowest (28.4°C) followed by H1-C1 (29.4°C) and H2-C3 (30.2°C)** (See Table 6.1).

Additionally, two sets of the environmental data (16 hours) recorded in each of the three-case study sites were compared to examine differences in air temperature between the sites. These data on both sunny and cloudy days revealed that **after mid-afternoon (12 pm), H1-C1 showed the lowest air temperature in both sets of environmental data,** followed by H3-C2 and H2-C3 (See Figure 6.1 (a) and (b)). Moreover, a higher temperature was recorded in these different sites during the sunny day when the skies were mostly clear. This could be because more direct heat reaches the HCG surface during sunny days which increases the air temperature in the HCG compared to cloudy days.



(a) (b)

Figure 6.1: (a) Air temperature in the HCGs during a sunny day, and (b) Air temperature in the HCGs during a cloudy day

The results also showed that during the sunny day, the air temperature in both H1-C1 and H3-C2 gradually increased from 9 am to 12 pm and then remained constant with little variation until 5 pm. H2-C3 showed a gradual increase between 12 pm to 3.30 pm and then gradually decreased from 3.30 pm to 5 pm. The possible reason for the higher temperature recorded in case study H2-C3 was because it was highly exposed to the sunlight especially during the mid-afternoon (12 pm to 3.30 pm).

6.2.1.2 Air humidity (%)

The results of the mean air humidity showed that H3-C2 has the highest percentage of air humidity (69.3%), followed by H1-C1 (69%) and H2-C3 (65.7%) (See Table 6.1).

This showed that there was little difference (4%) in mean air humidity in the three case study sites. Higher relative air humidity in the HCG sites indicated more water vapor in that environment. H2-C3 has higher humidity, which could be because of the presence of stagnant water in the pool that increased its humidity level. Figure 6.2 shows a one-day environmental data of the different sites which revealed that high relative humidity was recorded in these sites in the morning before subsequently decreasing gradually up to the afternoon.

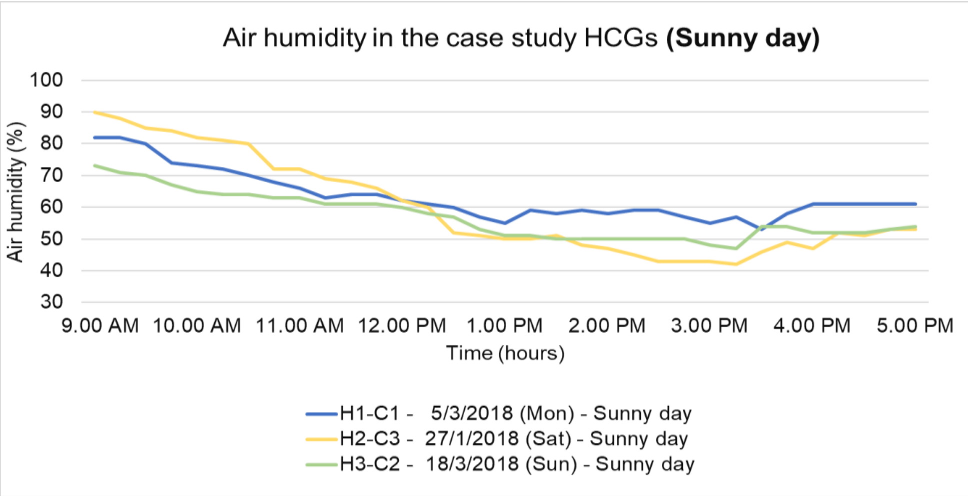


Figure 6.2: Air relative humidity in the three case study HCGs

6.2.1.3 Wind speed (m/s)

A higher average wind speed was recorded in H1-C1 (1.3 m/s) compared to H2-C3 (0.1 m/s) and H3-C2 (0.24m/s) (See Table 6.2 and Figure 6.3). Based on the Beaufort scale, the average wind speed in H1-C1 was categorised as light air (e.g. wind motion visible in smoke) while both H2-C3 and H3-C2 were calm (e.g. smoke rises vertically). Nevertheless, it was recorded that the maximum wind speed in H1-C1 was higher (3.19 m/s – light breeze), revealing that the presence of the wind could be felt on exposed skin and make leaves rustle.

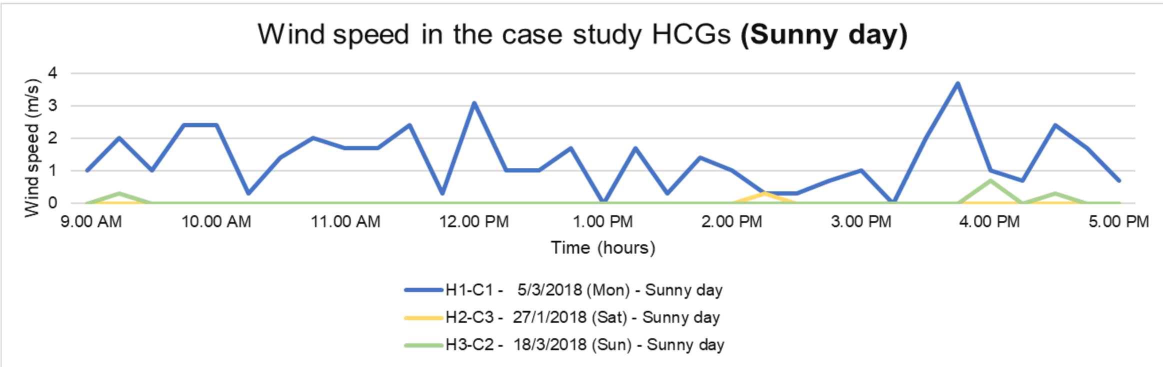
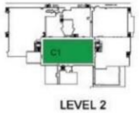
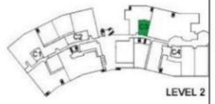
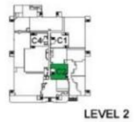
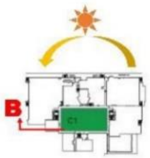
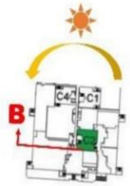
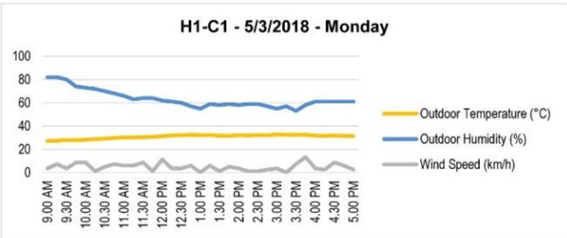
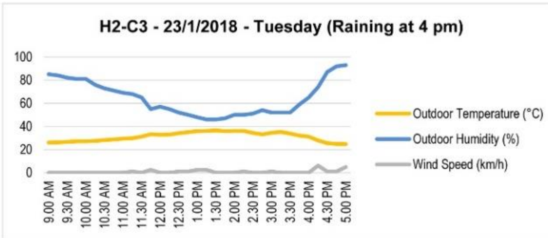
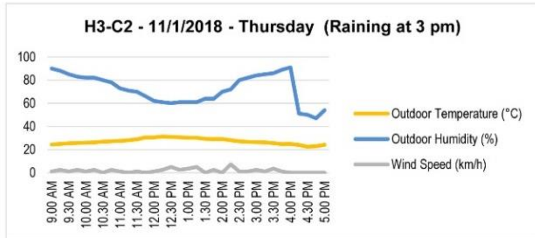


Figure 6.3: Wind speed in the three case study sites

Table 6.2: Results on the environmental data collected in the selected HCGs (Outdoor air temperature, air humidity and wind speed)

H1-C1		**H2-C3**		**H3-C2**	
					
Sun exposure in H1-C1 during the afternoon 	 H1-C1 is less exposed to the afternoon sun radiation because the ground area was shaded by the range of canopy trees and structures such as the bridge and pergola seating area	**Sun exposure in H1-C1 during the afternoon** 	 H2-C3 received high exposure to sun radiation during the afternoon and has less shaded areas. No shaded canopies were planted in the HCG	**Sun exposure in H1-C1 during the afternoon** 	 H3-C2 is highly exposed to sun radiation during the afternoon. Only some areas that were planted with palm trees wereare shaded during the day. This HCG has more hardscape than plantings
Air temperature (°C), humidity (%) and wind speed (km/h) Date: 5/3/2018 - Monday 		**Air temperature (°C), humidity (%) and wind speed (km/h) Date: 23/1/2018 - Tuesday** 		**Air temperature (°C), humidity (%) and wind speed (km/h) on Date: 11/1/2018 - Thursday** 	

Summary:

- The sun radiation and wet conditions caused by the rain significantly affected air temperature in the HCG.
- The more exposed the HCG to the sun radiation, the hotter the air temperature in the HCG. Wet condition during rainy days decreased the air temperature in the HCG and make the HCG cooler.
- All HCGs were highly exposed to sun radiation especially during the afternoon. However, in H1-C1, the temperature did not rise significantly because the ground area in the HCG was shaded by the canopies and varying types of plantings in the HCG also helps to lower the temperature in the HCG during the afternoon.

6.2.1.4 Difference between the air temperature in the HCG and outside the hospital

Based on the on-site field measurements, the air temperature in the HCGs was compared with that of outside the hospital to check the temperature difference in each case study site. Two sets of data loggers (HOBO UA-002-64) were used to record both the air temperature in the HCG and outside the HCG for 8 hours of recording (9 am to 5 pm) during March 2018.

The results showed that the overall air temperature in all three-case study sites were lower than that recorded outside the hospital building with a mean temperature difference of 2.1ºC (H1-C1), 3.8 ºC (H2-C3) and 2.6 ºC (H3-C2). The results showed that H1-C1 recorded the lowest air temperature throughout the day, followed by H2-C3 and H3-C2. Although H1-C1 was affected by rain during the afternoon between 1.00 pm to 1.30 and 3.00 pm to 4.00 pm, the temperature in H1-C1 remained lower compared to the other case studies (See Figure 6.4 and Table 6.3).

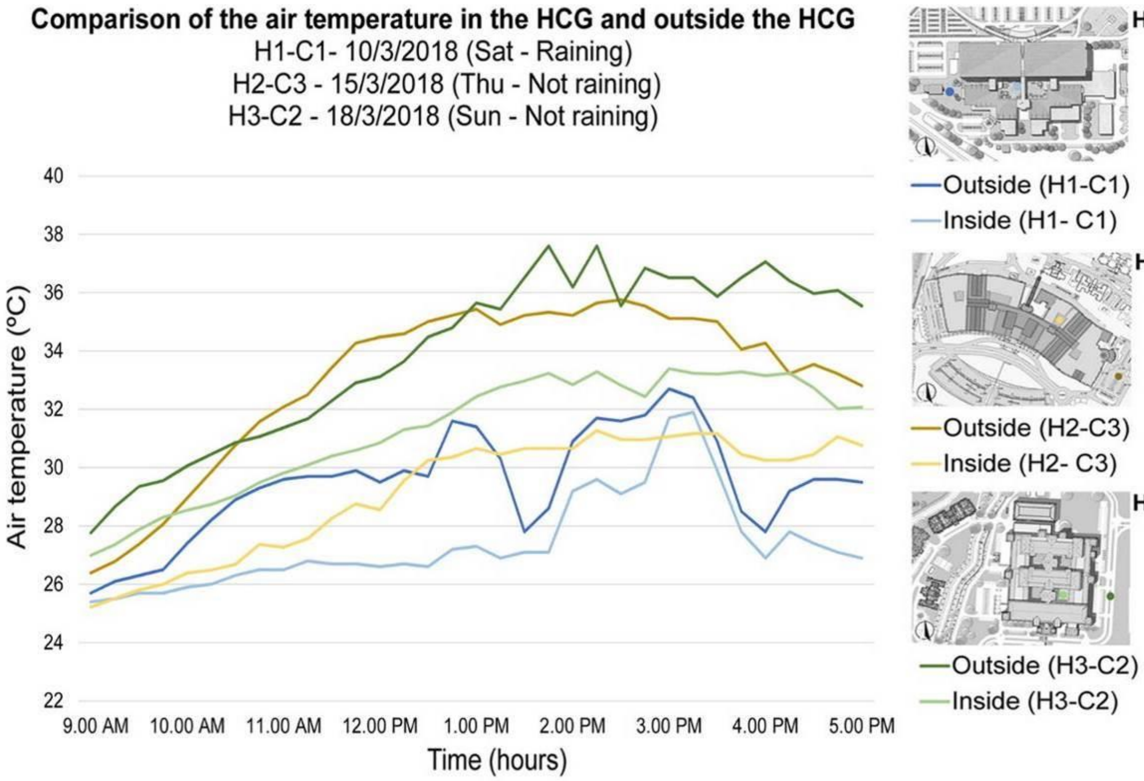
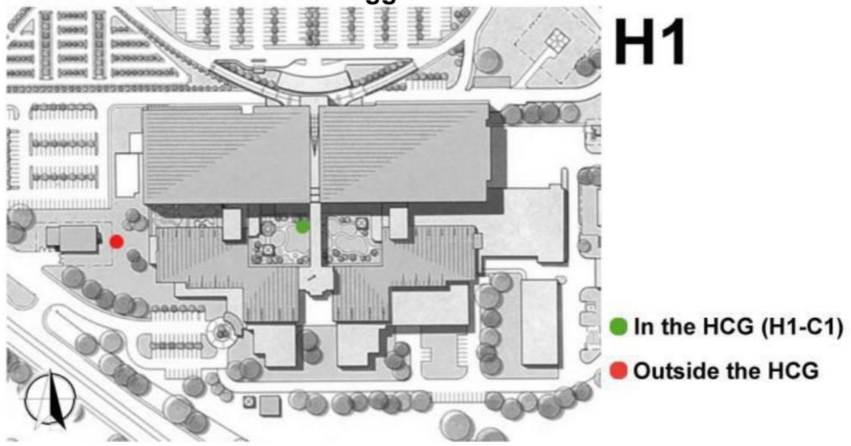


Figure 6.4: Comparison of the air temperature in the HCG and outside the HCG

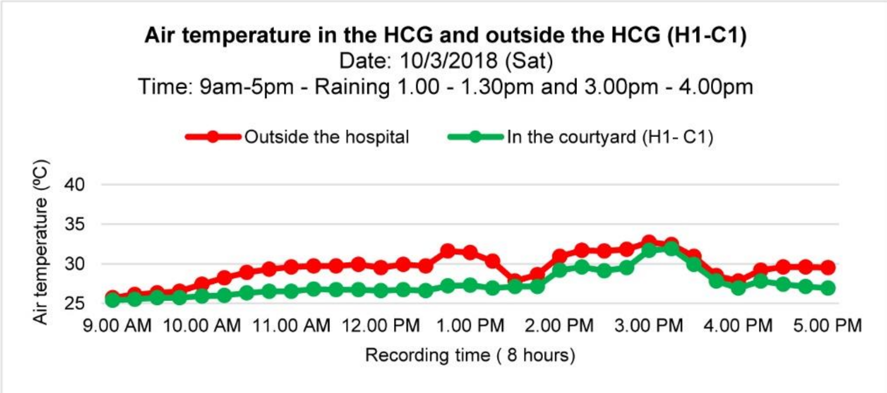
Table 6.3: Comparison of the air temperature in the HCG and outside the hospital

H1-C1

Location of the Hobo data logger



Comparing air temperature inside the courtyard with the outside HCG (H1-C1)



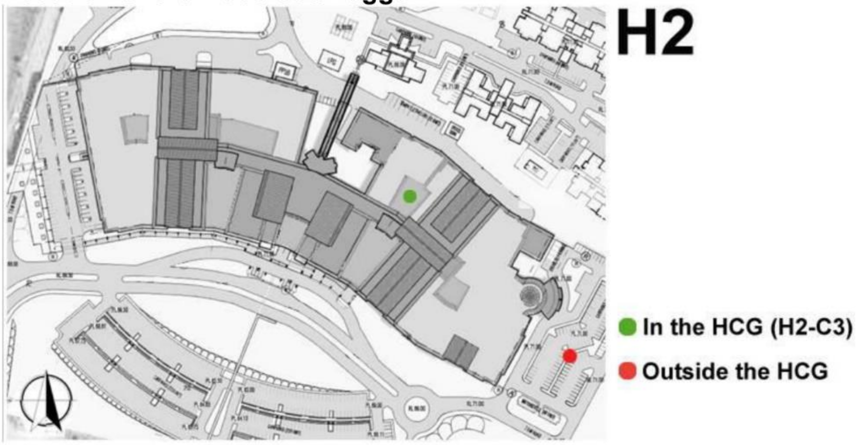
Average temperature difference (Mean): <u>2.1 ºC</u>

Difference of the air temperature recorded between outside HCG and inside HCG (Date: 10.3.2018 - Sat)

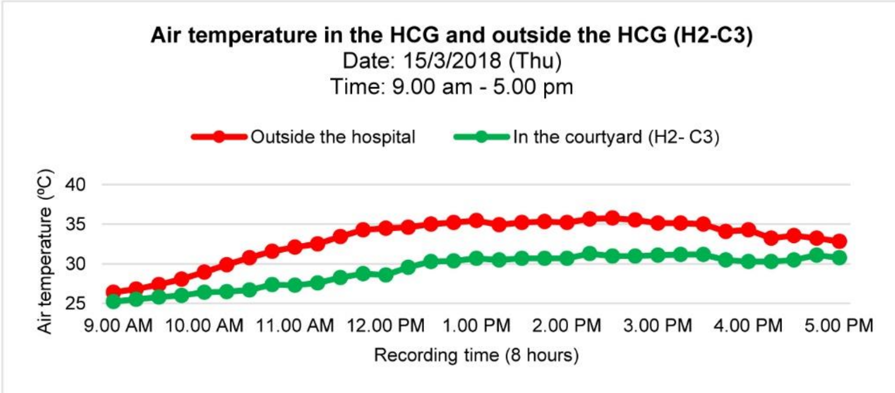
Time	Outside HCG	In the HCG	Temperature difference
9 am	25.7	25.4	0.3
11 am	29.6	26.5	3.1
1 pm	31.4	27.3	4.1
3 pm	32.7	31.7	1.0
5 pm	29.5	26.9	2.6

H2-C3

Location of the Hobo data logger



Comparing air temperature inside the courtyard with the outside HCG (H2-C3)



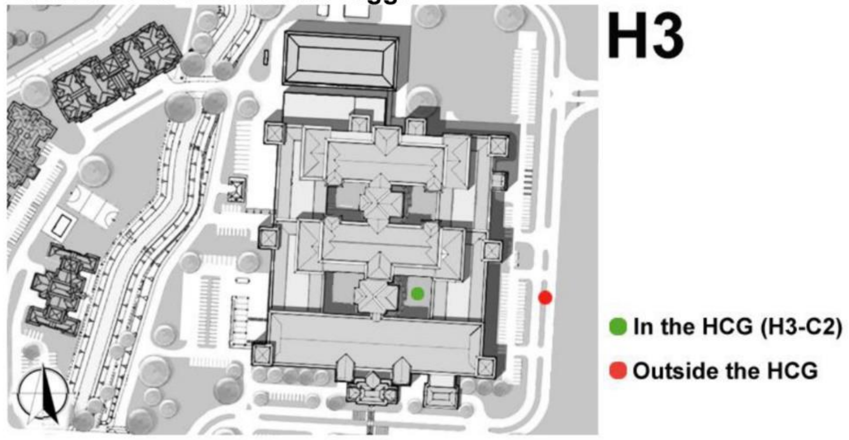
Average temperature difference (Mean): <u>3.8 ºC</u>

Difference of the air temperature recorded between outside HCG and inside HCG. (Date: 15/3/2018 - Thu)

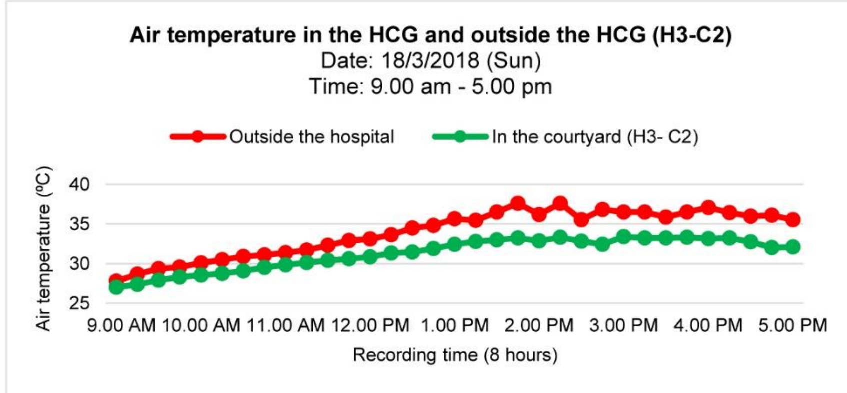
Time	Outside HCG	In the HCG	Temperature difference
9 am	26.4	25.2	1.2
11 am	32.1	27.3	4.8
1 pm	35.4	30.7	4.7
3 pm	35.1	31.1	4.0
5 pm	32.8	30.8	2.0

H3-C2

Location of the Hobo data logger



Comparing air temperature inside the courtyard with the outside HCG (H3-C2)



Average temperature difference (Mean): <u>2.6 ºC</u>

Difference of the air temperature recorded between outside HCG and inside HCG. (Date: 18/3/2018 - Sun)

Time	Outside HCG	In the HCG	Temperature difference
9 am	27.8	26.9	0.9
11 am	31.4	29.9	1.5
1 pm	35.6	32.4	3.2
3 pm	36.5	33.4	3.1
5 pm	35.5	32.1	3.4

Summary:

- The results show that the **<u>air temperature inside all three case study HCGs was constantly lower than the temperature outside the case study HCGs</u>**. The average temperature recorded in the case study HCGs is cooler than that outside the HCGs with an **<u>average temperature difference range between 2.0°C to 4.0°C</u>**
- The temperature difference in H2-C3 were higher than for the other case study HCGs with an average temperature difference of 3.8°C, followed by the H3-C2 at 2.6°C, and H1-C1 is 2.1°C
- Although the graph in H1-C1 fluctuated between 1.00 pm to 1.30 pm and 3.00 pm to 4.00 pm due to the rain, the air temperature inside the HCG remained cooler than the temperature outside the HCG with the average temperature difference of 2.1°C. **<u>The air temperature recorded in March 2018 in H1-C1 is lower than H2-C3 and H3-C2</u>** from 9.00 am to 1.00 pm (i.e. excluding the raining time in H1-C1)
- In certain conditions, if the HCGs are not properly designed, with little shading and exposure to too much solar radiation, the courtyard can act a thermal source and function similar too an 'oven'. This study suggests that **<u>the HCG functions as thermal sink</u>** rather than thermal sources in which it provides a cooler environment for people to spend time sitting in the HCG during the day compared to outside the HCG

6.2.2 Users' perceptions of thermal comfort in the case study HCGs

This section elaborates on how users feel regarding outdoor thermal comfort in the HCG including their sensation of the air temperature, wind flow and humidity. A total number of 120 survey interviews were carried out in all three case studies: H1-C1 (n=46); H2-C3 (n=36); and H3-C2 (n=38). Participants were asked about their thermal sensation using an ASHRAE 7-point scale, thermal preference were asked using 3-point McIntyre scale. Additionally, 5-point scale questions were used to ask regarding the wind speed and humidity sensation (See Table 6.4). See Question 8 to 11, in Appendix 1 for the actual survey questions. A detailed demographic of the HCG users in each of the three case study sites as explained earlier in Section 3.5.2.

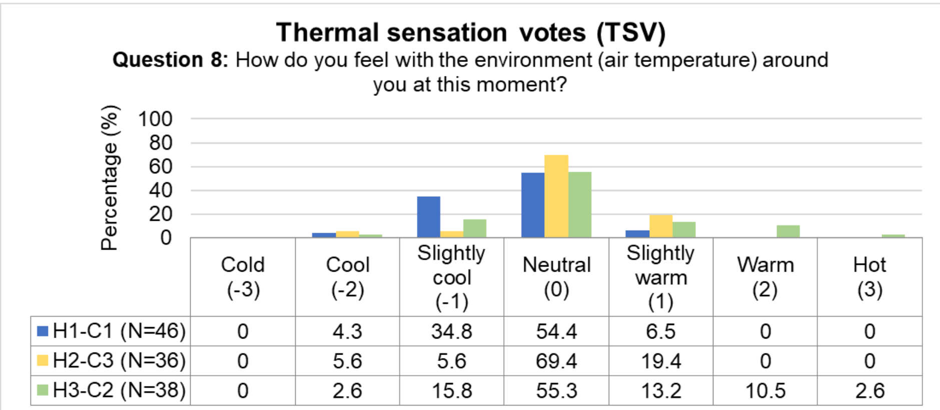
Table 6.4: Survey questions related to thermal sensation responses

Thermal sensation votes (TSV)	Thermal preference votes (TPV)	Wind speed sensation votes (WSV)	Humidity sensation votes (HSV)
ASHRAE 7-point scale	3-point McIntyre scale	5-point scale	5-point scale
-3 Cold -2 Cool **-1 Slightly cool** **0 Neutral** **+1 Slightly warm** +2 Warm +3 Hot	-1 Want cooler 0 No change +1 Want warmer	-2 Stale -1 Little Wind 0 OK +1 Windy +2 Too much wind	-2 Very damp -1 Damp 0 OK +1 Dry +2 Very Dry

6.2.2.1 Thermal sensation and thermal preference distribution

i- Thermal sensation votes (TSV)

In this study, users' thermal sensation votes were reported based on an ASHRAE 7-point scale ranging from 'cold' to 'hot' in which the middle point 'neutral' indicated a state of comfort (ASHRAE Standard 55, 2004). The present results showed that **more than half of respondents in the three case study sites voted 'neutral',** which indicated that they felt comfortable while spending time in the HCG (See Figure 6.5).



	Cold (-3)	Cool (-2)	Slightly cool (-1)	Neutral (0)	Slightly warm (1)	Warm (2)	Hot (3)
H1-C1 (N=46)	0	4.3	34.8	54.4	6.5	0	0
H2-C3 (N=36)	0	5.6	5.6	69.4	19.4	0	0
H3-C2 (N=38)	0	2.6	15.8	55.3	13.2	10.5	2.6

Figure 6.5: Distribution of thermal sensation votes

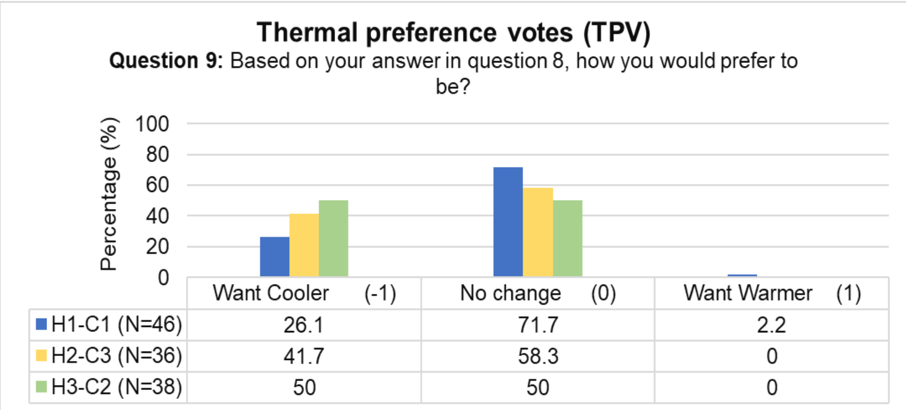
The thermal sensation votes at the central categories (-1, 0, 1) were considered an acceptable vote (Spagnolo and de Dear, 2003; Lin et al., 2008). What is interesting was that **93.3% of the respondent (n=112) in all the three representative sites found the climatic conditions in the HCG to be acceptable**, whereas only 6.7% respondents (n=8) thought this was unacceptable as supported by previous findings (Makaremi et al., 2012; Sharmin et al., 2015). The possible reason of these results could be because of the **types of passive activity (sitting) and less exposure to sun radiation** as they mostly sat in the shaded area. Therefore, the majority of the respondents felt **that the climatic conditions in the HCG were acceptable to them.**

It is interesting that the results showed that a higher percentage of respondents in H1-C1 mentioned that they felt slightly cool (34.8%, n=16), and a small percentage mentioned that they felt ‘slightly warm’ (6.5%, n=3). Conversely, a higher percentage of respondents in H2-C3 voted ‘slightly warm’ (19.4%, n=7), whereas less respondents (5.6%, n=2) felt the HCG as ‘slightly cool’. The numbers of responses as ‘slightly warm’ and ‘slightly cool’ in H3-C2 was slightly balanced with 15.8% and 13.2%, respectively. Surprisingly, none of the respondents in both H1-C1 and H2-C3 mentioned that they felt ‘warm’ of ‘hot’, but few respondents in H3-C2 mentioned that they felt ‘warm’ and ‘hot’.

The present results also suggested important findings that the microclimatic conditions in the HCGs influenced how users’ perceived thermal sensation, as reported in previous studies (Sharmin et al., 2015; Villadiego and Velay-Dabat, 2014; Nikolopoulou and Lykoudis, 2006). As evidenced in previous Section 6.1.1, the microclimate in the HCG is cooler than that outside hospital. This reinforced the current results that the majority of the users in the different sites voted for ‘neutral’ in which they felt comfortable while spending time in the HCG. Moreover, the higher number of users in H1-C1 who mentioned that they felt ‘slightly cool’ rather than ‘slightly warm’ also suggested that lower air temperature and a higher wind speed in H1-C1 than the other case study sites (As described in Section 6.1.1.2) contributed to the variation of responses in the three case study sites.

ii- Thermal preference votes (TPV)

The respondents were asked regarding their thermal preference using a 3-point McIntyre Scale: (Want cooler (-1), No Change (0) and Want warmer (+1) (McIntyre, 1980). Although the microclimatic conditions in the three different sites were found to be acceptable to most of the respondents, more than 70% of the respondents in H1-C1 preferred no change, whereas less than 60% in H2-C3 and H3-C2 wanted to keep up with the same air temperature. What is interesting is that half of the respondents in H3-C2 preferred a cooler temperature; this reflected a higher percentage than that evidenced for the other case study sites (See Figure 6.6). This study suggests that a cooler climatic condition contributed to a higher response from respondents who wanted no change regarding the air temperature, while a warmer climatic condition contributed to the preference of cooler conditions in the HCG. Surprisingly, one respondent who sat on a bench in H1-C1 was a cancer patient who preferred warmer conditions. This could be due to the subjectivity of the psychological and physiological conditions (e.g. skin sensitivity) which might influence his or her thermal sensation compared to other respondents.



	Want Cooler (-1)	No change (0)	Want Warmer (1)
H1-C1 (N=46)	26.1	71.7	2.2
H2-C3 (N=36)	41.7	58.3	0
H3-C2 (N=38)	50	50	0

Figure 6.6: Distribution of thermal preference votes

The cross tabulation test of a total 120 respondents in the three different sites showed that, among those feeling neutral or comfortable, (58.7%, n=44) preferred no change while only (40%, n=30) preferred a cooler environment, and only one respondent preferred warmer conditions (1.3%, n=1) (See Appendix 21, Table 9, for the cross tabulation results). These results reinforced a prior finding in a hot humid climate context. Sharmin et al. (2015) found that, among people who felt neutral, more than 60% preferred no change while only 30% wanted to be cooler. Conversely, the current finding differed from McIntyre's (1980) findings. McIntyre (1980) established that in warm climates, those who felt neutral preferred a cooler ambiance. This suggested that the difference of the findings related to thermal preference votes showed that people's expectations and adaptation levels varies across different climatic and cultural contexts.

6.2.2.2 Wind speed and humidity sensation distribution

i) Wind speed votes (WSV)

Figure 6.7 shows the distribution of the wind sensation reported based on a five-point Likert scale, ranging from 'stale' (-2) to 'too much wind' (+2). The results showed that less than 30% of the respondents felt 'OK' with the wind speed across all the different sites. The result showed that a higher percentage of respondents in H1-C1 voted either 'windy' or 'too much wind' (30.5%) compared to the other case study sites. Conversely, the results in H3-C2 showed that a higher percentage of respondents voted as either ‘little wind’ or ‘stale’ (73.7%) and none of them mentioned that they felt ‘windy’ or ‘too much wind’ while being there. In H2-C3, more than half of the respondent (63.9%) reported that they felt ‘little wind’ or ‘stale’ while being there, whereas very few felt windy (11.1%).

Overall, the results revealed **that a higher number of the respondents in H1-C1 felt the HCG as windy and too much wind, showing that H1-C1 was breezier than the other case study sites.** The results are in accordance with the recorded microclimatic data during the fieldwork day as described in Section 6.1.1 which revealed that **H1-C1 had a higher mean wind speed (1.3m/s – Light air) compared to H2-C3 (0.1 m/s) and H3-C2 (0.24m/s).** Also, the maximum wind speed recorded in H1-C1 was 3.19m/s. The high wind speed in H1-C1 were **able to create a cooling effect in the HCG that can reduce the air temperature in the HCG.**

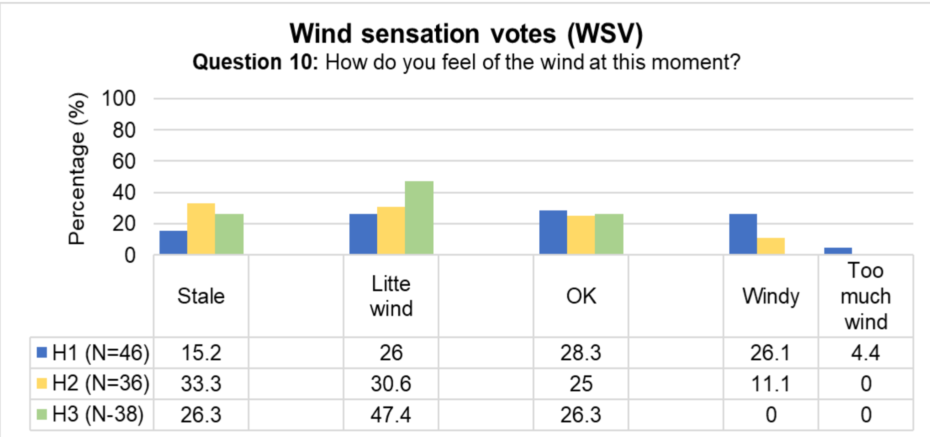


Figure 6.7: Distribution of wind sensation votes

ii) Humidity sensation votes (HSV)

User’ sensation of humidity was reported on a five-point Likert scale, ranging from ‘very damp’ (-2) to ‘very dry’ (+2). The result on the humidity sensation votes showed that the majority of users in H1-C1 (65.3%, n=30), H2-C3 (72.2%, n=26) and H3-C2 (57.9%, n=22) felt “OK” with the humidity level in the respective HCGs (See Figure 6.8). Less than 20% of the respondents in all three case study sites responded that they felt ‘damp’ and ‘dry’ and very few mentioned they felt ‘very dry’ and ‘very damp’. Based on the results of the average relative humidity recorded during the fieldwork, H2-C3 had the lowest mean humidity level (RH: 65.7%) compared to H1-C1 (RH: 69%) and H3-C2 (RH: 69.3%). A previous study suggested that people in hot humid climates may not be as sensitive to the change of humidity because they have been adapted to high humidity conditions (Yang et al., 2013).

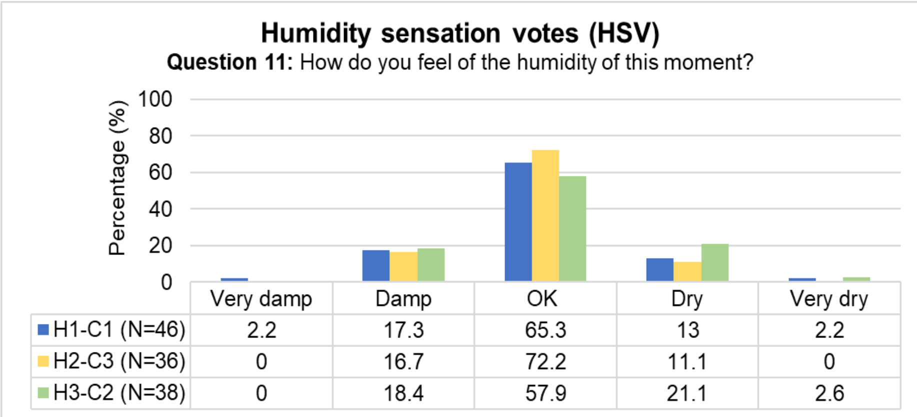


Figure 6.8: Distribution of humidity sensation votes

6.2.3 Cross tabulation between the thermal responses votes with the three case study sites and Chi-square results.

A cross tabulation and a Chi-square test between thermal respondents votes (thermal sensation votes, preference sensation votes, humidity sensation votes and wind sensation votes) with the three case study sites were analysed to examine the distribution of the two variables and to measure the association between the thermal responses with different case study sites. The results of the Chi-square test are shown in Table 6.5. The cross tabulation can be seen in Appendix 21, Table 2. The results showed that the thermal sensation votes ($p<0.01$), humidity sensation votes ($p<0.05$), and wind sensation votes ($p<0.05$), had a significant association across the three sites.

Table 6.5: The Chi-square results of the thermal responses by different HCGs

Cross tabulation between two variables	**Chi-square results (p - value)**	
Thermal sensation votes (TSV) by different case study sites	X^2=18.39, **p=.018)** C=.365	$p < 0.05$
Humidity sensation votes (HSV) by different case study sites	X^2= *18.39,* **p=.018)** C=.365	$p < 0.05$
Wind sensation votes (WSV) by different case study sites	X^2= *21.77,* **p=.005)** C=.392	$p < 0.01$

6.2.4 Correlation between thermal responses votes

The data distributed for TSV, TPV, WSV and HSV are ordinal variables. Therefore, a Spearman Rank correlation test which is a non-parametric test were used to **measure direction and strength of the relationship between two ordinal variables. It also measures the extent to which the two variables tend to change together** (Pallant, 2016, p.132)**.** The results of the correlation analysis of the thermal response variables across the whole three case study sites (N=120) is presented in Table 6.6.

Table 6.6: Correlation analysis among the thermal response votes (TSV)

Spearman Rank order correlation		Thermal Sensation Votes (TSV)	Wind speed sensation votes (WSV)	Humidity sensation votes (HSV)
TSV	Correlation Coefficient	1.000	**-.185***	**.254****
	Sig. (2-tailed)	.	.043	.005
	N	120	120	120

**. Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2 tailed)

Based on Table 6.6, the TSV had a perfect positive correlation with HSV (r=.254, p=.005), but a negative correlation with WSV (R= -.185, p=.043). The results showed that as **the humidity level increases, the thermal sensation (TSV) also increases.** It also revealed that **thermal sensation (TSV) tended to decrease as the wind speed sensation (WSV) increased.** The results showed that air temperature, relative humidity and wind speed have a positive effect on thermal sensation. In other words, an increase in air temperature and air humidity will make people feel warmer, while an increase in wind speed in the HCG will make people feel cooler. This is consistent with previous findings in a hot humid climate region (Yang et al., 2013; Ng and Cheng, 2012).

6.2.5 Correlation between microclimatic conditions and thermal sensation votes (TSV)

The Pearson correlation was used to investigate the correlation between the microclimatic data and the TSV across the whole database of the three case study sites. The correlation coefficient values ranging between +1 and -1 in which r=+1.0 indicated a perfect positive correlation and r=-1.0 indicated a perfect negative correlation. The guidelines for the relationship strength between variables are shows in Table 6.7.

Table 6.7: The guidelines for the relationship between variables

	Strength of relationship			
Value of r	**Strong**	**Moderate**	**Weak**	**Very weak or none**
+ values (Positive relationship)	1.0 to 0.5	0.3 to 0.49	0.1 to 0.29	0 to 0.09
- values (Negative relationship)	-1.0 to -0.5	-0.3 to 0.49	-0.29 to -0.1	-0 to -0.09

Referring to Table 6.8, the results revealed that air temperature has a strong correlation with the TSV (r= .275, p=.002). This means that when the air temperature in the HCG increased, the thermal sensation votes also increased towards warmer sensations. The correlation between air humidity and TSV were found to be a perfect negative correlation (r=-.306, p=.001). This means that as the humidity in the HCG increased, TSV decreased towards a more comfortable sensation. The correlation between wind speed and TSV showed weak correlation (r= -.067, p=.466) implying increased comfort as the wind speed in the HCG increased. Wind speed only became significant at a low air temperature which means that the cooling effect of the wind is desirable in a high temperature area.

Table 6.8: Pearson correlation analysis between TSV and microclimate data

		Microclimatic data		
Correlation		**Actual air temperature**	**Actual air humidity**	**Actual wind flow**
TSV	Pearson correlation	**.275****	**-.306**	**-.067**
	Sig. (2-tailed)	.002	.001	.466
	N	120	120	120
HSV	Pearson correlation	.353**	**-.316****	-.122
	Sig. (2-tailed)	.000	.000	.186
	N	120	120	120
WSV	Pearson correlation	-.069	-.049	**.368****
	Sig. (2-tailed)	.454	.595	.000
	N	120	120	120

**. Correlation is significant at the 0.01 level (2-tailed)
*   Correlation is significant at the 0.05 level (2 tailed)

Moreover, the results also showed a strong correlation between the humidity sensation votes with the on-site air humidity (r= -.316, p = .000) and between WSV and the recorded wind speed (r= .368, p= .000). These implied that as the humidity increased the humidity sensation votes decreased, whereas when the wind speed increased, the wind sensation votes increased.

6.2.5.1 Acceptable temperature range and neutral temperature

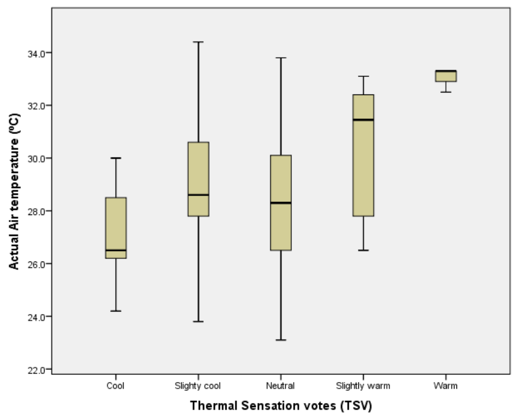
Thermal neutrality can be determined by analysing the relationship between the operative air temperature and TSV. A graph of the scatter plot and the box plot shows the correlation between the microclimate conditions of the combine dataset with the thermal sensation votes across the three different case study sites (See Table 6.9). T**he result showed that the acceptable temperature range for the hospital courtyard garden (semi-outdoor environment) in a hot humid climate is between 26.5ºC to 30ºC and the neutral temperature of 28.3ºC.**

The finding of this study are slightly similar to a study investigating the outdoor environment in Singapore (a hot humid climate) which found a neutral temperature of 28.7ºC and a temperature range of between 26.3ºC to 31.1ºC (Yang, 2013). Another study of temperature range in a semi-outdoor space (open terrace) in an office building in China showed that people preferred to stay in a semi-outdoor terrace (28.8 ºC to 30.6 ºC) even though it was considerably warmer than indoors (Cao et al., 2018). This study confirmed the effectiveness of introducing a courtyard garden in a hospital building which helps reduce the air temperature in the HCG and improve users' thermal comfort.

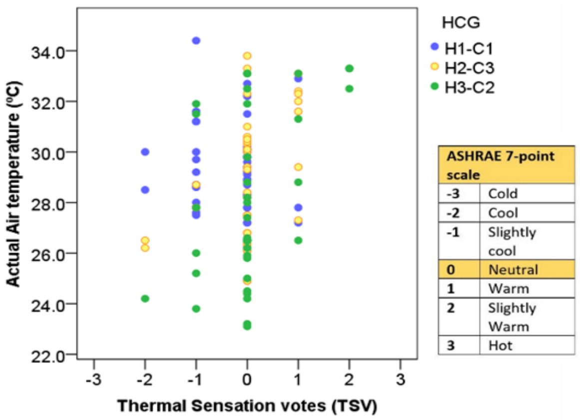
Table 6.9: Correlation between the actual air temperature with thermal sensation votes (TSV)

AIR TEMPERATURE – THERMAL SENSATION VOTES (TSV)

Box plot



Scatterplot



Pearson correlation	.257**
Sig. (2 tailed)	**.002**
N	120

6.2.6 Relationship between thermal sensation votes (TSV) with the gender, age group, time spent in the HCG.

6.2.6.1 Relationship between gender and TSV

A cross tabulation and Chi-square test were used to examine the association between TSV and gender across the whole sample in the three case study sites (N=120) (See Appendix 21, Table 1). The results revealed that a larger proportion of males felt 'neutral' compared to females, and a higher proportion of females voted 'slightly warm' (+2) and 'warm' (+3). Conversely, the current study also found that a higher percentage of males felt 'slightly cool' compared to females (See Figure 6.9). This is in agreement with a previous study which found that more male votes for neutral than female (Pantavou et al., 2013). The current results are also in line with a previous finding in Malaysia, that there was no significant association found between different genders (Makaremi et al., 2012).

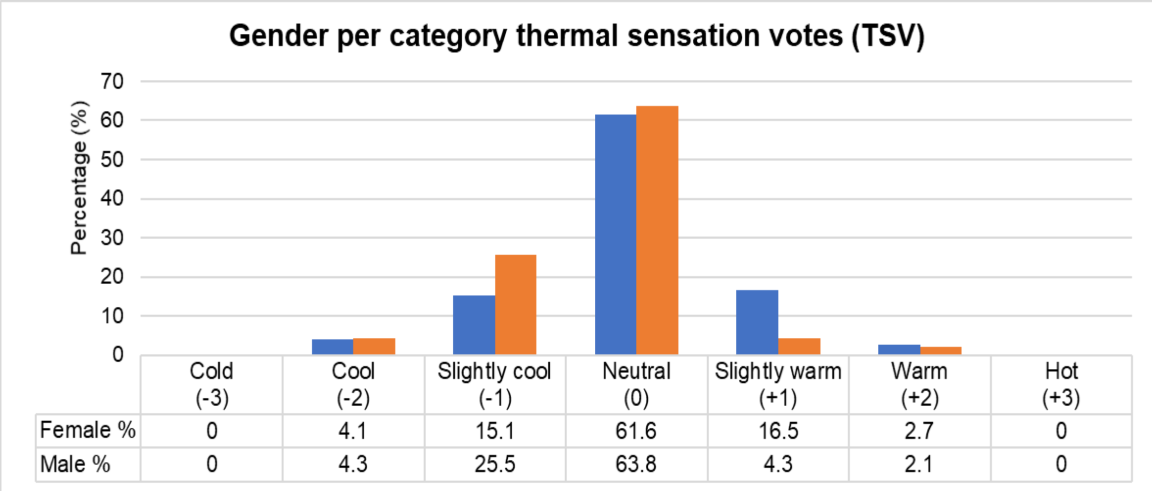
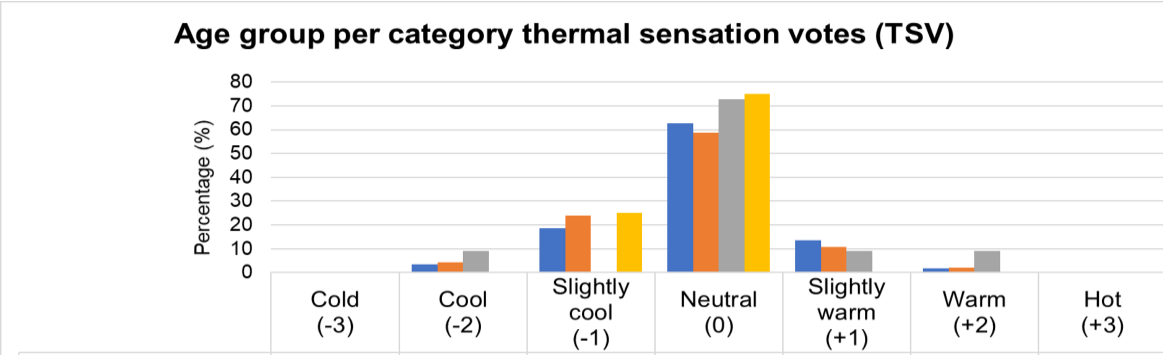


Figure 6.9: Percentage of gender per thermal sensation votes (TSV)

Surprisingly, the present results differed from prior studies which found that a large proportion of females fell in the extreme categories (+3 and -3), which suggested that female are at higher risk to thermal conditions in extreme categories (Sharmin and Steemers, 2018; Pantavou et al., 2013; Schellen et al., 2012; Krüger and Rossi, 2011). From the Chi-square test, the results showed that there was no relationship between TSV and gender (X^2= 5.34, p = .254). This means that the finding of this research disagreed with the previous studies, that men are less susceptible to heat exhaustion than women. Nevertheless, this study only has a small sample, indicating that a larger sample similar study would be worthwhile.

6.2.6.2 Relationship between age group and TSV

Although the Chi-square test revealed that no relationship was found between thermal sensation votes and age group (X^2= 6.94, p = .862), the cross tabulation showed some variation in the thermal sensation votes by different age group (See Figure 6.10). The result showed that a higher percentage of the older age group (55-64 years old) and senior age group (> 65 years old) felt ‘neutral’ compared to young age and middle age adults. It also showed that the senior age group tended to feel ‘slightly cool’ (-1), while some older age group were found to feel ‘cool’ (-2), ‘slightly warm’ (+1) and ‘warm’ (+2). The current findings are in agreement with previous studies that no association was found between TSV ranking and age group (Sharmin and Steemers, 2018; Krüger and Rossi, 2011), although Pantavou et al. (2013) found an opposite trend among older people who showed more sensitivity to heat.

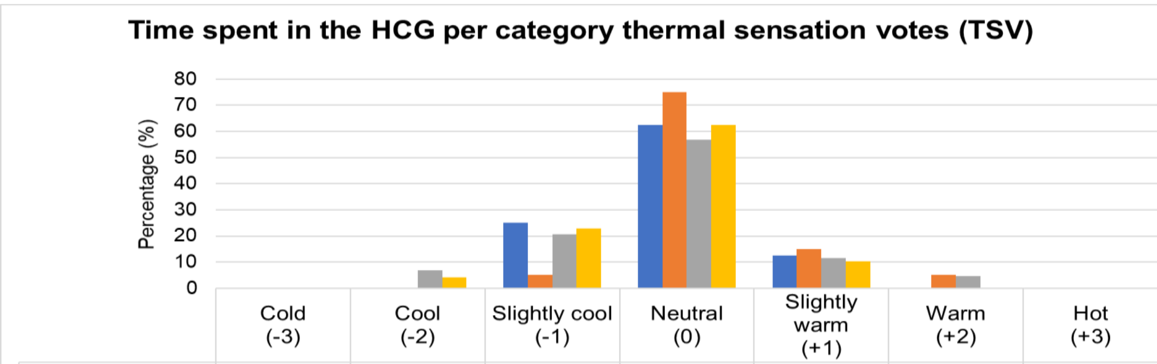


	Cold (-3)	Cool (-2)	Slightly cool (-1)	Neutral (0)	Slightly warm (+1)	Warm (+2)	Hot (+3)
Young adult %	0	3.4	18.6	62.7	13.6	1.7	0
Middle age adults %	0	4.3	23.9	58.7	10.9	2.2	0
Older age adults %	0	9.1	0	72.7	9.1	9.1	0
Senior age adults %	0	0	25	75	0	0	0

Figure 6.10: Percentage of gender per thermal sensation votes (TSV)

6.2.6.3 Relationship between the time spent in the HCG with the TSV

The current study found no significant difference between TSV and the length of time spent in the HCG (X^2=8.162, p= .772). However, the cross tabulation revealed that a higher percentage of those who felt 'neutral' spent around five to ten minutes in the HCG. Those **who felt 'cool' (-2) and slightly cool (-1) were found to have spent more than 30 minutes, while those who felt warm (+2) spent less than 30 minutes in the HCG** (See Figure 6.11). The present study suggests that people seem to stay longer in the HCG when they felt 'neutral' and 'slightly cool'. The present study is somewhat in accordance with a prior studies which found that people tended to spend more time in a square (19 min) and park (21 min) when the perceived thermal condition was within the acceptable comfort zone (slightly cool, comfortable, and slightly warm) (Thorsson et al., 2007).



	Cold (-3)	Cool (-2)	Slightly cool (-1)	Neutral (0)	Slightly warm (+1)	Warm (+2)	Hot (+3)
< 5 minutes %	0	0	25	62.5	12.5	0	0
5-10 minutes %	0	0	5	75	15	5	0
11-30 minutes %	0	6.8	20.5	56.8	11.4	4.5	0
> 30 minutes %	0	4.2	22.9	62.5	10.4	0	0

Figure 6.11: Percentage of the time spent in the HCG per thermal sensation votes (TSV)

6.2.7 Effect of orientation, courtyard ratio and vegetation on the microclimate conditions and outdoor thermal comfort of the HCG

Based on the physical site observation, **the courtyard configuration and vegetation** were studied to examine their impacts on microclimatic conditions and users' thermal comfort. Spatial geometric features of the HCG, including the **orientation and the courtyard ratio (size and height)**, were studied in detail to understand how these physical design parameters might influence the microclimatic conditions and users' thermal comfort.

6.2.7.1 Orientation

Buildings in a tropical climate receive higher solar intensity on the west walls and the roof while the wall facing in the north-south direction is less affected by the sun-radiation (Hanafi, 1991).The arrangement of the building form should be properly designed to minimise the impact of solar radiation. The building wall surface that face the east-west wall should be reduced, and the building wall surface facing a north-south orientation should be increased. This will form an elongated and thin building, as indicated in Figure 6.12.

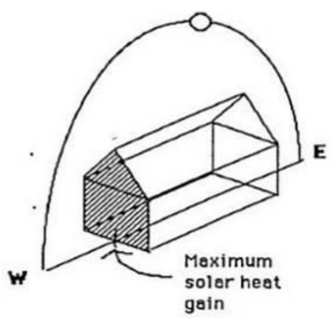
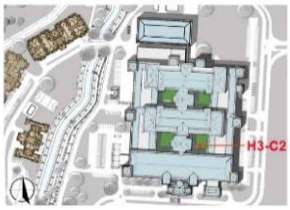
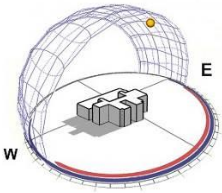
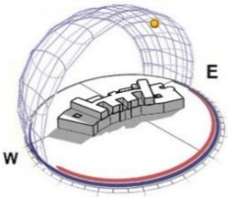
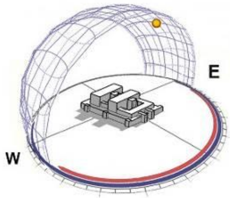


Figure 6.12: East and west orientation to reduce heat gain
Source: Hanafi (1991)

Solar radiation can influence the thermal comfort of the buildings. The high exposure of the long building plate will increase the heat in the building and decrease thermal comfort in a hot humid climate. A similar situation applies to the HCG where the orientation of the wider area of the HCG should be elongated to the South and North direction to minimise solar radiation penetration onto the HCG surface and increase the air temperature. In hot humid climates, increases in air temperature influenced the perception of thermal comfort in the HCG. Based on the east and west orientation diagram illustrated in Table 6.10, the large surface of the building wall in H1 and H2 faces in the north-south direction while the small surface building blocks facing the west-east side reduce the amount of solar received onto the large building wall of the hospital complex. However, in the case study H3 hospital, the large surface of the building wall was elongated towards a west-east orientation.

Table 6.10: East and west orientation of the HCGs

Description	H1-C1	H2-C3	H3-C2
Site Plan			
East and west orientation			

Additionally, the presence of wind flow in the HCG is also influenced by the orientation of the building and the enclosure of the HCG. If the opening of the HCG is placed in the direction of the prevailing wind, it can induce air into the HCG and bring natural ventilation into the adjacent spaces. It not only reduces the air temperature but also helps to cool the HCG and adjacent spaces which eventually improves thermal comfort.

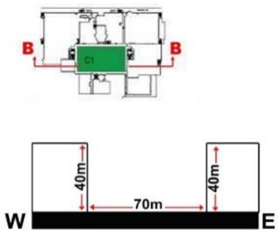
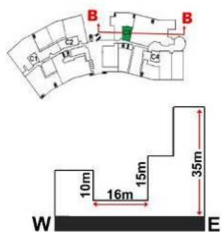
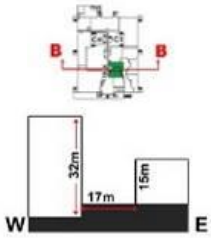
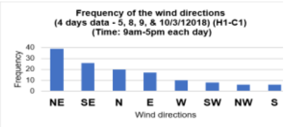
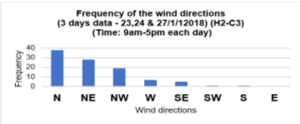
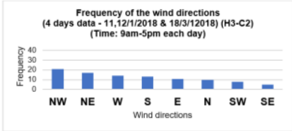
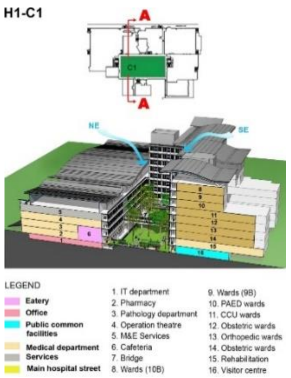
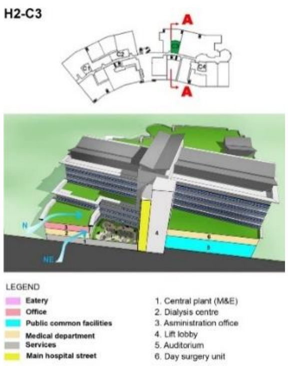
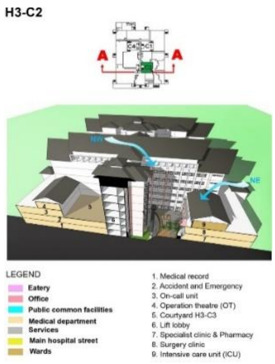
6.2.7.2 Courtyard ratio

a) Impact of courtyard ratio on the wind flow in the HCG

This study found that, the size (i.e. width and length) and the height of the courtyard have a significant influenced on wind movement and wind velocity in the HCG. In terms of size, H1-C1 is the largest HCG followed by H3-C2 and H2-C3. In terms of the height of the wall around the HCG, H1-C1 is the highest followed by H2-C3 and H3-C2. The length to height ratio is varied across the three sites (See Table 6.11). Comparing the size of the HCGs, H1-C1 has the most (higher) floor levels (10 floors) compared to H2-C3 and H3-C2 (8 floors).

The increment of the height of the wall enclosure around the courtyard causes a reduction in the wind speed in the courtyard space (Ghaffarianhoseini et al., 2015). Surprisingly, although the height of the building wall in H1-C1 is higher, it does not refrain from the wind flow onto the HCG as this was evidenced in the results of the monitoring data of an average wind speed recorded in H1-C1 as the highest compared to the other case study sites. This could be because the large size and width of the H1-C1 allows the wind flow into the HCG compared to the other case study sites which are four times smaller in size. This current study in the HCG of the case study hospitals found that the most frequent wind direction recorded came from the lower side of the hospital blocks which strategically oriented towards the prevailing wind (See Table 6.11).

Table 6.11: Courtyard ratio and wind flow in the HCG

Description	**H1-C1**	**H2-C3**	**H3-C2**
Size	2,100m² (including void area)	427m² (no void area)	460m² (including void area)
Total building floors	10 floors	8 floors	8 floors
Height around the HCG	N – 5 floors S – 9 floors **E – 9 floors** **W – 9 floors**	N – 2 & 3 floors S – 8 floors **E – 7 floors** **W – 2 floors**	N – 7 floors S – 3 floors **E – 3 floors** **W – 7 floors**
Length to height ratio *H=height* *L=Length*	**Ratio: 2 : 3 : 2** H-East: 40m = 2 L- South: 70m = 3 H-West: 40m = 2	**Ratio: 2 : 1 : 2** H-East: 30m = 2 L-South: 15m = 1 H-West: 10m = 2	**Ratio: 2 : 1 : 1** H-East: 32m = 2 L-South: 17m = 1 H-West: 15m = 1
N=North *S=South* *E=East* *W=West*			
Prevalent wind direction	NE & SE (Most frequent)	N & NE (Most frequent)	NW & NE (Most frequent)
Wind direction			
Sectional perspective of the HCG indicating the movement of the wind			
Average wind speed	1.3 m/s (light breeze)	0.1 m/s (calm)	0.24 m/s (calm)
Max wind speed	3.9 m/s (light breeze)	1.11 m/s (light air)	1.23 m/s (light air)
Users' wind sensation votes	30.5% felt windy or 'too much wind'	11.1% felt windy	None felt windy or too much wind

Based on the researchers' own experience and site observation throughout the day, the breeze could be frequently felt in H1-C1 compared to H2-C3 and H3-C2. The wind in H1-C1 can be felt on the face, and the leaves rustle, especially during the afternoon and late afternoon compared to H2-C3 and H3-C2. Moreover, based on the wind speed sensation votes, as described previously in Section 6.1.2, 30.5% of the users in H1-C1 mentioned that they felt windy and too much wind, but only 11.1% of users in H2-C3 felt windy. None of the respondent in H3-C2 felt the HCG as windy.

Overall, this study suggests that an increase in the width of the courtyard garden can significantly improve the wind flow in the HCG. This is evidenced in the case study H1-C1 which recorded higher average wind-flow compared to the other case study sites. Moreover, the orientation of the lower part of the courtyard wall facing to the prominent wind direction can also increase the wind flow to the HCG and increase cooling effect in the HCG. This is in accordance with a previous study which found that a courtyard building, a shallow building (i.e. a maximum of five floors) strategically oriented towards the prevailing wind provided better natural ventilation in the building (Haase and Amato, 2009).

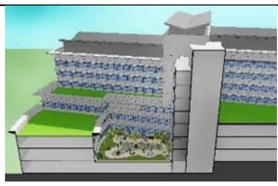
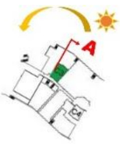
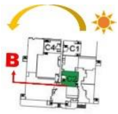
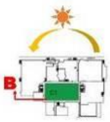
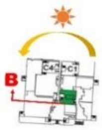
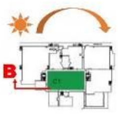
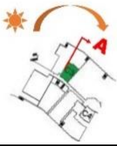
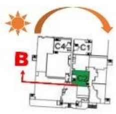
b) Impact of courtyard ratio on the solar radiation and air temperature in the HCG

Similarly, the size and the height also influenced on the amount of solar penetrate to the HCG. This present study found that there was a relationship with the amount of solar radiation received onto the HCG sites with an increase in air temperature in the HCG. Based on the observation, the courtyard wall that facing the west (W) and east (E) side of H1-C1 is at a similar height (E: 9 floors, W: 9 floors). However, in the H2-C3 the wall height is differed (E: 7 floors, W:2 floors) and H3-C2 is (E: 3 floors, W:7 floors) (See Table 6.12).

This current study also found a significant effect of the height of the courtyard wall with the air temperature in the case study HCGs: the higher the courtyard wall, the lower air temperature recorded in the HCG. This is evidenced in the H2-C3 which has the highest temperature followed by the H2-C3 and H1-C1 (As mentioned previously in Section 6.2.1.1). The west side wall in the H2-C3 is the lowest (2 floors) which has caused a high exposure to solar radiation during the afternoon and increased the air temperature. Moreover, a higher temperature was recorded in all the three sites during the mid-afternoon (12 pm to 3.30 pm) because these HCGs were highly exposed to sunlight (See Table 6.12). This is in accordance with previous studies which found that a higher temperature was recorded in the area exposed to direct solar radiation (Du et al., 2019; Yang et al., 2013; Ali-Toudert, 2005).

This study suggests that **a higher wall facing the east and west orientation of the HCG sites can reduce the amount of solar radiation onto the ground of the HCG and decrease air temperature.** Eventually, it enhances the outdoor thermal comfort in the HCG and increases visitation to the HCG especially in the morning and late afternoon.

Table 6.12: HCG areas that are exposed to solar radiation throughout the day

Description	H1-C1	H2-C3	H3-C2
Height around the HCG	N – 5 floors S – 9 floors **E – 9 floors** **W – 9 floors**	N – 2 & 3 floors S – 8 floors **E – 7 floors** **W – 2 floors**	N – 7 floors S – 3 floors **E – 3 floors** **W – 7 floors**
3D illustration: **Morning daylight**	 	 	 
3D illustration: **Afternoon daylight**	 	 	 
3D illustration: **Evening daylight**	 	 	 

6.2.7.3 Vegetation

a) Impact of vegetation on the solar radiation and air temperature in the HCG

Moreover, the use of vegetation in an outdoor space can result in a reduction in the air temperature and improve the outdoor thermal comfort environment (Ghaffarianhoseini et al., 2019; Nouri et al., 2018; Taleghani, 2018; Morakinyo et al., 2016; de Abreu-Harbich et al., 2015; Yahia and Johansson, 2014; Shashua-Bar et al., 2011). Based on the site observation, H1-C1 evidenced ample vegetation with a variety of tree canopies compared to H2-C3 and H3-C2. H2-C3 has no canopy trees while only some parts of H3-C2 were shaded with palm trees. The amount of exposure to solar radiation in H1-C1 was slightly lower compared to the other case study sites because of the presence of the tree canopies that helped to filter the amount of daylight hitting the ground surface and adjacent indoor spaces. Almost 60% of the area was shaded during the afternoon time. 70% of the HCG spaces were shaded, leaving 30% unshaded and exposed to solar radiation in the afternoon. In H3-C2, 40% of the area was shaded, leaving 60% of the area unshaded and exposed to solar radiation (See Table 6.13).

As mentioned previously in Section 6.1.2 regarding the thermal sensation votes, a higher percentage of users in H1-C1 mentioned that they felt slightly cool (34.8%) compared to the other case study sites. Whereas a higher percentage of users in both H2-C3 and H3-C2 reported that they felt slightly warm compared to H1-C1. **Therefore, this study suggests that an increased amount of vegetation and planting and tree canopies in the HCG can reduce solar radiation and lower the temperature in the case study HCG**.

Table 6.13: Landscape characteristics and design features in the HCG

Description	H1-C1	H2-C3	H3-C2
Ariel view			
Ratio Hardscape: Softscape	20:80	40:60	60:40

Overall, this study suggests **that orientation, courtyard ratio (i.e. size and height of the wall) and vegetation** are important design strategies that can help to cool down the microclimate in the HCG and provide a more comfortable environment by reducing the amount of solar radiation and the air temperature, improving the wind flow and the evaporative cooling in the HCG.

6.3 Users' perceptions on the importance of the environmental design aspects in the HCG

The results for this section were also based on survey interview data carried out with a total of 120 respondents (As described earlier in Section 3.5.2). Additionally, 5-point Likert scale questions from very important to not important were asked to assess how they perceived the factors related to the environmental design aspects (See Question 13, in Appendix 1). A cross-tabulation and Chi-square test were carried out to examine the association between demographic data and the users' perceptions of the environmental design aspects.

6.3.1 Users perceptions of the importance of the environmental design aspects across the three case study sites

The result of a cross-tabulation across the different HCGs showed that over 80% of the respondents in H2-C3 and more than 90% of the respondents in H1-C1 and H3-C2 thought that the shaded area, daylighting, breeze and fresh air as well as a comfortable temperature in the HCG were either important and very important to them (See Figure 6.13).

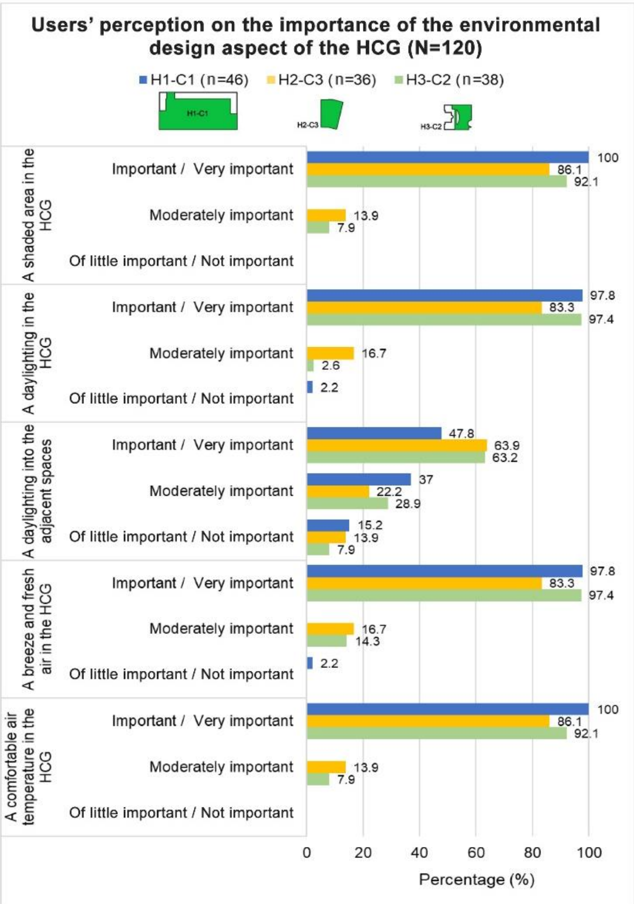


Figure 6.13: Users' perceptions of the importance of the environmental design aspects in the HCG

While daylighting in the HCG was highly rated by over 80% of all respondents in the three sites as either important or very important, over 60% of the respondent in the H2-C3 and H3-C2 and 47.8% of the respondents in the H1-C1, thought that daylighting in the adjacent spaces was either important or very important to them. Surprisingly, less than 16% of the respondent in all three sites thought that daylighting in the adjacent space was either of little importance or not important to them. The possible reason could be because to some people in a hot humid climate, they often associate daylighting with solar radiation and heat which caused an uncomfortable environment in the adjacent space (ref). Another reason could be because daylighting can cause glares on the floor of the adjacent space which impacted on their visual discomfort.

6.3.2 Association of the users' perceptions of the importance of the environmental design aspects with the three case study sites

The Chi-square test also revealed that there was a significant association between the three case study HCGs with perceptions of the importance of a breeze and fresh air (X^2=12.75, p=.013) and a comfortable air temperature (X^2=6.396, p=.041) in the HCG (See Table 6.14). A higher percentage of those who perceived a comfortable temperature and breeze and fresh air in the HCG suggested an important finding to provide a comfortable environment and natural ventilation in the HCG through the proper application of a passive cooling strategy in a building.

Table 6.14: Chi-square test results on the perceived of the environmental design

Perceived importance of the environmental design by different case studies	Chi-Square test (p-value)	Significant
A shaded area in the HCG	X^2=2.247, p=.325	p > 0.05 (No)
A daylighting in the HCG	X^2=2.423, p=.658	p > 0.05 (No)
A daylighting into the adjacent spaces	X^2=3.670, p=.453	p > 0.05 (No)
A breeze and fresh air in the HCG	X^2=12.75, **p=.013**	P < 0.05 (Yes)
A comfortable air temperature in the HCG	X^2=6.396, **p=.041**	P < 0.05 (Yes)

6.3.3 Relationship of perceived importance of environmental design with the demographic data

A cross tabulation between demographic data (e.g. types of user, gender, age group and ethnicity) with the perceived importance of the environmental design are analysed and discussed below.

6.3.3.1 A shaded area in the HCG

The results found that there was no significant association between the types of users (X^2 =2.55, p=.280), gender (X^2 =3.36, p=.067), age groups (X^2 =3.92, p=.270), and ethnicity (X^2 =4.78, p=.188) with the perceived importance of shaded area in the HCG (See Figure 6.14). The results showed some variation in the response of different gender. All males perceived the shaded area as either important or very important, but more than half of the female group perceived it as moderately important. Moreover, all older age adults and senior age adults and more than 80% of the young adults and middle age adult users thought that the shaded area in the HCG was either important or very important to them.

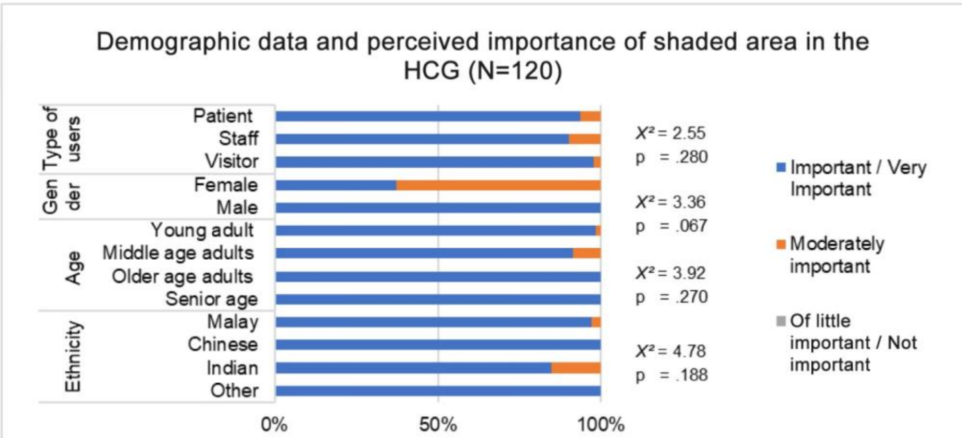


Figure 6.14: Percentage of demographic data by perceived importance of shaded area in the HCG

6.3.3.2 A daylighting in the HCG

A significant difference was found between different age groups with the perceived importance of daylighting in the HCG (X^2 =17.14, p=.009) (See Figure 6.15). More than 50% of the young age and middle age group and all older age adults perceived daylighting as either important or very important. However, 25% of the senior age group thought that daylighting was either important or of little importance to them. Additionally, the present study found that no significant difference was found between the types of users (X^2 =1.62, p=.806), gender (X^2 =.673, p=.714), and ethnicity (X^2 =2.93, p=.818) with the perceived importance of daylighting in the HCG.

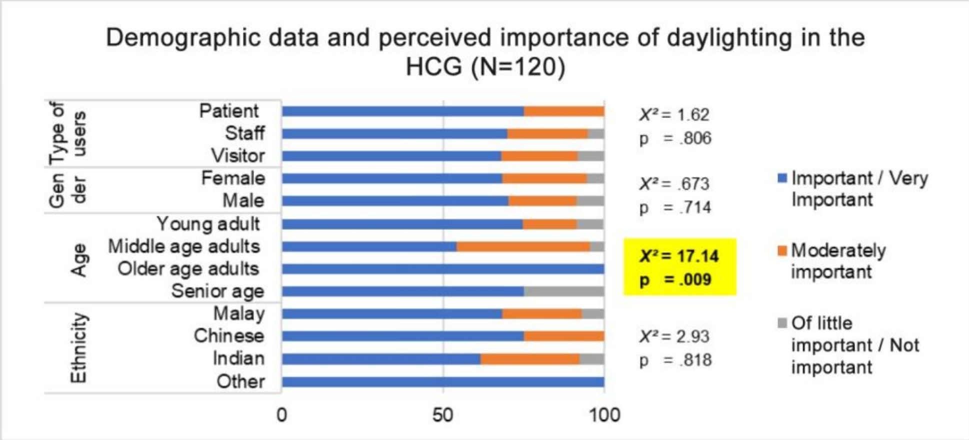


Figure 6.15: Percentage of demographic data by perceived importance of daylighting in the HCG

6.3.3.3 Daylighting in the adjacent spaces

In terms of the importance of daylighting into the adjacent space, the results showed a significant association with the types of users (X^2 =9.38, p=.05) (See Figure 6.16). While 25% and 13.2% of the visitors thought that the daylighting into the adjacent space was either of little importance or not important to them, none of the staff perceived it as either of little importance or not important to them. However, the study found there was no significant relationship between different types of users (X^2 =8.29, p=.082), gender (X^2 =.743, p=.690), age groups (X^2 =4.28, p=.639) and ethnicity (X^2 =8.72, p=.190) with the perceived importance of the flowering shrubs.

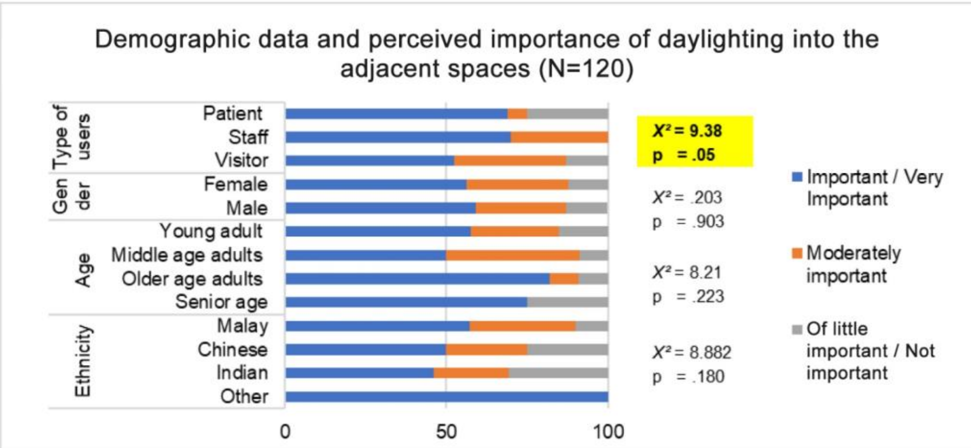


Figure 6.16: Percentage of demographic data by perceived importance of daylighting into the adjacent space

6.3.3.4 A breeze and fresh air in the HCG

Further analyses showed that a significant difference was found between the perceived importance of a breeze and fresh air in the HCG with ethnicity (X^2 =16.82, p=.010) (See Figure 6.17). The results showed that all Chinese and Other ethnic respondents (minority and expatriates) and over 90% of Malay respondents perceived a breeze and fresh air as either important or very important to them. However, some of the Indian ethnic respondents thought breeze and fresh air in the HCG as either of little importance or not important.

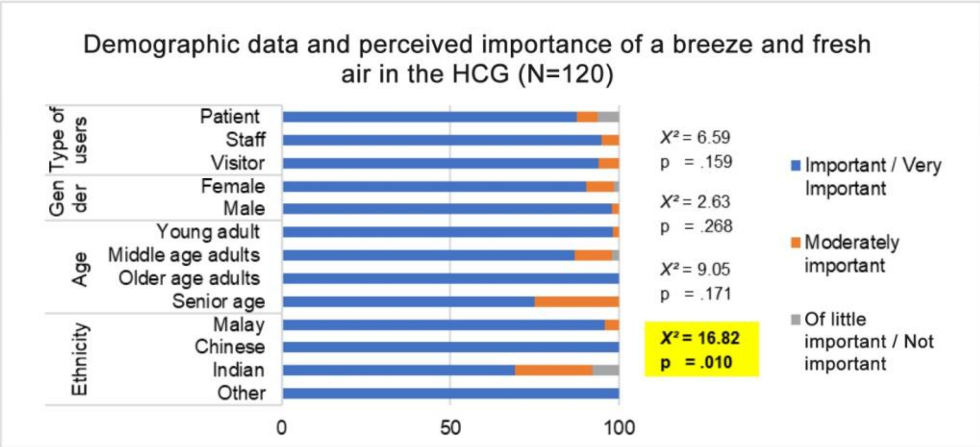


Figure 6.17: Percentage of demographic data by perceived importance of a breeze and fresh air in the HCG

6.3.3.5 A comfortable air temperature in the HCG

The study found that there was a significant association between a perceived comfortable air temperature with age groups (X^2 = 33.45, p=.000) (See Figure 6.18). The results showed that none of the users of different gender, age and ethnicity thought that a comfortable air temperature was not important. More than 80% of young age and middle age and all the older age group perceived comfortable air temperature in the HCG as either important or very important to them, and 75% of the senior age group thought it as moderately important.

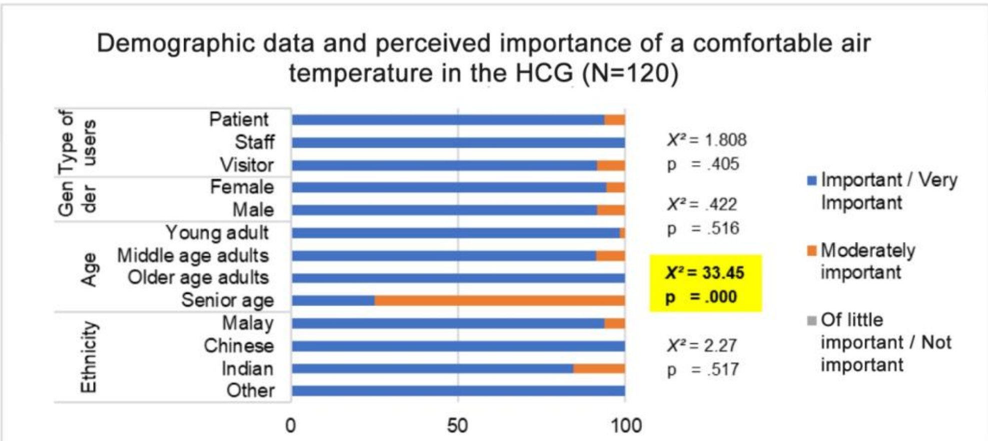


Figure 6.18: Percentage of demographic data by perceived importance of a comfortable air temperature in the HCG

6.4 Users' space use pattern in the selected case study HCG

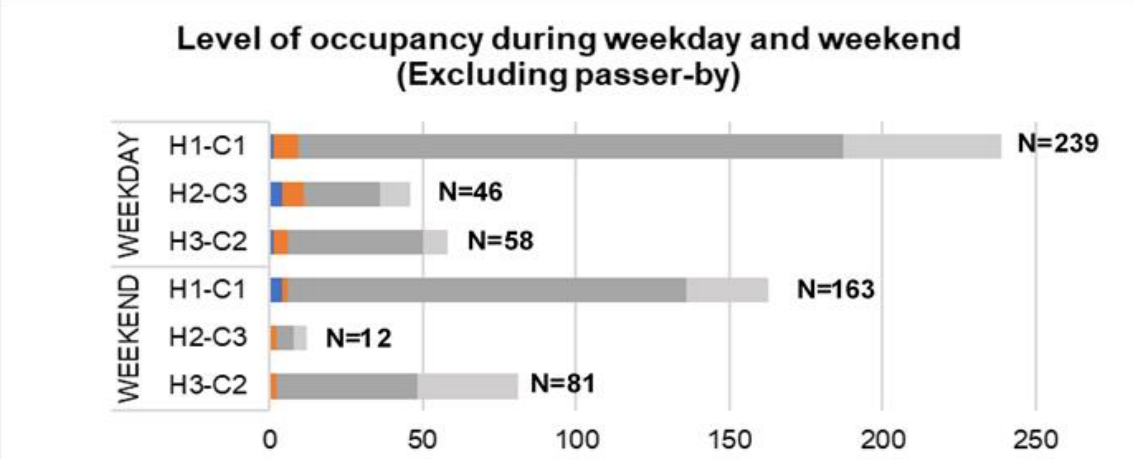
The previous sections have focused on the environmental aspects. This section will mostly elaborate on the **socio behavioural and cultural aspects of the HCGs** by examining users' space use patterns and their experiences while spending time in the HCG. The first section presents user space use patterns based on the on-site observation which includes the results of daily occupancy during a weekend and a weekday of the three case study sites and the spatial mapping of the types of activities by different types of users (See Section 6.4.1 to 6.4.4). Further, this section presents the results of the survey related to the users' activities (See Section 6.4.5). Finally, it discussed the factors that influenced the rhythm of user occupancy in the HCG, including the physical design, the microclimatic conditions and the hospital opening hours (See Section 6.4.6).

The results presented here were based on the on-site observation (i.e. direct and video-based observation (See Section 3.4.6.2) and a survey interview with the users (Section 3.4.6.4). The eight hours of observation from 9 am to 5 pm on two weekdays and two weekends were carried out in all three case study sites in January 2018 (H2-C3 and H3-C2) and March 2018 (H1-C1). It should be noted that due to time constraints (As explained earlier in Section 3.4.6.2), only the data from one weekday (8-hours) and one weekend (8-hours) for each site, with a total of 48 hours observation, were analysed and presented in this study. For the analysis, a mapping analysis using GIS software and frequency analysis using Microsoft Excel were used to analyse the observation data (See Section 3.6.3). Additionally, several questions related to the types of activities and duration of time spent were also asked to the HCG users to strengthen, support and validate the findings of the observation data as presented in Section 6.4.5) (Refer to Question 16 to 19, in Appendix 1). This survey data was analysed using frequency analysis in SPSS software.

6.4.1 Daily occupancy of different types of users during a weekday and a weekend

Based on a total of 48-hours observations during a weekday and a weekend in all the three representative HCGs, it became apparent that **the main users of the HCG were the visitors followed by staff and patients.** Based on the percentage of average HCG users, then, this study shows that the HCGs were primarily used by the adult visitors (72%) and children (22%) followed by staff (4%) and patients (2%). Based on the overall 8 hours observation per day in each site, it was found that **H1-C1 had the highest level of daily occupancy (excluding the passer-by) for a weekday (n=239) and a weekend (n=163) compared to H3-C2 and H2-C3** (See Figure 6.19). However, including the passer-by, H3-

C2 evidenced the higher number of respondents for both the weekday (n=720) and weekend (n=662) followed by H1-C1 and H2-C3. H3-C2 evidenced the lowest number of occupancies compared to the other case studies, with only (n=58) spending time on the weekday and (n=12) spending time in the HCG on the weekend.



	WEEKDAY			WEEKEND		
	H1-C1	H2-C3	H3-C2	H1-C1	H2-C3	H3-C2
Patient	1	4	1	4	0	0
Staff	8	7	5	2	2	2
Visitor (Adult)	178	25	44	130	6	46
Visitor (Children)	52	10	8	27	4	33

Figure 6.19: Level of occupancy during weekdays and weekends (Excluding the passer-by)

Figure 6.19 shows that, in H1-C1 and H2-C3, a higher number of visitors spent time in the HCG during the weekday compared to the weekend. The operation hour factor such as the clinic hours on the weekday could possibly increase the numbers of occupancy during the weekday, as the clinics were closed at the weekend. Conversely, in H3-C2, more visitors spent time in H3-C2 during the weekend than the weekday. This showed that a large group of people came with their family to H3-C2 during the weekend to visit their relatives in the wards. Therefore, more children were observed spending time in H3-C2 during the weekend compared to the weekday. Moreover, because of the restriction on children visiting the wards, they often spent time in the HCG while waiting for their parents who were visiting relatives or friends in the ward.

It was also observed that more staff spent time in the HCG during the weekday compared to the weekend in all three case study sites. The possible reason for this was that a lower number of staff spent time during the weekend because the office was closed during the weekend. Although they were observed to spend some time in the HCG both at the weekend and weekday, they only spent a very limited time in the HCG due to being occupied with busy tasks in the clinic or office. Some of them spent a few minutes to sit and rest, use a phone, or patrol around, while others were observed to have lunch or breakfast.

While patients were observed to spend more time during the weekday in H2-C3 and H3-C2, more patients were observed to spend time in H1-C1 during the weekend rather than the weekday. A long visiting hour from 12.30 pm to 7 pm during the weekend could be the factor that encouraged visitors to bring their family members who have been hospitalised to spend time and socialise in H1-C1. Conversely, none of the patients were seen to spend time in H2-C3 and H3-C2 during the weekend. The patients who were observed in H2-C3 during a weekday were those who had a rehabilitation program with the staff on the day of the observation.

6.4.2 Spatial distribution of different types of users on both weekend and weekday

The aims of the spatial mapping were to integrate the spatial and observation data to understand and visually inform how the places were used by the users (Mennis et al., 2015; Goličnik and Ward Thompson, 2010). Table 6.15 and 6.16 presents the spatial distribution by different types of users on both a weekday and a weekend based on GIS mapping (As described earlier in Section 3.6.3.1). The results of the spatial mapping in the three case study sites showed that a higher number of HCG users were recorded in H1-C1 and H3-C2 compared to H2-C3 for both the weekend and weekday.

The distribution of the different types of users on both the weekend and weekday showed that a higher proportion of visitors' distribution were found along the walkway which linked the several entrances in the HCG in both H1-C1 and H3-C2. The distribution of people in the three case study sites evidenced a very high density, especially at the seating area. For H1-C1, the concentration of the distribution of visitors and patients was at the pergola shaded seating area, the bench around the water fountain and seating under the bridge, while in H3-C2 it was at the table and bench area. The visitors were seen to disperse around H3-C2 because of a lack of choice of seating option. Whereas more staff were found to spend time on a weekday in H2-C3 and H3-C2, a significantly high proportion of staff were seen to pass through the HCG during the weekend in H1-C1 (See Table 6.16).

Table 6.15: Space use pattern by different types of users during a weekday

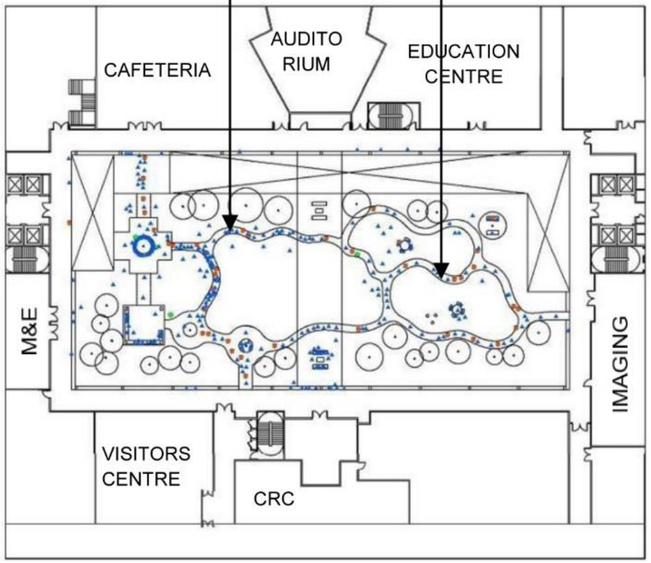
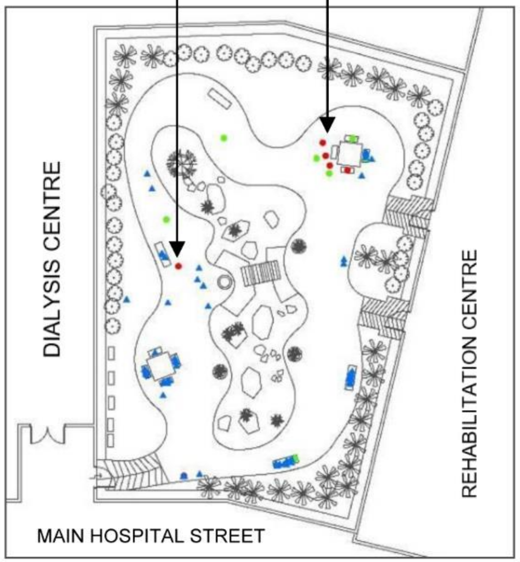
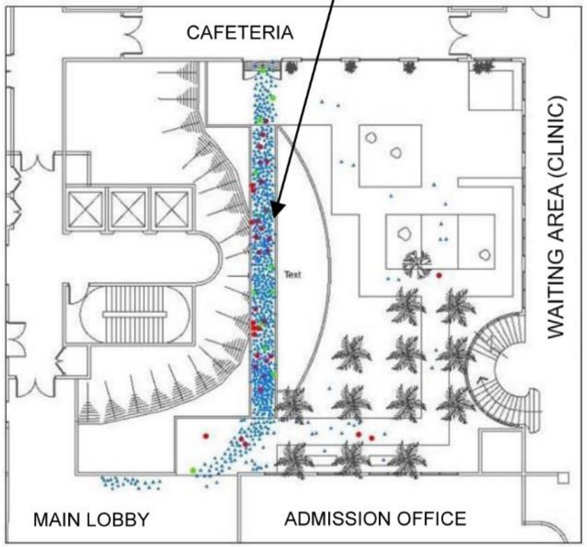
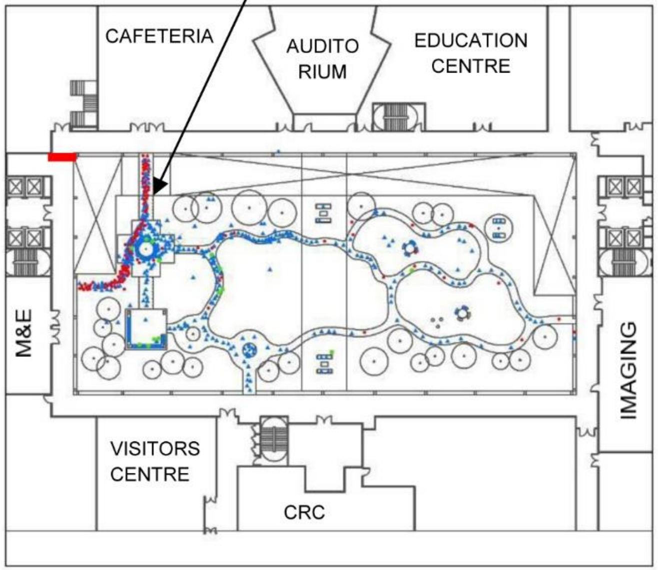
<table>
<tr><th colspan="3">WEEKDAY OBSERVATION (9AM – 5PM)</th></tr>
<tr><th>H1-C1</th><th>H2-C3</th><th>H3-C2</th></tr>
<tr>
<td>Most of the staff and visitors are found to walk around and pass through the HCG to go to another department. The variety of options of walkways within a spacious HCG allows flexibility for them to choose their path around the HCG.</td>
<td>Patients and staff are observed to walk around the walkway in the HCG during the rehabilitation program day. Other users are observed to sit on the bench and look around the HCG.</td>
<td>Very few people spent time walking around or sit on a bench in the weekday. The majority of them use the covered walkway to pass through the HCG to go to the cafeteria.</td>
</tr>
<tr>
<td>
</td>
<td>
</td>
<td>
</td>
</tr>
<tr>
<td>**Legend** N=520
H3_WEEKDAY - VISITOR
H3_WEEKDAY - STAFF
H3_WEEKDAY - PATIENT</td>
<td>**Legend** N=58
H3_WEEKDAY - VISITOR
H3_WEEKDAY - STAFF
H3_WEEKDAY - PATIENT</td>
<td>**Legend** N=720
H3_WEEKDAY - VISITOR
H3_WEEKDAY - STAFF
H3_WEEKDAY - PATIENT</td>
</tr>
</table>

Table 6.16: Users' space use patterns by different type of users in the weekend

WEEKEND OBSERVATION (9AM – 5PM)

H1-C1

Many staff were found to pass through the HCG via the shortest path in the HCG to go to the upper floor via the lift core at the west side of the hospital because the door along the main hospital street is locked during the weekend.

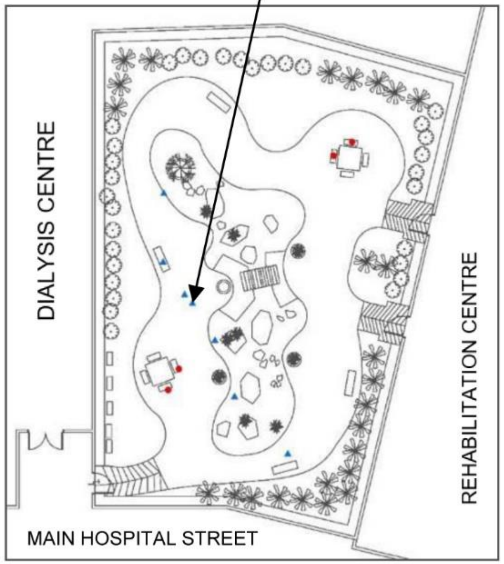


Legend **N=481**

- H1-WEEKEND - PATIENT
- H1-WEEKEND - STAFF
- H1-WEEKEND - VISITOR

H2-C3

Most people come to this HCG to sit. Only parents with a child are observed to walk around with their children in the HCG.

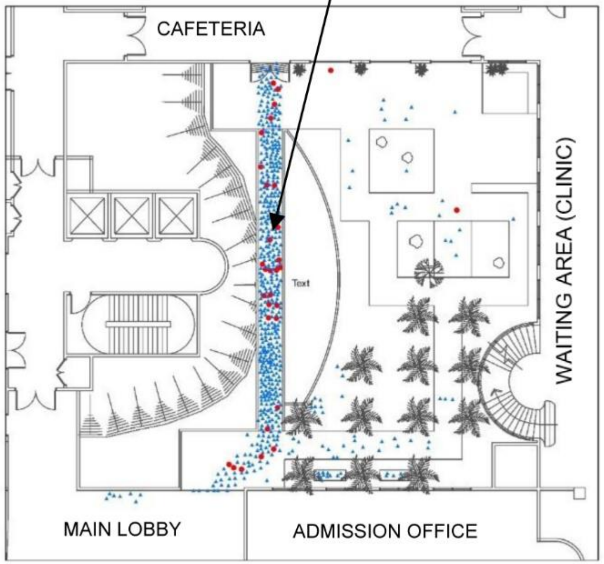


Legend **N=12**

- H1-WEEKEND - PATIENT
- H1-WEEKEND - STAFF
- H1-WEEKEND - VISITOR

H3-C2

More people walked around/passed through the HCG in the weekend. Similar to the weekday observations, most hospital users tended to use the covered walkway to pass through the HCG to the cafeteria.



Legend **N=662**

- H1-WEEKEND - PATIENT
- H1-WEEKEND - STAFF
- H1-WEEKEND - VISITOR

6.4.3 Level of occupancy at different time of the day on a weekday and a weekend

Examining the level of occupancy of different types of users at different times of the day on both weekday and weekend, this study found **that there was a significant variation in the pattern of usage among the HCG users** at different times of the day in the three case study hospitals (See Figure 6.20).The result in both H1-C1 and H3-C2 showed a higher number of occupancy in the weekend morning and lower in the weekend afternoon (1 pm to 3 pm). However, the results in H3-C2 showed that a higher number of users spent time in the HCG during the weekday morning from 9 am to 3 pm compared to the weekend.

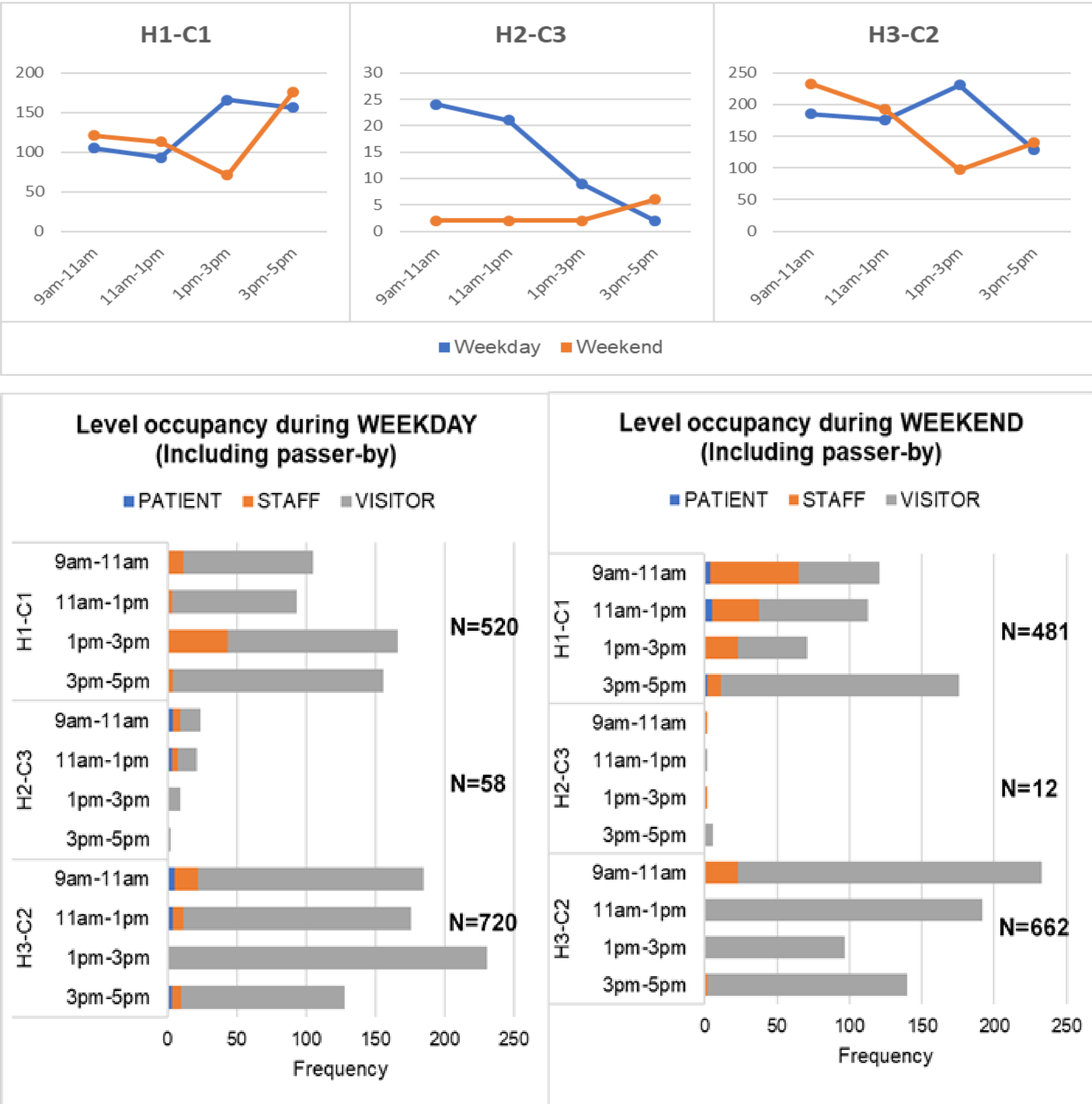


Figure 6.20: Level of occupancy by different types of users at different time of the day on a weekday and a weekend (including the passer-by)

6.4.4 Frequency and spatial distribution of activities by different types of users on a weekday and a weekend.

Based on the weekday and weekend observations, the result showed that the frequency and density used among all types of users in both H1-C1 and H3-C2 were higher than the H2-C3 during both the weekday and weekend (Figure 6.21). Moreover, the most frequent activities recorded among visitors and staff in H1-C1 and H3-C2 was walking (e.g. walking around or pass through), but in H2-C3, the most frequent activity recorded was sitting. Nevertheless, very few visitors, patients and staff were found sitting in H3-C2 due to the lack of available seating facilities in this H3-C2 compared to the other case study sites.

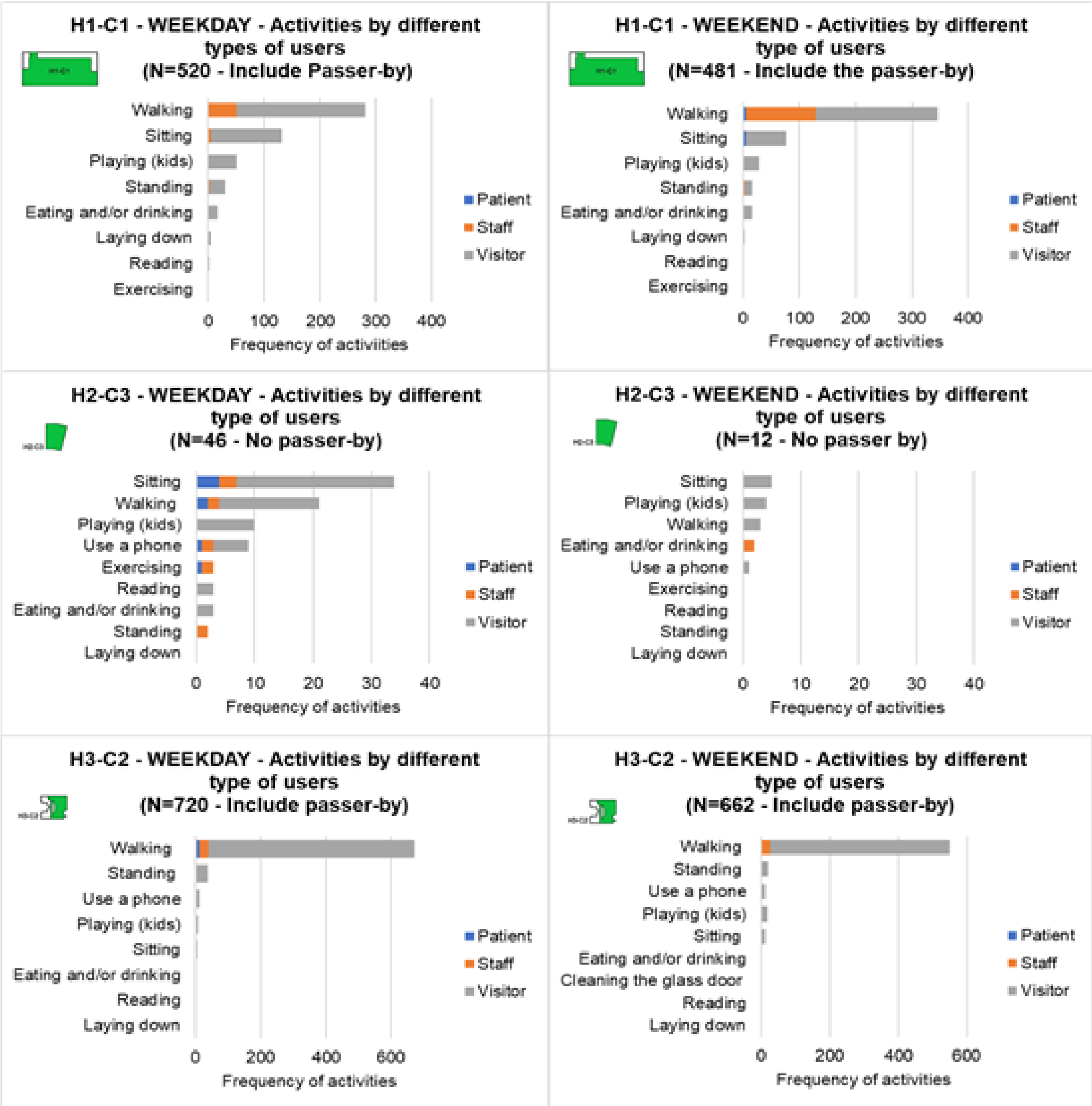


Figure 6.21: Frequency of activities by different types of users in the three case study sites on a weekday and a weekend

It was observed that visitors recorded the highest frequency and distribution of activities compared to staff and patients in all three case study sites. The most frequent types activities that were recorded among the visitors in both H1-C1 and H3-C2 were walking to pass through the HCG to go to other departments. In contrast, such activity was not recorded in H2-C3 as it only had one door opened throughout the day for public access, while the other case study sites had several entrances. This study suggests that, apart from **the availability of seating facility, the number of entrances in the HCG significantly influenced the types of activity and level of occupancy in the HCG.** In addition to activities such as walking and sitting, other activities recorded in the three case study HCGs included children playing around in the HCG, standing, phone use, eating and/or drinking as well as reading a book or newspapers (See Table 6.17 and Table 6.18).

Another significant activity among the visitors not recorded in H2-C3 and H3-C2, but was very common to observe in H1-C1, was laying down on the seating area around the periphery of H1-C1, especially during the late afternoon on both the weekend and weekday (See Figure 6.22). This group of people are among those who have been in the hospital from the morning and had to travel to the hospital from far away. Providing a break area with a comfortable microclimate as in H1-C1 allowed them to rejuvenate and refresh their state of mind before visiting family in the wards.

Figure 6.22: Several visitors were laying down on a bench under the pergola shaded seating area and bench around the periphery of the H1-C1 at 3.59 pm on a weekday

Comparing the frequency and usage of the HCG among a group of patients in the three case study sites, it was found that **more patients spent time in H1-C1, followed by H3-C2 and H2-C3.** It was very commonly observed during the weekday afternoon and late afternoon in the weekend that patients spent time in H1-C1 either with friends or family members, but none of the patients were recorded spending time in both H2-C3 and H3-C2 at the weekend. During the fieldwork in H2-C3, in the weekday morning (10 am to 11.45 am), a physical exercise program was held by the staff with the rehabilitation patients which increased the number of patients recorded on that day (See Figure 6.23). However, another observation during a different weekday in the H2-C3 showed that only a few patients spent time in the HCG during the weekday morning while waiting for their appointments. Similarly, in H3-C2, only one patient was found to spent time in H3-C2 while waiting for her mother to pay her hospital bills (See Table 6.17 and Table 6.18).

Figure 6.23: The rehabilitation program held in H3-C2 on the weekday morning

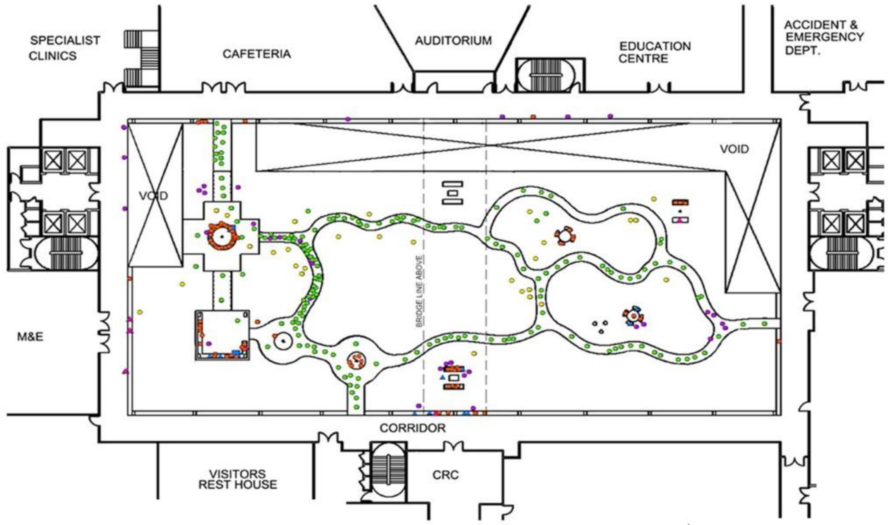
Regarding activities among the staff, it was observed that most of the activities recorded among the medical and administrative staff in H1-C1 and H2-C3 was that of walking to pass through to go to the cafeteria or other departments and units in the hospital. Only a few gardening and service staff were found to spend time in the HCG, to do upkeeping on the weekday morning and sit and rest during the lunch hour. Also, a member of security staff was observed to patrol around in H1-C1 during both the weekend and the weekday morning. Conversely, in H2-C3, it was found that a medical staff member held a rehabilitation program with a patient and a gardener cleaning the HCG during the weekday morning, while at the weekend, some security staff were observed having breakfast and lunch in H2-C3. Similarly, only a gardener was found to clean up H3-C2 during the weekday morning and security staff patrol in H3-C2 during both the weekday and weekend (See Table 6.17 and Table 6.18)

Table 6.17: Different type of activities in the case study sites during a weekday

WEEKDAY OBSERVATION (9am-5pm)

H1-C1

DATE: 5/3/2018 – MONDAY (9am-5pm) - Not raining



Legend

- WALKING AROUND
- STANDING
- SITTING ON A BENCH
- READING
- PLAYING AROUND
- LAY DOWN ON A BENCH
- EATING AND/OR DRINKING

N = 520

VISITOR Time: 9.00am Sitting and hold a baby

VISITOR Time: 10.41am Sitting on a bench

VISITOR & PATIENT Time: 11.30am Sitting on a bench

VISITOR Time: 11.04am Sitting and playing around

VISITOR Time: 11.35am Sitting on a bench

VISITOR Time: 1.39pm Look around

VISITOR & PATIENT Time: 2.28pm Sit and talk

VISITOR Time: 2.24pm Use a phone

VISITOR Time: 2.25pm Sit and eating

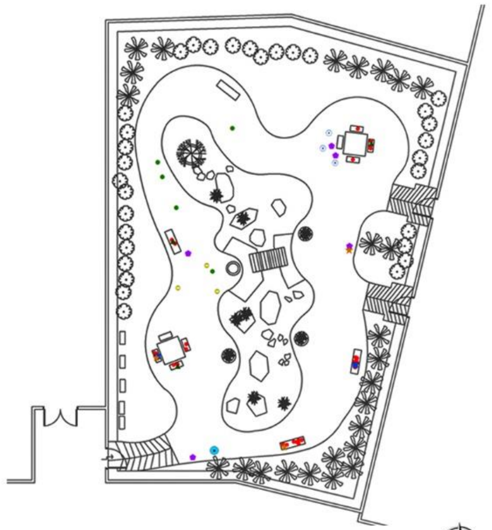
VISITOR Time: 3.25pm Sitting on a bench

VISITOR Time: 3.26pm Lay down on a bench

VISITOR Time: 3.26pm Lay down on a bench

H2-C3

DATE: 23/1/2018 – TUESDAY (9am - 5pm) - Raining at 4.00 pm



Legend

- EXERCISING
- USE A PHONE
- STANDING
- WALKING AROUND
- EATING
- PLAYING
- READING
- SITTING ON A BENCH
- CLEANING

N = 58

PATIENT Time: 9.38am Sitting on a bench

VISITOR Time: 9.38am Reading a newspaper

GARDENER Time: 9.30aM Cleaning

STAFF & PATIENT Time: 11.15am Exercising

VISITOR Time: 11.10am Playing around

STAFF AND PATIENTS Time: 11.26am Physiotheraphy program

VISITOR Time: 10.46am Walking & playing around

VISITOR Time: 1.20pm Sitting on a bench

VISITOR Time: 12.34pm Use a phone

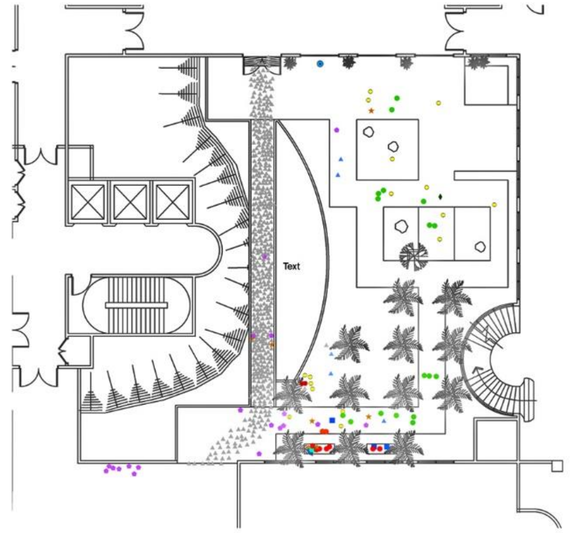
VISITOR Time: 1.30pm Sitting and eating

STAFF Time: 1.40pm Use a phone

VISITOR Time: 2.00pm Sitting on a bench

H3-C2

DATE: 11/1/2018 – Thursday (9am - 5pm) - Raining at 3.40 pm



Legend

- PASS THROUGH A BRIDGE
- PASS THROUGH A GARDEN
- WALKING AROUND
- USE A PHONE
- STANDING
- SITTING ON A BENCH
- SITTING ON A FLOOR
- READING
- EATING
- PLAYING
- PATROL
- LOOKING DOWN A SLOPE
- CLEANING

N = 720

VISITOR Time: 9.38am Use a phone

PATIENT Time: 11.15am Pass through a bridge

VISITOR Time: 11.21am Walking & playing around

STAFF Time: 10.41am Pass through a bridge

VISITOR & PATIENT Time: 11.30am Pass through a bridge

VISITOR Time: 11.33pm Walking & playing around

STAFF Time: 11.07am Patrol around

VISITOR Time: 2.50pm Playing around

VISITOR Time: 2.20pm Standing

PATIENT Time: 2.20pm Sitting on a bench

STAFF Time: 12.41pm Standing

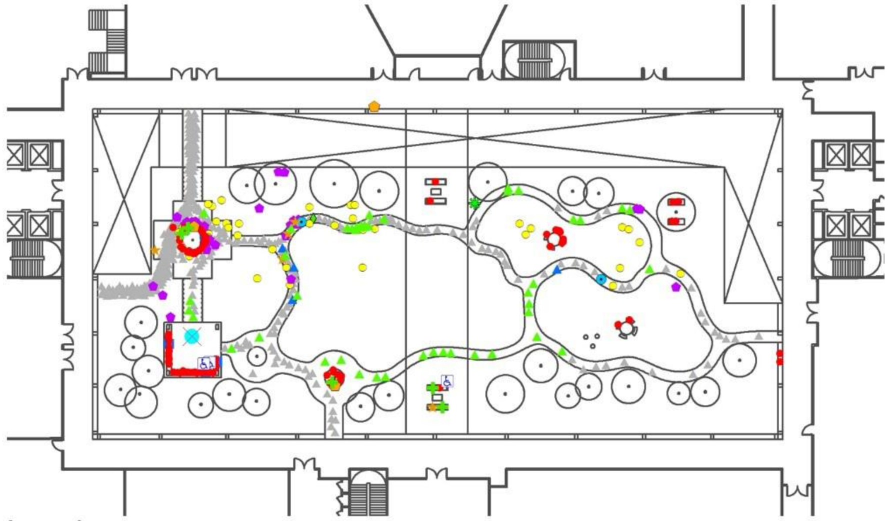
VISITOR Time: 2.20pm Walking & playing around

Table 6.18: Different types of activities in the case study sites during a weekend

WEEKEND OBSERVATION (9am-5pm)

H1-C1

DATE: 9/3/2018 – Friday (9am-5pm) - Not raining



Legend

- WALKING AROUND
- USE A PHONE
- SITTING ON A WHEELCHAIR
- LAYING DOWN ON A BENCH
- CLEANING RUBBISH
- READING
- SITTING ON A BENCH
- STANDING
- PLAYING AND/OR RUNNING
- PICKING LEAVES
- PATROL THE HOSPITAL AREA
- EATING AND/OR DRINKING
- PASS THROUGH A GARDEN
- PASS THROUGH A GARDEN (WHEELCHAIR)

0 3 9 m

N = 481

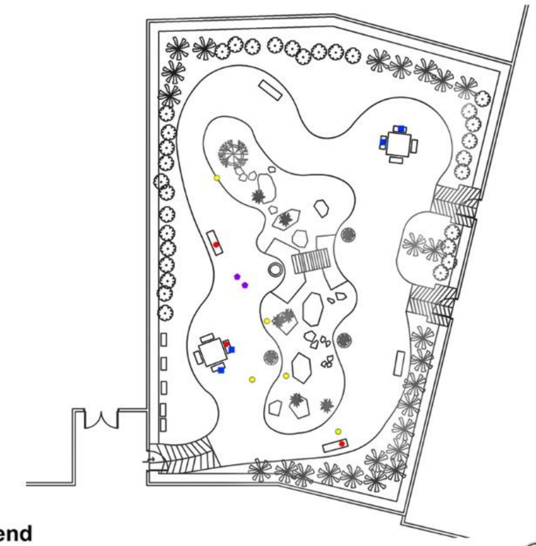
STAFF Time: 9.00am Patrolling around	VISITOR & PATIENT Time: 9.15am Pass through a garden	PATIENT Time: 9.20am Pass through a gaden	STAFF Time: 10.05am Pass through a garden

PATIENT Time: 11.38am Sitting & eating	VISITOR & PATIENT Time: 12.09pm Sitting and talking	STAFF (Cafeteria) Time: 12.09pm Picking leaves for cooking	VISITOR Time: 12.09pm Playing around

VISITOR Time: 3.31pm Sitting and laying down	VISITOR Time: 3.57pm Reading a book	VISITOR Time: 4.00pm Sitting & Laying down	VISITOR & PATIENT Time: 4.57pm Sitting and talking

H2-C3

DATE: 27/1/2018 – Saturday (9am - 5pm) - Not raining



Legend

- STANDING
- SITTING ON A BENCH
- PLAYING
- EATING

0 3 9 m

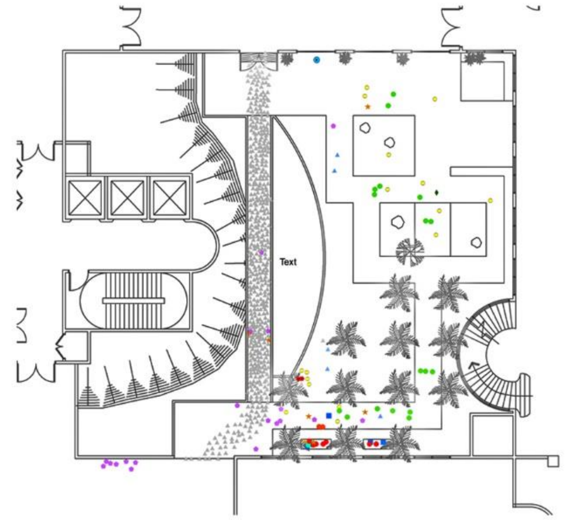
N = 12

STAFF Time: 10.00am Sitting and eating	VISITOR Time: 12.09pm Sitting & playing around	STAFF Time: 1.15pm Playing around	VISITOR Time: 3.55pm Sitting & playing around

VISITOR Time: 3.58pm Playing around	VISITOR Time: 4.00pm Playing around	VISITOR Time: 4.07pm Sitting & use a phone	VISITOR Time: 4.16pm Standing and walking out

H3-C2

DATE: 12/1/2018 – Friday (9am - 5pm) - Raining at 4pm



Legend

- PASS THROUGH A BRIDGE
- PASS THROUGH A GARDEN
- WALKING AROUND
- USE A PHONE
- STANDING
- SITTING ON A BENCH
- SITTING ON A FLOOR
- READING
- EATING
- PLAYING
- PATROL
- LOOKING DOWN A SLOPE
- CLEANING

0 3 9 m

N = 662

STAFF Time: 9.00am Cleaning the glass door	VISITOR Time: 9.30am Sitting on a bench	STAFF Time: 10.44am Patrolling	VISITOR Time: 10.45am Walking and playing around

VISITOR Time: 10.49am Pass through a garden	VISITOR Time: 11.41am Playing and running around	VISITOR Time: 12.00pm Sitting and eating	VISITOR Time: 12.09pm Use a phone

VISITOR Time: 3.01pm Playing around	VISITOR Time: 3.25pm Playing around	VISITOR Time: 3.34pm Walking around	VISITOR Time: 3.59pm Sitting and eating

6.4.5 Types of activities, time spent and frequency of visitation to the HCG based on surveys interviews with the users

In addition to the observation data, **the survey interviews with the HCG users** was analysed to examine the types of activities, the duration of time spent in the HCGs and frequency of visitation. The results from the interviews with the users is important to **support, cross check and validate the previous results** obtained from the on-site observation on users' activities.

6.4.5.1 Types of activities by different types of users

Based on the survey interviews, the responses on the types of activities by different types of users in each case study sites are shown in Table 6.19. The results indicated that the highest percentage of activities among respondents in all three case study sites was sitting (e.g. sit and wait, sit and relax and sit and talk with a friend). Other activities reported by the HCG users who spent time in the HCG was walking (either walking around on the way to another building or walking around to enjoy the view in the HCG).

The observation result showed a difference with what was reported by the users via the survey. Based on the observations, walking (e.g. walking around and passing through) were recorded as the highest activities in both H1-C1 and H2-C3, while sitting was higher in both H2-C3 and H1-C1 compared to H3-C2. The possible reason for the discrepancy between the observation and survey could be because the participants in the survey interviews were among those who sat at the bench, therefore sitting was reported as the main activity among them. Nevertheless, sitting and walking were found to be both important and the most frequent activities in the three case study sites based on the dual techniques of data inquiry (observation and survey interviews).

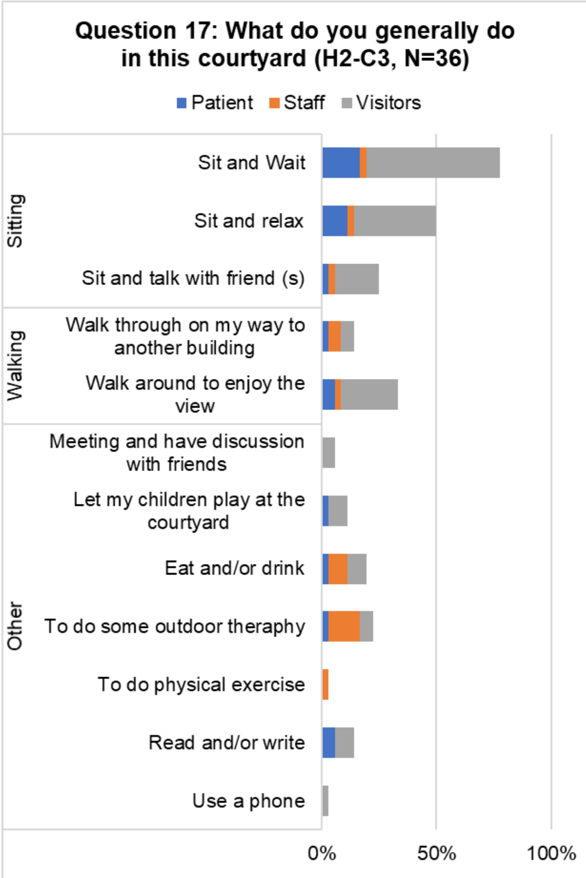
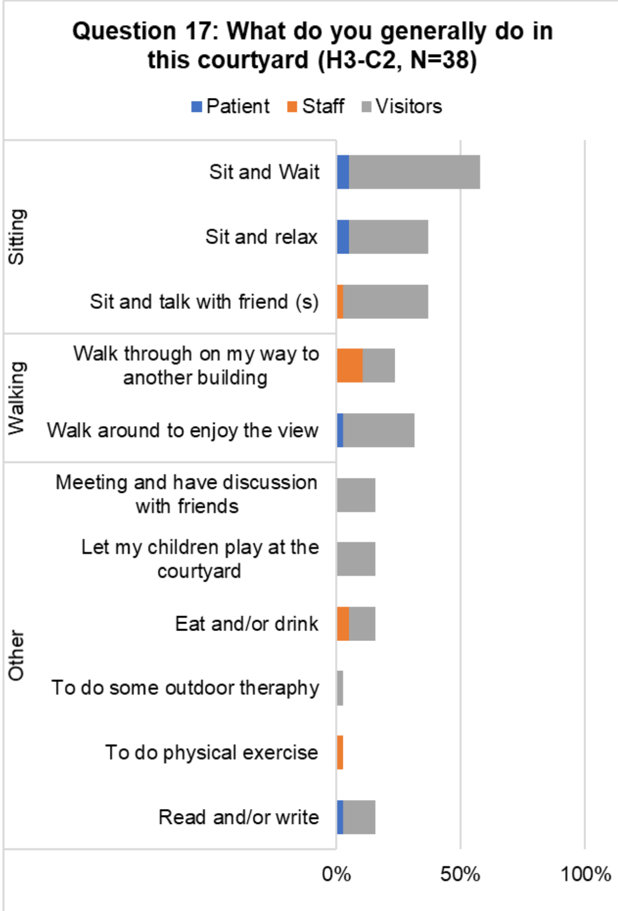
The advantage of conducting survey interviews with the users was that it also provided an important finding related to the types of activities in the HCG. Some of the activities which could not be captured via video recording or interpreted by the researcher can be supported by the users' responses on what they did on-site. For example, activities such as sitting. If the analysis depended only on the observation data, the researcher could only predict that the activities were only limited to sitting on a bench. But the researcher could not know if they sat and waited for their appointment in the clinic, or visiting hours, or sat and relaxed, sat and talked with friends or meeting and having a discussion with friends. Asking them, then, provided a more detailed explanation on the activity that they did on site which eventually supported and validated the researchers' assumption regarding the observed on-site activities.

Regarding the range of the activities reported by different types of users, this showed that 'sit and wait' were very common activities reported in the three case study sites. The result showed that patients in H1-C1 reported that they spent time in the HCG to meet and discuss with friends. However, none of the patient in both H2-C3 and H3-C2 reported such activities. Another important activity reported by the patients and visitors were that they spent time in the HCG to let their children play in the HCG while they had appointments in the clinics or were visiting their family members in the wards.

While some staff reported that they spent time to sit and rest in H1-C1 and H2-C3, none of the staff reported this activity in H3-C2. This is in accordance with the results from the observation which found that none of the staff were found to sit on a bench in the HCG. The most common activities as reported among the staff in all three sites was walking though the HCG on their way to another building rather than walking around to enjoy the view in the HCG.

A significant difference in the variation of the responses across the three case study sites related to activities such as eat and/or drink, read and/or write and to do outdoor therapy. Eat and/or drink is higher in H1-C1 compared to the other case study sites. The location of H1-C1 close to the cafeteria and the availability of seating area encouraged more people to have breakfast or lunch in the more informal and open space of the HCG. Moreover, few staff responded that they spent time in H1-C1 to read or write while none of the staff reported that they did such activity in H2-C3 and H3-C2. Additionally, a higher response related to activities such as outdoor therapy reported in H2-C3 than the other case study sites which was in accordance with the previous results on users' activities via site observation.

Table 6.19: Types of activities by different types of users based on surveys interviews with the HCG users

H1-C1	H2-C3	H3-C2
		

6.4.5.2 Frequency of visitation to the HCG

The users were also asked how often they came to the HCG and the users' responses in the three case study sites are presented in Figure 6.24. The results showed a significant difference across the responses in the three case study sites which indicated that more than 30% of the users in H2-C3 and less than 30% in both H1-C1 and H3-C2 were first-time users. This implied that the majority of the HCG users (more than 60%) were very familiar and had visited the HCG before.

The results also showed that the staff visited H1-C1 and H2-C3 everyday while none of the staff visited H3-C2 every day. Other staff reported that they went either once or twice a week or several times in H2-C3 and H3-C2. Conversely, while all types of users reported that they spent several times in H2-C3 and H3-C2, none of the staff visited H1-C1 several times. Additionally, the results showed that some of the patients in all the three sites visited the HCG several times. Other patients in H2-C3 reported that they were first-time users, and sometimes visited the HCG either once or twice a week or daily.

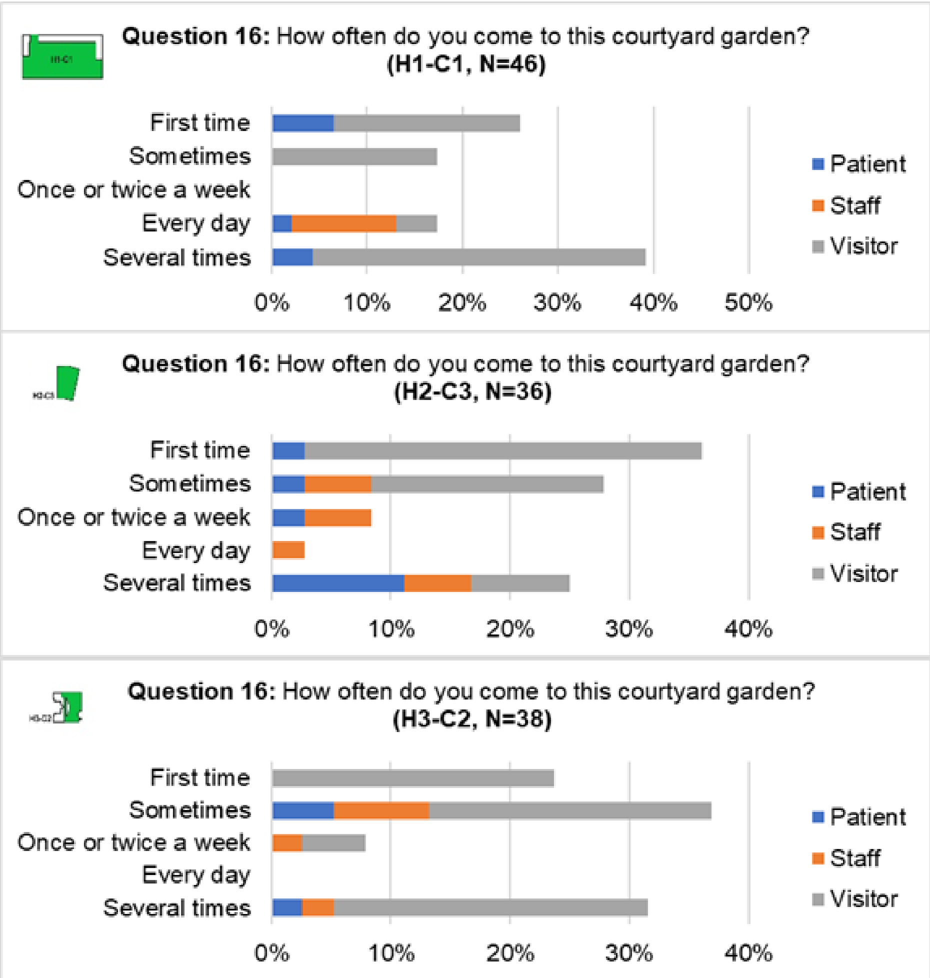


Figure 6.24: Frequency of visitation to the HCG among different types of users

6.4.5.3 Time spent in the HCG

The results showed a significant variation in terms of the time spent in the HCG across the three case study sites, which revealed that more than half of respondents in H1-C1 spent more than 30 minutes, followed by 38.9% in H2-C3 and only 21.1% in H3-C2 (See Figure 6.25). The results also showed that only one third of the respondents in H1-C1 spent around 11 to 30 minutes, while more than 30% spent between 11 to 30 minutes in H2-C3 and H3-C2. The results also showed that a higher percentage of users in H3-C2 spent less than 5 minutes (13.2%) and between 5 to 10 minutes (23.7%). Compared to the other case study sites, very few respondents spent less than 10 minutes in H1-C1 (6.5%) and H2-C3 (22.2%) as most of them were likely to spend more than 10 minutes and 30 minutes in these HCGs.

As described in Section 6.1.5.3**, those who felt 'slightly cooler' or 'cooler' in their thermal sensation votes were those likely to spend more than 30 minutes in the HCG**. Additionally, another possible reason for the longer time spent in the HCG was because of the availability of seating areas in H1-C1 and H2-C3 which encouraged more users to spend a longer time in the HCG.

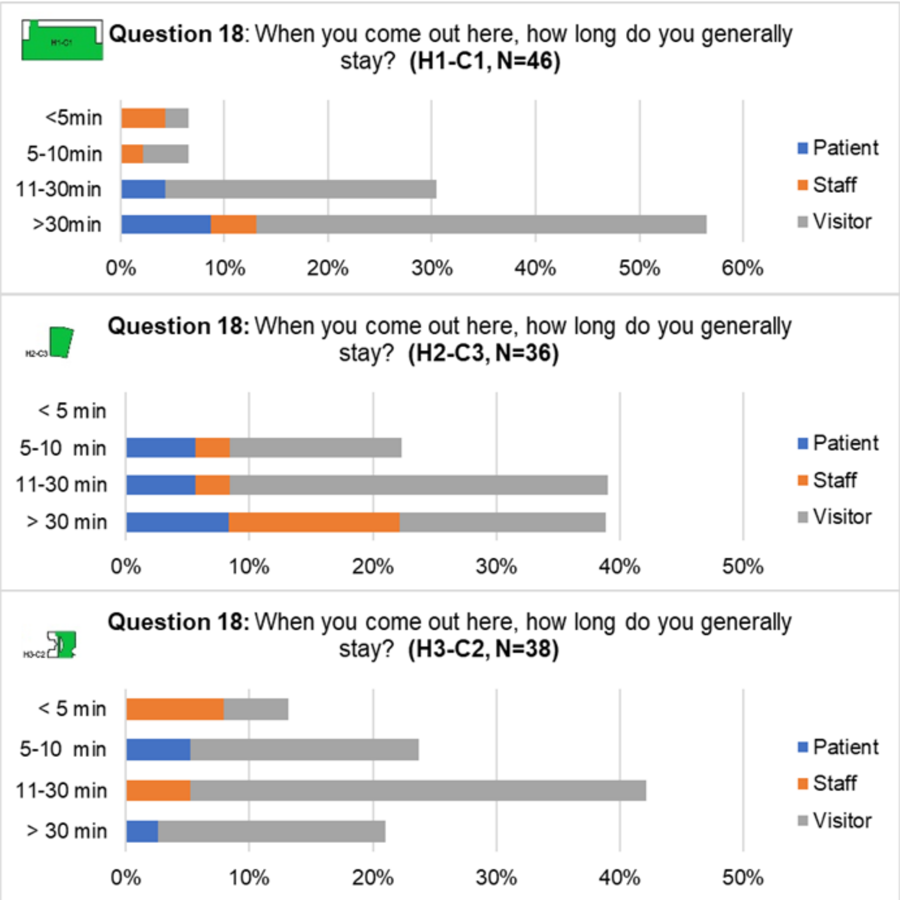


Figure 6.25: Time spent in the HCG by different type of users

6.4.6 Factors that influence the space use pattern at different time of the day

This section discusses several factors can influence the rhythm of the users' occupancy in the HCG, including the **physical design, the microclimatic conditions and the hospital opening hours**.

6.4.6.1 Physical design

In terms of the **physical design factors of the sites**, the results showed that a higher number of users in H3-C2 (including the passer-by) were observed in both weekend and weekdays compared to the other case study sites. The possible reason for this was because of the spatial organisation of H3-C2 which is located **close to the main entrance**. Throughout the day, most of the hospital users commonly passed through H3-C2 to go to the cafeteria, and this increased the number of occupancies in this HCG. However, it should be noted that the recorded occupancy in H3-C2 was high among those categorized as passer-by rather than those who stayed and spent time in the HCG. The **availability of seating facilities** also impacted on the usage pattern in the HCG. It was found that less users spent time to sit in H3-C2 due to the lack of seating compared to the other case study sites.

Another factor which increased user' occupancy was the HCG location **close to the high traffic zone area** such as the cafeteria which eventually increased its visibility to most users. This is evidenced in both H1-C1 and H2-C3 which had a higher number of occupancies compared to H2-C3. Moreover, **the access to the HCG** was also another factor that can impact on the level of occupancy in the HCG, as found in H2-C3 which had a lack of accessibility to the HCG because only one door was opened for access and it was also inaccessible to wheelchair users. Additionally, **the size of the HCG** can also influence the level of occupancy in the HCG. The bigger the size of the HCG, the higher the number of users in the HCG.

6.4.6.2 Microclimatic conditions

Based on the observations in the three case study sites, a higher numbers of HCG users were found to spend time in the HCG especially in the morning and evening time, whereas less users spent time during the mid-day (12.00 pm to 1.30 pm). Higher temperature and higher exposure to solar radiation in the middle of the day compared to the morning and late afternoon time could be the possible reason that could impact on the daily space use pattern in the HCGs. It was observed during the afternoon that those who spent time in H1-C1 choose to sit in a shaded area, such as the sitting under the shaded pergola, under the bridge and around the periphery of the HCG (See Figures 6.26 and 6.27). A majority of the HCG users including visitors, staff and patients preferred to sit in the shaded area during the afternoon, and only one patient was observed to sit in the sun during the morning time in H1-C1. Similar to H2-C3 and H3-C2, users were observed to sit in a shaded sitting area rather than sit in the unshaded area during the mid-afternoon. Moreover, during the cloudy day, a higher number of children and adults were observed to spend time walking around and sitting around the pool area in H3-C2 compared to a sunny day.

Figure 6.26: The space use pattern among HCG users during the afternoon time in H1-C1.

Figure 6.27: The space use pattern in H1-C1 among patients and visitors who preferred to sit at the unshaded seating area during morning time (left) and at a shaded seating area in the afternoon (right).

6.4.6.3 The operation hours

The hospital operation hours such as visiting hours, opening hours and clinic opening hours significantly influenced the space use pattern at different times of the day (both weekend and weekday). A higher number of visitors and outpatients spent time in the HCG during the weekday morning compared to the weekend. This is because, during the weekday morning, most of the HCG users were visitors who waited for their family members. During both the weekend and weekday, a similar space use pattern was found among visitors: The number of visitor occupancy reduced significantly as the visiting hours began at 12.30 pm because most of them were observed to leave the HCG to visit their family members in the wards, leaving behind several group of young children accompanied by their family members to play in the HCG.

This study also found that more staff spent time in the HCG during the weekday compared to the weekend. This is because the office and clinic were closed during the weekend (See

Figure 6.28). A lower number of medical staff were seen spending time in the HCG in the weekday mornings because this was the busiest time when medical staff examined patients in the wards and outpatients in the clinic. It was also observed that more staff, including the administrative and medical staff, were seen to pass through H1-C1 and H3-C2 to go to the cafeteria especially during the lunch hours.

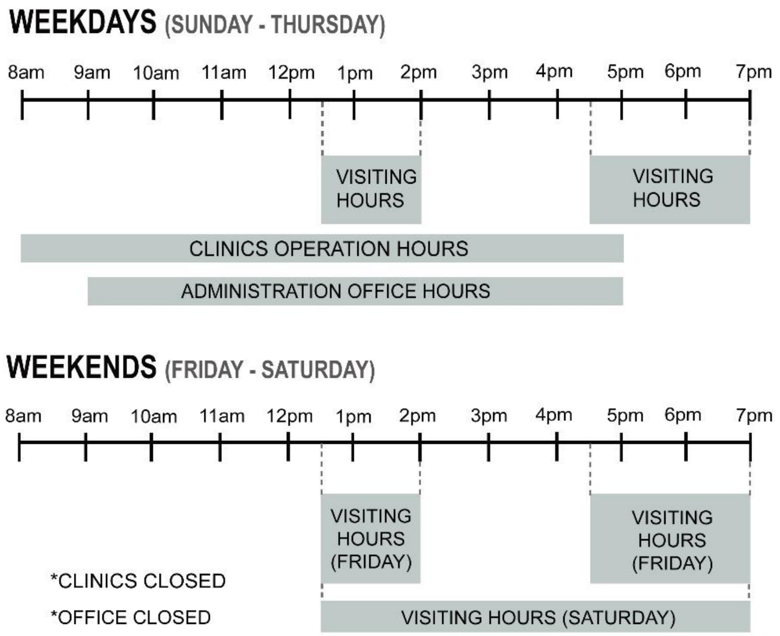


Figure 6.28: Operation hours in Malaysian hospitals for both weekdays and weekends

The space use pattern among patients across the different case study sites revealed that a higher number of patients spent time in H1-C1 compared to H2-C3 and H3-C2. During the weekday afternoon, more patients were observed to spend time in H1-C1, while on the weekday morning more patients spent time in H2-C3 to participate in physiotherapy activity with the staff. Only a few patients were found to sit in the HCG during the weekday in H3-C2. Moreover, a long visiting hour at the weekend allowed patients to spend more time with their family in H1-C1, especially during the weekend afternoon. However, none of patients were observed to spend time in H2-C3 and H3-C2 during the weekend.

6.5 Users' experiences and perceived restorative scales in the case study HCGs

This section examines the users' experiences and any psychological benefits that arose while spending time in the HCG. The results presented here were based on survey interview data and a frequency analysis to analyse the data using SPSS software. A total of 120 respondents who spent time in the respective HCGs (H1-C1 (N=46), H2-C3 (N=36), and H3-C2 (N=38) were randomly selected as the sample for this study (See Section 3.5.2 for demographic data). First, this section presents the results on the users' experiences in the HCG (Section 6.5.1). Further, the section presents the results on the factors that encouraged visitation to the HCG (Section 6.5.2). Section 6.5.3 presents and discusses the results on the perceived restorative score of the three case study sites in relation to the theories underpinning the concept of restorative environment (SRT and ART theories) as explained earlier in Section 2.4.4. Finally, this section presents the results based on the survey interview with a total of 135 participants from the non-user group which examined the factors that discouraged the use and visitation to the HCG (See Section 6.5.4).

6.5.1 Users' experiences while spending time in the HCG

The survey questions for this section is based on the 5-point Likert scale questions ranged from strongly agree to strongly disagree (See Question 20, in Appendix 1). Overall, the results showed that a majority of the respondents (more than 70%) perceived a positive mood change when spending time in the HCG (See Figure 6.29).

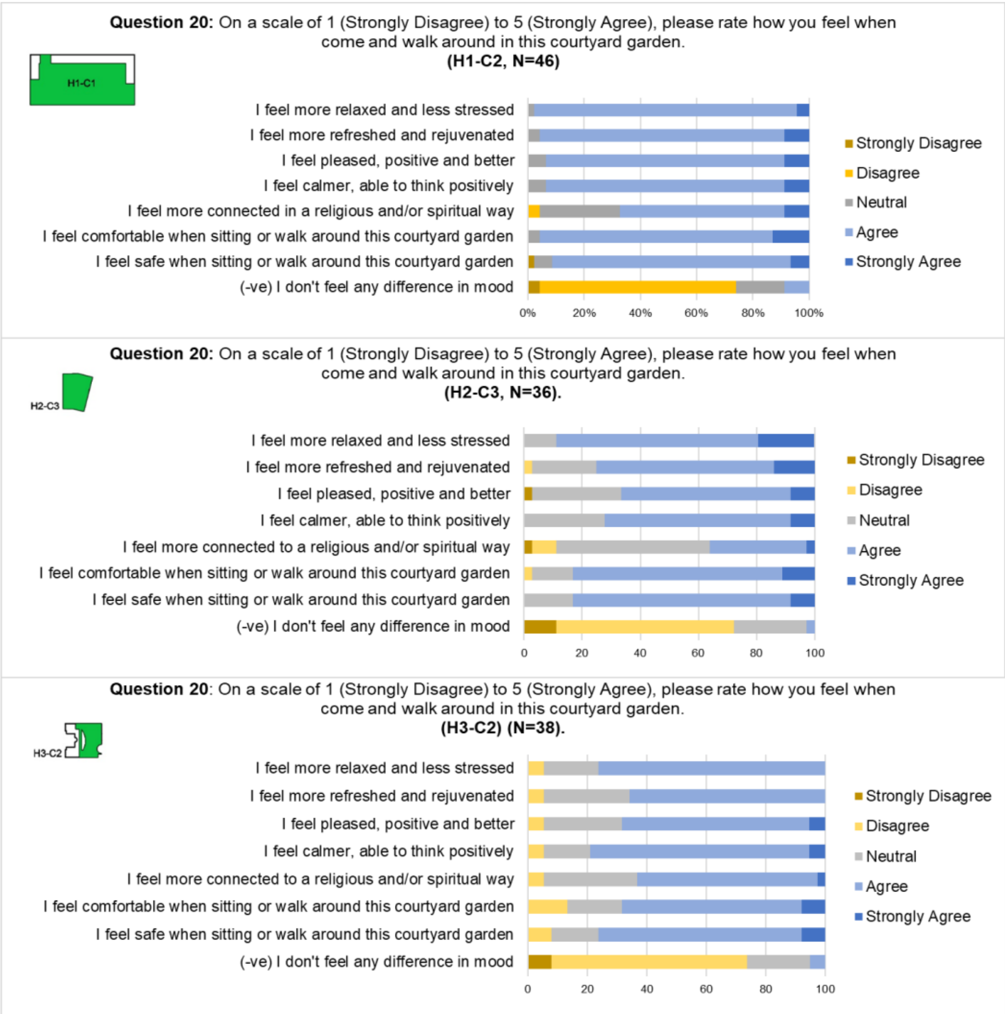


Figure 6.29: Users' experiences in the case study HCGs

While the majority of the respondents in H1-C1 (97.8%, n=45), H2-C3 (88.8%, n=32) and H3-C2 (76.3%, n=29) mentioned that they felt more relaxed and less stressed, surprisingly there were two visitors in H3-C2 who indicated different feelings. Similarly, the majority of respondents in H1-C1 (95.7%, n=44), H2-C3 (75%, n=27) and H3-C2 (68.5%, n=25) mentioned that they felt more refreshed and rejuvenated as indicated in Figure 6.29. However, two visitors in H3-C2 mentioned that they did not feel any change in their mood (See Figure 6.30). This study also found that the majority of the patients in H1-C1 and H3-C2 felt refreshed and rejuvenated. Unexpectedly, one older age female patient in H2-C3 responded differently. During the survey interview, this patient mentioned that she had muscle problems and still felt weak and worried about her health. This implied that, to some people, the psychological and physiological state might impact on their feelings while spending time in the HCG.

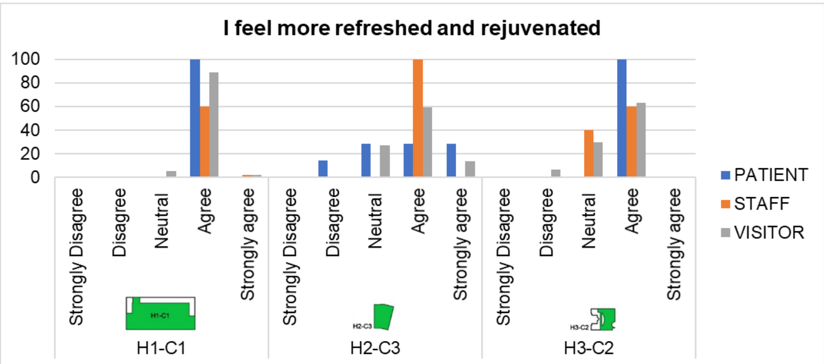


Figure 6.30: Feeling refreshed and rejuvenated by different types of users

Additionally, over 90% of respondents in H1-C1 (93.5%, n=43) agreed that they felt pleased, positive and better while spending time in the HCG, whereas only 66.6% and 68.4% of respondent H2-C3 and H3-C2, respectively, felt the same feeling. Unexpectedly, two visitors in H3-C2 mentioned that they did not feel any changes in their mood. Moreover, while the majority of respondents in H1-C1 (93.5%, n=43), H2-C3 (72.2%, n=n=26) and H3-C2 (79%, n=30) agreed that they felt calmer and better able to think positively while spending time in the HCG, only two respondent in H3-C2 expressed disagreement regarding that feeling.

A higher percentage of respondents in H3-C2 (63.2%) and H1-C1 (67.4%), but only a few respondents in H2-C3 (36.1%), felt connected to a religious and/or spiritual way. The cross tabulation results between religious connectedness with different types of users showed that some staff, patients and visitors in all three case study sites did not feel any connection with the religious and/or spiritual way while spending time in the HCG (See Figure 6.31).

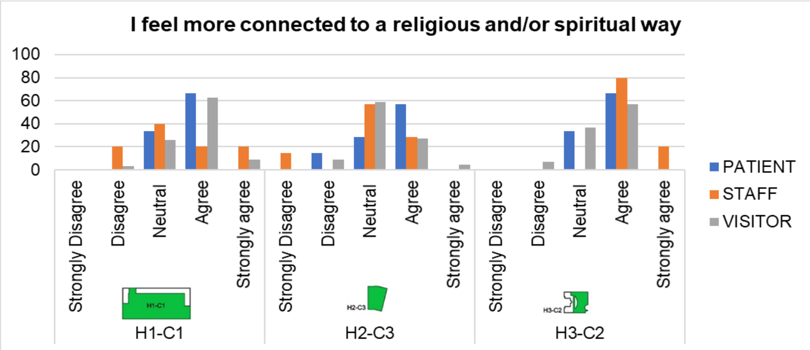


Figure 6.31: Feeling connected to a religious and/or spiritual way by different types of users

Regarding the feeling of comfortable in the HCG, over 90% respondents in H1-C1 felt comfortable while sitting and walking around the HCG. However, few staff and visitors in H2-C3 (2.8%, n=1) and H3-C2 (13.2%, n=5) felt uncomfortable while sitting and walking around in these HCGs (See Figure 6.32). In terms of safety, the majority of respondents in H1-C1 (91.3%, n=42), H2-C3 (83.3%, n=30) and H3-C2 (76.3%, n=29) felt safe while spending time in these HCGs. However, some visitors and staff in H1-C1 (2.2%, n=1) and H3-C2 (7.6%, n=3) mentioned that they did not feel safe being in this HCG (See Figure 6.33). Their safety concerns have been elaborated upon in detail in Chapter 5, Section 5.5.5.1 (a).

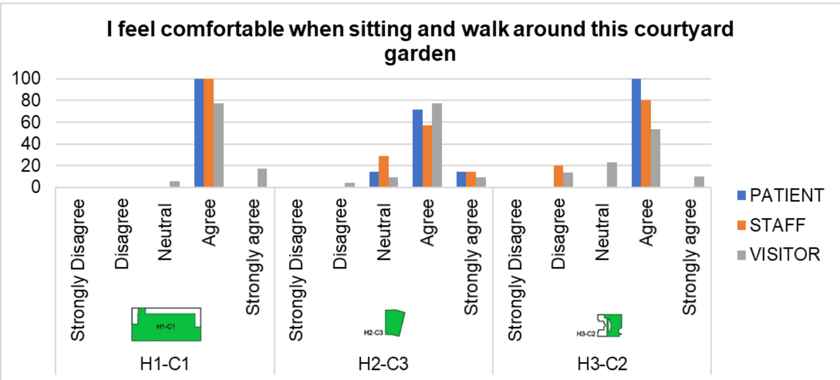


Figure 6.32: Feeling of comfortable by different type of users

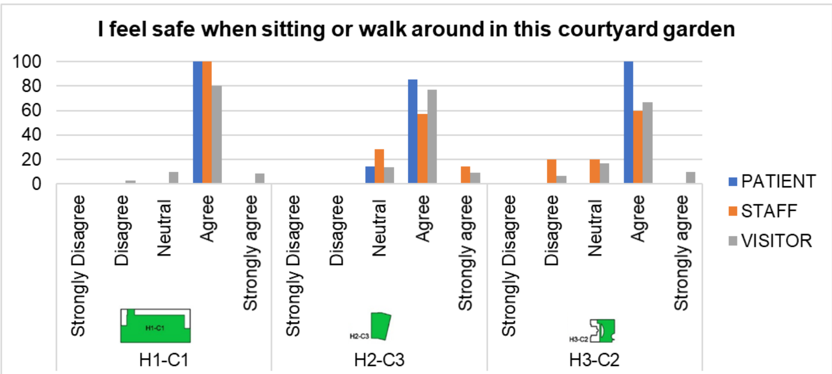


Figure 6.33: Feeling safe by different type of users

6.5.2 Factors that encourage the users to visit the HCG

This section was based on a multiple choice survey questions which examine on the factors that encourage their visitation to the HCG (See Question 19, in Appendix 1). The study found that, out of a total 120 respondents that were interviewed, over 50% of the respondents reported that they wanting to relax and rest, enjoy the view of the courtyard garden and refresh their minds (See Figure 6.34). This is in accordance with the findings of the open-ended responses in Chapter 5, Section 5.5.5.1 (d), in which the respondents mentioned that they liked the HCG because of the availability of a place for them to rest and relax. They also mentioned that they favoured the greenery and pleasant views of the HCGs.

Additionally, over 20% of the respondents in all three case study sites visited the HCG because they wanted to contemplate and find some privacy. Other factors that encouraged them to visit the HCG included letting their children play in the HCG, enjoy the outdoor therapy, a refuge that distracted them, coping with their worries, getting away from the everyday routine life, socialise and meet other people, and to do physical exercise.

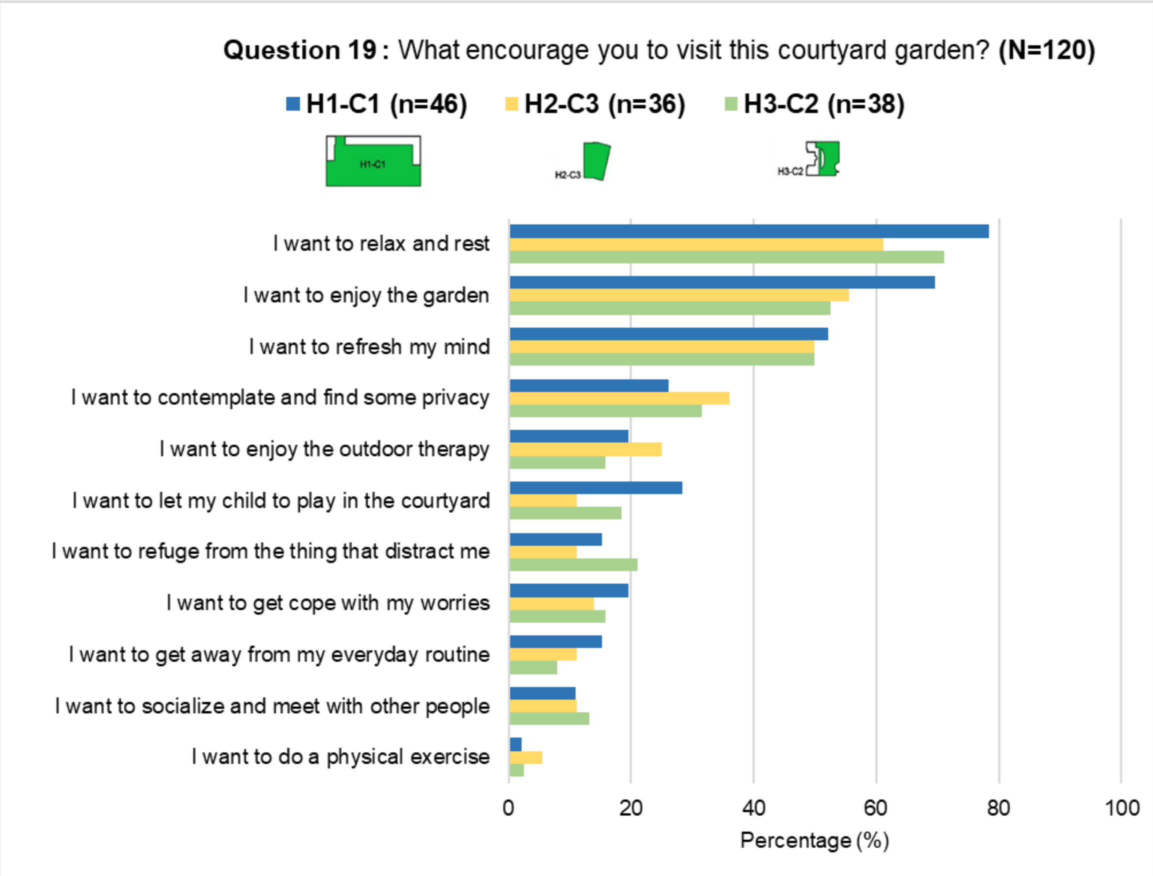


Figure 6.34: Factors that encourage visitation to the HCG

6.5.3 Perceived restorative score of the three case study sites

6.5.3.1 Perceived restorative score in relation to the SRT and ART theory

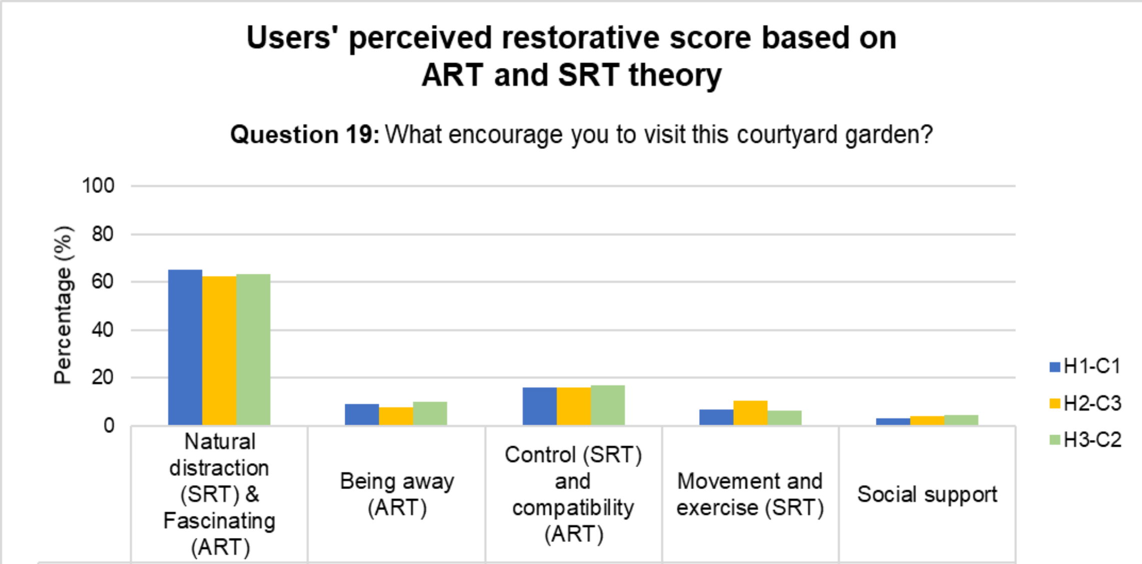
The perceived restorative score among users in the three different sites were analysed to examine which HCG was perceived to evidence the highest restorative score. First, the results from the survey questions related to the factors that encouraged them to visit the HCG were arranged according to their components of two important theories of restorative environment which are Attention Restorative Theory (ART) and Stress Reduction Theory (SRT). This is shown in Table 6.20.

Table 6.20: Perceived restorative based on Attention Restorative Theory (ART) and Stress Reduction Theory (SRT)

THEORY OF RESTORATIVE ENVIRONMENT ART – Attention restorative theory SRT – Stress reduction theory	**SURVEY QUESTION** **Question 19:** Factors that encourage you to visit the HCG?
Fascinating (ART) and Natural distraction (SRT)	I want to enjoy the garden I want to cope with my worries I want to refresh my mind I want to relax and rest
Being away (ART)	I want refuge from the things that distract me I want to get away from my everyday routine
Compatibility (ART) and Control (SRT)	I want to contemplate and find some privacy I want to let my child play in the courtyard
Movement and exercise (SRT)	I want to do physical exercise I want to enjoy the outdoor therapy
Social support (SRT)	I want to socialise and meet with other people

The ART theory proposed by Kaplan and Kaplan (1989) included four elements: **i) Being away; ii) Extent; iii) Fascination; and iv) Compatibility,** whereas the SRT theory proposed by Ulrich (1999) comprised four components: i) **Natural distraction; ii) Control; iii) Movement and exercise; and iv) Social support.** These theories were chosen for this study because they focused on people's interactions with nature in terms of how contact with nature contributed to more positive feelings and restoration from stress, which are crucially important aspects from the users in the hospital context**.** The details of each component related to these theories was explained in detail in Chapter 2.

The results of the perceived restorative score based on ART and SRT theory showed that **the main factors which encouraged users to visit the HCG related to the components of natural distraction (SRT) and fascination (ART)** in which they wanted to enjoy the garden, cope with their worries, and refresh their mind as well as to relax and rest in the HCGs (See Figure 6.35). According to SRT theory, 'natural distraction' is one of the important components for a restorative environment. This included providing access to nature such as plants, flowers, water and the sounds of nature. Based on ART theory, 'fascinating' is related to access to the interesting elements in the setting such as flora, fauna, water, play and light. **This suggests that users in the hospital context have a strong desire to be in contact with nature and to find a place where they can rest, relax, refresh their minds, cope with worries, and enjoy the outdoor garden.**



	Natural distraction (SRT) & Fascinating (ART)	Being away (ART)	Control (SRT) and compatibility (ART)	Movement and exercise (SRT)	Social support
H1-C1	65.2	9	16.1	6.5	3.2
H2-C3	62.3	7.5	16	10.4	3.8
H3-C2	63.2	9.7	16.6	6.1	4.4

Figure 6.35: Percentage of perceived restorative score of each case study site

The findings also found another factor related to SRT theory, which is 'being away'. This study found that less than 10% of respondents mentioned that they visited the HCG because they wanted refuge from the thing that distracted them and to be away from their everyday routine.

Moreover, another component of ART theory which is 'compatibility' refers to the environment that allows people to meet their desires and needs such as privacy. Similarly, SRT theory also suggests the component of 'control' in which it refers to the ability of people to determine their actions and make decisions based on their choices and options which can contribute to the reduction of the stress level in an individual. Based on the users' responses from the survey, they expressed their desire to contemplate and find some privacy in the HCG. They also visited the HCG to find a place for their children to play while spending time waiting in the hospital. SRT theory also includes a component of 'movement and exercise'. Based on the users' responses, this component was highlighted by some of the respondents. They mentioned that they visited the HCG because they wanted to do physical exercise and enjoy outdoor therapy in these HCGs.

Another aspect of SRT theory, found in this study, is related to 'social support'. Those who received a higher level of social support perceived less stress than those who received low support from others. Based on the survey responses, some of the users in the three case study sites mentioned their desire to socialise and meet people. This indicated the importance of providing an alternative place such as an outdoor garden where patients can interact with people and get support from their family or staff.

6.5.3.2 Perceived restorative score based on their experiences in the HCG

Additionally, users' experiences were analysed to examine the perceived restorative score in each of the case study sites. After evaluating respondent's answers in the survey, a pattern of the ranking of the users' responses regarding their experiences in the HCG in relation to the perceived restorative score became apparent (See Figure 6.36). **H1-C1 has the highest percentage of the Perceived Restorative Score (PRS) score with an average of 90.6% of the overall responses, followed by the H2-C3 (73%) and H3-C2 (71%).**

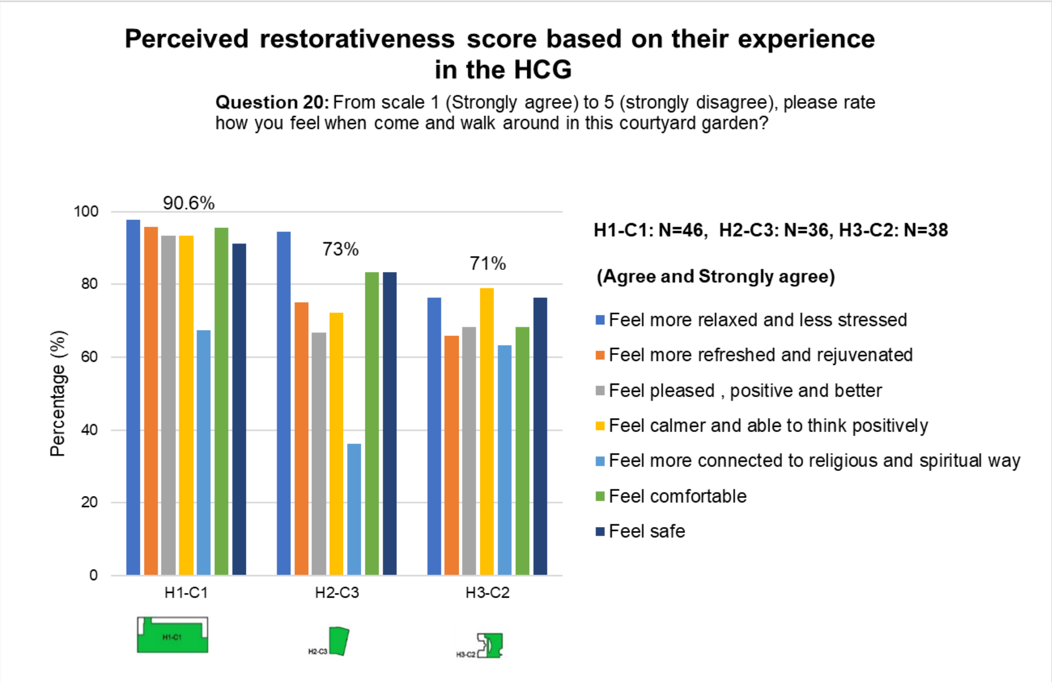


Figure 6.36: Perceived restorative score based on their experiences in the HCG

6.5.4 Factors that discourage the use and visitation to the HCG based on non-users' perspectives

The focus of this study was to assess the users' direct experiences in each of the case study HCGs who is among those who choose to use and visit the HCG. However, in order to reduce bias in the sample, it was also necessary to assess responses from the non-users' perspectives. A total of 135 respondents among the non-users group in three representative hospitals; H1, (n=45); H2 (n=45) and H3 (n=45), including 12.6% patients (n=17), 32.6% staff (n=44) and 54.8% visitors (n=74) who were sitting in the lobby and waiting area in the hospital were interviewed (See Section 3.5.3). The survey question was based on a multiple-choice question (See Question 7, in Appendix 1). The responses among the respondents in each of the case study sites is shown in Figure 6.37.

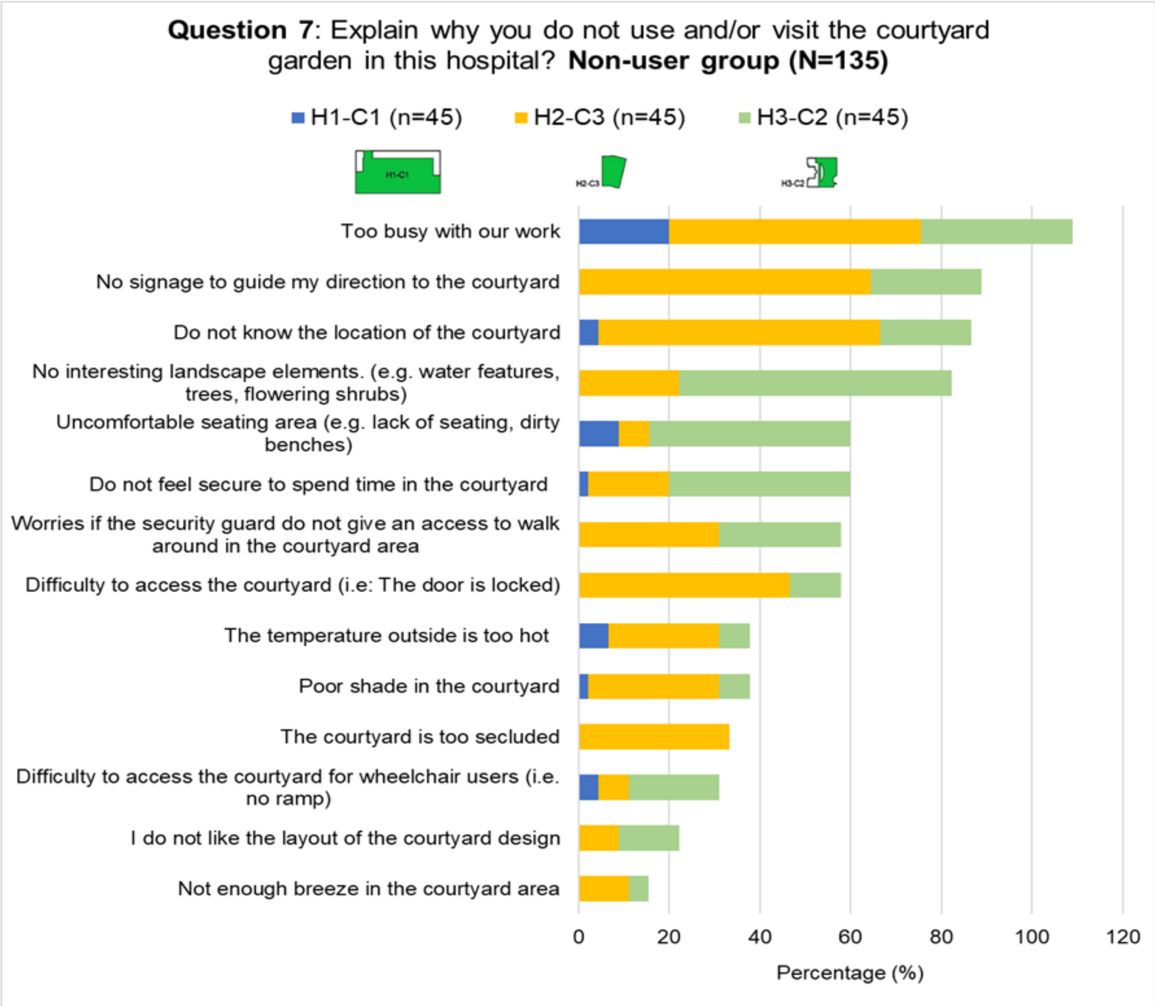


Figure 6.37: Factors that discourage visitation among non-users

In this study, the non-users group were asked why they did not use or visit the courtyard garden of the hospital. The factors that affected their visitation to the HCG included:

I. Life routine;
II. Physical design;
III. Accessibility;
IV. Safety; and
V. Microclimate.

6.5.4.1 Life routine

Based on Figure 6.37., H2-C3 showed the highest responses regarding the busy life routine (55.6%) followed by H3-C2 (33.3%) and H1-C1 (20%). Out of a total of 135 respondent in the three case study sites, 42.9% staff (n=21), 40.8% visitors (n=20) and 16.3% patients (n=8) mentioned that they were busy with their life routine. During the survey interview, the visitors explained that they went to the hospital with the intention to visit family members in the wards and spend a very short time in the hospital due to other responsibilities. Patients mentioned that they focused on their appointment in the clinic, and that they had no intention to visit the HCG. Staff also mentioned that they were mostly busy throughout treating patients and undertaking management work. They stated that they did not often do have the time to visit the HCG.

6.5.4.2 Physical design

Regarding the physical design aspects, 64.4% of the respondents in H2-C3 and 24.4% of respondent in H3-C2 mentioned the absence of signage to guide their direction to the HCG, while none of the respondents in H1-C1 complained about the signage. More than 60% of the respondent in H2-C3 and 20% of the respondents in H3-C2 complained that they did not know the location of the HCG which become one of the main barriers to garden visitation.

Moreover, a higher percentage of responses from H3-C2 (60%) and H2-C3 (22.2%) complained regarding the uninteresting landscape elements in these HCGs which become the factors that discouraged them to visit the HCG. Surprisingly, none of them mentioned uninteresting landscape in H1-C1. Despite the landscape, these groups of non-users also complained of the lack of available seating areas, which indicated the higher response in H3-C2 (44.4%) compared to H2-C3 (6.7%) and H1-C1 (8.9%). None of the respondents complained regarding the layout of H1-C1. However, some respondents in both H2-C3 and H3-C2 mentioned that they did not like the layout of the HCG which become one of the factors which refrained them from visiting the HCG. The users in H2-C3 also mentioned that the HCG was too secluded which put them off from visiting the HCG.

6.5.4.3 Accessibility

Accessibility factor also discouraging people from visiting the HCG. Some respondents mentioned difficulty in accessing the HCG due to the locked doors in the H2-C3 (46.7%) and H3-C2 (46.7%). However, none of the users in H1-C1 mentioned this. Moreover, the users in both H2-C3 and H3-C2 mentioned that they worried if the security guard did not give them access to walk in the HCG. Some of the respondents in all three case study sites also mentioned difficulty of access for disable people (i.e. no ramp).

6.5.4.4 Safety

Another barrier to HCG visitation was the feeling of lack of safety when spending time in the HCG. H3-C2 showed a higher response (40%) compared to the other case study sites, H2-C3 (17.8%) and H3-C2 (2.2%). The discussion of safety issues in each of the case study sites based the on open ended questions of positive and negatives aspects of the HCG was highlighted in Chapter 5.

6.5.4.5 Microclimate

A number of respondents also complained regarding the microclimatic conditions in the HCG which discouraged them from visiting the HCG: H2-C3 (24.4%), H1-C1 (6.7%) and H3-C2 (6.7%) mentioned that the weather outside was too hot. Some of the respondents in H2-C3 (28.9%), H3-C2 (6.7%) and H1-C1 (2.2%) complained about the poor shade in the HCG. Respondents mentioned the lack of breeze: H2-C3 (11.1%) and H3-C2 (4.4%) (See Figure 6.37).

6.6 Summary

The research findings revealed a significant difference in the microclimatic conditions of the three HCGs. The results of the two sets of daily data (9 am to 5 pm) revealed that H1-C1 recorded the lowest air temperature on both cloudy and sunny days, from 12 pm to 5 pm throughout the day, followed by H3-C2 and H2-C3. While H3-C2 recorded the highest humidity level in the morning, H1-C1 recorded the highest average wind speed throughout the field workdays compared to the other case study sites. Another important finding also indicated air temperature in the HCGs was lower than the air temperature outside the hospital area. This confirms the importance of a courtyard garden as a passive design strategy for a hospital building which facilitate a cooler environment that is acceptable to most of its users as found in the TSV; over 90% of the respondents felt that the climatic conditions in the HCG were acceptable to them.

Based on the environmental data, on-site observation and survey interviews with the users, this study suggested that different design configurations and landscape characters significantly influenced HCG microclimatic conditions and their sensation responses (e.g. TSV, HSV and WSV). The TSV result revealed that more users reported that they felt 'slightly cooler' in H1-C1 compared to the other case study sites. These differences in their thermal responses results suggested that high exposure to solar radiation due to lack of vegetation and tress canopies in the HCG contributed to increased air temperature. WSV also showed a significant difference in their responses as more users in H1-C1 mentioned that they felt ‘windy’ and ‘too windy’, whereas only a few respondents mentioned that H2-C3 was windy and none of the users reported H3-C2 as ‘windy’. The size of H1-C1, which is larger than the other sites, and its lower wall orientation facing the prominent wind direction, contributed to the increase in wind speed. Moreover, this suggested that these environmental factors (e.g. shaded area, daylighting in the HCG and into the adjacent spaces, a breeze and fresh air and a comfortable air temperature) are essential aspects that need to be considered by designers in designing a HCG in the future.

Regarding the users’ space use pattern in the HCG, this study found that the main users in the HCG were mainly visitors, followed by staff and patients. There results revealed a significant difference in occupancy in both the weekday and the weekend across the three case study sites. In H1-C1 and H2-C3, the level of occupancy was higher in the weekday. However, the level of occupancy in H3-C2 was higher on the weekend. The most frequent activities across the three case study sites were sitting and walking around. However, some activities such as laying down on the bench were found only in H1-C1 and doing physical therapy for a rehabilitation program was only found in H3-C2. This finding also suggested that the physical design aspects, the microclimatic conditions and the hospital operation hours influenced the pattern of usage in the HCG.

Finally, in terms of the experience in the HCG, this study found that more than 80% of the respondents expressed their desire of being in nature to relax and rest, refresh their mind and be away from the indoor hospital. This suggested that the HCG was an important element in hospital planning as an alternative place for the hospital users as it can contribute to the reduction in stress levels among users. The PRS, according to the experience of the users, revealed that H1-C1 had the highest score, followed by H2-C3 and H3-C2. Furthermore, the results of the survey interviews with the non-users group revealed that the busy life routines acted as the main barrier to HCG visitation. Other factors that also contributed to the lack of visitation to the HCG included the physical design factors, and safety and microclimate. Looking at the overall results, this showed that H1-C1, which evidenced a better environmental and restorative score than the other case study sites, implies the importance to provide a HCG that fulfils these aspects in future for the benefit of the intended users.

CHAPTER 7:
Architects and landscape architects’ views on design and planning of the HCG

7.1 Introduction

Having presents the results related to physical and operational aspects in Chapter 5 and environmental and social aspects in Chapter 6, this chapter presents the results of the semi-structured interviews with the architects and landscape architects who were involved in the design and planning of the three case study hospitals. This chapter aims to address **the fifth research objective:**

- To examine the designers' intentions, challenges, collaboration practice and their suggestion for future improvement in the design and planning of the HCG

For this study, semi-structured interviews were designed according to several themes to explore the related subjects, including:

i) Development stage in the hospital project;
ii) Collaboration practice among the stakeholders;
iii) Design intentions;
iv) Challenges in the design development stage; and
v) Suggestions for future improvement.

First, this chapter provides an overview of the development stage in the hospital planning include the procurement method, hospital project brief and the collaboration practice among stakeholders. Subsequently, it provides an explanation of the standpoint of the architects and landscape architects’ on their original design intentions in the design and planning of the HCG. Moreover, it also explores the challenges that they faced during the design and planning process before discussing some of their suggestions for improvement of the HCG.

As mentioned earlier in Section 3.4.6.5, two architects and two landscape architects were interviewed (i.e. the H2 and H3-architect is the same person). Face-to-face semi-structured interviews were carried out in English at their respective offices. Qualitative content analysis was used in the analysis of the interview with the designers and the architectural design brief as explained earlier in Section 3.6.4., Chapter 3. Additionally, the architectural design brief (secondary data) were analysed to support and strengthen the findings. For this interview data, analysis involved the process of comparing a similar phenomenon inferred from different textual data in response to research question 5 (See Figure 7.1). The process of coding and the comparative findings of the content analysis are illustrated earlier in Section 3.6.4.2. The findings from these sections were then compared to the findings based on other sources of data related to the physical, environmental, social and operational aspects examined in Chapters 5 and 6. This will further form a thoughtful interpretation of the final outcome which will be subsequently used in the formulation of the HCG framework and provide recommendations for policy and practice (Discussed further in Chapter 8).

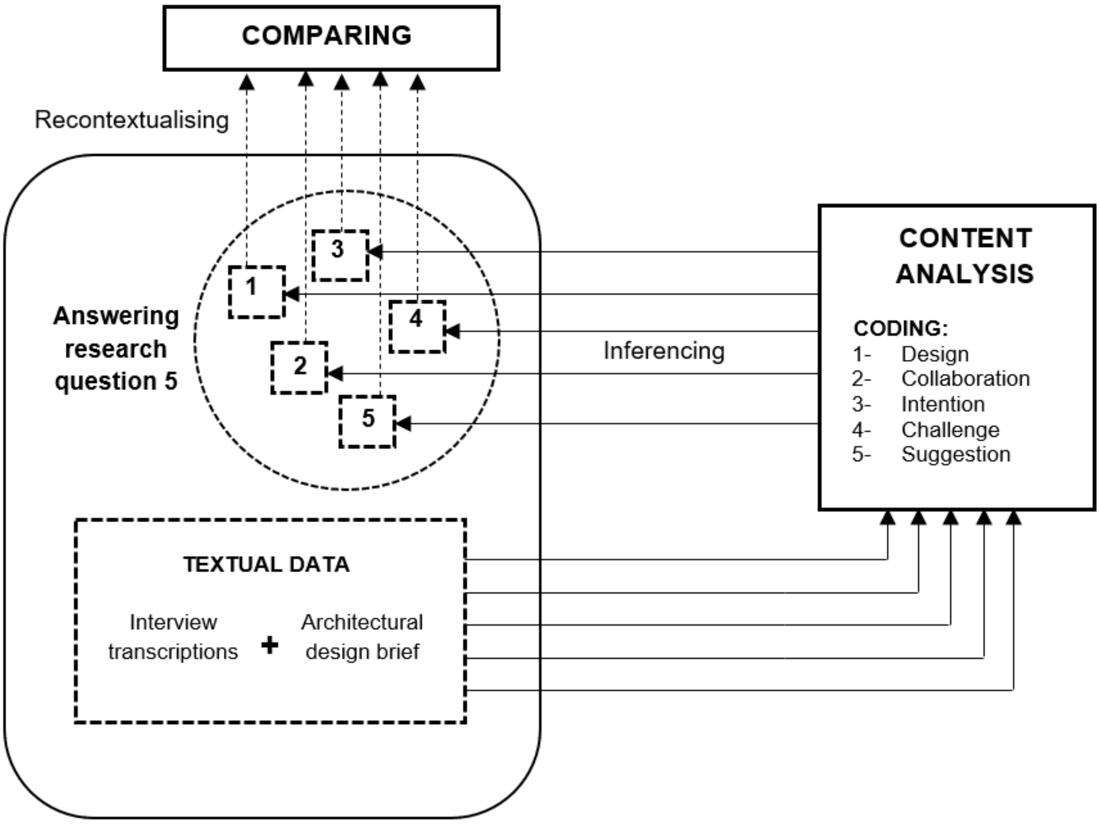


Figure 7.1: The flowchart of the process of content analysis in the current study
Source: Author, 2020, adapted from (Krippendorff, 2013, p.94).

Content analysis involves a systematic process of coding the textual data, examining the meaning of text, developing categories or theme, and recontextualising and reinterpreting the findings in response to the research questions (Vaismoradi et al., 2016; Krippendorff, 2013b). The process of rearticulating the meaning of the text was then carried out multiple times until a satisfactory and realistic conclusion was reached (Krippendorff, 2013b, p.88). For this study, qualitative content analysis was divided into several phases which included:

i) Design (i.e. Designing the source and methods for data inquiry);
ii) Collection (i.e. Gathering the data: Interview and architectural design brief);
iii) Conversion (i.e. Re-read data and coding into thematic categories);
iv) Analysis (i.e. Analysing the textual data to the subject of study);
v) Interpretation (i.e. Synthesising and recontextualising the findings from both sources in relation to the phenomenon under study); and
vi) Integration of the findings (i.e. Integrating the findings and drawing conclusions in relation to the research question) (See Figure 7.2).

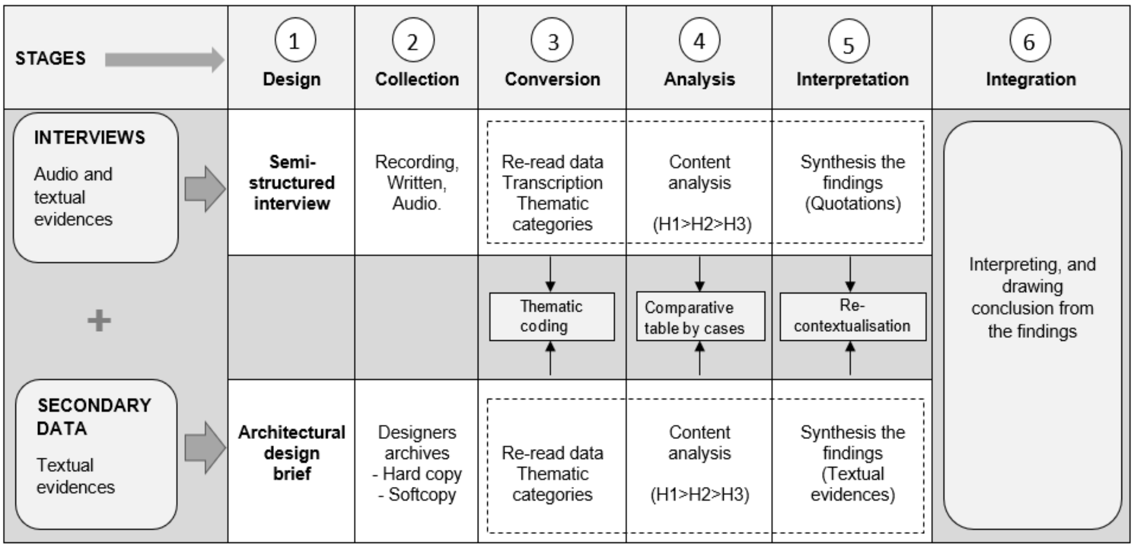


Figure 7.2: The flowchart of the integration of interview data and architectural design brief

7.2 The development stage of the hospital project

Before discussing the results regarding the designers' views on the design and planning of the HCG, it is important to provide an overview on the development design stage of the hospital project. Therefore, this section aims to examine the procurement process of hospital projects in Malaysia to understand the collaboration processes and practices among the design team and the stakeholders involved in the hospital projects. Further, this section provides an insight into the current state of hospital project briefs related to the provision of HCGs. Realising the limitation of the subject matter in the current hospital brief, which was highlighted by the designers, has assisted in developing necessary recommendations for the improvement of the design brief for future HCGs (Discussed further in Chapter 8, Section 8.5).

7.2.1 The procurement of hospital project in Malaysia

H1, H2 and H3 hospitals were designed by local private consultants in collaboration with the landscape architects, medical planners, contractors, engineers (i.e. mechanical and structural) and the PWD. These hospitals were procured through the Design and Built project (See Figure 7.3). It allows for the design team to formulate a creative design idea in order to meet the project requirements by the client and the end-users (Seng and Yusof, 2006). At the first stage, the contractor was invited by the Ministry of Health (MOH) to the open tender of the hospital projects. The bidder (contractor) prepared the technical and financial proposals taking into account design, construction and scheduling. The initial design brief, schedule of accommodation, work schedule and contract price involved several discussions and negotiations between the Project Management team (PMT) (i.e. design consultant, medical planner, public work department) and the client (MOH). Several approval meetings and checkpoints with the client and PMT were held throughout the design development process and construction until its completion. Once the construction stage reached completion and the certificate of fitness was endorsed, the hospital projects were ready to be handed over to the client for commissioning, use and maintenance.

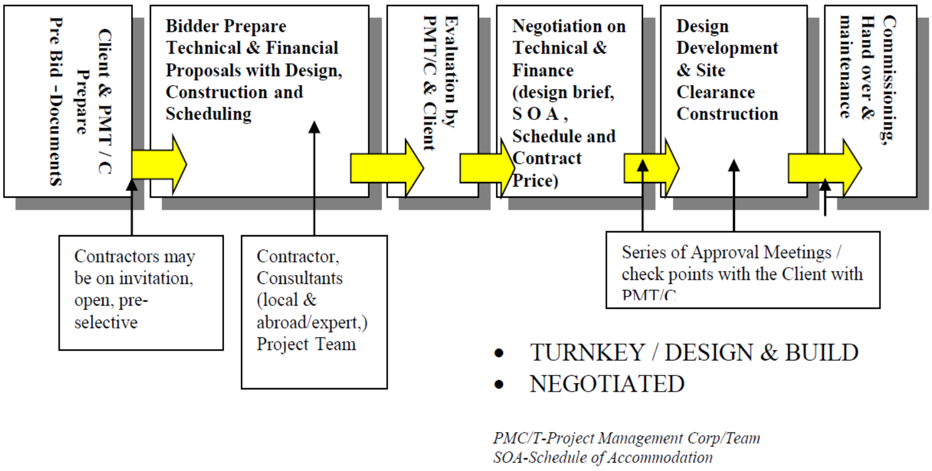


Figure 7.3: The procurement of a hospital project in Malaysia

(Source: Nawawi, 2003)

Based on the interview with these architects, they mentioned that the initial idea of the whole master plan, as well as design and planning of the hospital, initially originated from themselves in collaboration with the medical planners. For the H1 hospital, the medical planner was from the local firm (PPB) while the H2 hospital medical planner was from the UK medical planner (PTP Architects Ltd.). While the H1 architect reported that the ideas of the hospital design came from them, the H2 architect mentioned that the ideas and concept of the H2 hospital mostly came from the PTP medical planner. Collaboration with foreign firms is one of the government strategies to allow the transition of technology from those who specialise in healthcare projects to local private consultants (Nawawi, 2003):

> *'We have PPB as a medical planner, we did the interior design, (S) as a landscape architect, another consultant was (H) who was a mechanical & electrical engineer, and then DBI, the structural engineer'* - (H1-Architect).

> ***'We engaged together with this medical planner,*** *who has been designing hospital around Malaysia, they are from the United Kingdom (UK), PTP… if you see here (referring to the drawing), H2-Architect in association with PTP Malaysia'* - (H2- Architect).

7.2.2 The hospital project brief

In the design development process, the architects were responsible to understand the project brief and produce a physical master planning of the hospital projects including zoning for the hospital complexes, overall layout of the main hospital complex, and its circulation. The consultants needed to follow the requirements provided by the MOH and the PWD including the **medical brief and technical brief**, respectively. During the interview, the H1-architect explained that only two design briefs were provided by MOH and PWD to the architects. However, this did not provide information or detail on the conceptual design aspect; rather it is more focused on the practical and technical issues:

> *'They have* ***two briefs.*** *One from the PWD. The other one from the MOH. The PWD is talking about* ***technical things****. What kind of floor finishes you should have, it's not telling you how to design it. And then, the* ***Medical brief*** *will tell you the various departments and how they wanted each department to be designed'* - (H1-Architect).

The medical brief from the MOH described the requirement of various medical departments for the hospital, while the technical brief from the PWD basically focused on the indoor hospital spaces and facilities (i.e. types of floor finishes, dimensions of the door and main hospital streets). **The MOH and PWD did not provide a detailed guideline on how the courtyard garden should be designed**. When asked whether they were given any guidelines related to the hospital courtyard garden, they mentioned that the client only asked to provide some landscape in the hospital design and planning:

> *R: Is there any guideline for the landscape or courtyard garden?*
> *H2-AR: 'I can't remember. But as far as I remember,* ***not really****.* ***All they want is only some landscaping****. And then when we introduced this courtyard, they insisted, I mean that is the good thing that they insisted, all this courtyard to be properly landscaped'* - (H2-Architect).

This implies that the ideas and design decision to incorporate the courtyard garden initially come from the architects themselves. The architect design was based on their experience and expertise. The conceptual plan and functional aspects of the hospital were based on their professional expertise along with input from the medical planner. The architect proposed the design concept for the hospital, organised the space function according to the MOH brief, and arranged the circulation of the hospital based on discussions with the project team.

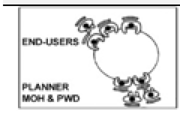
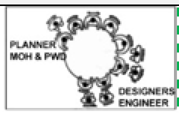
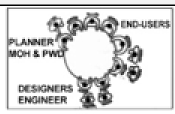
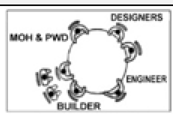
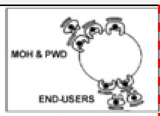
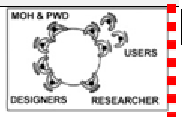
7.3 Collaboration practice among the stakeholders

As explained earlier on Section 2.2.4, extant research has criticised that landscapes are often created as an after-thought, and thus are not treated as part of the architecture component (Verderber, 2010, p.60). Cooper Marcus (2007) claimed that the architect tended to focus on designing the overall building plan and often treated outdoor gardens as a separate thing. Moreover, the landscape architect often starts designing the landscape only after the building has been completed. This has caused the courtyard to be disjointed from the overall master plan, with limited early consideration on the suitable location, accessibility and microclimatic aspects (Cooper Marcus, 2007). Therefore, investigating how architects and landscape architects collaborated between themselves and the ways in which they dealt with other stakeholders are fundamental to examining how the HCG design process has been practiced in the Malaysian context (Discussed further in Section 7.7.5). The findings related to the collaboration practice will allow the development of the HCG framework with particularly emphasis on the operational aspect; further, it will provide necessary recommendations concerning policy and practice (See Section 8.5).

The hospital projects in Malaysia involved various stakeholders: i) Client: MOH; ii) Project manager: PWD; iii) Design consultants: architect, professional medical planner, landscape architects; iv) structural and mechanical engineer; and vi) contractor. Table 7.1 indicates the design process which was carried out in several phases including the initial identification stage, the briefing stage, the design stage, the construction stage, the commissioning stage and the POE stage.

The design process initially began with the identification stage that involved an analysis of the needs. This stage prepared the project brief for a new facility. At this stage, the medical planners are usually engaged with the MOH and PWD in developing the project brief. Then, in the briefing stage, the design consultants (architect and engineers) engaged with the MOH and PWD requirement for the new facilities (medical and technical brief). During the design stage, it depends on the architect to interpret the project brief to ensure that the design meets the requirements set by the MOH and PWD. At this stage, active communication with the medical planner, the end-users, engineer and landscape architects is usually involved. Once the final design has been approved, construction started. At this point, the architect has to make sure that the contractor followed the approved masterplan and completed the project within the agreed schedule. The landscape architect also plays their roles in ensuring the landscape of the HCG is in accordance with the approved design drawing. Once the hospital project is completed, it is ready for commissioning. During the commissioning stage, the commissioning team finalise the facilities in the hospital to ensure the facility is ready to operate. Finally, after several years of occupancy, a POE was conducted to evaluate the hospital facilities to make necessary improvements based on user feedback.

Table 7.1: The collaboration during the design development stage

1 Identification stage	**2** Briefing stage	**3** Design stage	**4** Construction stage	**5** Commissioning stage	**6** Post occupancy evaluation (POE)
					
Need assessment team: Planner MOH & PWD	**Briefing team:** Planner MOH & PWD Designers Engineer	**Design team:** Planner MOH & PWD End-users Designers Engineer	**Construction team:** Builder MOH & PWD Designers Engineer	**Commissioning team:** MOH & PWD End-users (e.g.Medical staff, nurses, administrator)	**Evaluation team:** Researcher Users (i.e. patients, staff, visitors) Designers
Formulate and update project brief for a new hospital project.	Discussion of the medical and technical brief	Preparation of the architectural brief and technical drawing. Preparation of landscape concept and drawing by the landscape architect.			Current study: Diagnostic POE of hospital courtyard (HCG). Another POE was conducted by the MOH, the end-users and other researchers which focused on different aspects of study.

Green dotted line	The important stage which involves collaboration of the architect, landscape architect and MOH in the development of the HCG design.
Red dotted line	The important stage of gathering feedback from the users (patient staff and visitors) regarding the current HCG performance to improve users experience in the hospital.

7.3.1 A collaboration of architect with the landscape architect

The landscape architects play their part in designing the HCG once the hospital floor plan has been approved by the MOH. They mainly take part in designing the landscaping in the designated spaces in the hospital plan which were initially determined by the architect.

Their job scope included: proposing the landscape concept for the HCG and selecting the right choice of vegetation and hardscape which needs to be agreed with the MOH and the hospital administrator. The ideas for the size of the HCG, the location, the access to the HCG, the views and the space function around the HCG essentially originated from the architects:

> *'We basically determine where the courtyard should be, how big the proportion of the space.* ***We give them space and they (landscape architect) did all the planting and the walkways*** *and all that'* - (H1-Architect).
>
> *'they* ***(the architect)*** *told us the concept, intention, what they want regarding the overall concept of the building and then from there we* ***would do our own landscape concept,*** *what we want to achieve, let's say we say we want urban forest,* ***then we think of the species of trees that are able to achieve our intention'*** - (H1- Landscape architect).

Nevertheless, in H2-hospital, the MOH significantly influenced the final outcome of the HCG design. As mentioned by the H2-architects, the ideas regarding how the garden should be designed mostly originated from the MOH which had to be followed by the landscape architect:

> *'…They all (landscape architect) know this landscape,* ***they designed it and discussed it with the Ministry****. How they want each of these courtyards to look like and function. So, how they design it, we don't really have influence, because* ***most of them come from the Ministry'*** - (H2-Architect)

The architect was responsible for the arrangement of the spatial organisation for overall hospital planning and how it is linked to the HCG. This is very crucial because it affected how it functioned and subsequently was used by the users. On the other hands, the landscape architect was involved in designing the layout of the HCG, the arrangement of the spaces, planting, seating, walkway and water features which also impacted on users' experiences in the HCG depending on how it was designed. This study suggests that active collaboration between the architect and landscape architect will ensure a better design outcome, provided that the HCG is maintained properly by the administer.

7.3.2 A collaboration of landscape architect with the hospital provider (MOH) and structural engineer

Both the H1 and H2-landscape architects mentioned that essentially they developed their own ideas and landscape concept for the HCG and they have to follow the MOH requirement to design a 'low maintenance garden' (See Table 7.2). Although the H1-landscape architect does not face so many constraints regarding the HCG site because the HCG is on the earth, however, the H2-landscape architect needs to adhere with the loading requirement because the HCG is located on a floor slab. In other words, they need to design, limit the choice and consider the weight of the landscape features to comply with the approved loading requirement set by the structural engineer. The design development of the landscape must also go through numerous revisions following discussions with the MOH and the hospital administer. The H1-landscape architect did not have any disagreements in their design proposal and the concept was approved by the MOH. However, the H2-landscape architect mentioned that he failed to achieve his initial goal and as such had to adhere with MOH requirements to change the landscape concept for the H2-hospital.

Table 7.2: Collaboration practice between a landscape architect and the MOH and engineer

Main issue	Collaboration practice between a landscape architect and the MOH and structural engineer	
A requirement for a low garden maintenance	*'We need to talk to the client (MOH). Usually that operation is about **low garden maintenance,** this and that, you know, because it causes lot of money to pay, so, in terms of low maintenance, they are going to select the **type of trees that do not produce too much leaf litter that they need to clean, and are not easily attacked by disease or insects'***	H1-Landscape architect
Low garden maintenance and structural requirement	*'We based on the **client's requirements and the engineer's requirements.** The guideline is basically on the engineer's guidelines. That is **the loading** and then, the other thing is the client's guidelines, that is about **the garden maintenance'***	H2-Landscape architect
The landscape design highly depends on MOH approval	*But you got to understand, how does the design evolve, you know. We showed to the client, and the client said, No! We don't want, we do want, or they said, Ok, good! We will take it. And then they said, No! No! We don't want it, you know. So, it goes to the process whereby, **it's still up to the client'.***	H2-Landscape architect
A failed design	*'The architect did provide green spaces, but **in terms of our design, it is a failure'.***	H2-Landscape architect

7.4 Designers' intention of the hospital courtyard garden (HCG)

Different designers have individual ways of thinking in which they are highly based on the reasoning and imagining throughout the design process (Lawson, 2006, p.137). Reasoning is a purposive way of thinking which is often directed towards a particular design goal and includes the process of logical thinking, problem-solving and concept formation. In contrast, imaginative thinking is related to interpretation based on the designers' own experiences, which are often related to artistic and creative thought (Lawson, 2006). Understanding the architect and landscape architects' intentions are crucial to provide insight on how they apply their skills, creativity and experiences and interpret the architectural or landscape ideas to create an effective HCGs to meet the users' needs and expectations.

As mentioned earlier in Section 2.2.4, the architect and landscape architect have different roles. The architect is more focused on the environmental design and the landscape architect more concentrated on the landscape design. Therefore, this section presents the designers' initial intentions regarding HCG design to identify several themes that might develop from their perspective. Further, this section investigates the particular aspects that they considered during the design process of the HCG.

7.4.1 Architects' design intention

The architects highlighted that the main purpose of the inclusion of the HCG in the design and planning was due to the need to avoid a deep plan building, particularly in a large type hospital complex. The common design intentions that were mentioned by the architects are included:

i) Daylighting strategy;
ii) Ventilation strategy;
iii) Access to nature; and
iv) Point of orientation.

This design intentions are discussed further in the following section in order to examine the views of the architects and the aspects that they considered in designing the HCG for a hospital in relation to the environmental and restorative functions.

7.4.1.1 Daylighting strategy

Many studies highlighted the benefits of natural daylight to hospital occupants (Alzoubi et al., 2010; Aripin, 2006). A previous study revealed that patients who stayed in a well-daylit room required 30% or less pain relief than those in badly lit rooms; further, they also experienced quicker recovery times and returned home with a better and positive mood (Walch et al., 2005). Moreover, daylight can have an impact on the patient's average length of stay (Canellas et al., 2016; Joarder and Price, 2013; Choi et al., 2012).

a) Avoid a 'deep plan nature' of the building

In addition to the benefits of daylight to patient outcomes and visual comfort, the courtyard provides daylighting into the indoor hospital spaces in Malaysia. Based on the interview with the architects (H1, H2 and H3), the main intention to incorporate courtyard gardens in hospital planning is **to avoid a 'deep plan nature' of the building** as part of the requirement by the MOH and PWD. The courtyard allowed light into the building as explained by the H1-architect. Similarly, H2 and H3 architects also shared a similar aim as specified in their architectural brief:

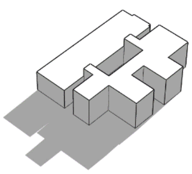
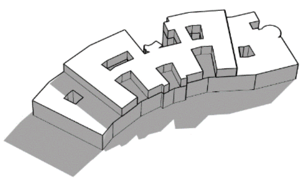
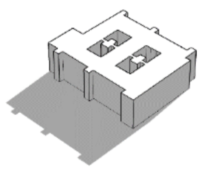
> '*…, there are so many medical departments here* [referring to the floor plan for level 2]*, so this is the diagnostic and treatment blocks, so you've* ***got very deep planning in itself.*** *So, the other part also you* ***want to have exposure to get the light*** *from here as well as this side* [Referring to the East and West side hospital blocks]' - (H1-Architect).

b) Bring daylight to the internal spaces

Similarly, the H2-Architect also mentioned the aim to use the courtyard as a strategy to prevent the deep planning hospital complex. He explained that having a courtyard in a large and linear hospital plan such as the H2-hospital helped **to break the long circulation of the internal corridor and bring daylight into the internal spaces** (See Table 7.3):

> '*As you can see in H2 Hospital, particularly it's a very long building. From one end to another is about… how many kilometres something. So,* ***if you don't introduce those courtyards, it'll be like a long continuous walkway, no break, no light***'- (H2-Architect).
>
> '*…* ***we don't want it to be too enclosed, that's why we introduced the courtyard****. So, in a way, as I said just now, this courtyard came into the picture because of the necessity*' - (H2-Architect).

Table 7.3: The arrangement of courtyards in the hospital planning

H1-C1	H2-C3	H3-C2
Central large courtyard	**Interlinked type courtyard**	**Clustered type courtyard**
		

b) Bring daylight to the basement level via the void area in the HCG

Both the H1-architect and H3-architect mentioned that the intention of introducing a void area in the courtyard garden was as a strategy to bring daylight into the lower ground floor (See Table 7.4).

> *'… **we want to bring the light to the level one**. Like I said it provides the solution for the lowest space and these are the courtyard corridor. So, that was the idea the courtyard being there and **make use of the light coming through into the building'** - (H1-Architect).*

> *'As you said just now, why did we make it slope here, I mean because of, firstly, the cost-saving, secondly because **we want to allow ventilation and daylighting into the basement (level one),** if not **it will be dark**'* - (H3-Architect).

Table 7.4: Strategy for daylighting at the lower ground level in the HCG

H1-C1	H2-C3	H3-C2
  The void area in the HCG brings daylight into the lower ground level (level 1).	H2  No void area	H3   The void area in the HCG to bring light down to the lower level (level 1).

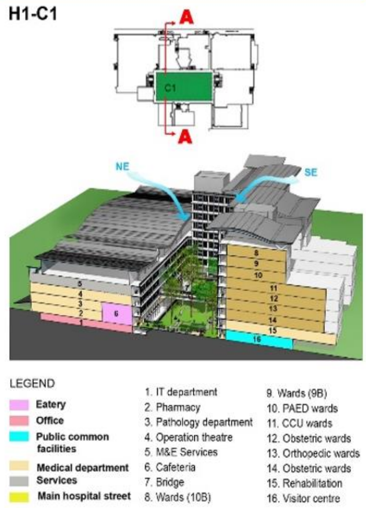
7.4.1.2 Ventilation strategy

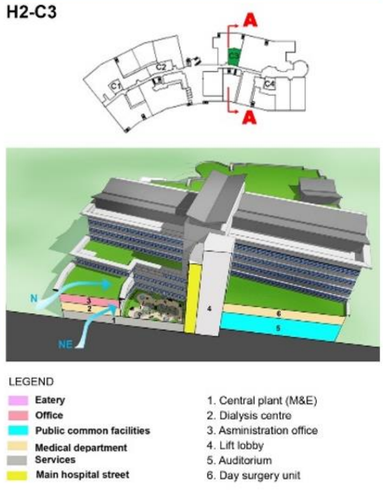
Courtyard gardens not only bring natural daylight into the building, but also function as a cooling strategy that allows air movement into the building spaces through the openings around the wall enclosure (Sharples and Bensalem, 2001; Rajapaksha et al., 2003; Jamaludin et al., 2015). The courtyard garden is one of a number of wind-driven ventilation strategies among other techniques including window opening, chimney cowl, wind tower, and windcatcher (Passe and Battaglia, 2015; Khan et al., 2008). Short and Al-Maiyah (2009) proposed a hybrid ventilation strategy that integrated both the natural ventilation (i.e. drawing air into the indoor spaces via a damper control inlet and out of the spaces via the exhaust stack) and mechanical ventilation (i.e. the use of mechanical fan and chilled water pipes) to cool the air inside a deep plan of a hospital building. The proposed hybrid ventilation strategy significantly reduced the building lifecycle cost.

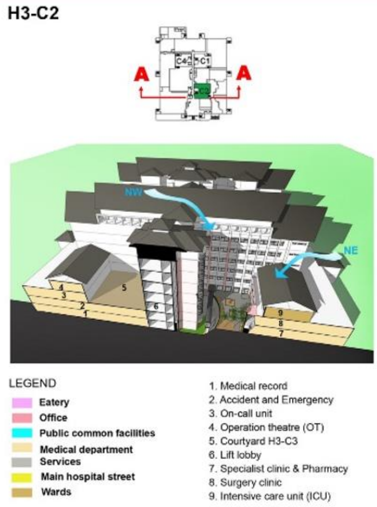
Jamaluddin et al. (2014) suggested that the elements of the internal courtyard and balconies are a vital aspect to be implemented in tropical Malaysian buildings because it can help in the reduction of energy consumption by maximising the use of natural daylighting and ventilation. Table 7.5 illustrates the use of the courtyard as a ventilation strategy in the three case study hospitals.

Table 7.5: The provision of a courtyard in the hospital planning to ventilate the indoor space

H1-C1	H2-C3	H3-C2







Based on the interview with the H2-architect, who designed one of the case study hospitals, the inclusion of the courtyard garden in the hospital **is due to the necessity of the designers to ventilate the corridor**, which also formed part of the requirements by the MOH as mentioned by the H2-Architect:

> '*The design brief* [referring to the MOH brief] *has not changed since the old time. So, their idea of the hospital is like this, so **whatever corridor they have, is supposed to be naturally ventilated***' - (H2-Architect).

All three architects mentioned the intention of incorporating a courtyard in the hospital planning to provide natural ventilation into the main hospital street (corridor) as well as the adjacent spaces around the courtyard garden:

> '*As you can see also, I think you've seen the building itself, the corridor or what we called the hospital streets are arranged around a courtyard. That also **provides natural ventilation to that corridor***' - (H1-Architect).

> '*When we do a design like this, quite compact, then you realise **how to ventilate the corridor**? Imagine if I don't have any of this courtyard, how can I ventilate, right? You imagine all this thing, internal with no opening, of course, natural ventilation will be terrible, right? **It's out of necessity we need ventilation***' - (H2-Architect).

7.4.1.3 Access to nature

a) Nature as a healing process

The idea of a healing environment has entered mainstream thinking in hospital design and is now accepted widely (Rawlings, 2017; Cooper Marcus and Sachs, 2014; Prasad, 2008, p.8; Cooper Marcus, 2007). Outdoor gardens may not cure chronic disease, but numerous research has revealed that having contact with nature either by being in nature or viewing nature contributes to stress reduction and elevates positive moods (Ulrich, 1984; Ulrich et al., 2018, 2019; Reeve et al., 2017; van der Riet et al., 2017; (Cooper Marcus and Sachs, 2014).

In the Malaysian context, the term 'healing garden' was used by the hospital provider (MOH), which envisioned creating a healthy hospital environment through the concept of the hospital in the garden (Ibrahim et al., 2015). A similar concept of 'hospital in a garden' was also applied in both H1 and H2. Based on the interviews with the three architects, this showed that they associated the courtyard garden with a healing process, thus highlighting that they understood the benefits of providing access to nature (e.g. light, breeze, sound of water and vegetation) in a hospital building:

> *'Um. I think the courtyard is not a new phenomenon or design element. It has been there for ages and centuries. But especially for the hospital I think it contributes towards a **healing type of environment.** That is important in hospital design'* - (H1-Architect).
>
> *'… whether you are a patient or staff or visitor, you still **want to be connected to the outdoor…** using a courtyard environment can **promote daylight into the indoor spaces, it is part of the healing process**'* - (H2-Architect).
>
> *'It can be more natural as I said... it has to feel... you see, **when something is felt more natural, people tend to be more relaxed**'* - (H3-Architect).

This is somewhat in accordance in previous study which found that the designers tend to associate the healing environment in a healthcare setting with the nature, spatial experience, privacy and domesticity (Van der Linden et al., 2016). Nature is also associated with anxiety reduction, increased relaxation, and the improved ability to think clearly (Berman et al., 2008; Kaplan, 1995). Access to nature facilitates recovery from stress and mental fatigue. Patients and family members are often those who experience stress due to the uncertainty of threatening health problems. Access to nature can be used as a strategy to address this problem. Whereas, staff often experienced mental fatigue as a result of their daily working routine which requires their ability to concentrate (Pati et al., 2008; Kaplan, 1995). Being outdoors allows them to refresh their mind and make them feel better. Further, the outdoor garden can serve as a place for refuge, peace and tranquillity.

b) Bringing the outdoor in

The spatial relationship between outdoor gardens and adjacent spaces is crucial to ensure it functions well and is used as intended. The H1-architect highlighted the point that common public spaces such as the cafeteria, visitor centre, auditorium and clinical space are all arranged around the HCG (See Figure 7.4 (a)) to provide a visual link between the indoor and outdoor. The H1-architect also intended to provide visual access where people can enjoy the view from each floor level, the main lobby (See Figure 7.4 (b)) and also from the bridge (See Figure 7.5).

> *'For example**, from the cafeteria you can enjoy the view**, from the clinics you can come out, from the visitor's centre you can come out, in other words, you make that space animated, so when you are up there you can **enjoy the view of the garden when you are on the bridge** you can enjoy it… whenever you are anywhere in the hospital, **you have the visual link at least'*** - (H1-Architect).

(a) (b)

Figure 7.4: The view from (a) the cafeteria and (b) the main lobby of H1-hospital

Figure 7.5: The view from the bridge of H1-hospital

c) Serve as an alternative waiting area for patients and families

All three case study hospitals were built and intended to be used by a wide range of users, including patients, staff and visitors. Thus, the facilities and the landscape features must ensure that it accommodates the variety of needs of the intended users. The H1-architect indicated his intention to provide an alternative place, such as the HCG, that patients and visitors can use as an alternative waiting area in addition to the indoor waiting area that is usually congested during the peak time of clinical operation hours (See Table 7.6).

> '*... and a lot of people also going to the imaging department, taking X-rays and all that, they would be passing through this corridor. And also, there is an accident and emergency department. Although it is an emergency, there would be people travelling from here to here* [referring to the main hospital street] *waiting for their family being treated. So**, they can utilise that courtyard garden***' - (H1-Architect).

> '*Especially in the public building, hospital, if you notice at any time during visiting hours, there will be a big crowd and most places they don't have places for people to go. I think that also becomes* ***a good place for people to disperse****…*' - (H1- Architect).

Table 7.6: The indoor waiting area in the three case study hospitals

H1-C1	**H2-C3**	**H3-C2**
Waiting area at **specialist clinics**	Waiting area at the **pharmacy**	Waiting area at the **pharmacy**
		
(Time: 8.45 am) The waiting area in the clinics was very crowded during weekday operation hours.	**(Time: 3.32 pm)** Less crowded during the late afternoon compared to morning time.	**(Time: 9.20 am)** The waiting area at the clinics is often crowded, particularly during the weekday operation hours.

Patients, staff and visitors used the HCG for a variety of reason. For example, they may use the HCG to sit and wait while waiting for family members who have appointments with doctors in the clinic or waiting for visiting hours. Patients also wanted to be outside the wards to enjoy the view of the garden and meet other people (See Figure 7.6 (a) and (b). Some parents accompanied their child playing in the HCG, and some staff use their break time to have lunch in the HCG. This implies that the HCG is an essential facility to support the needs of patients, families and staff as an alternative place for them to 'be away' from the indoor hospital and find a place where they can rest, refresh their mind and reduce stressful thoughts (See Figure 7.7).

(a) (b)

Figure 7.6: The HCG in H1-hospital which were used by the patients and families

Figure 7.7: The use of the HCG by families to rest and relax while waiting the visiting hours

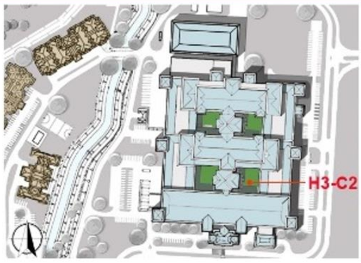
7.4.1.4 Point of orientation

The results of the interview with an H1-architect revealed that the idea for incorporating this type of large central courtyard garden originated from the architect himself with the aim to enhance users' experiences in the hospital through the concept of 'hospital in a garden'. Due to the availability of large land during that time, the architect explained that they had an opportunity to create a hospital with a central courtyard to act as a point of orientation or landmark. He explained that for a large-scale hospital complex, people can become easily disoriented. Therefore, the architect introduced the courtyard garden in the planning of the hospital to serve as a point of orientation to facilitate wayfinding in the hospital. It helps users to reorient and navigate themselves to find their way to particular departments in the hospital by referring to the courtyard garden:

> *'…The reason why we incorporated the courtyard in this particular design is that **this is a huge hospital**. It is a 704 beds hospital and the floor area is more than a million square feet. So, when you walk into a building that is in that size, you are **easily disoriented**… So, what we wanted to do is **to have a centre that could reorient you**… **Whenever you are in the courtyard you know where you were supposed to be, so it becomes a point of orientation** and, at the same time, it provides the garden, the green space and it would be used'* - (H1-Architect).

This in line with previous research which highlighted the importance of the courtyard garden or atrium as a landmark within the hospital building to enhance wayfinding and facilitate people to navigate themselves in the hospital (Peavey, 2015; Adams et al., 2010). Table 7.7 indicates the location of the HCG and the section of the case study HCGs within the hospital planning.

Table 7.7: The location of the HCG

H1-C1	H2-C3	H3-C2
		

7.4.2 Landscape architects' intentions

Interviews with the landscape architects revealed some important findings related to their design intentions regarding the HCG which categorised into:

i) Forest-like garden concept;
ii) Natural form rather than aesthetic;
iii) A place that contributes to stress reduction; and
iv) A place for social interaction.

These findings are elaborated further in the next section in order to examine their intentions and the considerations that they take into account in designing the HCG. It is also necessary to investigate to what extend their intentions and assumptions have been achieved to date.

7.4.2.1 Forest-like garden concept

The architect's design intentions are focused on the functional aspects of the courtyard garden as a strategy for daylighting and ventilation, which are mostly related to the spatial organisation of the hospital. In contrast, the interviews with both of the landscape architects found that their design intentions are more focused on the application of the concept which is to **create a 'forest-like' environment in the designated hospital courtyard garden.**

The H1-landscape architect mentioned that he intended to create a forest garden concept in this hospital by designing a free flow organic shape garden. Similarly, the H2-Landscape

Architect was also passionate to realise his idea of a forest concept (i.e. tropical rainforest). He aimed to implement 60-70% of landscaping in the courtyard gardens of the H2-hospital, but he was unable to proceed with the initial idea due to disapproval by the MOH because they wanted a hotel-like environment for the H2-hospital. Moreover, their design was also rejected by the engineer due to structural issues and loading requirements in the designated HCG space:

> *'Yeah, we tried to achieve a more local... what we call...* ***a hospital in forest,*** *that kind of theme… That's why we designed the courtyard like a* ***free flow organic shape*** *so that you can meet and mingle around'* - (H1-Landscape architect).
>
> *'… the whole idea is to* ***canopy the whole area by at least 60-70%*** *of the built environment, so that's what the proposal was... Initially we wanted to have the whole thing* ***forested****'* - (H2-Landscape architect).
>
> *'If I was given the chance to do it my way, you know, we* ***wanted to have a forest-like garden'…*** *'It was never accepted. They wanted it to be like a hotel environment, at that time the tropical rainforest was not the thing they wanted'* - (H2-Landscape architect).
>
> *'It is a failure in terms of landscape design… The architect did provide green spaces, but* ***in terms of our design, it is a failure'*** – (H2-Landscape architect).

7.4.2.2 Natural form rather than aesthetic

Both landscape architects mentioned the positive effect of nature on well-being. They associated the healing garden with the availability of greenery provided within the outdoor garden spaces. The H1-landscape architect also mentioned that he intended to create an informal garden which was not regimented and looked more natural. Similarly, the H2-landscape architect stated many times that it was important for the garden to look more natural rather than aesthetic:

> *I designed it to be* ***free and easy, move around, …it's not regimented and controlled,*** *what you see is* ***everything complements with each other****'* **-** (H1-Landscape architect).
>
> '***It should be more nature, it should be a healing environment, rather than aesthetic.*** *In this case, it was more aesthetic, if you look at this, this is part of, see, this circular thing, the design,* ***the form itself is not natural****'* - (H2-Landscape architect).

7.4.2.3 A place that contributes to stress reduction

Previous studies have revealed that people recover from stress more rapidly in green areas compared to urban areas, which resulted in lower blood pressure and slower heartbeat (Ulrich, 1991; Berto, 2005). Moreover, visiting natural areas contributed to a more positive feeling, and being calmer and refreshed than visiting urban areas (Carrus et al., 2015; Lee, 2017). Outdoor gardens with more natural elements such as water, grass, trees and flowering plants was perceived as being more restorative compared to settings with less natural features (Ulrich et al., 2019; Twedt et al., 2016; Carrus et al., 2015; Cooper Marcus and Sachs, 2014; Shukor, 2012).

Both the H1 and H2 landscape architects mentioned how a view of nature and greenery could elevate positive moods and encourage the healing process. Moreover, the H1-architect highlighted that a patient who has contact with nature could bring positive impact to the healing process of their body in which they will felt positive changes in mood, such as feeling calm, peaceful and happy in the garden which encouraged the body to heal:

> *'… when a patient could see a* **pleasant, and feel calm***, and have a sense of* ***happiness****,* ***no distress****, automatically the body will have its own* ***healing process****… It's a kind of therapeutic space where most of them can go, sit, and they can* ***feel relaxed****, and when you have a space that is pleasant, you can* ***release stress'*** - (H1-Landscape architect).

> *'…* ***when you see green****, your eye always calms, looking at space, let's say, looking out, instead of looking at the blank wall, automatically your* ***mind and mood will change…****'* - (H1-Landscape architect).

> *'If you* ***look at the green (nature) your stress will go down****. If you sit within green, your stress will go down, and then in certain areas, you know, in certain aspects, it will heal you'* - (H2-Landscape Architect).

7.4.2.4 A place for social interaction

Another interesting point highlighted by the H1-landscape architect but not the H2-landscape architect is a place for social interaction. The H1-landscape architect intended to create a HCG that promoted social interaction among its users to allow patients, families and staff to sit and converse or meet in the outdoor garden rather than sitting in the indoor hospital. The H1-landscape architect clearly stated the intention of providing landscape features such as shaded seating and the water fountain to encourage social interaction and enhance the users' experiences. Spatial organisation for the courtyard garden included the connection with adjacent spaces and its design features are fundamental to ensure it is well-functioning and utilised well by its users:

> *'And the courtyard purpose is, there are two main things, for visitors, what we call while waiting they* ***don't need to be staying in the building, they can go outdoors…*** *we designed the courtyard garden so that they can* ***meet and mingle around****'* - (H1-Landscape architect).

> *'We have trellis just in case that during the time in the early days of the project there was not much of shade, people can appreciate the green under* ***the trellis****… The w****ater splashing sound*** *in the courtyard garden* ***makes you feel like you are at the river, or at the stream****…'* - (H1-Landscape architect).

7.5 Challenges in hospital design development stage

This section discusses on the challenges faced by both the architects and landscape architects in hospital design development stage, particularly on the HCG design. Several issues are mentioned by the architects and landscape architects which concentrated on the physical design, environmental and operational aspects (i.e. collaboration with the users and clients). These are discussed further below.

7.5.1 Challenges faced by the architect in the design development stage

The interviews with the architects has revealed that their challenges are varied because it was based on the situation and difficulty that they faced during the whole design development stage. While the H1-architect was primarily focused on the challenges that he faced in the design and environmental issues, the H2-architect, who was also involved in designing the H3 hospital, mentioned that the challenges were more on the collaboration process with the 'end-users' (doctors, nurses, hospital administrators) and the hospital provider (MOH). Several issues were highlighted by these architects:

- Environmental design and climatic issues;
- The outdated project brief;
- Restriction of time and budget; and
- Meeting the needs of the 'end-users'.

These issues are discuss further in the following section to examine on the challenges that faced by the architect which will further provide necessary design recommendations for improvement in the future practice (Discussed further in Section 7.7.4).

7.5.1.1 Environmental design and climatic issues

a) Wind-driven rain issue in a building design

The issue of environmental design was highlighted the most by the H1-architect in which he mentioned the challenge that he faced to design of wall enclosure to allow ventilation and at the same time stop water getting into the building. Having a ventilated corridor is part of the hospital project brief which must be adhered to by the architect. In a hot humid climate like Malaysia, it is common to have days with heavy rain throughout the year. The H1-architect mentioned that it was hard to get a 'win-win situation' when designing an enclosure around the courtyard that is open to allow ventilation into the building because these opening permitted the rain to come into the building and wet the floor especially during heavy rain and breezy days. Eventually, it will lead to building defects such as mould growth, condensation, leakage, decay, peeling paint, and staining (Razak and Jaafar, 2012; Hassan et al., 2011).

> '***You want the ventilation to come through, to view,*** *because we open up, then* ***water comes in during heavy drain. That is the drawback****. So, if you close everything, it becomes stuffy and all that but of course you keep the water out. So, I think it is* ***more of a 'give and take' whichever that is more the priority.*** *That is one of the issues that certain openings like this, water can come in*' - (H1-Architect).

The lesson learnt from this is that prediction of this issue at the earliest design stage and tackling it by appropriate design solutions via computer modelling and simulation for building facades will help to overcome problems including wind-driven rain issue. This will be useful in designing a building that could adapt to future climatic changes. Further, this allows the design consultants to explore and simulate different options for problem-solving in the building design and, subsequently, would add value in the design and development process (Dodgson et al., 2010).

b) Macroclimate and microclimate changes due to urban development

Another issue highlighted by the H1-architect regarded macroclimatic and microclimatic changes to the current hospital sites due to urban development in the neighbourhood area. The development of high-rise, industrial and commercial areas in the surrounding area of the hospital slightly affected the macroclimate around the hospital complex and microclimate of the HCG. The H1-architect mentioned that, in the previous decade when construction began, the neighbourhood area was surrounded by palm tree and rubber tree estates. Today, with so many developments in that area, this has affected macroclimatic and microclimatic conditions. The high wind velocity recorded in the HCG could also result from climatic changes due to deforestation and urban development of the surrounding area:

> '*But those days, when we were building this surrounding that hospital, nothing!* ***There was no building****. So now it is different.* ***Now you have a high rise.*** *I think it helps;* ***it would have changed the microclimate around the area.*** *Last time it was a big 'Kelapa sawit'* [Palm trees] *or 'getah'* [Rubber estates] *or something, you know. Now, all housing, all buildings, what we could see, Jusco (shopping mall) was being built at that time*' - (H1-Architect).

It is true that the architect cannot control the changes in urban development to overcome climatic change. In previous years, lack of computer modelling and simulation technology at that time could have acted as a barrier to predicting how environmental aspects might impact on the building design. Nevertheless, although some environmental issues cannot be controlled due to climatic changes (i.e. higher temperature, extreme weather, changes in rainfall), this study found that the H1-hospital has been well-designed to adapt to changes of microclimatic conditions with an appropriate passive cooling strategy (i.e. courtyard) in the design and planning of the hospital.

7.5.1.2 The outdated project brief

Another challenge mentioned by the H2-architect concerned the requirement to follow the outdated design brief in the hospital design. The architect further explained that each hospital design evidences site-specific design constraints and issues which differed across the hospital and which need to be tackled differently. The architect mentioned that this design brief did not change until today and as such was outdated. He also added that the requirement for a corridor to be naturally ventilated is only suitable for the old type hospital building which has one side corridor, but was unsuitable to be implemented to internal corridors such as that found in the H2-hospital (i.e. departmental rooms arranged between the internal corridor) which resulted in condensation problems to the internal wall. The H2-architect argued that the MOH needed to update the design brief and be more flexible in adapting new ideas to tackle the environmental issues of particular hospital planning so that it would not result in subsequent building defects:

> '*To me, to be honest,* ***it sounds radical because they still have the design brief, which in my opinion, is quite outdated*** *because* ***they have been based on the idea of an old hospital design****, let me sketch, if you look at the old-time design, you have to compare to the type of old hospital, always they may have corridor, so* ***their design brief has not changed since the old time.*** *So, their idea of a hospital is like this, so* ***whatever corridor they have, is supposed to be naturally ventilated***' - (H2-Architect).

7.5.1.3 Restriction of time and budget

The H3-architect mentioned one of the challenges faced during the design development stage of the H3-hospital as the restriction of time and budget for this hospital. The H3-architect mentioned that the project was based on turnkey procurement and that the contractor was required to finish the project at the earliest time possible. This resulted in the lack of opportunity to explore the design due to the short time for completion, an issue compounded by the limited budget available for this hospital. This implies that the restriction of time and budget of a particular hospital project can significantly influence the project outcome, as found to be an issue for the H3-hospital. In turn, this then affected users' experiences when they used improperly designed hospital facilities due to the time and budget constraints:

> '*Their approach* [the contractor] *is more like just do the bend around,* ***get it done****… what I mean is... they* ***don't want to explore too many ideas****… you know... they* ***don't want to spend too much on design****… basically just make everybody happy is enough*'— (H3-Architect).

7.5.1.4 Meeting the needs of the 'end-users.'

Satisfying the 'end-users' (e.g. doctors, midwifes, pharmacists, therapists, administrators) was one of the challenging factors in the design process as mentioned by the H2-architect. The architect commonly becomes the middle party who needs to deal with several stakeholders and try to satisfy and follow their client (MOH) and end-users' needs. However, in the end, once the design is completed, many things are commented by the end-users and require changes to meet their functional requirements. This explains the need for a better collaboration process between stakeholders, especially the end-users during the design development stage so that any functional needs can be addressed at the earliest possible stage in order to avoid or significantly reduce any design changes after the commissioning stage:

> '*So we have to try to* ***get everybody to be happy… So that's actually more the challenge…*** *Even after it was completed, when they wanted to get in and take over the hospital, they* ***started to complain****, that's not right, that's not right… Actually, we have discussed all of those things with the planning department. So, we don't know, you know… Sometimes we just, if they don't like what to do...*' - (H3-Architect).

7.5.2 Challenges faced by the landscape architect in the hospital development stage

This section discusses the challenges faced by the landscape architects in the hospital development stage, particularly with regard to the HCG design. The landscape architects discussed this issue differently from the architects as they were more focused on the following:

- The constraint of the soil condition;
- Insufficient sunlight for the plants due to shade area in the HCG;
- Restriction of low garden maintainance; and
- Meeting the needs of the hospital administrator and MOH.

Examining the challenges faced by the landscape architect provides insights on the issues related to the HCG design. This is important to address issues related to the operational and physical design aspects. This finding helps to inform the practice, so that necessary improvements could be made in future HCG design (Discussed further in Section 7.7.4).

7.5.2.1 The constraint of the soil conditions

Generally, the H1-landscape architect mentioned that his challenge was concerned with landscape design in terms of the selection of appropriate plants and shrubs for the courtyard garden in the H1-hospital. As the initial idea was to implement an herb garden in the planning of the HCG, the landscape architect proposed a variety of anti-oxygen plants in H1-C1 (i.e. plants that can clean or purify the air and convert toxins to oxygen) (See Table 7.8). However, due to the soil conditions in H1-C1, only a limited type of herb plants were used in this HCG:

> '*… for this courtyard garden, we didn't propose enough anti oxygen plants because the particular* ***soil condition is not suitable***' - (H1-Landscape architect).

Table 7.8: Several types of oxidative trees and shrubs in the current H1-C1

Herbal trees			Herbal shrubs			
'Pulai'	'Dadap'	'Semambu'	'Pandan'	'Misai kucing'	'Bunga kantan'	'Kunyit'
						

7.5.2.2 Insufficient sunlight for the plants due to the shaded area in the HCG

The designers mentioned that only those herbs plants that could withstand a low amount of daylighting were chosen in this courtyard garden. However, he mentioned that the grass did not grow so well in this HCG due to the shady area in the courtyard garden and insufficient sunlight:

> '*… the disadvantage is that **grass can't grow well because it's too shaded***' - (H1-Landscape architect).

7.5.2.3 Restriction of low garden maintenance imposed by the MOH

This issue of limitation of the landscape design and concept was highlighted the most by the H2-landscape architect. He mentioned that they needed to adhere to the requirements stipulated by the hospital provider (MOH) and the administrator, and this limited the choice of planting to ensure low garden maintenance in the long term. Their initial landscape design changed after several discussions and approval meetings with them:

> '*We need to talk to the client (MOH). Usually that operation, is about a low garden maintenance, this and that, you know, because it causes lot of money to pay, so, in term of **low maintenance**, they are going to select the types of trees that do not produce too much leaf that they need to clean, and are not easily attacked by disease or insects*' - (H1-Landscape architect).

7.5.2.4 Meeting the needs of the hospital administrator and MOH

The landscape architect mentioned that he had designed landscape gardens in several hospitals in Malaysia. However, none of these hospital garden designs catered for the recovery of patients. This was due to the imposition of many restrictions on the landscape architects by the hospital administrator which later disrupted and modified his initial intentions to develop a healing type garden. It is therefore crucial to bring awareness to hospital managers and providers regarding the health benefits of nature interaction to ensure the success of the healthcare outdoor garden (Shackel and Walter, 2012):

> '*But you got to understand, how does the **design evolved**, you know. We showed to the client, and the client said, No! We don't want, we do want, or they said, Ok, good! We will take it. And then they said, No! No! We don't want it, you know. So, it goes to **the design process whereby, it's still up to the client***' - (H2-Landscape architect).

> '*We want something like this (healing garden). The problem is the hospital design in Malaysia, is the doctors **(hospital managers) themselves. They don't want to listen to us.'*** - (H2-Landscape architect).

'So, the nutshell of the hospital design, we did hospital A, hospital B, H2 hospital, we did D hospital, if you asked me, ***none of our designs catered for the recovery of the patient*' **-** (H2-Landscape architect).

7.6 Designers' suggestion for improvement of the HCG design

The final question to the designers concerned any changes they would like to see to improve the design and planning of the HCG. Their responses included two main aspects which are the physical design aspect (See Table 7.9) and the operational aspect (See Table 7.10). These findings are important in developing the HCG framework and for providing recommendations related to policy and practice which are discussed further in Section 8.5.

In terms of physical design, the H2-architect mentioned that the HCG should be less formally designed, and that access to the HCG needed to be improved to ensure it is accessible to all users including mobility users. The H1-landscape architect suggested changes to vegetation, especially the herbs plants in the HCG after five years as part of the garden maintenance.

Table 7.9: Designers suggestion for improvement of the physical design aspect of the HCG

Suggestions	Physical design aspects	Designers
Make the HCG look less formal	'*I like to look at the courtyard as**... less formal**… you see, what happened here in* [H2-hospital] *and others, it became a bit too formal; it's like a private garden*'.	H2-Architect
Planting replacement after 5 years	'… But *after they (the trees canopies) matured, we got shaded, so the herb plants that grow under full sunlight* ***can't grow in the shade,*** *so you have to change*'. '*It's the process of landscaping, it's also the process of nature. In nature, when there is no tree, there will be a lot vegetation, when the tree grows, the vegetation changes…* ***After 5 year or 10 years, you need to change the plants'***.	H1-Landscape architect
Improve access to the HCG	'*... We* ***should allow the public or whoever to use it****, but the security and all that things, they're quite concerned*'. '*To me... it* **[courtyard garden]** ***has to be more accessible...*** *what's the point in having the courtyard, but you can't access it*'.	H2-Architect

Regarding the operational aspects, both the H1-architect and H2-landscape architect mentioned the maintenance culture in Malaysia, namely that it depended on the hospital administrator's ability and continuous motivation to maintain the landscape features and vegetation in the HCG. Nevertheless, operational cost is also one of the factors that caused the maintenance of the HCG to not be sustained throughout the years. The hospital provider should therefore allocate sufficient budget for landscaping work and maintenance as this can support and improve users' experiences in the hospital.

Moreover, the H1-architect also highlighted the need to update the project brief of the hospital and improve the medical brief and technical brief by having effective discussion between both the hospital provider and the 'end-users' in revising the project brief. The design brief does not apply to every hospital design. Some of the information in the project brief should be altered and changed according to particular issues due to different hospital typologies. There is a need for the end-users and the MOH to discuss and develop updated design brief that designers can follow.

Table 7.10: Designers suggestion for the improvement of the operational aspects of the HCG

Suggestions	Operational aspects	Designers
Improve the culture of maintenance	'*The thing is the **maintenance cost,** and another one is the **operation cost**. **If you see a lot of water fountains in Malaysia, after a while, they are shutting down**. But water, the sound the visual of it, should give you a calm feeling. Yeah, we can design, but finally, **it depends on the owner of the hospital to continue maintaining it***'.	H1-Architect
	'*Yes! It is nice to have a water feature... **but a lot of people don't like the maintenance,** right. Whatever water feature that you have, you need to have a pump, suction... **it is money***'.	H2- Architect
	'*the issue is on the design, or the issue on people or users, you know, I think in Malaysia, you know, **the issue is always the policy-makers and administrator, and it's up to them whether they want to maintain it or not**, this is the issue that happened*'.	H2- Landscape architect
Update the project brief through active communication and collaboration between the stakeholders.	'*But what I'm saying is this, because of **the brief, they don't ever want to change since the early 60s until now**! You know, I'm not criticising them, but it is, the fact*'. '*Make sure that the **planning department in MOH, and the end-users** (e.g. administrator, and medical staff), **come together, and come out with a brief that everybody will have to follow***'.	H2- Architect
Provide a guideline for a hospital courtyard design	'*I wish that **someone will come and tell us, this is what a Malaysian Hospital should be, without bias,** with truth, you know, that this is how the hospital garden should be, and the reason is this!*'.	H2-landscape architect

7.7 Discussion of the findings

Based on the results from the interviews with both the architects and landscape architects, several important findings were determined as follows:

- Courtyard garden as a passive design strategy in the hospital planning;
- Importance of greenery and forest-like environment;
- The culture of HCG maintenance is still at a lower level;
- Site and time constraint, project brief requirement and financial budget influenced the final outcome of the HCG design; and
- Good collaboration in design development stage leads to a positive outcome.

7.7.1 Hospital courtyard garden is a common practice in Malaysia as a passive design strategy

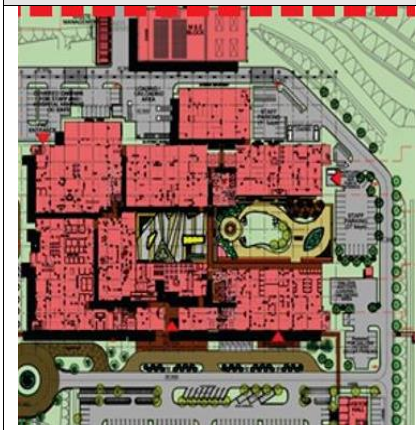
This study found that the inclusion of a courtyard in the hospital buildings is due to the necessity **to avoid a deep plan nature of a large-scale building. The architects mentioned the need to provide ventilation to the corridor and maximise daylighting** into the hospital building and this is part of the project brief requirement by the MOH. Therefore, to interpret this design brief the architect sets out their design solution following consideration of all the site constraint in order to determine their own design concept for a particular hospital project and including the courtyard as part of the hospital planning. The courtyard garden is commonly utilised as part of a passive design strategy in varied building typologies: hospitals and residential, institutional and commercial buildings. It not only helps to mitigate air temperature and improve microclimatic conditions (Ghaffarianhoseini et al., 2019; Nouri et al., 2018; Taleghani, 2018), but also has the potential to cool down the indoor environment, enhance user satisfaction and reduce the building's overall energy consumption level (Jamaludin et al., 2014).

A passive design strategy is found to be one of the strategies to achieve the green hospital building that has been applied by Malaysian architects since the 1990s (Aripin and Nawawi, 2011). A green building is also considered as a solution to achieve sustainable development in the built environment by reducing the environmental impact of the construction industry (Nawawi et al., 2013). This is highlighted by the architects, that the courtyards are one of a number of design strategies to achieve an environmentally friendly building. **This shows that the courtyard garden concept is found to be the common strategy which is practised by the majority of design consultants in Malaysia to achieve a green and environmentally friendly building**.

7.7.2 Importance of greenery and forest-like outdoor garden

Both the H1 and H2 landscape architects highlighted the **importance of providing a forest-like environment.** Moreover, the architects and landscape architects also mentioned the importance of access to nature and impact on users' well-being in which they associated the benefits of nature as an aide to the healing process (i.e. reduction of stress and mental fatigue). The HCG was found to be implemented in several government hospital projects in Malaysia (See Appendix 8), and that this type of hospital courtyard design is still being implemented in recent hospital projects in Malaysia (See Table 7.11).

Table 7.11: Recent government hospital projects with the courtyard garden

RECENT GOVERNMENT HOSPITAL UTILISED COURTYARD GARDEN IN THE HOSPITAL PLANNING	
 **Hospital Kuala Krai (HKK)** Year of completion: 2018 No of Bed: 268 beds	 Concept: **Hospital in a garden** - *'Hospital dalam taman'* Source: https://es-la.facebook.com/jkr.malaysia & https://en-gb.facebook.com/spkhkk/
 **Hospital Pendang** Expected year of completion: 2021 No of beds: 158 beds	 The use of the courtyard garden in the hospital planning Source: https://twitter.com/bernamadotcom/status/

However, it can be seen that the recent HCG design has a lack of variety in terms of seating facilities, insufficient amount of greenery and shade in the HCG, which might affect users' experiences and levels of comfort. As a result, the HCG that has 80% hardscape compared to vegetation might possibly be left vacant and unutilised. Several previous studies have revealed the impact of vegetations in reducing temperature in the HCG (Ghaffarianhoseini et al., 2019; Nouri et al., 2018; Taleghani, 2018; Morakinyo et al., 2016; Shashua-Bar et al., 2011). Moreover, Cooper Marcus and Sachs (2014) suggested that the **best practice for an outdoor garden was to have at least a ratio of 70:30 for vegetation and hardscape,** respectively. It was also found that the outdoor garden that has a high amount of greenery was found to be more restorative and appealing to its users (Jiang et al., 2018; Reeve et al., 2017; Shukor et al., 2012), which also corresponded with the findings in the present study (Refer to Chapter 5).

7.7.3 The culture of the HCG maintenance still at a lower level

Moreover, the designers mentioned the culture of maintenance among hospital managers that need to be improved because HCG maintenance responsibility (e.g. to maintain the facilities and plantings in the HCG) fell under their jurisdiction. However, this depends on the availability of a maintenance budget from the hospital provider to facilitate the maintenance work. To achieve a successful healing garden, meeting users' needs must come first rather than a strong focus to reduce maintenance costs (Cooper Marcus and Sachs, 2014; Shackell and Walter, 2012). It is vital to ensure that the HCG design achieves its function to provide a comfortable environment, that makes people feel safe, relaxed and calm while being there. **If the HCG appears well-cared for, then it provides subliminal message to the patients that they also will be well-cared.**

Based on the interviews with the designers, it was found that maintenance and operational cost often became the factors that affected garden maintenance in the hospital. According to both the H1 and H2 landscape architects, their final design was based on their discussions with the MOH following revisions from the initial plan. The final outcome of the landscape design was based on the approved design by the MOH and the hospital manager. These HCGs were completed and have been used for several years. Over the years, surely there will be wear and tear in the provided facilities in the HCG especially if it is not well-maintained. Based on the users' evaluations, several problems related to maintenance issues were frequently mentioned by the HCG users (Refer to Chapter 5).

Several aspects of maintenance that can be considered by the hospital managers included as follows:

- Upkeep the plantings and maintain the facilities in the HCG;
- Maintain the cleanliness in the HCG;
- Improve the safety on the HCG; and
- Conduct a regular inspection in the HCG.

Previous research has also mentioned the need to upkeep and maintain the facilities in the outdoor garden to ensure this facility can be sustained and well-used over the long term (Cooper Marcus and Sachs, 2014; Shackell and Walter, 2012). Garden maintenance work includes watering and fertilising the plants, weeding, pruning and sweeping-up debris on the walkway. To ensure this maintenance work is properly done, well-trained gardeners can be hired to upkeep the HCG. As a result, it will make the garden look more thriving over time and helps to reduce the cost for tree maintenance in the long term. Without proper maintenance, several issues such as dead plants, broken water features and broken seating left unreplaced, and the presence of black stains on the wall will significantly affect users' experiences, as revealed in the present study.

Moreover, maintaining HCG cleanliness is another crucial aspect to ensure its physical appearance, namely to look more appealing and inviting, which has been also highlighted in previous studies (van der Riet et al., 2017; Adnan, 2016; Ibrahim et al., 2015). A problem such as the dirty pavement, a black stain on the wall, full trash bins, fallen leaves on the walkways and bird droppings on the seating area can refrain people from visiting the garden and using the seating facilities.

Additionally, improving safety and an enhanced sense of security in the outdoor garden was one of the crucial aspects to achieve a successful HCG (Lygum et al., 2013; Uwajeh, 2018; van der Riet et al., 2017; Jonveaux et al., 2013; Cooper Marcus and Sachs, 2013; Shukor, 2012; Said, 2003a). Some of the safety issues found in the case study HCGs included sharp edged plants, exposed electrical cables, and unsafe railing design (See the detailed explanation in Chapter 4) must be taken into consideration by the hospital management; they must provide their utmost care to ensure a proper and safe environment around the hospital. Table 7.12 indicates the image of the three case study HCGs in a comparison with previous years and the most recent year (of this study).

Lastly, conducting a regular inspection of the HCG is a crucial part of any maintenance regime to detect any unexpected problems in the HCG, intervene regarding any damage to facilities and monitoring improper maintenance work in the HCG. This will help to ensure that the gardeners and cleaners follow the standard operation process in maintaining the HCG over time. They are also able to monitor the users' activities to prevent any undesirable activities or damage to HCG facilities. A fundamental culture change in hospital management is necessary to ensure that the HCG facilities are well-maintained, so that it can be used over the long term and benefit the users.

Table 7.12: Comparison of the HCG condition in the past years and recent day

CASE STUDY	BEFORE (SEVERAL YEARS AGO)	DURING THE FIELDWORK (2018)
H1-C1	 The greenery in H1-C1 in 2012. The canopy trees height reaches up to the third-floor level and provides some shade to the ground. *Source: HSI (2012)*	 Some of the plantings were changed, and trees canopies have matured. The height of the trees is up to the fifth-floor level. *Source: Author (2018)*
	 The water fountain in H1-C1 still functioned a few years ago, *Source: Nilawati (2012)*	 The water fountain was not operated and fixed until today. *Source: Author (2018)*
	 10 years ago *Source: GDP Architect*	 Year: 2018 *Source: Author (2018)*
	Comments: Comparing images of H1-C1 with previous years, some of the plantings have been replaced with new plantings. Colourful shrubs were added in the HCG. Canopies provided shade to the ground, which creates a comfortable atmosphere in the HCG.	

<table>
<tr><td rowspan="2">H2-C3</td><td>
Source: Shaari (2015)</td><td>
Source: Author (2018)</td></tr>
<tr><td colspan="2">Comment:
Comparing images of H2-C3 in 2015 and 2018, there is little change found in the vegetation and seating facilities. Some cracks are found on the walkway close to the entrance to the rehabilitation centre. Some exposed cabling from the lighting fixtures can pose danger to children.</td></tr>
<tr><td rowspan="3">H3-C2</td><td>
• Image of H3-C2 around ten years ago shows only two seating areas provided and some palm trees and shrubs were planted in the HCG.

Source: HSAH</td><td>
• The seating is not in good condition.
• Only half of the area was shaded by the palm trees during the afternoon.

Source: Author (2018)</td></tr>
<tr><td>
• Around ten years ago, the trees in H3-C2 still looked healthy and well-cared.
• There were sharp edged plants and stones in the shallow pool.
• No covered walkway across the HCG that linked the main lobby and the cafeteria.

Source: HSAH</td><td>
• The plantings and a small stone in the shallow pool area are no longer there. Stagnant water exists in the pool after a rainy day.
• Some of the grass, palm trees and shrubs are dead. The current plants look unhealthy.
• A new covered walkway has been built across the HCG.

Source: Author (2018)</td></tr>
<tr><td colspan="2">Comments:
Several changes were found in H3-C2 include the plantings, the pool, the condition of the wall around the HCG and the walkway. The main safety concern is the unsafe railing design that can pose a danger to children (i.e. the width between the balustrades is too wide and does not meet standard safety requirements).</td></tr>
</table>

7.7.4 Site and time constraint, project brief requirement and financial budget influenced the outcome of the HCG design

Based on the findings from the interviews, this study suggested that **site constraint, financial budget, the requirement of the project brief and time constraint** are among several factors that influenced the outcome of HCG design and the hospital planning. For the H1-hospital, the architect mentioned that they managed to achieve their initial design intentions to create a central HCG because they have been given **enough land and budget** to develop such a hospital design at that time. Similarly, the H2 hospital was not constrained by the budget for the hospital project, but they needed to fulfil structural and MOH requirements regarding the HCG design which did impact on the final design outcomes. For the H3-hospital, they also had enough land to develop the hospital project. However, their design constraints differed from the other case study sites. The H3-architect mentioned that they faced restrictions to complete the design and construction in a short time period. Thus, the architect did not have sufficient time to explore the design for the H3 hospital due to time constraints and budget limitations.

7.7.5 Excellent collaboration in design development stage leads to a positive outcome

Previous studies have also highlighted the importance of active collaboration between various stakeholders including the designers, the end-users and the policymakers, which is crucial to assist the quality of the outdoor garden and its maintainability (Chew et al., 2019; Li, 2018). One previous study highlighted that poor communication between the architect and the landscape architect led to defect problems such as drainage and waterproofing problem of the green wall for high rise project in the tropics (Chew et al., 2019). It is vital for the hospital managers to not just focus on cutting the cost of garden maintenance as this led to neglect and the resultant impact on the quality of the HCG (Shackel and Walter, 2012). Moreover, the landscape architects should collaborate with the design teams at an early stage in the design process to provide suggestions including the location of the garden, orientation, microclimate and types of plantings (Cooper Marcus and Sachs, 2014). Surprisingly, the practice in Malaysian hospital differs from what has been suggested by Cooper Marcus and Sachs (2014) in which the landscape architect designs the landscape in the designated space(s) provided by the architect in the finalised hospital plan.

As explained previously in Section 7.3, collaboration during the design stage of the HCG only involved the architect, landscape designers, and the end-users (e.g. hospital managers, staff, doctors and nurses). However, it failed to include patients, families and visitors who are among the actual users of the HCG sites as found in the present study (refer to Chapter 6). **This study suggests that it would be more fruitful if the process for decision making of the HCG design also considered the input from actual HCG users (i.e. staff, patients, visitors).** Poor communication between the designers and the actual users can lead to ineffective landscape design that does not meet the needs of the intended users.

This study suggests that there is the need to have a good collaboration practice between the stakeholders at all design development stages to ensure successful hospital planning. In the context of HCG design, **good collaboration between the landscape architect, the hospital managers and the MOH is crucial to ensure the best design decisions for the HCG can be made.** The hospital managers and hospital providers are the top parties involved in the decision making on the final product of the hospital planning. Although the private consultant was hired to design and visualise the hospital planning, the hospital provider and managers are the ones who decide whether to proceed with the proposed design proposal. The findings show that designers also mentioned the cost of garden maintenance and operation of water features has always been an issue in HCG design. However, the hospital managers should place too much emphasis on cutting the cost of landscape design and its maintenance. Meeting users' needs and improving their satisfaction is highly essential to enhance their experiences in the hospital.

7.8 Summary

This chapter outlined an important understanding regarding the development stage and practice of hospital projects in Malaysia. It provided an overview of the procurement of hospital projects in Malaysia which involved various stakeholders and offered information on the related hospital project brief provided by the MOH and PWD which primarily included the requirement for medical and technical aspects.

Furthermore, this chapter explained the collaborative practice between architects and landscape architects during the design development stage. It also provided an overview of how the design of the HCG has evolved from the beginning to the final HCG design which involved several discussions with design teams and required approval from the MOH.

Additionally, this chapter elaborated on designers' intentions in the design and planning of the HCG. On the one hand, the architects highlighted that the primary purpose of the inclusion of the courtyard in the design and planning of the HCG was due to the necessity to avoid a deep plan building and to provide daylighting and ventilation to the building.

Besides that, they also mentioned that the HCG allowed access to nature and acted as a point of orientation to the hospital users. On the other hand, the landscape architects mentioned that they intended to create a forest-like environment and natural look in the HCG. Additional design intentions specified by the landscape architects included a place that contributed to stress reduction and a place for social interaction.

This chapter also highlighted the challenges faced by designers during the design development stage, including the design aspects and collaboration with stakeholders. For instance, the architect mentioned the environmental design and climatic issues, an outdated design brief, a restriction in terms of time and budget, and meeting the needs of end-users. In contrast, the landscape architects stressed the constraints of soil conditions, insufficient sunlight due to the shade in the HCG, restriction of low garden maintenance and meeting the needs of the hospital manager and MOH.

It also emphasised the suggestion from the designers which mainly focused on the physical design and operational aspects. Regarding the physical design, some of the ideas involved making the HCG look less formal, change the plantings after 5 years and improve access to the HCG. In terms of the operational aspects, they suggested the need to improve the culture of maintenance, update the project brief through active communication and collaboration between the stakeholders and provide a guideline for a hospital courtyard design based on scientific evidence.

To sum up, this current POE is the first step to inform decision-makers (the hospital provider and the hospital managers) regarding the positive and negative aspects of the HCG design based on users' feedback and designers perspectives, so that they could learn from it and, where necessary, implement improvements to enhance the design brief as well as retrofit the existing HCG.

CHAPTER 8:
Formulation of the HCG framework and recommendations for policy and practice

8.1 Introduction

This chapter discusses the formulation of the framework for the HCG in Malaysian public hospitals based on the overall findings of the present POE study. It also outlines the recommendations for the improvement of the policy and practice related to the HCG, as a response to the **sixth research objective:**

- to develop the HCG framework based on the overall findings and provide recommendation for policy and practice.

The first section of this chapter elaborates on the development of the HCG framework from the initial to the final conceptual framework. Then, it discusses the overall findings obtained from different sources of data, including the users' perceptions survey, observation, field measurement, and interview with designers in relation to the literature review and theories underpinning this study (As discussed in Chapters 5, 6, and 7). Following that, it describes the final HCG framework which comprised the four main aspects, namely:

i) Physical design;
ii) Environmental;
iii) Social; and
iv) Operational aspect.

Finally, this chapter presents the implications of the study and provides specific policy and practice recommendations based on the findings from the study. The suggested recommendations for the practitioners are presented together with sample images from the best practice research and researcher's sketches to improve the understanding of the best HCG design.

8.2 Development of conceptual framework

Before discussing the conceptual framework of this study, it is important to note that this study aimed to investigate the performance of different types of courtyard design in relation to their environmental and restorative roles. Figure 8.1 indicates the initial conceptual framework.

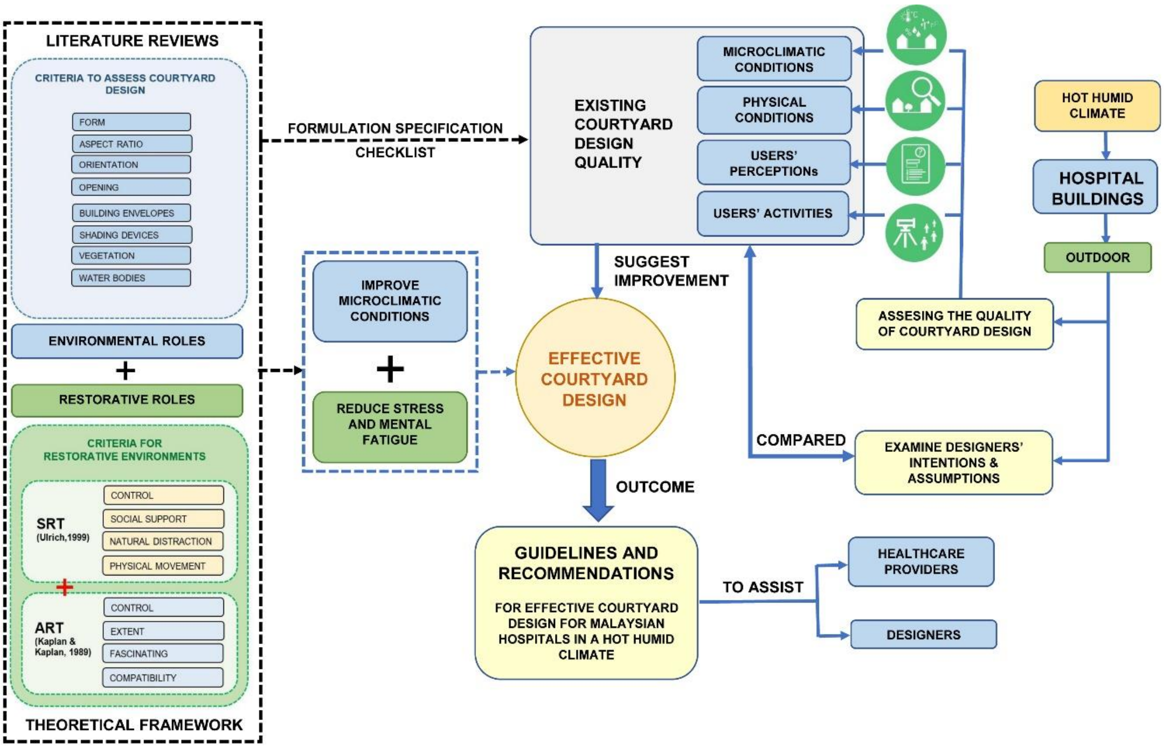


Figure 8.1: The initial conceptual and theoretical framework of the study
(Source: Author, 2017)

Firstly, the framework explored effective courtyard design criteria that involved the two important roles of HCG: environmental and restorative roles. Based on the literature review, there were several environmental designs considered for courtyard design, such as the form of the courtyard, aspect ratio, orientation, opening, building envelopes, shading devices, vegetation, and water bodies. Additionally, it also explored the two important theories related to the restorative outdoor garden in a healthcare facility, namely the Stress Reduction Theory (SRT) by Ulrich (1999) and the Attention Restorative Theories (ART) by Kaplan and Kaplan (1989).

As explained in Chapter 1, the research scope focused on the assessment of the quality of the three selected case studies of HCGs. The assessment findings were used to formulate a guideline or framework to achieve an effective HCG design that would successfully integrate both environmental and restorative roles. This finding was derived from multiple sources of data, including users' perceptions survey, observation on the site conditions and users' activities, field measurement of the microclimatic conditions, and interview with the designers. All the instruments used in this study (i.e. users' perceptions survey and the interview with the designers) were formulated based on the literature review of the environmental design, best research evidence, and theories underpinning the restorative environment. The final outcome of this study was to generate a framework of an effective HCG design that can provide better microclimatic conditions, facilitate stress reduction, and decrease mental fatigue among its intended users (e.g. patient, staff, and visitors) (Figure 8.2).

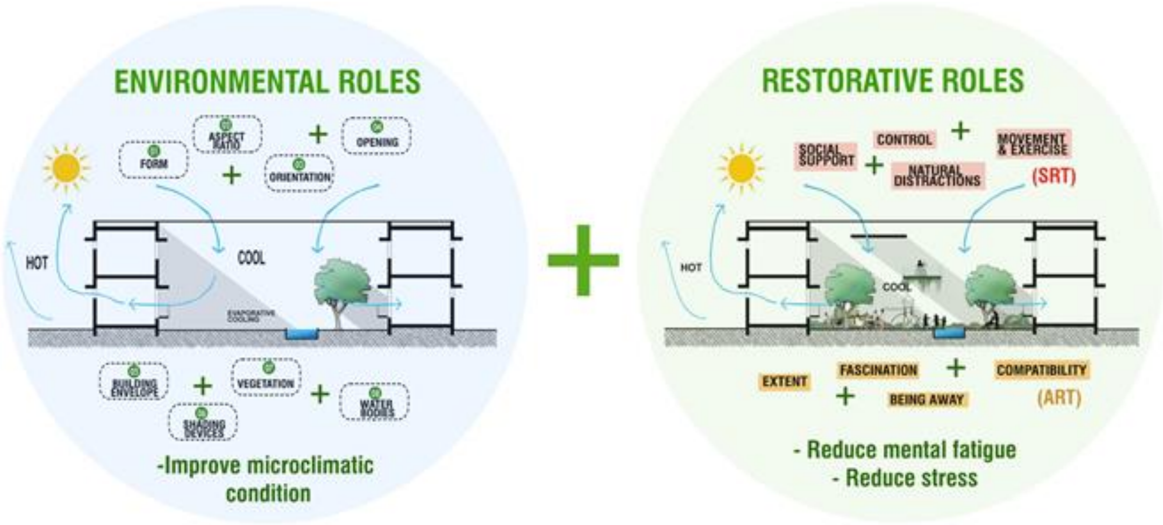


Figure 8.2: Environmental and restorative roles
(Source: Author, 2017)

Based on the overall findings, a comprehensive HCG framework was established as a guideline for healthcare practitioners and policy-makers. As indicated in Figure 8.3, this research outlined the four important and inter-related components of the HCG framework (i.e. physical, environmental, social, and operational). The four components would be vital in achieving a successful and functional HCG that could integrate environmental and restorative roles.

For the architects and landscape architects, the physical, environmental, and social aspects are interrelated aspects to be taken into consideration during the design and planning of HCG. However, the operational aspect is the fundamental aspect that determines the long-term success of HCG. Therefore, it is vital to obtain the full commitment from the hospital management to implement HCG in any future design brief and to provide substantial funding to maintain all the facilities in the HCG.

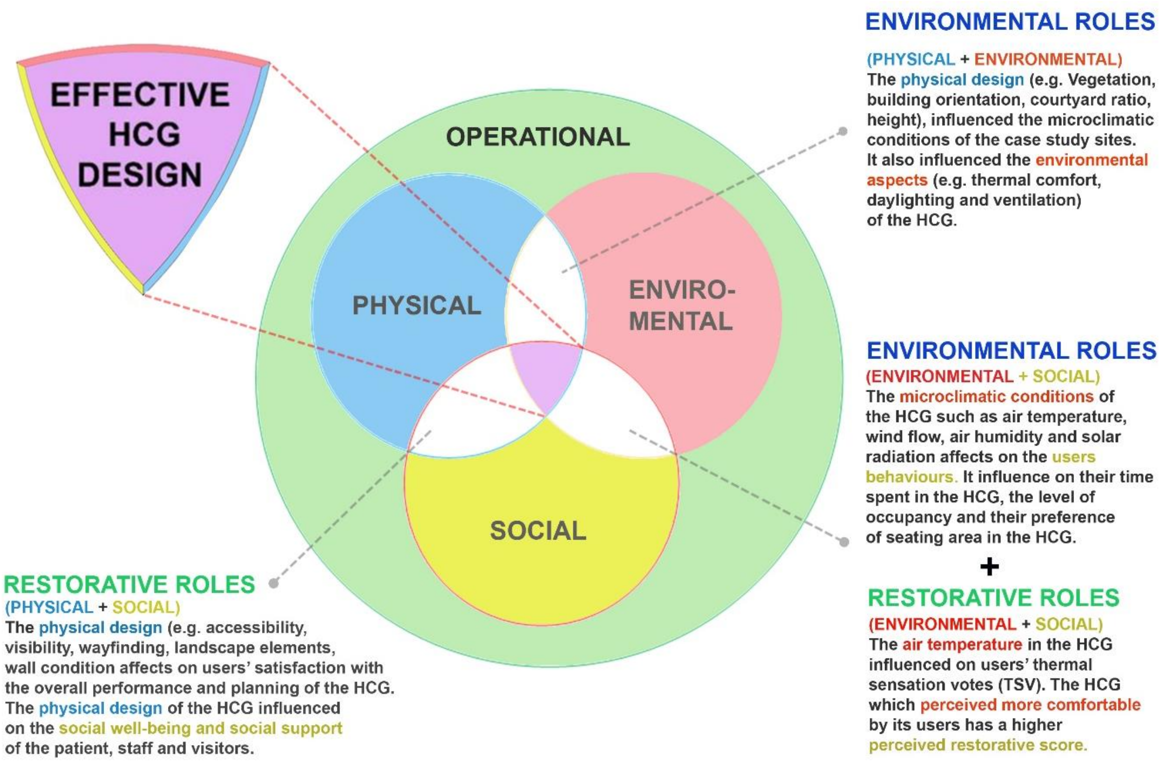


Figure 8.3: Final conceptual framework for an effective HCG design developed based on the empirical findings of POE study

8.3 Formulation of the HCG framework

The framework used in this study entailed the use of multiple methods including on-site observation, field measurement of the microclimatic conditions, survey interviews with the users and non-users, and interviews with the architects and landscape architects. The overall key findings based on the diversified investigation techniques applied in the multiple case studies were outlined in Chapters 5, 6, and 7.

These empirical evidences covered several aspects of HCG design which were then compiled to form the HCG framework. They included the physical aspect, environmental aspect, social aspect, and operational aspect. The following section will explain the overall findings of this study and how they are linked with the HCG components. The discussion will be conducted in accordance with the best research evidence from the literature review and the theories related to this study.

8.3.1 Physical design aspect

The first component of the HCG framework was based on the aspect of the physical design. Figure 8.4 illustrates all the findings related to this aspect. It comprised of six subcomponents:

- Accessibility
- Visibility
- View
- Variety
- Wayfinding
- Safety

8.3.1.1 Accessibility

One of the essential components in the aspect of HCG design was accessibility. Several aspects that must be considered in terms of accessibilit**y are: i) access to the HCG; ii) access around the HCG; and iii) wheelchair access.**

Based on the current findings and previous literature review, the provision of multiple entrances, unlocked doors, and a location close to the main hospital entrance would improve the access to the HCG (See Section 5.5.2.2, iii). The availability of more than one entrance in the HCG would also enhance the access pathways around the HCG (Butterfield, 2014; Shackel and Walter, 2012; Davis, 2011; Naderi and Shin, 2008; Said et al., 2007). The findings from this study also showed that HCGs with multiple entrances linking to the main lobby and cafeteria of the hospitals had higher occupancy than those with a single entry point (Ulrich et al., 2019; Paraskevopoulou and Kamperi, 2018; Reeve et al., 2017; Ibrahim and Jer, 2014; Pasha, 2013; Whitehouse et al., 2001; Pasha, 2013; Cooper Marcus, 2007) (See Section 5.5.2.3, i). Similarly, this study found that an even surface on the entrance and interior area of HCG allows ease navigation for wheelchair users and they would be more inclined to use the HCG (See Section 5.5.2.4, i).

8.3.1.2 Visibility

Visibility is another crucial physical aspect to be considered in designing HCG. It includes: **i) the location of the HCG; ii) the hospital circulation; and iii) the types of wall enclosure** (See Section 5.5.2.2, iv).

Firstly, a location close to highly accessible zones in the hospitals such as the main lobby, cafeteria, and main waiting area would increase the visibility of the HCG to the potential users among the hospitals visitors (Pasha and Shepley, 2013; Butterfield, 2014; Shackell and Walter, 2012; Shukor, 2012; Cooper Marcus, 2007). Moreover, the hospital circulation also influences the visibility of the HCG. By arranging the main hospital street along the HCG, it would make the HCG more prominent to the hospital users and encourage them to visit the HCG (Ulrich et al., 2018; Uwajeh, 2018; Jiang et al., 2018; Gonzalez and Kirkevold, 2016). Last but not least, the types of wall enclosure could also enhance the visibility of the HCG. The size of the opening on the wall enclosure provided a view into the HCG (Jiang et al., 2017; Reeve et al., 2017; Shackell and Walter, 2012). For example, if the HCG is located next to the hospital cafeteria, a wider window and opening of the HCG would make the HCG more visible to the users of the hospital cafeteria.

8.3.1.3 View

A pleasant and soothing view can bring a positive mood to the viewers. The view of HCG includes: **i) the view to the HCG; and ii) the view around the HCG.**

Firstly, the view of the HCG is very important. As discussed in Section 7.4.1.3, (b)), the designers must provide a visual link to nature that can be associated with the process of well-being and healing. Numerous studies also highlighted the benefits of nature viewing to the well-being of people, especially how it contributed to better job satisfaction among the staff (Cordoza et al., 2018; Nejati et al., 2016; Pati et al., 2008). Moreover, patients staying in rooms with a window view were found to take less pain medication. They also recorded a shorter length of stay in the hospitals (Ulrich, 1984) and tended to be less aggressive in their behaviours (Ulrich et al., 2018). In addition, an earlier study revealed that visual access to nature views contributed significantly to stress reduction among the family members of ICU patients (Ulrich et al., 2019).

Apart from that, the view around the HCG is also an important element when designing the HCG. As discussed in Section 5.5.1.1, a majority of the users in all the three study sites expressed their desires to have more pleasant greenery and nature view in the HCG. In the context of the HCG, the wall of the HCG is a vital aspect of the design because it would affect the view around the HCG and subsequently the users' satisfaction with the overall performance of the HCG. Providing a pleasant view is a crucial aspect of designing outdoor gardens as it could enhance the overall experience of the users (See Section 5.5.2.2, ii). Providing a pleasant view are crucial aspects in the outdoor garden as it enhanced user's overall experiences (Reeve et al., 2017; Cooper Marcus and Sachs 2014). Moreover, the view of nature could also serve as a positive distraction for hospital users who might be experiencing unpleasant moods and feeling (Weerasuriya et al., 2018; Ulrich, 1999).

8.3.1.4 Variety

The fourth subcomponents of the physical design centred on variety in terms of: **i) planting; ii) seating; and iii) pathway.**

Firstly, the planting (i.e. greenery) can change the appearance of the HCG and make the HCG looks more attractive and evoke varying experience to the user while exploring the garden (See Section 5.5.1.1). Trees and shrubs improve air quality in the HCG because it helps to filter the dust and pollutants from the air, while releasing the oxygen into the HCG (Dela Cruz et al., 2014; Dadvand et al., 2012). The use of various vegetations including the tree canopies can decrease a building energy use because the tree can block the solar radiation onto the building and reduce the air temperature in the surrounding surface as well as the indoor temperature (Ghaffarianhoseini et al., 2019; Taleghani, 2018; Jamaludin et al., 2017; Morakinyo et al., 2016; de Abreu-Harbich et al., 2015; Shahidan et al., 2010; Akbari, 2002).

Additionally, it is a good practice to provide a mixture of seating styles in the HCG because it offers choice and flexibility for people to choose where to sit. The lack of number of seating and its variety can impact on the usage in the HCG. Earlier studies highlighted that an inadequate and improper design of seating area reduce the usage of the outdoor garden in healthcare facilities (Jiang et al., 2018; Pasha, 2013; Whitehouse et al., 2001). Moreover, a pathway routes are an essential component in the HCG to orientate and facilitate people to walk around or pass through the HCG (Butterfield, 2014; Shackel and Walter, 2012; Davis, 2011; Naderi and Shin, 2008; Said et al., 2007). This study is in accordance with earlier study that multiple pathway that linked to the different departments are found to influence of their level of satisfaction with the HCG planning (See Section 5.5.2.3, ii).

8.3.1.5 Wayfinding

Wayfinding are the fifth sub-component of the HCG which involve: **i) location, ii) circulation, iii) signage and, iii) landmark** (See Section 5.5.2.3, iii).

Firstly, the location of the HCG is an important determinant of the ease of navigation to the HCG. This study found that HCG located close to the main entrance, a high traffic zone, were associated with a higher satisfaction level in terms of wayfinding, a finding that was aligned with previous studies (Jiang et al., 2018; Adnan and Shukor, 2015; Pasha, 2013; Cooper Marcus and Barnes, 1995). In addition, the circulation, or the main hospital street that is connected or linked to the HCG could also ease the navigation to the HCG. Moreover, earlier studies highlighted the important role of signages in directing and guiding hospital users to the HCG (Alvaro et al., 2018; Potter, 2017; Passini et al., 2000). This current study found that the HCG was designed to function as a landmark and point of orientation, as mentioned by the architect who designed the H1-C1. This was in concordance with recommendations made by other published studies (Peavey, 2015; Adams et al., 2010).

8.3.1.6 Safety

The last subcomponent of the aspect of physical design aspects is safety. It includes physical safety and health safety (See Section 5.5.1.1, b, iii).

Safety is an important aspect in designing an outdoor garden to ensure the users would feel safe and secure in there (Lygum et al., 2013; Uwajeh, 2018; van der Riet et al., 2017; Jonveaux et al., 2013; Cooper Marcus and Sachs, 2013; Shukor, 2012; Said, 2003a). Some of the safety issues detected in the study sites of this research were similar to issues highlighted in previous studies. For example, the presence of toxic and thorny plants that could be dangerous, especially to children (Pachana et al., 2003) and the slippery ground and pavement which posed as a tripping hazard to the elderly and frail people (van der Riet et al., 2017). In addition, this study reported a few additional safety issues that were not previously reported, including unsafe railing design in the HCG, exposed electrical cable, unsuitable location of mousetrap, and risk of children falling into the water fountain.

SOURCE OF DATA

- Field measurement
- Survey interviews
- Site observation
- Interview with designers

VISIBILITY:

The visibility of the HCG was **closely related to the users' satisfaction level with the overall planning of the HCG ($p<0.01$)** (Chap 5).

The HCG that located in **close proximity to the cafeteria and main lobby** can enhance the visibility of the HCG (Chap 5).

The location of the HCG at **the centre of the hospital planning and along the main hospital street (corridor)** increased the visibility to the HCG (Chap 5).

The **design of the wall enclosure (i.e. size of opening, transparency)** influenced the visiibility to the HCG from the adjacent space (Chap 5).

ACCESSIBILITY:

Access from the main hospital entrance contributed to higher satisfaction with the overall planning of the HCG **$p < 0.05$)**. It also influence on the level of occupancy in the HCG on both weekend and weekday as revealed in the H1-C1 and H3-C2.(Chap 5).

The HCG which **located close to a highly frequent zone area such as the main lobby and cafeteria** received **a higher satisfaction level** among the respondent (Chap 5).

The **HCG with several entrances** to the HCG received **a higher satisfaction level** compared to the HCG that has few entrances or locked door. (Chap 5).

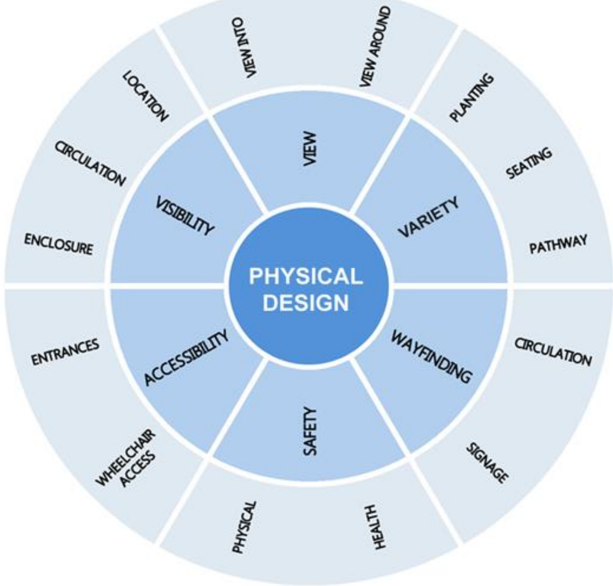
>70% respondents in the H1-C1 and H3-C2 expressed their satisfaction with a wheelchair access in these HCG. Uneven level at the entry point of H2-C3 has refrained wheelchair users to visit the HCG (47.2% - Dissatisfied) (Chap 5).

VIEW:

The **wall conditions around the HCG** are found to be the most related factors ($p<0.01$) that affected on users satisfaction level with the overall planning and performance of the HCG (Chap 5).

The majority of the respondents in all the three sites mentioned that they favoured **the greenery and pleasant view** (Chap 5).

All designers mentioned on the improtance of **visual access to the greenery and nature** which they associated with the healing environment and well-being (Chap 7).



SAFETY:

The visitors (i.e. parents) were those who responded the most regarding the physical and health safety of their children (Chap 5).

Several safety issues highlighted in all the three sites are:

i) the presence of the **thorny plants** (H2-C3);
ii) the **slippery ground or pavement** in the HCG (H3-C2);
iii) the wide gap between **the railing which does not follow safety standards** (H3-C2);
iv) the **unsuitable location of a mouse control trap** (H1-C1);
v) the **danger of an exposed lighting cable** H1-C1 and H2-C3); and
vi) the risk of children **falling into the water fountain** (H1-C1).

VARIETY:

The **landscape elements are found to be the most related factors ($p<0.01$)** that affected on users satisfaction level with the overall planning and performance of the HCG (Chap 5).

The HCG that has **more variety of vegetation (e.g. canopies, grass ,shrubs) has a cooler microclimate** than the HCG with less choice of vegetation (Chap 6).

The HCG that has **abundant of greenery perceived more restorative** than the HCG with less greenery. (Chap 6)

The **green plants, flowering plants and pedestrian walkwaynwas highly rated as either important or very important** followed by **seating and water feature** by all the respondent in the three case study sites (Chap 5).

WAYFINDING:

The wayfinding to the HCG contributed to higher satisfaction with the overall planning of the HCG **($p < 0.05$)**.

The HCG that located at the centre of the hospital planning, **close to the main entrance, close to the high traffic zone perceived higher satisfaction level regarding the wayfinding** as revealed in both the H1-C1 and H3-C2 (Chap 5).

The case study that **provide signage to the HCG received higher satisfaction level** regarding the wayfinding to the HCG (Chap 5).

The **circulation of the main hospital street (corridor) around the HCG** ease of the navigation to the HCG (Chap 5).

The H1-Architect mentioned that the **H1-C1 serve as a point of orientation** for the users to navigate themselves in the hospital (Chap 7)

Figure 8.4: The overall findings of the current study related to the physical design aspects of the HCG

8.3.2 Environmental aspect

The second component of the HCG framework revolves around the environmental aspect. Figure 8.5 shows the overall finding related to the environmental aspect of the HCG design that includes:

- Comfort
- Daylighting
- Ventilation

8.3.2.1 Comfort

The first environmental aspect is comfort. It is categorised into three subcomponents, namely: i) visual comfort; ii) acoustic comfort; and iii) thermal comfort.

i) Visual comfort

The first component of comfort is visual comfort. International standard EN-12665 defines visual comfort as a ‘subjective condition of visual well-being induced by the visual environment’ (EN12665, 2002, cited in Castilla et al., 2014, p.41). In indoor comfort research, several parameters that determine the visual comfort in buildings included: illuminance and its uniformity, luminance distribution, colour of light, amount of daylight, amount of glare and flicker rate (Castilla et al., 2014, p.42).

In Section 2.2.3, the findings showed that over 40% of participants in the H3-C2 (i.e. the building envelope is made of aluminium) perceived the daylighting in the HCG and into the adjacent space as not being important to them. When further asked the reason, some of them related it to the presence of the glare into the adjacent space which caused eye strain and discomfort to them. As highlighted by (Baker and Steemers, 2005), the lighting level, whether it is too little or too much light, can result in eye strain and discomfort to some people. Baker and Steemer (2005) also suggested designers to carefully design the building or space to minimise glare and reduce the obscuring reflection. Moreover, the glare would affect the well-being of patients, staff and visitors and reduce the productivity of the hospital staff (Kim et al., 2015; Dianat et al., 2013).

Additionally, the research findings also suggested that the canopy trees in the HCG could help to filter the daylight. Based on on-site observation, findings showed the HCG with a large amount of vegetation and less reflective wall materials was associated with a lower amount of glare and had better visual comfort (See Section 4.5). The shading represents a welcoming visual relief for the HCG users. Apart from trees, the use of less reflective materials on the exterior wall and pavement would also reduce the glare and provide visual comfort to the users (ref). This is in accordance to a previous study suggested that careful selection of the tree species would lead to a reduction in the solar penetration to the ground and improvement in visual comfort (Bakar et al., 2013). Moreover, the use of non-reflective floor surfaces could also lead to the same intention of reducing uncomfortable glares in the outdoor garden (Cooper Marcus and Sachs, 2014; Cooper Marcus, 2008, Naderi and Shin, 2008). Therefore, it is important to undertake strategies that can reduce uncomfortable glare when designing HCG to ensure that the users feel comfortable in both indoor hospital rooms and outdoor space (i.e. the courtyard garden).

ii) Acoustic comfort

The second comfort component is acoustic comfort. It refers to the capacity of the spaces to protect users from any unwanted, harmful noises and instead of providing them with the sound they want to hear (Al-horr et al., 2016). The sources of noise in the hospitals could originate from alarms, telephones, staff, trolleys, and visitors of the patients. Several evidences highlighted that the levels of hospital noise contributed to stress (Morrison et al., 2003; Ryherd et al., 2008) and burnout among the nurses in the U.S (Toft and Dillon, 1988). Apart from posing a health risk to the staff and contributing to a decreased work performance, the noise pollution could also affect the patients in terms of increasing their anxiety level (Luzzi and Falchi, 2002).

The current study found that some of the HCG users complained about the noise from the air conditioner in the HCG, especially in the H2-C3 and H3-C2 (See Section 4.5). Based on the observation, all the HCG in this study had in-built air-condensers which created unpleasant noise, especially if the air-condenser was located close to the seating area or the HCG was of a smaller size. In view of this, it is vital for the hospital managers and designers to consider the suitable placement of the air condenser where it would not disturb the peacefulness in the HCG. This study also suggested that a quiet environment was an important aspect desired by the HCG users as they associated it with an increased level of tranquility and calmness (Amat, 2017; Erbino et al., 2015; Guaita et al., 2011).

Moreover, to improve acoustic comfort, water features such as fountains could be installed in the HCG. They would create a pleasant sound of trickling and flowing water that is soothing. This would ensure a sense of relaxation and calmness for HCG users (Zhao et al., 2018; Ma and Shu, 2018; Pradhan, 2012; Alvarsson et al., 2010). Furthermore, the sound of water could serve to mask any unpleasant noises such as footsteps, surrounding speech, noises from traffic or children. This would ultimately improve the soundscape and acoustic comfort of HCG (Jeon et al., 2012; Yang and Kang, 2005).

iii) Thermal comfort

The third aspect of comfort is thermal comfort. The assessment of how users perceived the outdoor thermal comfort in the HCG was part of the objective four of this study. The field measurement results of the microclimatic conditions revealed that the air temperature in the HCG was lower than the air temperature outside the hospital area (See Section 6.2.1.4). Moreover, based on the subjective thermal perception of the users, more than half of the respondents in all the three study sites chose ‘neutral’, indicating that they felt comfortable with the temperature while spending time in the HCG (See Section 6.2.2.1). This study also found that HCG with a large amount of greenery and vegetation recorded the lowest air temperature on both cloudy and sunny days compared to the HCG with less vegetation (See Section 6.2.7.3). This study also suggested that an increased amount of vegetation and tree canopies in the HCG could reduce solar radiation and lower the temperature in the HCG, similar to the finding reported in earlier studies (Ghaffarianhoseini et al., 2019; Nouri et al., 2018; Taleghani, 2018; Morakinyo et al., 2016; de Abreu-Harbich et al., 2015; Yahia and Johansson, 2014; Shashua-Bar et al., 2011).

Additionally, this study revealed that HCG users who felt ‘slightly cooler’ or ‘cooler’ were likely to spend more than 30 minutes in the HCG (See Section 6.4.5.3). A previous study found that both international and local students who sat in a courtyard of an institutional building preferred an increased wind speed to alleviate the heat stress during sunny days (Makaremi et al., 2012). In urban areas with a hot and humid climate, faster air speed is vital as a cooling strategy as reported by several published studies that the number of participants who voted for neutral thermal sensation (i.e. felt comfortable) increased gradually with increased wind speed (Ng and Cheng, 2012; Ahmed, 2003).

8.3.2.2 Daylighting

Previous studies indicated that daylight is beneficial to the recovery and rehabilitation of the patients, as well as for the well-being of the hospital staff (Alzoubi and Al-Rqaibat, 2015; Aripin, 2006). Numerous studies reported on the reduction of length of hospitalisation among the patients exposed to sufficient natural daylight (Canellas et al., 2016; Joarder and Price, 2013; Choi, Beltran and Kim, 2012). These patients also reported a lower level of perceived stress, the use of analgesics, and subsequently pain medication cost (Walch et al., 2005). Moreover, exposure to morning sunlight in an outdoor setting can boost the vitamin D supply in the body. A rich supply of vitamin D is beneficial for bone health, prevention of cancers and cardiovascular diseases (Holick, 2004), and management for chronic pain (Martin and Reid, 2017). In this study, open-ended questions about the respondents’ favourite aspect of HCG revealed that most of them expressed their preferences for morning sunlight, especially how they could feel the warmth of the sunshine on their skin (See Section 5.5.1.1, c).

Beside of the benefits of daylight to the patients, previous studies also highlighted the contribution of natural daylight towards energy saving in the hospitals (Sala et al., 2017; Baker and Steemers, 2005, p.134) and other building complexes (Jamaludin, Mahmood and Ilham, 2017; Krarti and Hajiah, 2009). Additionally, this study revealed that the inclusion of HCG in hospital planning could be the main strategy to divert the daylight into the corridors and internal spaces of the hospital, including the basement level. It was also viewed as a strategy to avoid the deep-plan building design that would lead to a higher level of overall energy consumption in the hospital complexes (See Section 7.4.1.1).

Taking into consideration the benefits of daylight to the well-being of the hospital occupants and its impact towards efficient energy usage in a building, this study suggested for HCG to be included in hospital planning to obtain good coverage of daylight in the large hospital complexes. As evidenced in the current study, more than 80% of the respondents in all the three study sites concurred that daylighting into the HCG is important to them (See Section 6.3.1). Several important design considerations that should be factored in to achieve better daylighting in the HCG and its adjacent spaces are: i) orientation, ii) courtyard ratio, and iii) wall enclosure.

i) Orientation

The arrangement of the buildings should be properly designed to reduce the amount of solar radiation onto the building wall so that there would be less burden on the cooling loads of the buildings (Baker and Steemers, 2005; Hanafi, 1991). Orientating the long axis of the courtyard away from the east and west sides also contributed to a reduced air temperature in the courtyard (Rodríguez-Algeciras et al., 2018). Therefore, this study proposed the reduction of the size of the wall surfaces facing the east and west direction. In contrast, the size of the wall surfaces facing the north-south orientation should be increased (See Section 6.2.7.1). In the context of HCG, as the hospital was built in an elongated shape facing the north-south direction, the west side of the HCG would be exposed to sunlight during the early morning while the east side would be shaded by the building wall. However, in the afternoon, it was the opposite whereby the east side of the HCG would be shaded, and the west side would be exposed to the sunlight (Refer to Table 6.12 in Section 6.2.7.2, b). In general, the morning sunlight is considered cooler and less scorching compared to the afternoon sunlight.

A comprehensive understanding of the sunlight penetration during different times of the day allows the landscape architects to arrange the location of the shaded and unshaded seating areas. The tree canopies should be planned accordingly to ensure that the users can reap the most benefits from the morning daylight while receiving the least exposure from the afternoon sunlight. As detected in the current study, HCG users preferred to sit in a shaded seating area compared to areas that were directly exposed to hot afternoon sunlight (See Section 6.4.6.2). Additionally, the knowledge of which exact areas in the HCG receive a high or low amount of sunlight would aid the landscape architects in choosing the suitable trees, shrubs, and groundcovers for the conditions of the site. Apart from that, it is also vital to select suitable plants based on their preferred sunlight requirement, as different plants would thrive under full sun, a partial shade, or a full shade.

ii) Courtyard ratio

Based on the site observation, field measurement, and users' perceptions survey in the study, it was found that the H1-C1 that was rectangular in shape with a ratio of 1:2 (width:length) recorded the lowest temperature and was perceived by the respondents to be slightly cooler than the quadrilateral shaped H2-C3 (ratio=1:1) and square-shaped H3-C2 (ratio=1:1). This finding was in accordance with an experimental study that found a courtyard in the shape of a rectangle with a ratio of 1:2 (width:length) provided more shades and recorded a lower temperature than a square-shaped courtyard with a ratio of 1:1 (Almhafdy et al., 2015).

Additionally, the current study also found that increasing the height of the walls on the east and west sides would decrease the sunlight penetration on the HCG ground level and reduce the air temperature in the HCG (See Section 6.2.7.2, b). This reaffirmed the findings of earlier studies that suggested an increment in the height of the courtyard wall led to a reduction of solar radiation and increased shaded areas in the courtyard. Subsequently, this could reduce the air temperature inside the courtyard and contribute to better outdoor thermal comfort (Rodríguez-Algeciras et al., 2018; Almhafdy et al., 2013). Moreover, this finding also supported the finding of a previous experimental study in which a semi-enclosed six-storey courtyard with a ratio of 6:1 (height:width) created a better thermal performance, followed by a three-storey courtyard with a ratio of 2:1 and a single-storey courtyard with a 1:1 ratio (Ghaffarianhoseini et al., 2015).

In short, based on the findings of this study and the previous literature review, the aspect ratio is a very crucial component to be considered during the early stage of HCG design. The use of simulation software in the initial stage of the design process would be useful for the architects to explore the suitable courtyard form and ratio that can provide a sufficient amount of daylighting into the HCG and its adjacent spaces.

iii) Wall enclosure

A simple strategy to achieve an optimum daylighting is through the alteration of the openings in the HCG, the window parameters, and the types of glazing used (Wong, 2017; Zain-Ahmed et al., 2002) The width and height of the window must be carefully designed to ensure an acceptable amount of daylight distribution into the building spaces (Jamaludin et al., 2015). Based on the on-site observation in this study, a wide opening around the HCG allowed more natural daylight to penetrate into the adjacent spaces compared to the smaller openings (See Section 4.5). (Zain-Ahmed et al., 2002) reported the optimum window size should be 25% (wall to floor ratio) to achieve a 10% energy saving in a tropical climate like Malaysia. However, if a window of a bigger size was used, then it would increase the heat penetration.

Additionally, the current research also found that only less than 15% of the respondents in all the three study sites felt that the daylight into the adjacent spaces of HCG was of little importance to them. This could be due to the presence of the glare that caused discomfort to them (As discussed earlier in Section 8.3.2.1, i). Moreover, based on the site observation, this study found that the use of reflective materials such as aluminium cladding on a wall enclosure increased the amount of glare in the HCG due to the reflection of sunlight on the HCG spaces. Therefore, proper consideration should be given on the choice of materials for wall and floor surfaces to minimise the presence of glare in the HCG.

8.3.2.3 Ventilation

Another important environmental aspect is the ventilation strategy. Internal courtyards and balconies should be incorporated in tropical Malaysian buildings because they can help to maximise the use of natural daylighting and ventilation in order to reduce the energy consumption (Jamaluddin et al., 2014). Several design aspects that need to be considered in the improvement of ventilation in the HCG are include: i) orientation; ii) courtyard ratio; and iii) wall enclosure.

i)The orientation

The first aspect to be considered to maximise the ventilation in the HCG and its adjacent spaces is the orientation. This study found that by orientating a lower courtyard wall to face the most prominent wind direction would contribute to increased wind speed in the HCG (As discussed in Section 6.2.7.2, a). Therefore, it is of utmost importance for the design team to determine the path of wind flow through the buildings. They should consider the orientation and form of the building, the depth of the floor plate, and the sectional layout of the building to balance the external wind forces and the internal needs of aeration to ensure sufficient air flow circulation into the indoor spaces (Passe and Battaglia, 2015, p.179).

ii) Courtyard ratio

Another important aspect to be considered is the influence of the courtyard ratio on wind speed in the HCG. The current study found that the size and the height of the courtyard wall significantly influenced the wind flow in the HCG. This study suggested reducing the height of the courtyard wall facing the windward direction to ensure that circulation of the air flow into the HCG. Similarly, a previous study also found that a five-storey shallow courtyard building that was designed to be strategically oriented towards the prevailing wind had better natural ventilation in the building (Haase and Amato, 2009). In addition, this study also found that the larger the size of the HCG, the higher the wind speed that circulated into the courtyard and its adjacent spaces (See Sections 6.2.2.2 and 6.2.7.2, a)). This finding was in concordance with a previous simulation study that found that a wider courtyard with a width:height ratio of 0.66 promoted a better air circulation in the central courtyard and at the adjacent indoor rooms compared to the narrow courtyard with a width:height ratio of 0.33 (Tablada et al., 2005).

iii) Wall enclosure

The third aspect to consider in enhancing the wind flow into the adjacent spaces around the HCG is the wall enclosure. According to a previous study, courtyard gardens did not just function to divert natural daylight into the building, but they were also important as cooling strategy by allowing air movement into the building spaces through the openings on the wall enclosure (Sharples and Bensalem, 2001; Rajapaksha et al., 2003; Jamaludin, 2015). An indoor room that allowed cross ventilation was found to have higher indoor air speed compared to a room with only single-sided ventilation (Tablada et al., 2005). However, in the case of hospital complexes, a cross ventilation strategy is often difficult to be implemented due to the deep plan design of the hospital. This ventilation strategy or two-sided ventilation is more suitable for buildings with a shallow plan such as apartments and offices (Passe and Battaglia, 2015, p.180). If the wind speed in the courtyard is not sufficient (i.e. less than 0.4 m/s), the opening of the wall enclosure should be designed to be as open as possible to avoid obstruction of the circulation path to that the required flow rate could reach the courtyard (Tantasavasdi et al., 2001).

A good design of the opening size of the courtyard wall should take into consideration the wind speed in the internal courtyard so that better natural ventilation could reach the adjacent rooms (Yeang, 2008). In this study, at one of the case study sites, the H1-C1, there was an absence of wall along the HCG corridor at level 2 of the hospital. Instead, a screening wall was installed along the corridor to allow maximum ventilation into the building throughout the day. However, the design of having an opening around the courtyard wall also has certain drawbacks in terms of wind-driven issues (See Section 7.5.1.1). This is important to ensure that the design can promote the entry of fresh air into the building and also prevent any spillage of rainwater onto the corridor that can cause wet floor, particularly during rainy days.

COMFORT:

Visual comfort:

The wall condition is found as the **most related factors to the satisfaction with the overall planning and performance of the HCG (P<0.01).** It affected the visual appearance and the aesthetical view of the HCG (Chap 5).

The designers mentioned on the importance of providing a visual link to nature (e.g. courtyard garden) to enhance users' experience in the hospital building (Chap 7).

Acoustic comfort:

Some of the HCG users complained on the noise nuisance of the air condenser placed in the HCG (Chap 5).

Some users mentioned that they **favoured the quiet environment in the enclosed HCG** which contributed to a calm and positive feeling while spending time in the HCG (Chap 5).

Thermal comfort:

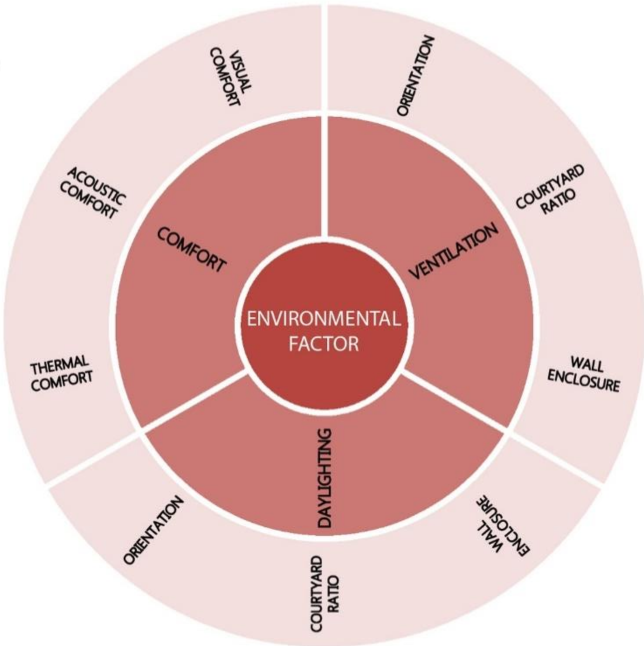
The air temperature in the HCGs was lower than the air temperature outside the hospital area. **More than half of the respondents** in all three sites voted for 'neutral' which indicated that they **felt comfortable while spending time in the HCG** (Chap 6).

The results of the two sets of daily data (9 am to 5 pm) revealed that **H1-C1 recorded the lowest air temperature on both cloudy and sunny days,** from 12 pm to 5 pm throughout the day, followed by H3-C2 and H2-C3 (Chap 6).

The Thermal sensation votes (TSV) result revealed that more users reported that they **felt 'slightly cooler' in H1-C1** compared to the other case study sites. This study suggests that **an increased amount of vegetation and planting and tree canopies in the HCG** can reduce solar radiation and lower the temperature in the case study HCG. (Chap 6).

SOURCE OF DATA

- Field measurement
- Site observation
- Survey interviews
- Interview with designers



VENTILATION:

Orientation :

The **orientation of a lower wall around the HCG facing the prominent wind direction**,contributed to the increase of wind speed (Chap 6).

Courtyard ratio

Overall, this study suggests that **an increase in the width of the courtyard garden can significantly improve the wind flow in the HCG.** This is evidenced in **the case study H1-C1 which recorded higher average wind-flow** compared to the other case study sites (Chap 6).

Wind speed votes (WSV) also showed a significant difference in their responses as **more users in H1-C1 mentioned that they felt 'windy' and 'too windy',** whereas only a few respondent mentioned that H2-C3 was windy and none of the users reported H3-C2 as 'windy' (Chap 6).

Wall enclosure:

The **design of the wall enclosure with a large opening at around the corridor at the ground level of the H1-C1 maximise the wind flow into the adjacent spaces of the hospital** (Chap 6).

Openable wndow and louvers was used as part of the wall enclosures around the HCG to allow natural ventilation into the indoor rooms or corridor (Chap 6).

A majority of the HCG users mentioned the importance of having **a shaded area, daylighting in the HCG and into the adjacent spaces, a breeze and fresh air and a comfortable air temperature** (Chap 6).

The architect mentioned that the inclusion of the courtyard in the design and planning of the HCG is due to the necessary to **avoid deep plan building** and **to provide DAYLIGHTING and VENTILATION into the building** (Chap 7). .

DAYLIGHTING:

Orientation:

The hospital block is **elongated along a north-south orientation** to **minimise sunlight penetration from the East and West side** of the hospital building to minimise the impact of solar radiation (Chap 6).

Courtyard ratio

Ahigher wall facing the East and West orientation of the HCG sites can reduce the amount of solar radiation onto the ground of the HCG and decrease air temperature. Eventually, it enhances the outdoor thermal comfort in the HCG and increases visitation to the HCG especially in the morning and late afternoon (Chap 6).

Wall enclosure

The wide opening around the HCG wall allows **more natural daylighting penetrate into the adjacent rooms** (Chap 6).

The **types of the wall enclosure (e.g. aluminium cladding)** around the H2-C3 **caused the glare in the HCG** especially during the sunny day (Chap 6)..

Figure 8.5: The overall findings of the current study related to the environmental aspects of the HCG

8.3.3 Social aspect

The third component of the HCG framework is the social aspect. Figure 8.6 presents the overall findings related to the social aspects of the HCG design, including:

- Social behaviour
- Social well-being
- Social support

8.3.3.1 Social behaviour

Understanding the social behaviour of the HCG's users is another important aspect to be studied. By having direct contact with the users to study how they use the space, the architects would gain access to insightful thoughts that aid their design process (Kujala, 2003). This study found that different types of users (i.e. staff, patients, and visitors) used and behaved differently in the HCG based on the influence of several factors, namely the physical design, microclimatic conditions, and the hospital operation hours (See in Section 6.4.6). Several aspects of social behaviour were studied in the current study, including: i) type of users, ii) types of activities, iii) level of occupancy, and iv) time spent in the HCG.

i)Type of user

One of the noteworthy findings of this study was regarding the main users of the HCG in a Malaysian public hospital. A total of 8-hour daily observation from 9 am to 5 pm on a weekend and a weekday was conducted at all the three study sites. Based on the results, the visitors used the HCG significantly more than the staff and patient (See Sections 6.4.1 and 6.4.2). This is accordance to the earlier studies in a hospital outdoor garden in other country that patients are found as the user group used the garden the least (Poel and Griffin, 2017; Sherman et al., 2005). However, a local study found that the outdoor garden in a hospital in Malaysia was more frequently used by staff compared to visitors and patients (Adnan, 2016). However, the finding might be biased as it was based on a self-administered survey among the selected off-site staff, patients, and visitors in a single hospital. There was also no on-site observation to examine the actual activities by different types of users. Having said that, a few other studies from different countries also reported that the hospital staff was the main users of the outdoor garden in healthcare facilities (Shukor,2012; Pasha, 2013; Naderi and Shin, 2008; Cooper Marcus and Barnes, 1995).

Although this study found that visitors were the main users of the HCG, the designers should not focus merely on fulfilling the visitors' needs because the HCG is intended for patients, staff, and visitors alike. Furthermore, this study found that H1-C1 recorded a higher number of staff and patients, including patients on a wheelchair compared to the H2-C3 and H3-C2. This could be due to certain issues from the physical aspects of H2-C3 and H3-C2, for example, accessibility, wayfinding, visibility, and safety that led to low usage of the HCG. Overall, this finding suggested the need for the designers and hospital managers to deliberate further on the most effective HCG design that can meet the needs of the intended users. Several suggestions for HCG improvement were outlined in Section 8.5.2.

ii)Type of activities

Based on the on-site observation, walking and sitting are the frequent activities recorded in all the three study sites (See Section 6.4.4). Additionally, the survey interviews showed that the main activity reported by the HCG users was sitting (e.g. sit and wait, sit and relax, and sit and talk with a friend). These two techniques of data inquiries (observation and survey interviews) confirmed that sitting and walking were the most important activities in all three case study sites (See Section 6.4.5.1). This was in accordance with previous studies that found most of the users visited the garden to sit and relax, or to find a place for respite and a short period of rest (Reeve et al., 2017; Adnan, 2016; Shukor, 2012; Cooper Marcus and Barnes, 1995).

In this study, it was observed that adults were most likely doing sedentary activities such as sitting, using phone, or reading compared to the children who tended to be more active in exploring the site such as playing and running around (See Section 6.4.4). Similar findings were reported in previous studies. Children who visited the gardens tended to be more active and they would interact with the structures and natural elements while staff and visitors were often carrying out more sedentary activities such as sitting, talking and relaxing (Pasha and Shepley, 2013; Sherman et al., 2005; Whitehouse et al., 2001).

Moreover, this study also revealed that a higher variety of less sedentary activities were recorded in the H3-C2 (e.g. exercising, playing) while more sedentary activities (e.g. sitting, eating, drinking, lying down on a bench, standing) were observed in the larger H1-C1. The lack of available seating in H3-C2 could have resulted in a lower frequency of sedentary activities being observed there. This highlighted how the features of the HCG, particularly its facilities and landscape elements, could influence on its usage. Furthermore, understanding what people prefer to do in HCG will allow the designers to think creatively about the design and planning of the HCG that can accommodate different types of activities that can meet the users' expectations (Thompson, 2013).

iii) Level of occupancy

Based on the eight hours daily on-site observation, H1-C1 reported the highest level of occupancy (excluding passer-by) on both weekday (n=239) and weekend (n=163), followed by H3-C2 and H3-C2 (See Section 6.4.3). However, among the different types of activities, sitting was the least recorded activities in H3-C2, likely due to a lack of available and comfortable seating. This finding was consistent with previous studies in which the garden usage depended on the availability of variety of comfortable seating area (Pasha,2013; Cooper Marcus, 2005) Furthermore, a central location and good accessibility also influenced the level of occupancy of HCG (Poel and Griffin, 2017).

In addition to the availability of seating facilities, this current research suggested that influential physical design factors of HCG, such as a larger size, close location to the main entrance and high traffic zone area (e.g. main lobby), and easy access were associated with a higher level of occupancy (See Section 6.4.6.1). Moreover, this study also revealed that the availability of shading in HCG, a better microclimate, and user-friendly operation hours also influenced the usage of HCG at different times of the day (See Sections 6.4.6.2 and 6.4.6.3). This suggested the importance of incorporating physical and environmental factors that impact on the level of occupancy in the HCG in the design of HCG. As highlighted by previous research, if a garden was delightful but not accessible to most people, then it would not serve the purpose (Eckerling,1996).

iv) Time spent

This study revealed that more than half of the respondents in the H1-C1 spent longer than 30 minutes in the HCG, followed by 38.9% in H2-C3 and 21.1% in H3-C2 (See Section 6.4.5.3). However, this finding contrasted with studies done in other countries of different climates and cultures (Poel and Griffin, 2017; Sherman et al., 2008; Whitehouse et al., 2001) in which a majority of the users spent less than 5 minutes in the outdoor garden. This study pointed out the influence of physical design such as the availability of comfortable and variety of seating on the time spent by the users in the HCG. This finding concurred with earlier studies that reported on how a comfortable seating with an attractive view (Poel and Griffin, 2017; Whitehouse et al., 2001) and a shaded seating area (Pasha, 2013) would encourage visitors to stay longer in the outdoor garden.

Additionally, the current finding also suggested that visitors would stay longer in the HCG when they felt 'neutral' and 'slightly cool' (See Section 6.2.6.3). This finding was also supported by Thorsson et al. (2007), who concluded that users who perceived thermal condition to be within the acceptable comfort zone (slightly cool, comfortable and slightly warm) were found to spend a long time in a square (19 minutes) and a park (21 minutes). Similarly, a study in an outdoor garden of an educational institution in Malaysia also found that both international and local students would stay longer in the outdoor area that had a shaded condition and comfortable microclimate (Makaremi et al., 2012).

Based on these findings, this study recommended that a variety of seating area that can accommodate people who visit the HCG as individuals or in groups should be prepared. There should also be a comfortable microclimate with sufficient shaded areas in the HCG to encourage people to stay longer in the HCG.

8.3.3.2 Social well-being

Several recent literatures reviewed the emerging evidence-based research regarding the benefits of nature contact for the well-being of individuals (Frumkin et al., 2017; Seymour, 2016; Hartig et al., 2014) Several aspects of social well-being based on the findings of this study were discussed in relation to the evidence from literature and known theories. The aspects include: i) Stress reduction; ii) Being away; and iii) Physical exercise.

i) Stress reduction

This study suggested that the HCG should be able to promote a restorative environment that can help to reduce the stress of its intended users. The research provided evidence that more than 70% of the users in all the three study sites reported better mood in terms of feeling more relaxed and less stressed when they spent time in the HCG (See Section 6.5.1). This finding was similar to earlier studies that reported the time spent in an outdoor garden to be a positive distraction for many users, particularly through the landscape features (e.g. plants, flowers, water, wildlife). Most of them showed a positive mood change after spending time there (Cooper Marcus and Sachs, 2014; and Cooper Marcus,1995). A recent study also found that the family members of ICU patients preferred to have a break in the garden as they reported a greater stress reduction compared to having a break in the atrium café or indoor waiting area (Ulrich et al., 2019).

Based on the survey interview with 120 users in the three study sites, this study revealed that more than 50% of the respondents visited the HCG because they wanted to: i) enjoy the garden, ii) refresh their mind and, iii) relax and rest in the HCG. This finding was in line with one of the components of the SRT, namely the 'natural distraction' (Ulrich, 1999). This component suggested that viewing a scene of nature had a greater impact on alleviating the stress level. Additionally, this finding was also in accordance with the 'fascination' component in ART (Kaplan,1995). In a previous study, nature was considered as a 'soft fascination' as it provided us with a variety of elements (e.g. breeze, sunset, sunrise, flower, plants) that were fascinating for people that could keep their attention focused (Kaplan and Kaplan, 1989). When a person is in a state of stress, viewing pleasant views or soothing natural features can distract their attention and filter out their negative thoughts and subsequently promote restoration.

ii) Being away

One of the components of ART, 'being away', refers to escaping from a stressful environment or situation or any source of mental fatigue. In this case, having access to a positive natural view would promote restoration and provide relief from mental fatigue (Kaplan,1995) (Section 2.4.4.1, i).

Based on the findings of the open-ended questions in the user survey, many users favoured the HCG because it offered them an alternative place to be away from a congested waiting area in the hospital (Section 5.5.1.1, d). Moreover, this study also revealed that about 20% of the respondents reported that they wanted to have a refuge from the things that distracted them and to get away from their daily routine by using the HCG (Sections 6.5.2 and 6.5.3.1). This finding was in concurrence with previous studies which concluded that HCG provided an opportunity for the users to seek solace in a more relaxed environment, away from the sterile indoor hospital environment (Jiang et al., 2018; Reeve et al., 2017; Ibrahim et al., 2015; Pasha, 2013; Davis, 2011).

iii) Movement and Exercise

Based on the results from the survey interview, it was found that the main pushing factor for the HCG users was their desire to perform physical exercise and to enjoy the outdoor therapy in the HCG (Section 6.5.3.1). This followed the components of SRT (Ulrich, 1999) which highlighted the importance of movement and exercise in reducing stress, enhancing moods, and improving other health outcomes. Moreover, several researchers indicated that outdoor exercise in nature had a more significant impact on physical and mental wellbeing than indoor exercise (Gladwell et al., 2013; Thompson Coon et al., 2011). Another study also found that outdoor exercise was able to enhance mood and self-esteem (Barton, Griffin and Pretty, 2012) and positively improve attention and social interaction (Rogerson et al., 2016).

According to the user survey, the staff favoured the H2-C3 because of the availability of space to perform physical therapy for patients. During the on-site observation, patients could be seen performing stretching exercises and walking activity around the looped path for rehabilitation purposes (Section 6.4.4). Notably, a previous observational study at the same site as the hospital of H3-C2 revealed that cardiac patients preferred outdoor exercise rather than indoor exercise. It was also found that their heart rates significantly decreased after walking in the outdoor garden (Amat, 2017). Moreover, previous studies also suggested that integration of therapy programs into garden use would encourage more patients to visit the garden (Pasha and Shepley, 2013; Davis, 2011; Whitehouse et al., 2001).

Several recommendations to increase the opportunity of movement and exercise in the outdoor garden were provided by earlier research. For instance, the provision of a looped pathway to increase patients' ability to walk around (Winterbottom and Wagenfeld, 2015; Ulrich, 1999). Other suggestions from another study involved the provision of a circular route, even surfaces suitable for brisk walking, pathway with suitable width for two people to pass through at any one time, and strolling pathway with a nice view (Cooper Marcus and Barnes, 1995). A few other similar recommendations included the provision of a walking path with stopping points (Naderi and Smith, 2008) and a meandering walkway (i.e. narrow and curvy walking path) (McDowell and Clark-McDowell, 1998).

8.3.3.3 Social support

HCG also plays a vital role as a supporting facility when the hospital is planning for events that foster social interaction between staff, patients, and visitors. Several important aspects to promote social support in the HCG are include: i) sense of belonging; ii) sense of privacy; and iii) equality.

i) Sense of belonging

The feeling of belonging within a community can influence an individual's identity in which they would want to participate in the community and be less isolated (Howarth et al., 2016; Diamant and Waterhouse, 2010). Based on the survey response, one of the reasons the users visited HCG was because they wanted to socialise and meet with other people (Sections 6.5.2). Moreover, during the survey interview, some patients also mentioned that they preferred to go outdoor rather than staying the whole day in the ward. Going to the HCG would provide them with the opportunity to enjoy the view, mingle around, and make new friends.

This was in accordance with the SRT (Ulrich,1999) which suggested that social support should be considered as one of the important aspects in designing an HCG. The hospital users, especially patients, require social support from their family, friends, and staff so that they will not feel isolated. A previous study revealed that people who received better social support often had a better health status than those who were socially isolated (Ulrich, 2000). Moreover, those who received a higher level of social support recorded a shorter hospital stay and longer survival, depending on their medical conditions (Cooper Marcus, 2000).

ii) Sense of privacy

Cooper Marcus and Barnes (1995) highlighted that some of the people visited the garden to be alone so that they could escape temporarily from the hospital setting to seek privacy. Ulrich (1992) highlighted that while it was important to design a garden that promoted social support and interaction, the privacy in the garden should not be taken for granted as well. For example, the design of an enclosed courtyard could offer a sense of quietness and privacy within the space. In the survey, many respondents appreciated the quietness in the HCG because they were much calmer in there (Section 5.2.4.4 and 5.5.1.1, d). Similarly, previous studies also found that HCG managed to deliver a better sense of privacy compared to outdoor gardens with an open concept that were exposed to noise disturbances from the surrounding traffic (Ibrahim and Jer, 2014). Moreover, several studies also highlighted the importance of providing a place for quiet reflection and privacy to garden users in the healthcare facilities (Amat, 2017; Erbino et al., 2015; Guaita et al., 2011).

Additionally, this current study suggested the importance to promote a sense of privacy in the HCG through a proper design strategy. For instance, the design should incorporate a seating area that allowed worried or grieving family members to hold private conversations by having some screening plants close to the seating area and ensuring that the seating area is not facing the main hospital street where many people tend to pass by. In contrast, it should be noted that if the garden was dominated with more seating area to allow for social interaction, it could lead to excessively crowded space and less privacy, especially when the garden was already a small garden with little greenery, to begin with (Cooper Marcus and Sach, 2014). As discussed earlier in Section 5.5.1.1, a, iv, a small courtyard garden lacking in screening plants could possibly cause the ‘fish-bowl’ effect and reduce the sense of privacy among the users (Jiang et al., 2018; Pasha and Shepley, 2013; Naderi and Shin, 2008; Cooper Marcus, 2007).

iii) Sense of equality

Another essential design criteria that can foster access to social support is a sense of equity. According to Act 658, the Person with the Disability Act Malaysia (2008), it is fundamental to remove barriers and provide access for disabled people to achieve social equity in all aspects of life (Hussein and Yaacob, 2012). Sempik et al. (2014) highlighted the importance of considering the needs of vulnerable users to promote social inclusion and interaction within the community. In the context of this study, the disabled people should also have equal access to the facilities provided in the hospital, including access to HCG. Based on the observation, it was found the HCG with easy access for disabled people (e.g. even surface, wide pathway) resulted in a higher usage by patients on wheelchair or stretchers compared to HCG that were difficult to access (See Table 5.2 in Section 5.3.1.4). Moreover, this study also found that HCG that allowed wheelchair access recorded a higher users' satisfaction levels compared to those that did not have the same feature.

In addition, previous studies have shown that user-friendly access to an outdoor garden was not only important for wheelchair users, but also for other users, including those who were using transporters, walkers, cots, or gurneys. Thus, a smooth and even surface for all primary pathways should be provided in all HCG (Ulrich et al., 2019; Winterbottom and Wagenfeld, 2015; Cooper Marcus and Sachs, 2014). By doing this, different groups of users would be able to navigate the garden safely and independently. Shukor (2012) discovered that an outdoor garden with a straight pathway and ramp would encourage patients to spend more time there for their physical training. Moreover, Shackell and Walter (2012) determined that the pathway should be made wide enough to allow wheelchair users or other mobility users to access the garden easily. In addition, Hussein et al. (2016) also suggested for the heights of raised planters to be not more than 600mm to allow the wheelchair users to engage with the plants and flower bed, based on the Malaysian Standard 1184 - Universal design and accessibility in the built environment (2014).

1 SOCIAL BEHAVIOUR

Types of activities

Visitors: Sit and relax, walking around, use a phone, reading, eating, laying on a bench and playing around (children).

Staff: Sit and rest, patrolling, having breakfast and lunch, and upkeeping the garden.

Patients: Sitting on a bench,meeting friend and families, walk around, do a physical exercise (Chap 6).

Types of users

This study shows that the HCGs were mainly used by the **adult visitors (72%) and children (22%) followed by staff (4%) and patients (2%)** (Chap 6).

Level of occupancy

The H1-C1 (n=239) had the highest level of daily occupancy (excluding the passer-by) for both the weekday and weekends,followed by H3-C2 and H2-C3. This is due to its large size and location close to the cafeteria, easy access from the main hospital street,variety seating facilities and have a more comfortable microclimate (H1-C1) (Chap 6).

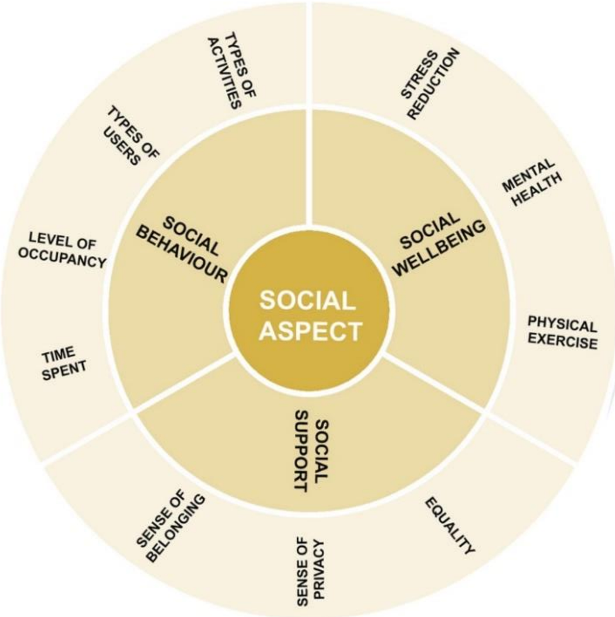
Time spent

Those who felt 'slightly cooler' or 'cooler' in their thermal sensation votes (TSV) were those **likely to spend more than 30 minutes in the HCG** (Chap 5).

The users in the H1-C1 and H2-C3 spent longer time in the HCG compared to H3-C2 due to **the availability of variety of seating area** (Chap 6).

SOURCE OF DATA

- Field measurement
- Site observation
- Survey interviews
- Interview with designers



2 SOCIAL WELLBEING

Stress reduction

The results of the perceived restorative score based on ART and SRT theory showed that the main factors which encouraged users to visit the HCG related to the components of **natural distraction (SRT) and fascination (ART)** in which they **wanted to enjoy the garden, cope with their worries, and refresh their mind as well as to relax and rest in the HCGs** (Chap 6).

H1-C1 has the highest percentage of the Perceived Restorative Score (PRS) score with an average of 90.6% of the overall responses, followed by the H2-C3 (73%) and H3-C2 (71%) (Chap 6).

Being away

Visitors reported that one of the factors that encourage them to visit the HCG is becasue they **want to 'being away' from indoor hospital. HCG provide an alternative place for them to refuge from the things that distract them** (Chap 6).

Medical staff and nurse often suffered a mental fatigue due to the longer working hours provide treatment and consultation with the patient. Having contact with nature or viewing to nature can help them **to rejuvenate their mind and reduce stress and improve their job satisfaction** (Chap 6).

Spending long hours in the hospital wards can be stressful to most of the patients. They mentioned of their needs to **get away for a while from indoor hospital and socialise with other people in the courtyard garden** (Chap 6).

Physical exercise

Among the factors that encourage the users to visit the HCG are **to do physical exercise and enjoy the outdoor theraphy** (Chap 6).

The users also suggested to add equipment exercise and playground area for children in the HCG to encourage physical exercise in the HCG (Chap 5).

3 SOCIAL SUPPORT

Sense of belonging

Gardening and volunteering in garden maintainance can help to enhance the sense of belonging and encourage social interaction among the HCG users (patient, staff and visitors). However, these activities are not common in Malaysian context (Chap 6).

Sense of Privacy

The enclosed courtyard garden provide a sense of privacy. A place that promote a better sense of privacy can foster better social support and interaction among the patient,families and staff (Chap 6).

H1-C1 provide a variety of seating area whether to sit individually, in pair or in a group. The arrangement of seating area that surround with a screening plants provide a sense of privacy for the patient to have a conversation with their family or friends and received support in a more conducive environment (Chap 6).

Equality

The HCG design should be accessible to various range of users including the mobility users (e.g. wheelchair users). Based on the observation, only H1-C1 and H3-C2 easy accessible to the wheelchair users, but not in the H3-C2 due to the uneven entry point without ramp (Chap 6).

Figure 8.6: The overall findings of the current study related to the social aspects of the HCG

8.3.4 Operational aspect

Apart from the physical, environmental, and social aspects, another important component of the HCG framework is the operational aspect. Figure 8.7 illustrates the overall findings related to the operational aspect that includes:

- Maintenance,
- Regulation, and
- Awareness.

8.3.4.1 Maintenance

Numerous studies highlighted the fundamental needs to maintain and upkeep the outdoor garden in the healthcare facilities because it had a significant impact on the users' level of satisfaction (van der Riet et al., 2017; Adnan, 2016; Ibrahim et al., 2015). Several components related to the maintenance of HCG are i) Growing and cultivation, ii) Cleanliness and, iii) Inspection.

i) Growing and cultivation

HCG design is unlike other types of designed space because it consists of landscape elements that are alive and require constant attention and care. According to the survey, the users in all the three study sites mentioned about the lack of care in the HCG, particularly the vegetations (Section 5.5.1.1, i). Therefore, as suggested by the landscape architect, it is important to carefully select the plants that match the site condition. Any dead or dying plants must be replaced. Constant upkeep and maintenance should be carried out to ensure the plants stay healthy and continue to thrive over time (Section 7.6). This echoed the recommended strategies by previous studies that included periodical plant replacement, watering, mulching, fertilising, pest control, and irrigation (Barnes in Cooper Marcus and Sachs, 2014, p. 286). Furthermore, this study also recommended that the selection of planting should match the soil conditions in terms of the pH level (i.e. alkaline or acidic) and texture (i.e. dry or soggy) to ensure the plants can grow well, as what was outlined by some previous studies (Barnes in Cooper Marcus and Sachs, 2014, p. 263).

Moreover, in the interview, the landscape architect also highlighted that proper attention should be given in the selection of the right plants based on the amount of light required, either full sun, partial shade, or full shade (Section 7.5.2.2). For example, a similar recommendation made in an earlier study outlined that certain plants should receive an adequate amount of sunlight at least half of the day to ensure that they would thrive (Barnes in Cooper Marcus and Sachs, 2014, p. 264).

ii) Cleanliness

Cleanliness can affect the physical appearance of the HCG and subsequently influenced the users' satisfaction levels about HCG. This current study revealed that the cleanliness of the wall was the most influential factor that determined the users' satisfaction levels with the overall planning and performance of HCG (Sections 5.3.5 and 5.5.2.2, ii). Based on the on-site observation and open-ended responses in the survey, this study found that dirty pavement, black stain on the wall, unemptied waste bin, and unswept fallen leaves affected the aesthetic view of the HCG (See section 5.2.4.2, page 179-180).

Moreover, the findings revealed that bird droppings on the benches significantly deterred people from spending more time in the HCG due to the poor condition of the seating facilities (Section 5.5.1.1, b, ii). Thus, it is important for hospital managers to maintain the cleanliness of the HCG. An outdoor garden that receives constant upkeep had a positive psychological impact on the patients because a well-maintained garden provided the impression that it was 'in good care' and 'well looked after' (Barnes in Cooper Marcus and Sachs, 2014; Butterfield, 2014).

iii) Inspection

As discussed in Section 7.7.3, this study suggested the need to improve the culture of HCG maintenance. In the interview with the HCG users at all three study sites, many of the comments revolved around the aspects of maintenance and safety that should be addressed by the respective hospital managers. This study suggested that regular inspection of the facilities in the hospital so that any maintenance problems can be detected at an early stage and addressed right away to maintain the quality of the facilities. Broken or damaged seating and pavement can endanger the users' safety. Early detection and repair of the damage can reduce the maintenance cost in the long term. Poorly maintained vegetation and damaged garden features send out a message to the patients that the institutions do not care about the facilities. Worse still, the patients might interpret themselves to be in an unhealthy and non-caring environment (Cooper Marcus and Sachs, 2014, p.58).

Therefore, it is vital to conduct a constant inspection to ensure that the gardeners and cleaners follow the standard operation process in maintaining the HCG. Earlier research recommended the landscape architect and facility management to issue a maintenance manual to outline how the garden should be maintained and preserved, for example, the frequency of pruning, watering, and fertilising. The manual could be used as a guide for the supervision of the staff and gardeners in-charged of the HCG (Barnes in Cooper Marcus and Sachs, 2014, p.285). This study also suggested that regular inspection would help the facility managers to supervise the activities of the HCG users, for example, if they are conducting any undesirable activities or causing any damages.

8.3.4.2 Regulation

The current study also suggested that the introduction of HCG regulation via proper signage in the compound. This is vital to convey the rules and responsibilities for the users when using the HCG facilities. The idea was sparked by one of the respondents who mentioned during the survey interviews that legible signage that explains the dos and don’ts for the HCG users (Section 5.2.1.3, see also Figure 5.4). Based on the observation, there were no such regulation signages regarding the usage of the garden and facilities in all the three study sites. It is vital to display the rules at suitable locations in the HCG, for example, the seating area or entrance. The signage should be visible to all the users to ensure that they are well informed about the rules and thus will take the appropriate steps in following the stipulated rules. Therefore, this study proposed two categories of garden regulation that should be endorsed in the HCG, including the garden usage and the facilities care.

i) Garden usage

Some of the proposed HCG regulations regarding the responsibilities of the HCG users include:

i) The following activities are prohibited in the HCG:
   - ‘Smoking or vaping. A penalty of RM 10,000 will be imposed on those who break the rules (This penalty is in accordance with the existing smoking rules in all the Malaysian hospitals).
   - Damaging the lawn, trees, flowers, shrubs, or other facilities in the HCG.
   - Plucking flowers or herb plants, removing or stealing any plants and shrubs in the HCG. Any person found cutting and removing the plants, flowers, or shrubs in the HCG is liable to pay the penalty set by the hospital management.
   - The use of a camera or video camera in the HCG without consent from the hospital management.

ii) All children must be accompanied at all times by an adult to ensure their safety. The adults must be aware that:
   - The children do not disturb other HCG users from the peaceful enjoyment of the garden. The children should not be screaming, throwing stones, or playing ball games in the HCG.

- The children must be prohibited from climbing on the railing or balustrades to prevent any danger to themselves.
- The hospital management is not responsible for monitoring the children's activities or any accidents involving children in the HCG.

iii) The HCG can only be used during the daytime from 8 am to 7 pm. It is close to the public at night.

ii) Facilities care

In addition to the regulation on garden usage, the regulation regarding the facilities care in the HCG is also crucial to ensure the maintenance of HCG, for example:

i) Users are prohibited from littering in the HCG. All papers, bottles, glass, food containers, or other litter must not be left in the HCG.

ii) The litter must not be left on the table or benches in the HCG and must be disposed of in the provided trash bin.

iii) The litter must not be thrown into the water fountain. All areas in the HCG must be kept clean all the time.

iv) The seating facilities should not be damaged. Any damage in the HCG should be reported immediately to the security officer or the hospital management office

8.3.4.3 Awareness

i) Project brief

The design brief is the fundamental document that guides the overall development of a hospital building project. Findings from this study suggested an improvement in the design brief, in which periodic revision of the technical or functional aspects of the hospital project should be conducted by the policy-makers, especially the MOH and PWD. As discussed earlier in Section 7.6, this study found that both architects agreed in the interview that the hospital brief must be constantly updated based on the functional requirement of the particular project. In fact, this study found that no specific guidelines related to HCG were provided as part of the hospital project brief (Section s7.2.2). Therefore, the HCG framework developed based on this study will serve as a useful guideline for the policy-makers to improve their hospital project brief, particularly on the aspects related to the design and planning of HCG.

Furthermore, the current study found that the incorporation of HCG in hospital planning had been practised in Malaysia since the early 1970s. In recent years, several public hospitals under MOH were still practising the courtyard design for the new hospital complexes (Sections 7.7.1 and 7.7.2). Based on the findings of this study, an optimal HCG design should be implemented to ensure that the incorporation of the garden is not just to avoid a deep plan building but also to provide a positive, comfortable, and restorative feeling to the users. Consequently, the architects and landscape architects can refer to the updated hospital project brief and follow the proposed design recommendation in order to achieve a functional and well-utilised HCG.

An example of the design guidelines of Department of Health in the UK: the 'Health Building Note 00-01, focus on the design principle and issue related to the acute care healthcare facilities including the evidence based design for a therapeutic environment which found to be very useful guidance for the designers, architect and healthcare planner (Phiri, 2014).

ii) Collaboration practice

As discuss earlier in Section 7.7.5, this study also highlighted the importance of forming an excellent collaboration between all stakeholders, including the architects, landscape architects, contractors, engineers, medical planners, hospital providers, and end users). When they are fully committed and working as a team from the design development stage of the hospital project, it will lead to a better quality of the HCG and its long-term maintenance (Chew et al., 2019; Li, 2018).

Based on the interview with the designers, this study suggested that both the architects and landscape architects should discard the old practice of working separately at different stages of the project. Instead, they should collaborate and engage with each other from the initial stage of design until the completion of the HCG (Section 7.3.1). In this way, any issues related to the landscape or architectural design can be discussed and addressed earlier to avoid any unnecessary errors in the design specification. This finding was in accordance with earlier research (Chew et al., 2019; Cooper Marcus and Sachs, 2014). Another important finding stressed the need for better collaboration between the hospital manager and the landscape architect (Section in 7.3.2).

iii) Users' need

Understanding the need of the actual users is important in the design process of HCG. This study found that the end users who were involved collaborated with the design team during the design development stage included the hospital staff such as nurses, pharmacists, and hospital managers. However, it did not include patients, visitors, or family members. It was important to include these groups of users as this study showed than most of the HCG in the Malaysian public hospitals were utilised by the visitors, followed by the staff and patients (Section 6.4.1).

As highlighted in earlier studies, the attempt to meet the needs of multiple user groups could be particularly challenging for the design team. It was rare to find an outdoor garden that could fulfil the needs of all the groups of users (Cooper Marcus and Sachs, 2014, p.95). Therefore, it is crucial to know who are the actual HCG users and to understand how they use the space so that necessary design consideration can be made to fulfil the functional needs of the visitors, staff, and patients. The suggestions based on the feedback from the actual users in this study should be considered by the hospital managers during the retrofitting of an existing HCG or designing a new hospital project brief.

iv) Benefits of nature

There is growing evidence to show that access to nature, particularly in the healthcare setting, ameliorated the stress level (Ulrich et al., 2019; Kim et al., 2009; Ulrich, 1984; Verderber and Reuman, 1987) and contributed to a positive and relaxed mood (Jiang et al., 2018; Reeve et al., 2017; Shukor, 2012; Naderi and Shin, 2008; Toone, 2008; Sherman et al., 2005; Whitehouse et al., 2001, Cooper Marcus and Barnes, 1995). Furthermore, it could improve the quality of work-life and job satisfaction among the healthcare staff (Cordoza et al., 2018; Nejati et al., 2016; Pati et al., 2008).

This study found that there was still a lack of awareness among the hospital managers and healthcare providers about the benefits of a well-designed HCG for the patients and other users. This was highlighted by the H2-landscape architect. He stated the need to inculcate awareness among the hospital managers and healthcare providers to update them on the best available research evidence regarding the benefits of nature to individual well-being (See Section 7.6, Table 7.10).

Furthermore, this study suggested that besides imparting awareness on the benefits of nature to the hospital managers, it is also necessary to educate other stakeholders such as the medical staff, administrative staff, hospital planners, architects, landscape architects, patients, family members, visitors, and the community (Section 7.5.2.4). If everyone is aware of the connection between nature and wellbeing, they will work together to ensure the programming, design, construction, and ongoing management of the facility are done seamlessly to achieve the goal of providing a caring environment. Furthermore, this will encourage all the stakeholders, particularly the hospital managers, to maintain the HCG in the best possible condition for the benefits of all the users.

SOURCE OF DATA

- Field measurement
- Survey interviews
- Site observation
- Interview with designers

1 MAINTENANCE

Growing and cultivation

The majority of the users in all the three sites complained that the **HCG suffers from a lack of care.** **C**oncerns included that the **plants needed to be better captivated and fertilised to maintain the plants' life** (Chap 5).

The responses were related to the dissatisfaction with the plantings associated with **untrimmed grass, unfertilised plants and unrepaired planting labels as reported in H1-C1** (Chap 5).

Cleanliness

The cleanliness of the HCG impact on its appearance and users satisfaction.

Wall condition: The users complained on the presence of a black stain and rust on the wall around the HCG area caused an unpleasant view in the HCG (H3-C2) (Chap 5).
Dirty seating: The users complained that the seating in the H3-C2 is full of birds dropping which refrain them to use it (Chap 5).
Unclean fallen leaves: The users also complained on the unclean fallen leaves on the ground of all the three HCGs which affect on its appearance (Chap 5).

Inspection

A regular inspections on the facilities and users' activities in the HCG need to be done to ensure the HCG is well maintained and safe. The designers mentioned that the culture of maintainance among the hospital adminitor need to be improved (Chap 7).

Another issues highlighted by the HCG users are include: **the unfixed broken seating and water fountain (H1-C1), the unsafe railing around the slope area (H3-C2) and the expose electrical cable (H1-C1 and H2-C3)** (Chap 5).

2 AWARENESS

Project brief

The H2-architect mentioened that the MOH **need to update the design brief and to be more flexible in adapting new ideas to tackle the environmental and functional issue of particular hospital planning** so that it would not result in the building defect in a later day (Chap 7).

Collaboration practice

An active collaboration between various stakeholders including the designers, the end-users and the policymakers is very crucial to assist the quality of the outdoor garden and its maintainability

Poor communication between the designers and the actual users (i.e. patient, staff and visitors) can lead to ineffective landscape design that does not meet the needs of the intended users.

Users' need

It is importance for the designers to adress on the users' need when designing the HCG. **The findngs on the users' perception, preference and experience in the HCG provide a useful insight on design consideration for both the architect and landscape architect** (Chap 5).

The findings of the POE inform the hospital managers on the users suggestion and their preference so that necessary improvement on the existing facilities could be made (Chap 5).

Benefits of nature

This study found that the HCG with abundant of greeenry, variety of seating facilities and a comfortable microclimate perceived a higher restorative score compared to the one with less greenery, lack of choice of seating and have less comfortable microclimate (Chap 6).

The landscape architect highlighted on the importance **to increase awareness among the hospital manager and healthcare providers on the benefits of nature on the health outcome** through evidence based design and a good design practice (Chap 7).

3 REGULATION

One of the user in the H1-C1 suggest on the need to introduce the regulation for the HCG . Only in the H1-C1 provide a non-smoking signage in the HCG . No regulation signage that explained on the garden usage and facilities care were found in the three case study sites (Chap 5)

Garden usage and facility care

The need for the hospital administrator to provide a signage that inform the HCg users on the regulation related to a garden usage and facilities care. This will ensure that the users realised their responsibility and obey the rules in the HCG.

Figure 8.7: The overall findings of the current study related to the operational aspects of the HCG

8.4 The final HCG framework

The earlier sections discussed the main components (i.e. physical, environmental, social, and operational aspects) and the subcomponents of the HCG framework in relation to the findings from this study and literature review. The final HCG framework is illustrated in Figure 8.8.

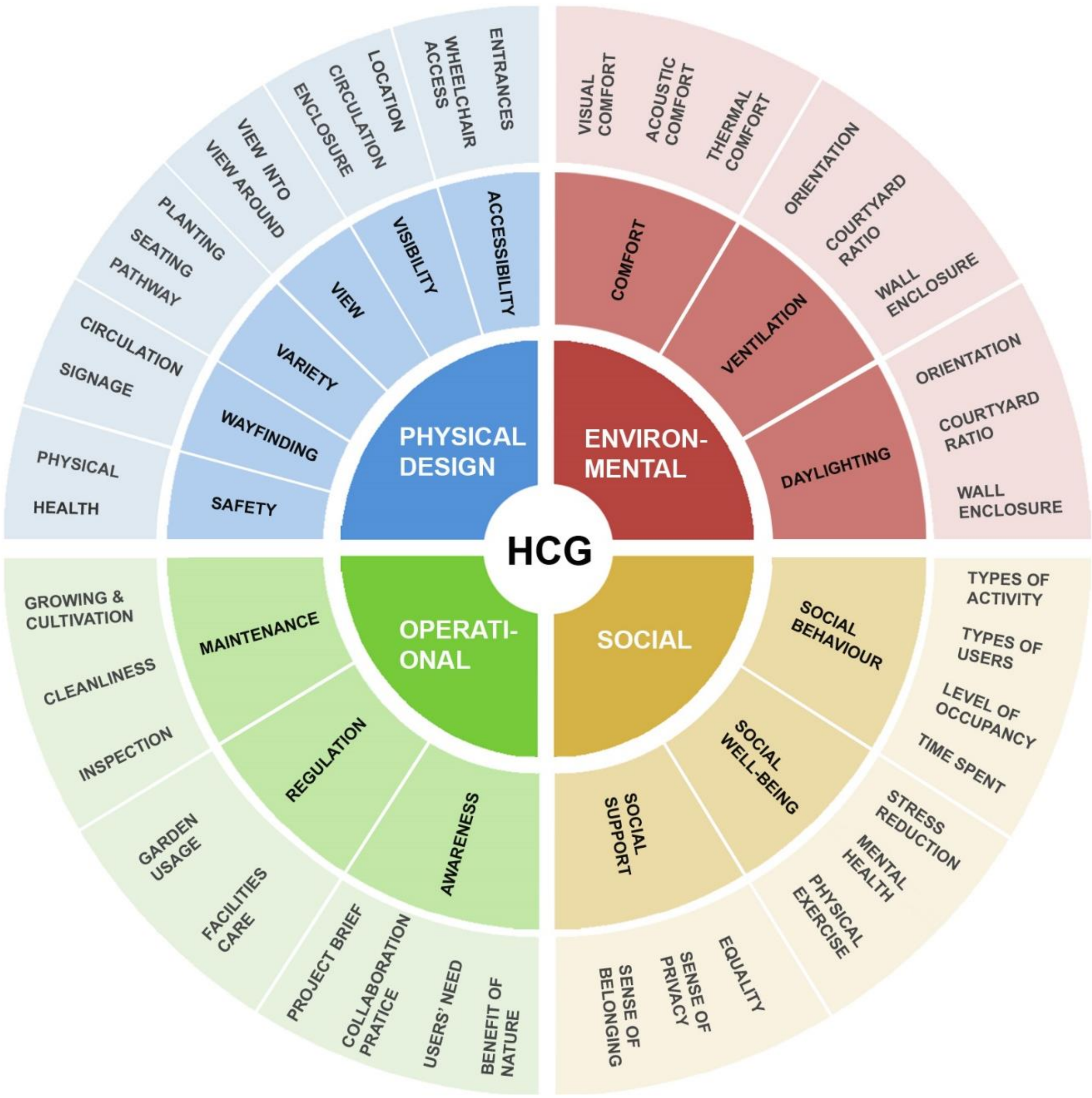


Figure 8.8: The HCG framework

There have been numerous studies proposing the design guidelines and recommendations for outdoor gardens in healthcare facilities (Paraskepoulou and Kamperi, 2018; Winterbottom and Wagenfeld, 2015; Cooper Marcus and Sachs, 2014; Shukor, 2012; Said, 2003a; Kaplan, 1995; Ulrich, 1999). However, there is still no comprehensive framework that specifically focuses on the courtyard garden in a hospital. Moreover, the available Malaysian studies based on local hospitals (e.g. Said, 2003a; Shukor, 2012; Ghazali and Abbas, 2012) only outlined the recommendations for outdoor garden targeting on specific types of users or certain design and maintenance aspects.

It is important to note that a courtyard garden is different from the outdoor garden with an open concept in terms of the configuration and the ambience experienced by the users. As found in this study, the wall condition and landscape elements were important determinants of the users' satisfaction with the overall planning and performance of the HCG (See Section 5.5.2.1). As evidenced in this study, the wall enclosure also played an important role in maintaining a pleasant microclimatic condition in the HCG. By comparison, the design recommendation for an open concept outdoor garden would not require much consideration on the wall enclosure. Similarly, an enclosed courtyard garden would provide a quieter ambience compared to an open outdoor garden exposed to noises, such as one located close to the adjacent traffic (Cooper Marcus and Sachs, 2014). Based on the lessons learned from the three case studies, the following HCG framework was established for the development of future policy and practices which discussed further in the following section. The significant features of the HCG framework which are also the thesis contribution to knowledge is explained further in Section 9.3, Chapter 9.

8.5 Implication of the study: Recommendations for policy and practice

The findings from this study carry huge implications for the policy-makers, healthcare practitioners, and other relevant stakeholders to use the framework as a guideline to improve the design and planning of the HCG. This will hopefully help them to achieve both the desired environmental and restorative spatial qualities of the HCG. This study contributed towards the enhancement of the social needs of the hospital users by providing them with a positive experience and opportunity of engagement in the HCG. The specific recommendations developed based on the evidence from this study for the reference of policy-makers and practitioners are as below:

8.5.1 Recommendations for policy

Referring to the findings of the study (As discussed earlier in Section 8.3), several recommendations for policy for both the hospital manager (HM) and hospital provider (HP) are described briefly in Table 8.1.

Table 8.1: Recommendations for hospital provider and hospital manager

Main components	**Sub-components**	**Recommendations for policy (Operational aspect)**	**Who is involved?**
Maintenance	Growing and Cultivation	**To employ a gardener who has the knowledge, experience, and commitment in upkeeping the HCG** (i.e. mulching, fertilising, pest control). Provide storage area or tool shed close to the garden area for the gardener to keep their tools.	HM
		To carry out periodical plant replacement to change the dead plants after taking into consideration the cost of the plants and the types of plants that are suitable for the site conditions.	HM
		To provide a manual book on garden maintenance. The facility management personnel is recommended to check on the gardeners' work periodically to ensure that they follow the right quality control of plant care.	HM
		To allocate a sufficient amount of budget for the hospitals to carry out the continuous maintenance of the HCG.	HP
	Cleanliness	**To provide a dustbin as close as possible to the seating area** in the HCG. A larger HCG is recommended to be provided with multiple trash bins compared to the smaller HCG.	HM
		To impose a penalty on those litter in the HCG to inculcate a sense of responsibility in the users to take care of the cleanliness of the HCG.	HM HP

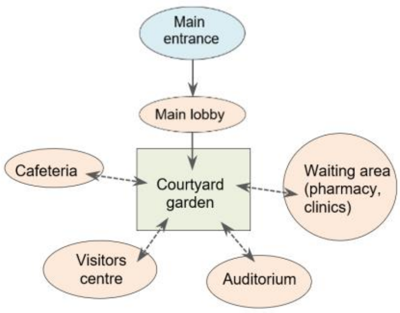
		To encourage volunteering among the community members. A Garden Club can be formed to maintain and upkeep the HCG. The members can also carry out fundraising to support the maintenance and retrofitting of the HCG. Horticulture students can be invited to collaborate and contribute to the establishment and maintenance of a horticulture program for the HCG.	HP HM
Regulation	Garden Usage	**To endorse regulations** related to **garden usage** (See Section 8.3.4.2, i)	HP HM
	Facilities Care	**To endorse regulations** related to facilities care (See Section 8.3.4.2, ii)	HP HM
Awareness	Project Brief	**To review the current project brief** to integrate a specific design requirement for the HCG based on the current findings, previous research evidence, and a collection of best design practices. **To revise and update the project brief periodically** to ensure that it is relevant to the functional needs of a new project	HP HP
	Collaboration Practice	**To encourage all the stakeholders to sensibly and effectively collaborate** and discuss the budget for the landscaping and maintenance cost without compromising the needs to provide a positive experience in the HCG. **To ensure that the architects and the landscape architects engage and collaborate closely at an early stage of the design and planning of the HCG** so that they can work together to achieve the same goal of	HP HP

		establishing a well-functioned HCG and providing a positive experience to the users.	
	Users' Need	**To continuously strive to improve the users' satisfaction with the facilities and services in the hospital** including the HCG. A well-designed HCG can enhance the users' experiences because it can portray a positive image of the hospital as an **'environment of care'.**	HP HM
	Benefits of Nature	**To organise seminars or workshops to inculcate awareness for the stakeholders** who are involved in the design and development of the hospital project to ensure an effective HCG design can be achieved. When everyone shares the same goal of creating a healthy and low-carbon environment to provide a positive experience to the hospital users, it is easier to achieve a successful HCG design without compromising the quality of life and wellbeing of the users. **To arrange seminars or workshops to foster awareness among the hospital staff, patients, and family members** to keep them updated about the best research evidence on the benefits of nature to the health and wellbeing. In this way, they will be more committed to practise a healthier lifestyle such as spending more time outdoors for physical exercise.	HM HP

8.5.2 Recommendations for practice

Based on the HCG framework, several design recommendations were suggested for the practitioners, especially for the architect and landscape architect. Some of the recommendations also involved other practitioners such as the mechanical engineer and the hospital manager. Table 8.2 presents the design recommendations related to the physical, environmental, and social aspects of the HCG design.

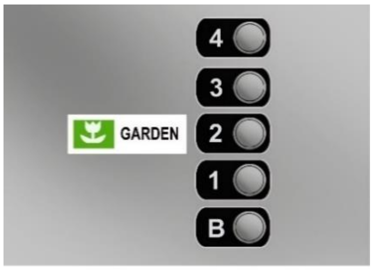
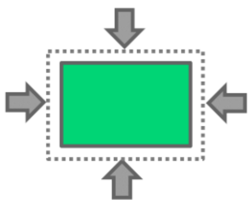
Table 8.2: Design recommendations for practice

Physical design aspect	**Sub-components**	**Design recommendations for practice**	**Who is involved?**
Accessibility	Entrances and access to the HCG	• To provide several entrances to the HCG to allow easy access and to encourage people to pass through or walk around in the HCG. • To ensure the doors are not locked and can be accessed by all users depending on the operation time of the HCG. • To locate the HCG close to the main entrance, the main hospital street, or common areas for easy access.  A spatial organisation of the HCG *Source: (Author, 2019)*	AR LAR HM AR
	Access for wheelchair users	• To provide an even pathway that is accessible to all mobility users (i.e. wheelchair users). • To provide a rubberised pathway to facilitate wheelchair users or patients pulling an IV pole to move around in the HCG. *Source: Clare cooper Marcus (2014)* • To provide a wide entry point to ease access to the HCG for patients on wheelchairs or stretchers. • To provide a ramp for wheelchair users if the floor has a split level. Remove any steps to allow wheelchair users to access the HCG.	LAR LAR LAR AR AR

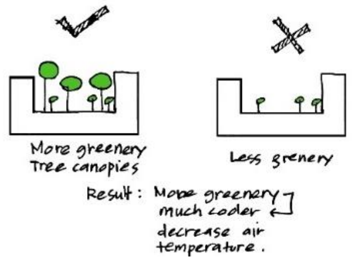
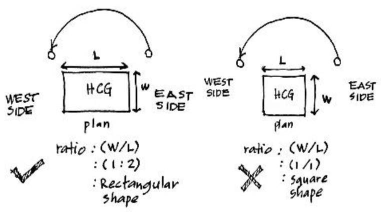
		• To provide a swing door at the entrance to ease access for wheelchair users.  *Source: Detex coorporation*	
Visibility	Location	• To locate the HCG near to the main entrance of the hospital or high traffic zones of the indoor areas such as the main lobby, cafeteria, toilet, and waiting area. • To place the HCG next to main entrance to enhance the visibility, invite more people to use the HCG, and provide an inviting and soothing feeling to the hospital users once they enter the hospital.	AR AR
	Hospital circulation	• To provide easy direction towards the HCG. • To organise the main hospital street to be along the HCG to enhance visibility.	AR AR
	Wall enclosure around the HCG	• To design a wall enclosure with a wide opening (i.e. high wall window) to allow visual link and connection with the outside nature.  Owensboro Health regional hospital, USA. *Source: (Jiang et al., 2017).*	AR
View	View to the HCG	• To provide greenery and pleasant view in the HCG. • To ensure the ratio between greenery and hardscape in an acceptable range of 70:30.	AR LAR

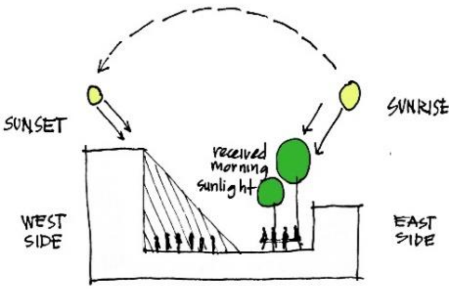
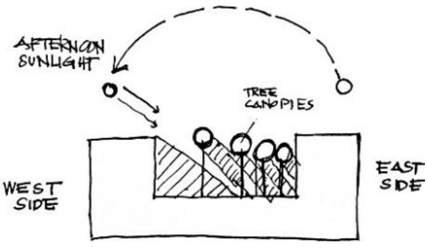
		• To allow a window view of the garden from the inpatient wards to allow the bedridden patients to enjoy the outdoor views.  Full height glass in the wards offers wide view to the outside nature *Source: (Maarof, 2016)* • To design a full-height glass window in the wards to offer a wide view of the nature.	
	View around the HCG	• To provide a garden view from the indoor areas such as the cafeteria, main lobby, or waiting area. • To provide a pleasant and interesting view surrounding the HCG with a combination of hardscape and softscape. • To ensure that the wall condition is clean without any black or rusty stains. • To ensure the cleanliness in the HCG by making sure no fallen leaves or litter on the floor	LAR LAR HM HM
Variety	Variety of planting	• To provide a various range of plants of different colours and species to give different experience and excitement to the users. • To provide medicinal herbs and oxidative type of plants in the HCG. • To avoid planting fruit trees in the HCG because it can attract insects and diseases that may compromise the hospital environment. • To avoid planting toxic or thorny plants that can be dangerous to the children. • To provide a herb garden with properly-labelled herb plants to serve as an interesting educational tool for children visiting the HCG.	LAR LAR LAR LAR LAR

	Variety of seating facilities	• To provide a shaded seating area for the HCG users to sit on during sunny days. • To avoid seating facility at an area that is exposed to direct sunlight in the afternoon. • To provide a variety of seating facilities that allow conversations either in pairs, in a small group or a large group. • To arrange seating area at the right angle facing a pleasant view (e.g. flowers, water features, green wall, or artwork). • To provide some mobile seating to support casual conversation. • To avoid placing a steel bench because it becomes hot and uncomfortable in the afternoon.	LAR LAR LAR LAR LAR LAR
	Variety of pathway	• To provide a looped pathway to encourage people to walk around the HCG and to encourage them to perform physical exercise. • To provide a pathway with a width of no less than 2 metres to allow at least two people or users on a wheelchair, buggy, or stretcher to pass through at the same time. • To provide a pleasant view by arranging interesting plants and features along the routes in the HCG to encourage strolling activities. • To design an organic or a curving pathway to facilitate people to slowly stroll and meander in the HCG.	LAR LAR LAR LAR
Wayfinding	Location	• To place the HCG at the central area of the hospital or near the high traffic areas to the wayfinding to the HCG without needing to depend too much on the signages. • To place the HCG close to the main hospital circulation to facilitate people to navigate their ways to the HCG.	AR AR

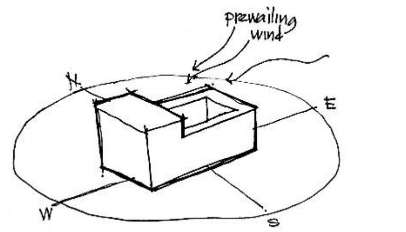
	Signage	• To provide directional signage to direct people to the HCG.  A signage mounted on the wall *Source: (Author, 2019)*  Simple signage at the lift button *Source: (Author, 2019)* • To provide location signage close to the garden entry to attract people to visit the HCG.  A location signage at the entry *Source: (Author, 2019)*	AR LAR
	Landmark	• To design the HCG as a landmark and central point of orientation for the hospital users when there are in the hospital.  Courtyard serves as a landmark. *Source: (Author, 2019)*	

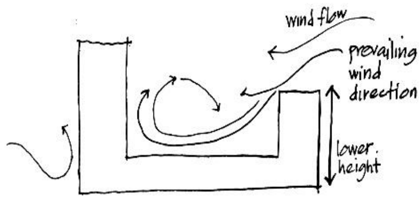
Safety	Physical safety	• To ensure the railing in the HCG is designed according to standard safety measures. The wide gap between the vertical and horizontal railings are not safe for children as they tend to climb and play around in the HCG. • To avoid any slippery grounds and pavements in the HCG as they can be a tripping hazard for elderly and frail people. • To provide a mesh on top of the water fountain to avoid children from falling into it. • To ensure no stagnant water in any area in the HCG that can become potential mosquito breeding grounds.	AR LAR HM HM
	Health safety	• To place any mouse control trap or pest control equipment away from the seating area to prevent the children from playing with them. • To avoid planting fruit trees in the HCG because it can attract insects and diseases that may compromise the hospital environment. • To avoid planting toxic or thorny plants that can be dangerous to users, especially children.	HM LAR LAR
Environmental aspect	**Sub-components**	**Design recommendation for practice**	
Comfort	Visual comfort	• To avoid using reflective materials such as aluminium cladding for the wall enclosure that can cause excessive glare in the HCG. • To avoid bright colour for the pavement and choose a non-reflective floor material to prevent reflection from sunlight and reduce glare in the HCG.	AR LAR
	Acoustic comfort	• To avoid placing any air condensers in the HCG area especially close to the seating facility because it can cause noise disturbance and spoil the mood of the users who want to rest and relax. • To provide a positive and soothing sound such as the trickling and falling sound by placing water features next	ME LAR

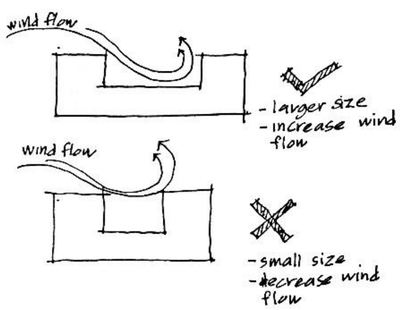
		to the seating area to mask any unpleasant noises from traffic, air condenser, footsteps, surrounding speech, and children.	
	Thermal comfort	• To increase the amount of vegetation, especially tree canopies in the HCG to reduce solar radiation and to lower the temperature in the HCG.  *Source: (Author, 2019)* • To orientate the lower courtyard wall to face the prevailing wind to promote air flow into the courtyard. This will provide better comfort in the HCG and the adjacent spaces. • To ensure the wall ratio is 1:2 or 1:3 (width:height). The higher the courtyard wall in the HCG, the higher the percentage of ground area that can be shaded. This will increase the comfort in the HCG and encourage people to spend more time in there.	LR AR AR
Daylighting	Orientation	• To orientate the long axis of the building and the courtyard away from the east and west sides to reduce the amount of solar radiation onto the building wall and the HCG surface. This will help to lower the air temperature in the HCG and the adjacent indoor spaces and significantly reduce the cooling loads of the building.  *Source: (Author, 2019)* • To identify the sides of the HCG that receive high or low daylight so that the right plants can be selected	AR LR LR

		based on sunlight requirements and the site conditions.	
	Courtyard ratio	• To increase the height of the courtyard wall at the east and west sides to reduce the amount of solar radiation onto the courtyard surface and increase the shaded areas in the HCG. This can reduce the air temperature and enhance outdoor thermal comfort in the HCG. • To ensure the height of the east courtyard wall is lower than the west courtyard wall to allow a cooler morning sunlight into the HCG, especially at the seating area. If the seating is in the west, a higher west side wall is recommended to block the scorching afternoon sunlight.  *Source: (Author, 2019)* • If the wall on the west side is the same height as the wall on the east side of the HCG, then more tree canopies is recommended to be planted on the east side to filter the afternoon sunlight that is more scorching than the morning sun. This can provide a shaded area, reduce the air temperature, and make people feel comfortable.  *Source: (Author, 2019)*	AR AR AR LR

<table>
<tr><td></td><td>Wall enclosure</td><td>To select the right parameters (width and the height) and glazing types for the openings or windows to ensure an acceptable amount of daylighting distribution into the building spaces.
To provide a wide opening around the HCG to allow more natural daylighting to penetrate the adjacent spaces of the courtyard garden.</td><td>AR

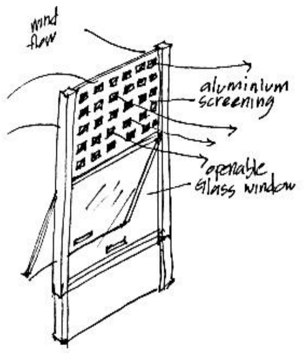
AR</td></tr>
<tr><td>Ventilation</td><td>Orientation</td><td>To position the courtyard wall facing a prominent wind direction at a lower level to increase the air flow into the HCG.


Source: (Author, 2019)</td><td>AR</td></tr>
<tr><td></td><td>Courtyard ratio</td><td>To ensure the height of the courtyard wall which is facing the windward direction to be lower to ensure that the air flow can circulate into the courtyard gardens.


Source: (Author, 2019)
It is recommended to increase the size of the HCG (the width and length), to maximise wind flow in the courtyard and adjacent spaces.


Source: (Author, 2019)</td><td>AR

AR</td></tr>
</table>

	Wall enclosure	• To design a courtyard wall with a sufficient amount of opening to maximise the air flow into the corridor or indoor space. • To install a louvre or screening wall along the corridor around the HCG to maximise the air flow into the adjacent spaces  *Source: (Author, 2019)*	AR AR
Social aspect	**Sub-components**	**Design recommendation for practice**	
Social behaviour	Types of users	• To ensure the actual users of the HCG. If it is designed to be used by multiple types of users (i.e. visitors, staff, and patients), the HCG design and its facilities is recommended to be tailored to meet their expectations and preferences. • The main users of HCG in Malaysian public hospitals are mostly visitors, followed by staff and patients. It is recommended to enhance the HCG design to ensure it can support the need of the staff and patients so that they can also utilise the space and gain the benefits of the HCG like the other visitors.	AR LR AR LR HM
	Type of activities	• The physical design characters of the HCG (i.e. vegetation, shaded and unshaded areas, seating, pathway design) significantly influence the range of the activities in the HCG.	AR LR
	Level of occupancy	• To place the HCG near the main entrance and high traffic zone of the hospitals to increase the number of visitors to the HCG. • To enhance the use of HCG by providing easy access to and around the HCG, for example, wheelchair-	AR LR AR LR

		friendly pathway, unlocked doors, and multiple entrances.	
	Time spent	• To provide a comfortable microclimate and a variety of seating areas to increase the time spent in the HCG.	AR LR
Social well-being	Stress reduction	• To design the HCG to provide a substantial amount of greenery, pleasant view, a variety of seating facilities, and better microclimates to support the needs of the HCG users.	LAR AR HM
	Being away	• To provide an alternative place in the hospital such as the HCG to that the users can have a positive experience to support their needs. • To provide a facility such as HCG in the hospital where patients and family members can enjoy the peaceful environment and pleasant view besides distracting themselves from any worries and stress. • To provide a private area in the HCG for the staff to take a break from the long stressful working hours and spend some time outdoors. This would improve their working productivity and reduce possible burnout.	LAR HM LAR HM
	Movement and exercise	• To connect the main hospital circulation with the garden routes to enhance the walking loops. • To provide a walking path with a range of shapes, width, and routes to encourage people to walk around. • If the HCG is big enough, it is recommended to provide some outdoor gym equipment in the HCG to encourage people to be active rather than sedentary (i.e. sitting, laying down). • In a large HCG, it is recommended to provide a small playground or play equipment so that children in the HCG can have a small sensory play area to encourage them to explore.	LAR LAR LAR HM LAR HM

Social support	Sense of belonging	• To provide a seating area for the visitors to sit and have a conversation in small or large groups to support their needs to meet people or make new friends. • To provide various facilities in the HCG that can aid social support and interaction between patients and their families and friends in a more relaxed environment so that the patients are not isolated and can feel like they are part of the hospital community.	LAR HM
	Sense of privacy	• The design of seating and vegetation is recommended to be planned carefully so that the space in the HCG will not be too crowded and the privacy of the visitors will not be compromised. • To provide divisions in a large HCG so that various subareas can provide a sense of privacy. • To provide seating areas that are buffered by plantings to enhance the sense of privacy. • The seating area is recommended to be placed at the right angle so that it does not face the busy traffic or windows of the adjacent rooms. • To provide a semi-private space for staff to have restful breaks so that they can rejuvenate themselves from the stress of long working hours.	LAR LAR LAR LAR LAR
	Sense of Equality	• To provide easy access, smooth and even surface on all primary pathways for wheelchair users and other mobile users who use transporters, walkers, cots, or gurneys. • To provide a straight pathway and ramp to encourage patients to spend more time in the HCG to do physical training. • The height of raised planters is recommended to be kept at less than 600mm to allow wheelchair users to engage with the plants and flower beds as stipulated in the Malaysian Standard 1184 - Universal design and accessibility in the built environment (2014).	LAR LAR LAR

8.6 Summary

This chapter addressed the last research objective of this study to generate the HCG framework and make recommendations for policy and practice. It elaborated on the development of the framework from the initial to the final conceptual framework to provide a comprehensive guideline for an effective HCG framework that integrates both environmental and restorative roles.

Additionally, this chapter also presented each of the main components of the HCG framework, from the physical, environmental, social, and operational aspects. All the subcomponents in this HCG framework were discussed in this chapter, based on the findings from the current study and the best available research evidence and important theories related to the field of study. It also explained how this framework was developed based on the findings from multiple sources of data, including the survey interviews with the HCG users and non-users, on-site and participant observations, field measurement, and interviews with the architects and landscape architects. The significance of the HCG framework was also outlined in this chapter.

This chapter concluded with the study implications about the impact of the findings towards policy makers, practitioners, and society members. Several recommendations for the policy makers and practitioners based on the findings of this study were highlighted in this chapter. Based on the lessons learned from this POE study, these recommendations will be an indispensable resource for both the architects and the landscape architects. The recommendations will also be of great value for the hospital managers to improve the management policies related to the HCG design and planning.

CHAPTER 9:

Conclusion

9.1 Introduction

This chapter starts with restating the research problem and the rationale of the study. It then continues to present a summary of the research structure, including the research questions and study findings. In addition, this chapter also presents the contributions of this study based on the empirical findings that were used to establish a comprehensive HCG framework. Finally, this chapter ends with the limitations of the study and recommendations for future study.

9.2 A research structure linking to the research questions and study findings

This study investigated how different types of HCG in Malaysian public hospitals that were built after 1998 are currently performing, used and perceived by the intended users in relation to the environmental and restorative roles. Additionally, it explored how the HCG in Malaysian public hospitals can be improved before proposing a comprehensive HCG framework. The suggested framework would cover four important aspects, namely physical, environmental, social, and operational with the aim of achieving an optimal HCG design for Malaysian public hospitals. The thesis also outlined useful recommendations for the reference of practitioners and policy makers.

This research was a case study that adopted a mixed method approach to answer the main research question and the six sub-research questions. A cross-case analysis of both the quantitative and qualitative data was adopted to triangulate and confirm the diverse findings from this study. The following section provides an overview of the research structure linked to the findings of the main research question and sub research questions. Figure 8.9 illustrates how the key findings are linked to the research question and thesis structure.

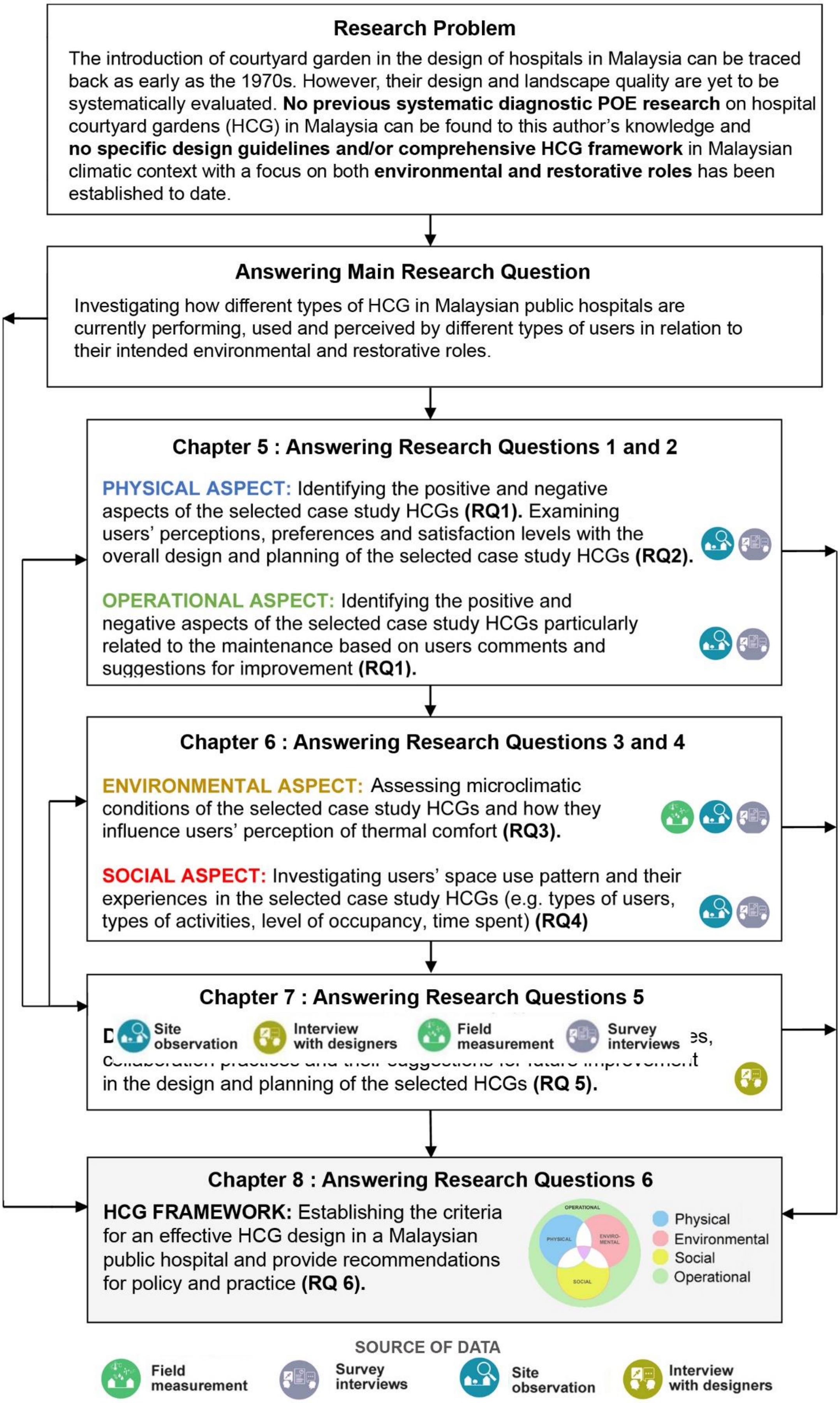


Figure 8.9: Structure linking to the research questions

9.2.1 Rationale of the study

As explained earlier in Sections 1.3 and 1.5, the key driver that motivated this study was the need to systematically evaluate the design and quality of HCG design in the Malaysian public hospitals based on the users' feedback. The aim was to establish a holistic framework for the HCG design in relation to their environmental and restorative roles. Since 1998, the integration of a courtyard garden in the planning of large or medium hospitals has become a common practice among the private consultants involved in hospital projects as part of the passive cooling strategy. This practice is still being implemented in new hospital projects in recent years (See Section 7.7.1). However, it remains unclear whether the HCG has fulfilled its functions to provide a comfortable environment and positive experience for the users, and also if it has been well-utilised by their intended users (i.e. patients, staff, and visitors).

Furthermore, very little systematic POE studies that focused specifically on the HCG design in Malaysian context have been conducted. Most of the POE studies in the Malaysian government hospitals focused on technical issues related to the inpatient and outpatient facilities, such as wards, clinics, and laboratories (Mastor and Ibrahim, 2010). Although there are numerous studies about the users' evaluation of outdoor gardens in healthcare facilities carried out in Western countries (Jiang et al., 2018; Sachs, 2017; Reeve et al., 2017; Butterfield, 2014; Pasha, 2013; Shukor, 2012; Davis, 2011; Naderi and Shin, 2008; Sherman et al., 2005; Whitehouse et al., 2001; Cooper Marcus and Barnes, 1995), none of these studies focused explicitly on the comparative diagnosis between the different physical characteristics of HCG (e.g. vegetations, courtyard aspect ratio, orientation, and wall conditions). These studies also did not perform any field measurement of the microclimates in the HCG to assess the users' perceptions of the outdoor thermal comfort in the HCG.

Additionally, very few studies on the assessment of the quality of outdoor gardens in Malaysia (Adnan, 2016; Ibrahim and Jer, 2014; Said et al., 2005). Similar to the case studies in the Western countries, these Malaysian studies also did not focus on the courtyard garden even though it is one of the most common design practices in Malaysia used to avoid a deep-plan building in most of the large hospitals. To the best of the researcher's knowledge, no comprehensive guidelines that covers the physical, environmental, social, and operational aspects of the HCG design have been established to date. Therefore, a diagnostic POE study of the different HCG designs in the Malaysian public hospitals would be a vital groundwork to generate a comprehensive HCG framework for the Malaysian public hospitals.

9.2.2 Research questions and a summary of research findings

This subsection presents the main research and sub-research questions, followed by a summary of the research findings.

Main research question:

How are different types of a representative HCG in a Malaysian public hospitals that were built after 1998 currently performing, used and perceived by the intended users in relation to their environmental and restorative functions.

Sub research questions:

1. What are the positive and negative aspects of the current conditions in the selected HCGs based on users' perspectives?
2. What are the users' perceptions, preferences, and satisfaction levels with the overall design and planning of the selected HCGs?
3. What is the microclimatic conditions in the HCGs and how does it influence the users' perceptions of thermal comfort?
4. What are the users' space use patterns and experiences in the selected HCGs?
5. What are the intentions, challenges, and suggestions from the architects and landscape architects for the future improvement of the design and planning of the HCGs?
6. What are the criteria for an effective HCG design in a Malaysian public hospital and what are the policy and practice recommendations?

9.2.2.1 Answering the main research question

This study investigated the performances of the three different HCG and their respective space use pattern by different types of users, including patients, staff, and visitors. It also found that the large central type and rectangular-shaped HCG (H1-C1) represented a good consideration of the spatial organisation and also received the highest level of users' satisfaction compared to H3-C2 (a clustered type and square-shaped HCG) and H2-C3 (an interlinked type and quadrilateral-shaped HCG) (See Section 5.3.6). H1-C1 also recorded the highest level of daily occupancy for both the weekday and weekend (Refer to Section 6.4.1). H1-C1 also recorded the highest level of daily occupancy on both weekdays and weekends. Moreover, this study reported that H1-C1 demonstrated a good combination of the hardscape and softscape with a ratio of 70:30. It also had a better courtyard configuration, aspect ratio, and orientation, leading to a higher level of thermal comfort among the users and a higher restorative score, compared to H2-C3 and H3-C2 (See Sections 6.2.2.1 and 6.5.3.2).

It is important to note that this study did not conclude that all future hospitals oughtt to follow the design of a large central type and rectangular-shaped HCG like H1-C1. The design and planning in the Malaysian hospitals will evolve. The shape and typology of the hospitals also depend on the functional purposes of the hospitals and the requirements of the hospital providers. This study aimed to identify the key design criteria required to establish a HCG which is both effective and user-friendly that can be applied and adopted to the courtyard of different layouts or geometries. Additionally, the study findings were used to integrate both environmental and restorative qualities in the framework that are useful for research in a similar field. The comprehensive HCG framework that was established as part of the research objectives would serve as valuable tool for the hospital managers, hospital providers, architects, and landscape architects in improving the experience of the HCG users (As discussed earlier in Chapter 8).

9.2.2.2 Answering the sub-research questions

The following section presents a summary of findings that answered all the six sub-research questions.

- **Research question (RQ) 1:** Firstly, based on the findings from the open-ended survey on the positive and negative aspects of the current HCG conditions, the majority of the users expressed their positive appreciation towards the greenery and pleasant view in the HCG. However, they also highlighted the need for substantial seating areas that are in good condition (Section 5.5.1). Regarding the negative comments, most of the complaints were concerning the upkeep, maintenance, and safety issues in the HCG (Section 5.5.1). This highlighted the importance of the physical design and operational aspects of HCG and how these two aspects need to be critically considered by the hospital managers in the retrofitting of the existing facilities to improve the experience of the HCG users.

- **RQ 2:** The findings from the user's perception survey confirmed that the majority of the users perceived the landscape elements as important to them, with the highest to lowest of importance ranking for green plants, flowering shrubs, pedestrian walkway, grass, seating area, and lastly water features (Sections 5.4.1 and 5.5.3.1). Additionally, a higher percentage of respondents indicated their preferences for views with an abundance of greenery and a good combination of hardscape and softscape features (Section 5.5.3.2). Moreover, the Chi-square testing revealed that the landscape elements and the wall conditions were the two most significant factors that influenced the users' satisfaction with the overall planning and performance of the HCG (Section

5.5.2.1). Although there were many positive responses related to the greenery and pleasant views in the HCG, the problems related to the maintenance of HCG remained a significant determinant of the users' satisfaction with the overall planning and performance of the HCG (Section 5.5.1).

- **RQ 3:** Based on the results of the daily environmental data collected at 9 am and 5 pm in the three HCG sites, the air temperature in the HCGs was found to be lower than the air temperature outside the hospital areas (Section 6.2.1.4). This suggested that HCG played an important role as a passive design strategy to facilitate a cooler environment in the hospital building. The finding was concurred by 93.3% of the total HCG users in all the three sites reported that they perceived the thermal comfort as acceptable to them (Section 6.2.2.1). Moreover, according to the environmental data, on-site observation, and survey interview with the users, the different courtyard configurations (i.e. orientation and aspect ratio) and landscape characters (i.e. amount of vegetations and tree canopies) significantly influenced the HCG microclimatic conditions and their sensation responses (e.g. TSV, HSV and WSV) (Section 6.2.7). The findings suggested that a high degree of exposure to solar radiation due to a lack of shading and tree canopies in the HCG contributed to increased air temperature in the HCG, eventually affecting the TSV.

- **RQ 4:** Further evaluation of the users' space use pattern based on the direct and video-based observation revealed that the visitors, followed by the staff and patients spent the most time in the HCG. Furthermore, it was found that the level of occupancy in H1-C1 and H2-C3 was higher during weekdays while it was higher during weekends for H3-C2 (Section 6.4.1). The most frequently performed activities recorded in all the three sites were sitting and walking (Section 6.4.5). This study suggested that the physical design, microclimatic conditions, and hospital operations hours were among the factors that influenced space use patterns in the HCG (Section 6.4.6). Additionally, **more than 70% of the users perceived a positive mood change when they were spending time in the HCG.** Moreover, they also expressed their desire of being in a natural environment to relax and rest, refresh their mind, and stay away temporarily from the hospital's indoor areas (Sections 6.5.1 and 6.5.2).Based on the users' experiences survey, the H1-C1 had the highest PRS (90.6%), followed by H2-C3 (73%) and H3-C2 (71%) (Section 6.5.3).

- **RQ 5:** Interviews with the architects and landscape architects provided a general conclusion about their intentions and practices in the design and planning of the HCG.

For the architects, the HCG was incorporated in the hospital planning to avoid deep-plan building and to provide daylighting and ventilation into the building. Besides that, they also mentioned that it would allow access to nature besides acting as a point of orientation for the hospital users (Sections 7.4.1 and 7.7.1). On the other hand, the landscape architects mentioned that they intended to create a natural forest-like environment in the HCG (Sections 7.4.2 and 7.7.2). Moreover, they also highlighted their intentions to provide a place for social interaction that could contribute to stress reduction. Additionally, the architects and landscape architects highlighted the challenges they faced such as site and time constraints, project brief requirement, financial budget, and collaborative practice with the stakeholders and end users (Sections 7.74 and 7.7.5). They also put forth several suggestions to overcome the challenges that mainly focused on the physical design and operational aspects (Sections 7.6 and 7.7.3).

- **RQ 6:** One of the contributions of this study was the generation of a comprehensive HCG framework. It comprised four important aspects towards achieving an effective HCG design, including the physical, environmental, social, and operational aspects. Based on the findings, six physical design aspects, three environmental aspects, three social aspects and three operational aspects were formulated as the subcomponents of the framework. The framework will be a valuable guideline for the designers because it provides several key criteria in the design and planning of the HCG to achieve an optimum level of users' experiences and satisfaction levels. The HCG framework also includes various recommendations from the operational aspects to aid the hospital managers and hospital providers in the maintenance and decision-making regarding HCG. The details of each subcomponent and how the findings of the current study could be related to the existing theory and literature review were discussed in Section 8.2.

9.3 Contribution of the research

HCG design and implementation has been common practice in the hospital planning of Malaysian public hospitals since the 1970s. However, no systematic evaluation has been conducted to assess the quality of the HCG designs or to determine if they managed to achieve their intended environmental and restorative roles. To the best of the authors' knowledge, to date no comprehensive HCG framework has been specifically formulated for the local Malaysian context. This study is highly significant in view of the contributions from the study findings towards this subject area of interest. The list of original contributions of this thesis to the body of knowledge are set out below:

9.3.1 Establishment of the HCG framework

The main contribution of this thesis to knowledge is **the generation of a holistic and comprehensive HCG framework** based on the research findings. The significance of the HCG framework which is also the thesis contribution to the knowledge are listed below:

i. **The HCG framework is developed based on the lessons learnt from the evaluation study in the selected HCG study sites** and references from the **literature review** of the related fields of study. This framework is established based on the users' feedback which covers the physical, environmental, social, and operational aspects of the HCG.

ii. **The framework provides the basic principles of effective HCG design that integrates both environmental and restorative roles.** All the interrelated aspects including physical, environmental, social. and operational aspects are reflected in the HCG framework. This is aligned with the initial goal to provide a guideline for an effective HCG design that can meet the intended environmental functions (i.e. comfortable microclimates) and restorative functions (i.e. reduction of stress and mental fatigue).

iii. **The use of multiple sources of evidence to establish this framework enhanced its validity.** The different types of methods used including surveys with both users and non-users, direct and video observation, mapping of users' activities, field measurement of the microclimatic conditions, and interviews with the architects and landscape architects provide robust and comprehensive evidence towards the establishment of the HCG framework.

iv. **Some part of this framework can be scaled and transferred to other building typologies.** A scalable framework means that some of the related components or the subcomponents in the HCG framework can be adapted and adopted to suit the functional needs of the building typology or the types of outdoor garden, be it a rooftop garden, front garden, or open concept garden. Some part of this framework can also be transferable. In other words, it is not only limited to the use of Malaysian public hospitals. Some components in the framework are useful in designing the courtyards of other buildings typologies, whether residential, institutional, or commercial. Moreover, a similar framework can be modified to suit the climatic context of other regions.

9.3.2 Methodological enhancement

This thesis also makes a contribution via the methodological enhancements adopted through the employment of different methods in data collection which are found to be effective in aiding the data collection process. The triangulation of multiple methods provides a more in-depth understanding on the phenomenon under study. Several enhancements on the research methods of the current study are presented below:

i. The utilisation of a multiple method approach including survey interviews with users and non-users, participant observation, field measurement and interviews with the designers provide a comprehensive set of data and enhance the validity of the findings. As a result, this study offers new knowledge on the current performance of different types of HCGs in Malaysian public hospitals in terms of how the staff, patients and visitors used and perceived the HCG in relation to their intended restorative and environmental roles (See Section 3.2.1).

ii. Based on a combination of video-based and direct observation techniques in the long-hours daily observation, this study provides more comprehensive and robust findings on how these HCGs were being used by patients, staff, and visitors. Moreover, the study reveals a new finding regarding the actual users of the HCG study sites based on the extensive on-site observation and survey interviews with the actual HCG users at the three selected sites (See Section 3.4.6.2).

iii. Provided a new method of data visualisation of different types of users' activities in the HCG by mapping the location of each activity on the floor plan using GIS. The utilisation of GIS allows the management and analysis of different layers of data related to each users' characteristics (e.g. age, gender, type of users and type of activities) gathered from the on-site observation. The integration of on-site mapping techniques and GIS mapping techniques can be replicated by future researchers in the same field (See Section 3.6.3).

9.4 Limitation of the research

There are three main limitations to this research, namely:

i) sample recruitment;
ii) methodological techniques; and
iii) research instrumentation.

9.4.1 Limitation in the sample recruitment

9.4.1.1 Users' survey interview

This study acknowledged that only a small sample of the HCG users from all the study sites were involved in the survey interview (H1-C1: N=46, H2-C3: N=36, and H3-C3: N=38). Most of the surveyed users were the visitors, followed by hospital staff and patients. It is important to note that the variation of this sample size was based on the general population of the users who utilised the HCG space as recorded during the on-site field observation. A shorter time was needed to randomly recruit the participants in H1-C1 compared to H2-C3 and H3-C2 because H1-C1 had a higher frequency of usage during the day. However, if there were no time and budget constraints, it would be more fruitful to recruit an equal sample of visitors, staff, and patients as the representative sample in each study site. This would ensure more diverse feedbacks from different groups so that the results could be generalised to further explain the needs and preferences of each group.

Additionally, the survey interview was only confined to those who sat down and spent time in the HCG. Due to the practicality issue, the survey did not include the people who were just passing through the HCG, those who were standing and viewing from the corridor or the top of the bridge. Moreover, those who were in distressed or difficult situations were also excluded from the survey.

9.4.1.2 Interview with the designers

Another limitation of this study was the absence of an interview with the landscape architect from the H3 hospital. This was because of a lack of information from the stakeholders about the landscape architect who was involved in the HCG design, thus restricting the researcher in approaching the landscape architect for the interview. Nevertheless, this did not refrain the researcher from fully understanding the design intentions, collaborative practice, and challenges involved in HCG planning.

9.4.2 Limitation in the methodological approaches and data analysis

9.4.2.1 Limitation in the video-based observation methods and analysis

A video-based observation was employed in this study to provide a more robust data. Compared to the conventional direct observation method, a video-based observation was able to record multiple activities that occurred over a similar period to minimise any unrecorded activities. However, there were several drawbacks to the video-based observation method in the current study. Firstly, there was only a limited number of available video cameras (two units). Furthermore, the limited coverage area of the camera lenses meant that some of the interactions between the HCG users of their activities could not be fully captured, especially in a large HCG such as H1-C1. Certain characteristics of the site, including the trees, sculpture, and column bridge became barriers that hindered the video camera from capturing the activities that took place behind them. Therefore, to ensure that this study was able to capture a complete set of observation data, direct observation was also carried out simultaneously to capture and map the activities that happened behind the coverage of the video camera.

Another limitation of the video-based observation was the overwhelming and time-consuming analysis of the extensive video data. Although the video records of this study lasted for both two weekdays and two weekends, only 16 hours of total observations on a weekday and a weekend were analysed in each case study site due to the time constraint and complexity of the research. Furthermore, some of the videos taken during the long hours of rain were not analysed in the study because the heavy rain affected the normal pattern of the recorded activities.

9.4.2.2 Limitation in the GIS mapping analysis

Due to the time constraint in conducting a full analysis for all the video data, the GIS mapping on the different groups of age and gender was not carried out in this study. However, the GIS software was used for data visualisation to achieve the study objectives of examining the space use pattern and mapping the different types of users and activities based on the floor plans of the study sites.

9.4.3 Limitation in the research instrumentation

9.4.3.1 Limitation in the field measurement

With regard to the assessment of the outdoor thermal comfort, only measurement of air temperature, air velocity, and air relative humidity were taken due to the restriction of available equipment. In view of this, future research could measure the solar radiation level in the different HCG sites to explore the influence of solar radiation on users' perceptions of thermal comfort. Moreover, it would be worthwhile if future study could also measure the amount of glare and daylighting quality in the HCG to investigate the impact on visual comfort. If budget and time is not a constraint, the measurement and analysis of sky view factors is highly recommended for a comprehensive analysis of thermal comfort.

9.4.3.2 Limitation in the survey questions

In addition, the survey questions about their perception on daylighting has led to another important question regarding users' perceptions about glare in the HCG. Thus, it would also be worthwhile to include a question asking how they perceived visual comfort in the HCG (related to the perception of glare). Another limitation to this study is the reliability of the self-reported questionnaire. For example, the survey questions related to the users' experiences, for example, whether they were feeling more relaxed or less stressed, could be biased when the responses were self-reported. Hence, future research can be strengthened by integrating psychological measurement indices such as the level of the stress hormone, heart rate, blood pressure, and salivary cortisol to assess the effects of spending time in the HCG (Ulrich et al., 2019; 2018; 1989).

9.5 Recommendation for future research

This research identified several potential areas that can be considered in future research as described below:

9.5.1 Development of HCG evaluation tool based on the HCG framework

Future research can explore how this HCG framework can be used to develop a comprehensive evaluation toolkit for the HCG in Malaysian hospitals. It can be adapted and improvised to generate an evaluation tool that is applicable to other types of outdoor gardens (i.e. rooftop, entry garden, and terrace gardens) in public or private healthcare facilities, or in a different climatic region.

9.5.2 Simulation model study

Future research can consider a simulation model study based on the current fieldwork data to reinforce the study findings. Different parameters in the various courtyard designs (e.g. vegetation, aspect ratio, orientation) could be assessed in the simulation study to determine their influences on the microclimatic conditions of the HCG. The results of the simulation study will strengthen the current findings and provide simulation-based evidence to generate specific design strategies and recommendations for different HCG typologies, either rectangular, quadrilateral, or square-shaped.

9.5.3 Enhancement of data collection with technological devices

If there are available sources of funding and an unlimited time frame, different approaches could be taken to enhance the on-site observation of users' activities in the HCG. Firstly, the use of a video-based human tracking application could be considered to enhance the efficiency of the real-time on-site observation data collection and significantly reduce the duration for video analysis. This application can recognise the single-person activity, multiple people interaction, the crowd behaviour, and the abnormal activity (Ke et al., 2013; Blasch et al., 2013; Nanaware et al., 2018).

Secondly, a GIS mapping device is a useful tool to support the behavioural mapping of on-site users' activities (Chen et al., 2016; Marušić, 2011). However, it will be more beneficial if future research can develop a device that can support the on-site mapping data collection. For instance, the data of the users' activities, age, gender, duration, and movement can be recorded directly into the devices, thus facilitating the data analysis process.

Thirdly, an eye-tracking device would be beneficial in future research to assess the users' preferences of images in the HCG. This device can scan the user's observation pattern and identify the design features or objects in the HCG that are most attractive to them (Dupont et al., 2014). The results from the tracking device can be used to corroborate with the self-reported responses given by the participants to establish a more valid association pattern.

Finally, a mobile device can be used to conduct the survey interview with the respondents. This method is more efficient and less costly than the paper-based survey. The integration of 3D landscape visualisation can also enhance users' engagement and participation in the face-to-face interview survey (Bilge et al., 2015). Nevertheless, the practicality of incorporating these technological aids needs to be tested to ensure that they are compliant with the ethical protocol of conducting research involving human participants, particularly in a healthcare facility.

9.6 Dissemination and publication

9.6.1 Workshops and conferences

The sharing of the study findings with key policy-makers (MOH and PWD) and practitioners (e.g. architects, landscape architects, and hospital managers) through workshops, forums, or conferences is planned to take place in the near future. The intention is to provide stakeholders with the up-to-date relevant findings to facilitate improvements in current design practice. This will also inculcate awareness concerning the importance of outdoor gardens in healthcare facilities among the stakeholders. They would also be kept updated on the best available research evidence on the benefits of interaction with nature in a healthcare facility.

9.6.2 Publication of papers

This thesis would not end up here. Following the completion of this thesis, it will be published into several papers in well-established peer-reviewed journals such as Health Environments Research and Design (HERD) and Building and Environment. Two papers will be published from Chapter 5 and Chapter 6, respectively. Another paper will be published derived from Chapter 7. These papers will be disseminated to the respective policy-makers, practitioners and other researchers in the related fields of study. The dissemination of information related to the recommendations (with a focus on policy and practice) will have a significant impact on future HCG design and users' experiences. This is also in response to the designers' expectations to learn from the findings of the current study (See Section 7.6).

9.7 Summary

This final chapter presented the achievement of this research in answering the main research questions and sub-research questions. It also illustrated how these questions were linked to the study findings and the thesis structure. It concluded the key contributions of the thesis to the knowledge of the topic of interest and recommendation for future research. In short, the study succeeded in investigating the performances of the different types of HCG in Malaysian public hospitals. It also successfully identified several key design criteria required to create an effective and user-friendly HCG that integrates all the environmental and restorative qualities derived from this research.

This research also examined the positive and negative aspects of the three HCG sites, the users' perceptions of the landscape elements, their preferences of the HCG images and satisfaction levels with the planning and performance of the HCG. This research also evaluated the microclimatic conditions of the HCG, the users' perceptions on outdoor thermal comfort and environmental design, the space use pattern, and their experiences in the HCG. Furthermore, this research also investigated the views of the architects and landscape architects on the design and planning of the HCG, including the design development process, their collaboration practice, design intentions, challenges, and suggestions for HCG improvement.

Based on all the study findings from multiple sources of data, including survey interviews with the HCG users and non-users, field measurement, participant observation, and interviews with the designers, this research successfully generated an HCG framework to provide useful recommendations for the policy makers and practitioners. It is hoped that the architects and landscape architects can work together with the policy makers, medical planners, and hospital managers to transform the study outcomes into practice. A well-designed HCG that integrates both the environmental and restorative roles will be able to improve the users' experiences in the hospital. As Winston Churchill once said: *'We shape our buildings and afterward our buildings shape us'.*

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LIST OF PUBLICATION AND PAPER PRESENTED

Peer-reviewed proceeding paper:

Idris, M.M., Sibley, M. and Hadjri, K. (2018) Investigating Space Use Patterns in a Malaysian Hospital Courtyard Garden: Lessons from real-time observation of patients, staff and visitors. *Environment-Behaviour Proceedings Journal,* 3(8), pp.32-45.
(2nd runner up best paper award)

Idris, M.M., Sibley, M. and Hadjri, K. (2018) Users' perceptions, experiences and level of satisfaction with the quality of a courtyard garden in a Malaysian public hospital. *Environment-Behaviour Proceedings Journal,* 3(9), pp.63-73.
(1st runner up best paper award)

Peer-reviewed journal:

Idris, M.M. and Sibley, M. (2019) What are users' perceptions of the hospital courtyard garden and how satisfied are they with it? *Asian Journal of Environment-Behaviour* Studies, 4, pp.60-75.

APPENDICES

LIST OF APPENDICES

APPENDIX 1: Survey with the HCG users

H1	Location: _________	T:________RH:________	Date: ____ ____ 2018	Time: ________ am/pm

Study on the Quality of Courtyard Garden in the Malaysian hospital: *Perceptions, Experience and Level of Satisfaction*

The purpose of this survey is to collect data for my PhD research project at the School of Architecture, The University of Sheffield on the project entitled: ***'Post Occupancy Evaluation of Courtyard Design in Malaysian: Evaluating their Environmental and Restorative roles'.*** *In this study, we are interested to know your experience in this courtyard garden and how it affects you. It is important that you answer based on how you personally perceived this place.*

The questionnaire will take approximately 5-10 minutes to answer. This research has been reviewed and approved by the Malaysian Medical Research Ethics Committees (MREC) and School of Architecture (SOA) Research ethics committees, The University of Sheffield. This research also has been granted a permission to conduct a study from the director of the selected case study hospitals.

Before you start, please read the participant information carefully and signed the consent form at the end of this survey. If you have any question at any point please feel free to ask.
Thank you very much for your time and effort in answering this questionnaire.

SECTION 1: Demographic

1. Please indicate who you are.
(Mark only one bullet)

- ○ A patient
- ○ A staff
- ○ A visitor
- ○ Other, please specify: ___________________

2. Which race best describes you?
(Mark only one bullet)

- ○ Malay
- ○ Chinese
- ○ Indian
- ○ Other, please specify: ___________________

3. What is your age?
(Mark only one bullet)

- ○ 18 to 24
- ○ 25 to 34
- ○ 35 to 44
- ○ 45 to 54
- ○ 55 to 64
- ○ 65 to 74
- ○ ≥ 75

4. What is your gender?
(Mark only one bullet)

- ○ Female
- ○ Male
- ○ Other, please specify: _____________

5. Please mark which clothing is best to describe what you are wearing right NOW?
(Mark only one bullet that is closely similar to your clothing)

Female clothing	**Male clothing**
	

1

SECTION 2: Perceptions of courtyard settings.

The images below show the view of the courtyard garden in the H1-Hospital:

SITE PLAN H1-Hospital

LOCATION: LEVEL 2 - Adjacent to Clinical Research centre, Imaging Department and Accident & Emergency Department.

LOCATION-LEVEL 2 - Adjacent to cafetaria , Visitors common area and Specialist clinics.

6. Please explain what do you like about this courtyard garden?

____

____

____

7. Please explain what you do not like about this courtyard garden?

____

____

____

8. How do you feel with the environment (air temperature) around you at this moment?
(Mark only one bullet)

- ❍ Cold *(You feel much too cold)*
- ❍ Cool *(You feel too cold)*
- ❍ Slightly cool *(You feel comfortably cold)*
- ❍ Neutral *(You feel comfortable. Not too cold. Not too hot)*
- ❍ Slightly warm *(You feel comfortably warm)*
- ❍ Warm *(You feel too warm)*
- ❍ Hot *(You feel much too hot)*

9. **Based on your answer at no.8, how would you prefer to be?**
(Mark only one bullet)
- ❍ Cooler
- ❍ No change
- ❍ Warmer

10. **How do you feel of the *wind* at this moment?**
(Mark only one bullet)
- ❍ Stale
- ❍ Little wind
- ❍ OK *(you feel comfortable with the wind at this moment)*
- ❍ Windy
- ❍ Too much wind

11. **How do you feel of the humidity at this moment?**
(Mark only one bullet)
- ❍ Very damp
- ❍ Damp
- ❍ OK *(you feel comfortable with the humidity at this moment)*
- ❍ Dry
- ❍ Very dry

12. **On a scale from 1 (not important) to 5 (very important), please rate which landscape elements in this hospital courtyard garden are most important to you.**
(Mark only one bullet per row)

	Not important	Off little important	Moderately important	Important	Very important
Water features	○	○	○	○	○
Green Plants	○	○	○	○	○
Flowering shrubs	○	○	○	○	○
Seating area	○	○	○	○	○
Walkway	○	○	○	○	○
Grass	○	○	○	○	○

13. **On a scale from 1 (not important) to 5 (very important), please rate which environmental aspects of this hospital courtyard garden are most important to you.**
(Mark only one bullet per row)

	Not important	Off little important	Moderately important	Important	Very important
A shaded area in the courtyard space	○	○	○	○	○
A daylighting in the courtyard area	○	○	○	○	○
A daylighting into the adjacent spaces	○	○	○	○	○
A breeze and fresh air in the courtyard	○	○	○	○	○
A comfortable temperature in the courtyard garden	○	○	○	○	○

14. Based on the images below, please indicate which courtyard garden you like the most?
(Mark only one bullet)

- ❍ Image A
- ❍ Image B
- ❍ Image C

Please explain why you choose the image above.

15. Based on the images below, please indicate which courtyard garden you like the most?
(You may tick up to three (3) images from (6) six images above)

- ❍ Image 1
- ❍ Image 2
- ❍ Image 3
- ❍ Image 4
- ❍ Image 5
- ❍ Image 6

Based on your answers in question 15, please explain why you choose each of those images.

SECTION 3: Users' Activities and experiences in the courtyard.

16. How often do you come to this courtyard?
(Mark only one bullet)

- ❍ My first time
- ❍ Sometimes
- ❍ Once or twice a week
- ❍ Almost everyday
- ❍ Frequently use
- ❍ Other: ________________________________

17. What do you generally do in this courtyard?
(Tick all that apply)

- ❍ Sit and wait (For example: waiting for visiting hours and appointment time at clinic, etc.)
- ❍ Sit and relax
- ❍ Sit and talk with a friend(s), colleague(s)
- ❍ Walk through on my way to another building (For example: Cafeteria, clinic, other department, etc.)
- ❍ Walk around to enjoy the view
- ❍ Meeting and have a discussion with friends
- ❍ Let my children to run and play in the courtyard garden
- ❍ Eat and/or drink
- ❍ To do some outdoor therapy
- ❍ To do a physical exercise
- ❍ Read and/or write
- ❍ Other, please specify: ____

18. When you come out here, how long do you generally stay?
(Mark only one bullet)

- ❍ Just a few minutes
- ❍ 5 -10 minutes
- ❍ 10-30 minutes
- ❍ More than 30 minutes

19. What encourage you to visit this courtyard garden?
(Tick all that apply)

- ❍ I want to enjoy the garden
- ❍ I want to relax and rest
- ❍ I want to get away from my everyday routine
- ❍ I want to help to cope with my worries
- ❍ I want to refresh my mind
- ❍ I want to refuge from the things that distract me
- ❍ I want to contemplate and find some privacy
- ❍ I want to do some physical exercise
- ❍ I want to enjoy the outdoor therapy
- ❍ I want to socialize and meet people
- ❍ Other, please specify: ____

20. On a scale from 1 (Strongly Disagree) to 5 (Strongly Agree), please rate how do you feel when come and walk around in this courtyard garden.
(Mark only one bullet per row)

	Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree
I feel more relaxed and less stressed	○	○	○	○	○
I feel more refresh and rejuvenated	○	○	○	○	○
I feel pleased, positive and better	○	○	○	○	○
I feel more calm, able to think positively	○	○	○	○	○
I feel more connected in religious or spiritual way.	○	○	○	○	○
I feel comfortable when sitting or walk around this courtyard garden.	○	○	○	○	○
I feel safe when sitting or walk around this courtyard garden.	○	○	○	○	○
I don't feel any difference in mood	○	○	○	○	○

SECTION 4: User' Satisfaction with the quality of courtyard design.

21. On a scale from 1 (Very Dissatisfied) to 5 (Very Satisfied), please rate which design aspects of the hospital courtyard garden (HCG) is satisfying to you.
(Mark only one bullet per row)

	Very dissatisfied	Dissatisfied	Slightly satisfied	Satisfied	Very satisfied
Access from the main entrance to the hospital courtyard garden	○	○	○	○	○
Access to the hospital courtyard garden for wheelchair users	○	○	○	○	○
Access to different departments via the hospital courtyard garden	○	○	○	○	○
Number of the hospital courtyard garden entrances	○	○	○	○	○
The visibility of the hospital courtyard garden from the adjacent spaces	○	○	○	○	○
The location of the hospital courtyard garden close to the cafeteria	○	○	○	○	○
Wayfinding to the hospital courtyard garden	○	○	○	○	○
The wall condition around the hospital courtyard garden	○	○	○	○	○
The overall planning of the hospital courtyard garden	○	○	○	○	○

22. How would you rate the overall quality of this courtyard garden?
(Mark only one bullet)

- ❍ Excellent
- ❍ Very good
- ❍ Good
- ❍ Fair
- ❍ Poor

23. Is there anything that you would like to see changed or added in this courtyard garden?

____

____

____

____

End of question.

APPENDIX 2: Survey with the Non-users

H1- (HSI)	Location: ___________________	Date: ____ ____ 2018	TIme: ________ am/pm

Study on the Quality of Courtyard Garden in the Malaysian hospital: *Constraints and barrier of the courtyard visitation.*

The purpose of this survey is to collect data for my PhD research project at the School of Architecture, The University of Sheffield on the project entitled: 'Post Occupancy Evaluation of Courtyard Design in Malaysian: Evaluating their Environmental and Restorative roles'. In this study, we are interested to know if there is any constrains or barrier to use or visit the courtyard garden. It is important that you answer based on how you personally think about the courtyard garden in this hospital.

The questionnaire will take approximately 5-10 minutes to answer. This research has been reviewed and approved by the Malaysian Medical Research Ethics Committees (MREC) and School of Architecture (SOA) Research ethics committees, The University of Sheffield. This research also has been granted a permission to conduct a study from the director of H1-hospital.

Before you start, please read the participant information carefully and signed the consent form at the end of this survey. If you have any question at any point please feel free to ask.
Thank you very much for your time and effort in answering this questionnaire.

SECTION 1: Demographic

1. Please indicate who you are.
(Mark only one oval)

- ○ A patient
- ○ A staff
- ○ A visitor
- ○ Other, please specify: ___________________

2. Which race best describes you?
(Mark only one oval)

- ○ Malay
- ○ Chinese
- ○ Indian
- ○ Other, please specify: ___________________

3. What is your age?
(Mark only one oval)

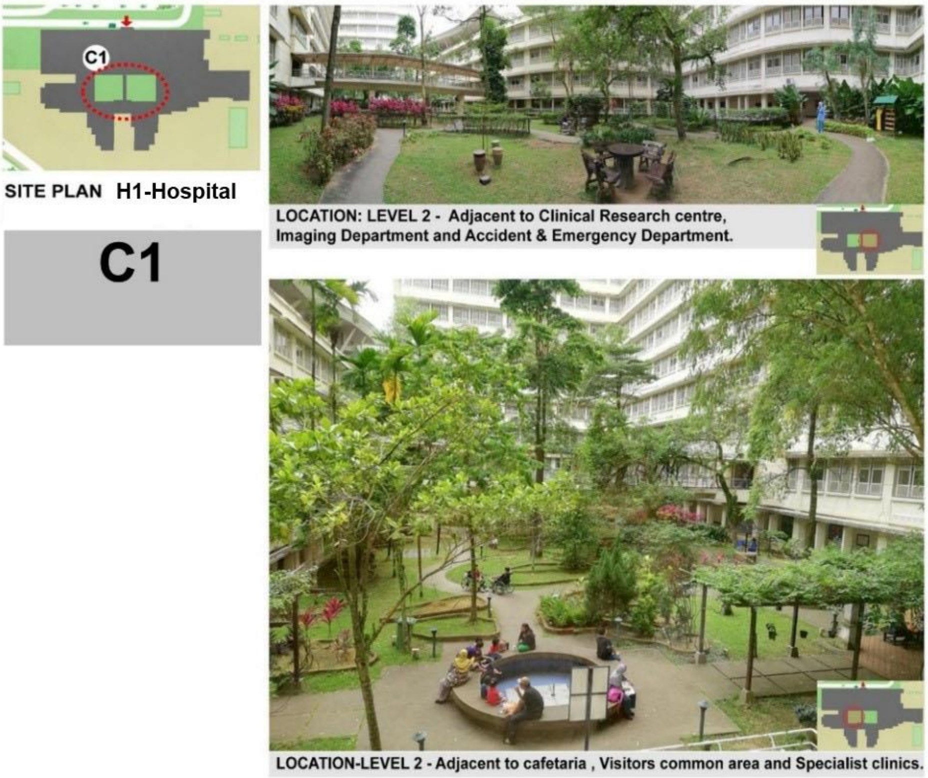
- ○ 18 to 24
- ○ 25 to 34
- ○ 35 to 44
- ○ 45 to 54
- ○ 55 to 64
- ○ 65 to 74
- ○ ≥ 75

4. What is your gender?
(Mark only one oval)

- ○ Female
- ○ Male
- ○ Other, please specify: ___________________

SECTION 2: Constraint and Barrier of courtyard visitation.

Those images below indicated several views of courtyard garden located at level 2 of H1-Hospital which labelled as **C1.**



Those images below indicated several views of courtyard garden located at level 3 of H1-Hospital which labelled as **C2.**

5. **Do you know about the courtyard gardens in this hospital?**
*(Please **answers in both tables** below either I know about the courtyard and/or I don't know about the courtyard)*

> ***Example:*** *Please circle which courtyard do you know and have seen it?*
> (**C1 / C2**)

❍ **I know about this courtyard.**	❍ **I don't know about this courtyard.**
Please ***circle*** which courtyard do you know and have seen it? (**C1 / C2)** Please explain what do you know about this courtyard? __________ __________ __________ __________ __________	Please ***circle*** which courtyard you do not know and have never seen it? (**C1 / C2)** Please explain why you don't know about this courtyard? __________ __________ __________ __________ __________

6. **Have you been to these hospital courtyard gardens before?**
*(Please **answers in both tables** below either I have been to this courtyard and/or I have never been to this courtyard)*

❍ **I have been to these courtyards before.**	❍ **I have never been to this courtyard before**
Please explain how many times you have visited the courtyard before? __________ __________ __________ Please explain what activities you usually do while you visit this courtyard before? __________ __________ __________ __________ __________ __________	Please explain why you do not visit the courtyard? __________ __________ __________ __________ __________ __________ __________ __________ __________ __________

7. **Referring to the courtyard that you mentioned in question 5 and 6. Explain why you do not use and/or visit the courtyard gardens in this hospital?**

You may tick more than 1 oval

- ❍ Do not know the location of the courtyard garden.
- ❍ Difficulty to access the courtyard (i.e: The door is locked)
- ❍ Worries if the security guard does not give access to walk around in the courtyard area.
- ❍ Too busy with our work.
- ❍ There is no signage to guide my direction to the courtyard.
- ❍ Difficulty to access the courtyard for disable people (i.e. no ramp)
- ❍ Do not feel secure to spend time in the courtyard garden
- ❍ The courtyard garden is too secluded
- ❍ I do not like the layout of the courtyard design.
- ❍ No interesting landscape elements. (e.g. water features, trees, flowering shrubs)
- ❍ Poor shade in the courtyard garden
- ❍ The weather outside is too hot
- ❍ Not enough breeze in the courtyard area.
- ❍ Uncomfortable sitting area (e.g. lack of sitting area, dirty benches)
- ❍ The courtyard garden is not important for me

8. **How would you rate the overall quality of this courtyard garden?**

Mark only one bullet.

- ❍ Excellent
- ❍ Very good
- ❍ Good
- ❍ Fair
- ❍ Poor
- ❍ I don't know because I don't use and/or visit this courtyard.

9. **Is there anything that you would like to see changed or added in this courtyard garden?**

____

____

____

____

End of question.

APPENDIX 3: Question for a semi-structured interview with the architect and landscape architect

QUESTION FOR SEMI-STRUCTURED INTERVIEW WITH THE ARCHITECT

Research Objective 4:

What are the intentions and assumptions of the courtyard designers (architects and landscape architects) of selected hospitals and ***how have these been achieved in the real setting?***

Interview question	Subject of study
1. **Please provide some overview of the design concept of H1- hospital?** *Boleh encik berikan sedikit penerangan berkenaan konsep senireka H2-hospital?*	Design intention
2. **Why do you decide to incorporate the courtyard garden in the planning of the hospital?** *Mengapakah encik membuat keputusan untuk memasukkan courtyard dalam susun atur perancangan hospital ini?*	
3. **Please explain the design and planning of this hospital courtyard garden?** *Bolehkah encik jelaskan dengan lebih lanjut mengenai proses susun atur courtyard/taman di hospital ini?*	Design planning process
4. **Who involved in this project? Who is the Landscape architect?** *Siapakah yang terlibat dalam projek hospital ini? Siapakah landscape arkitek yang terlibat?*	Decision making process.
5. **Is there any meeting between the landscape architect in the early process of designing the courtyard of this hospital?** *Adakah terdapat perbincangan yang dilakukan bersama landscape arkitek ketika proses awal untuk membina taman di hospital ini?*	
6. **How have you decided on the size, location and orientation of the courtyard garden in that hospital?** *Bagaimanakah encik membuat keputusan berkaitan saiz ukuran dan lokasi serta arah kedudukan yang sesuai dalam pembinaan courtyard di hospital ini?*	
7. **Is there any design guidelines or design brief provided by the Ministry of Health (MOH) or Public Work Department (PWD) to include a courtyard garden in the hospital?** *Adakah terdapat guidelines atau design brief daripada Kementerian Kesihatan Malaysia atau JKR yang mewajibkan pembinaan courtyard atau taman di hospital ini?*	Design requirement / Design brief
8. **Based on your experiences as an architect, how the courtyards in the hospital should be designed to achieve an environmentally friendly building? Any element/criteria needed.** *Bedasarkan pengalaman anda sebagai arkitek, bagaimanakah taman atau courtyard di sesebuah hospital perlu di bina untuk mencapai bangunan yang menepati criteria environmentally friendly building? Adakah terdapat criteria penting yang encik rasa perlu diaplikasi dalam pembinaan sesebuah taman di hospital?*	Consideration of the environmental aspects

9. **Why do you decide to incorporate a large enclosed courtyard (4 sided) rather than a semi-enclosed courtyard (3 sided) to incorporate in the hospital planning?** *Mengapakah encik memilih untuk membina courtyard yang besar dan tertutup dan tidak memilih untuk membina courtyard yang courtyard separa tertutup dan bersaiz lebih kecil?*	
10. **Could you please explain how the design of these courtyards influences on the environmental aspects such as daylighting and ventilation?** *Bolehkah anda terangkan, bagaimanakah proses binaan dan susun atur courtyard/taman boleh mempengaruhi aspek persekitaran seperti sinar cahaya matahari dan pengaliran udara di sesebuah hospital.*	
11. **Could you please explain how the courtyard garden can improve the health and well-being of the building occupant?** *Bolehkah encik terangkan bagaimanakah persekitaran taman dapat membantu pemulihan kepada tahap kesihatan dan minda pengguna di sesebuah hospital?*	Consideration on the restorative aspect
12. **Do you think, the interaction with the garden can help in reducing the stress of the users in the courtyard hospital?** *Adakah anda rasa dengan adanya taman di hospital dapat membantu untuk mengurangkan kekusutan minda seseorang pengguna taman di hospital?*	
13. **Do you think the landscape elements such as water features, vegetation, seating area are important elements for a hospital courtyard garden?** *Adakah anda rasa elemen landskap seperti air pancut, air terjun, pokok-pokok hijau, tempat duduk merupakan elemen yang penting dan perlu ada di dalam taman hospital?*	
14. **Could you please explain why you think these elements are important when designing the courtyard?** *Boleh encik terangkan, kenapa encik rasa elemen-elemen tersebut penting dalam susun atur sesebuah taman di hospital?*	
15. **Can you recall any difficulty and challenges that you face when you decide to include the courtyard in the hospital planning?** *Boleh encik ingat balik apakah perkara yang sukar yang encik hadapi yang encik rasa very chalengging semasa dalam proses pembinaan courtyard di hospital ini?*	Challenges, Constraint
16. **What improvement will you make in designing the future hospital courtyard garden?** *Apakah perkara yang encik ingin membuat penambahbaikan dalam pembinaan dan susun atur taman di hospital pada masa hadapan.*	Future improvement

INTERVIEW WITH THE LANDSCAPE ARCHITECT

Research Objective 4: *What are the intentions and assumptions of the courtyard designers (architects and landscape architects) of selected hospitals and* how have these been achieved in the real setting?

Interview question	Subject of study
1. **Could you please explain how you come out with the design concept for courtyard gardens of the H2- hospital?** *Boleh encik berikan sedikit penerangan berkenaan konsep susun atur taman di H2-hospital?*	Design intention (Concept)
2. **How do you ensure that the design of courtyard gardens at H2- hospital suit with the tropical climate in Malaysia?** *Bagaimanakah encik memastikan bahawa susun atur taman di hospital Serdang adalah memenuhi kesesuaian cuaca tropikal di Malaysia?*	
3. **Could you please explain, what do you like about the planning and design of the courtyard garden at H2- hospital?** *Apa yang encik suka berkaitan susun atur taman dan keseluruhan struktur pelan bangunan di H2-hospital?*	Design planning process
4. **What do you not like about the planning and design of courtyard gardens at** *Apa yang encik tidak suka berkaitan susun atur taman di H2-hospital?*	
5. **Are you satisfied with the overall size and location of courtyard gardens provided by the architects of** *Adakah anda berpuas hati dengan keseluruhan saiz dan kedudukan courtyard yang telah dibina oleh pihak arkitek di H2-hospital?*	
6. **Please explain how the design process of the hospital courtyard garden and your collaboration with the architect?** *Bolehkah encik jelaskan dengan lebih lanjut mengenai proses susun atur courtyard atau taman di H2-hospital dan bagaimana encik berkerjasama dengan pihak Arkitek?*	Decision making process.
7. **Is there any meeting with the architect in the early process of designing the hospital courtyard garden?** *Adakah terdapat perbincangan diadakan dengan pihak arkitek pada awal proses pembinaan hospital dan susunatur taman di H2-hospital?*	
8. **As far as you can remember when the architect will ask for the landscape architect to design the courtyard gardens?** *Bilakah selalunya pihak arkitek akan menggunakan khidmat arkitek landskap untuk menyusun atur courtyard di H2-hospital?*	
9. **Are there guidelines or design brief of the landscape design in the hospital that you follow while you designed for the hospital Serdang?** *Adakah terdapat guidelines atau design brief daripada Kementerian Kesihatan Malaysia atau JKR yang mewajibkan pembinaan courtyard atau taman di hospital ini?*	Design requirement / Design brief

10. As a landscape architect, how the design of the courtyard garden can promote in achieving an environmentally friendly building? Are there any element/criteria needed that you could share? *Berdasarkan pengalaman anda sebagai arkitek landskap, bagaimanakah taman atau courtyard di sesebuah hospital perlu di bina untuk mencapai bangunan yang menepati kriteria environmentally friendly building? Adakah terdapat ciri-ciri penting yang encik rasa perlu diaplikasi dalam pembinaan sesebuah taman di hospital?*	Consideration on the environmental aspects
11. What do you think about the courtyard configuration in H2- hospital which has two types of courtyards; fully enclosed courtyard (level 2) and semi-enclosed courtyard (level 5 & 6)? *Apakah pendapat anda berkenaan bentuk courtyard di H2-hospital yang mempunyai dua jenis iaitu courtyard yang besar dan tertutup di tingkat dua dan courtyard separa tertutup yang terletak di tingkat 5 dan 6?*	
12. Could you please explain, how the design of these courtyards influences on the environmental aspects such as daylighting and ventilation? *Bolehkah anda terangkan, bagaimanakah proses binaan dan susun atur courtyard/taman boleh mempengaruhi aspek persekitaran seperti sinar cahaya matahari dan pengaliran udara di sesebuah hospital.*	
13. Could you please explain, how the courtyard garden can improve the health and well-being of the building occupant? *Bolehkah encik terangkan bagaimanakah persekitaran taman dapat membantu pemulihan kepada tahap kesihatan dan minda pengguna di sesebuah hospital?*	Consideration on the restorative aspect
14. Do you think, the contact with nature in the hospital courtyard garden can help in reducing the stress of the users? *Adakah anda rasa dengan adanya taman di hospital dapat membantu untuk mengurangkan kekusutan minda seseorang pengguna taman di hospital?*	
15. Do you think the landscape elements such as water features, vegetation, seating area are important elements for a courtyard garden? *Adakah anda rasa elemen landskap seperti air pancut, air terjun, pokok-pokok hijau, tempat duduk merupakan elemen yang penting dan perlu ada di dalam taman hospital?*	
16. Why do you think these landscape elements are important when designing the courtyard? *Boleh encik terangkan, kenapa encik rasa elemen-elemen tersebut penting dalam susun atur sesebuah taman di hospital?*	
17. Can you recall any difficulty and challenges that you face during the design and construction stage of the courtyard garden in the H2- hospital? *Boleh encik ingat balik apakah perkara yang sukar yang encik hadapi yang encik rasa very chalenging semasa dalam proses pembinaan courtyard di hospital ini?*	Challenges, Constraint
18. What improvement do you want to make in designing future hospital courtyard garden? *Apakah perkara yang encik ingin membuat penambahbaikan dalam pembinaan dan susun atur taman di hospital pada masa hadapan.*	Future improvement

APPENDIX 4: Consent Form and Participant Information Sheet

CONSENT FORM - SURVEY WITH HCG USERS

INFORMED CONSENT FORM

(For those who use the hospital courtyard garden)

Title of study : Post Occupancy Evaluation of courtyard design in the Malaysian hospitals: Evaluating the environmental and restorative aspects.

By signing below, I confirm the following: Please mark √ in the box below.

1. I have been given oral and written information for the above study and have read and understood the information given. I have had sufficient time to consider participation in the study and have had the opportunity to ask questions and all my questions have been answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any question or questions, I am free to decline. ☐

3. I agree to take part in the above research project. I agree to participate in the survey. I understand that my responses will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses. I understand that my name not be identified or identifiable in the report or reports that result from the research. ☐

4. I agree for the data including the survey data collected from me and the video recording of the observation on the users of the courtyard in this hospital to be used in future research and conference presentation. I agree for my anonymised data to be shared with other researchers within open access that is useful in answering future research question. ☐

5. I understand that the data collected about me is untraceable back to me and the outcome of this research will be reviewed and received approval from the Secretary, Medical Research & Ethics Committee, Ministry of Health Malaysia before it will be disseminated to other people. ☐

6. I will receive a copy of this subject information/informed consent form signed and dated to keep as a record. ☐

____________________	____________	______________
Name of Participant	Date	Signature

Madihah binti Mat Idris	____________	______________
(Lead Researcher)	Date	Signature

CONSENT FORM - SURVEY WITH THE NON-USERS

INFORMED CONSENT FORM

(For those who do not use the hospital courtyard garden)

Title of study : Post Occupancy Evaluation of courtyard design in the Malaysian hospitals: Evaluating the environmental and restorative aspects.

By signing below, I confirm the following: Please mark √ in the box below.

1. I have been given oral and written information for the above study and have read and understood the information given. I have had sufficient time to consider participation in the study and have had the opportunity to ask questions and all my questions have been answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any question or questions, I am free to decline. ☐

3. I agree to take part in the above research project. I agree to participate in the survey. I understand that my responses will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses. I understand that my name not be identified or identifiable in the report or reports that result from the research. ☐

4. I agree for the data including the survey data collected from me and the video recording of the observation on the users of the courtyard in this hospital to be used in future research and conference presentation. I agree for my anonymised data to be shared with other researchers within open access that is useful in answering the future research question. ☐

5. I understand that the data collected about me is untraceable back to me and the outcome of this research will be reviewed and received approval from the Secretary, Medical Research & Ethics Committee, Ministry of Health Malaysia before it will be disseminated to other people. ☐

6. I will receive a copy of this subject information/informed consent form signed and dated to keep as a record. ☐

____________________	____________________	____________________
Name of Participant	Date	Signature
Madihah binti Mat Idris	____________________	____________________
(Lead Researcher)	Date	Signature

CONSENT FORM - SEMI-STRUCTURED INTERVIEW WITH DESIGNERS

INFORMED CONSENT FORM

Title of study : Post Occupancy Evaluation of courtyard design in Malaysian hospitals: Evaluating the environmental and restorative aspects.

By signing below, I confirm the following: Please mark √ in the box below.

1. I have been given oral and written information for the above study and have read and understood the information given. I have had sufficient time to consider participation in the study and have had the opportunity to ask questions and all my questions have been answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any question or questions, I am free to decline. ☐

3. I agree to take part in the above research project and to be interview. I understand that my responses will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses. I understand that my name not be identified or identifiable in the report or reports that result from the research. ☐

4. I agree for the data for the data such as the audio data of the interview including to be used in future research and conference presentation. I agree for my anonymised response to be shared with other researcher within open access that is useful in answering future research question. ☐

5. I understand that the data collected about me is untraceable back to me and the outcome of this research will be reviewed and received an approval from the Secretary, Medical Research & Ethics Committee, Ministry of Health Malaysia before before they are disseminated to other. ☐

6. I will receive a copy of this subject information/informed consent form signed and dated to keep as a record. ☐

____________________ ______________ __________________

Name of Participant Date Signature

____________________ ______________ __________________

Madihah binti Mat Idris Date Signature
(Lead Researcher)

PARTICIPANT INFORMATION SHEET – HCG USERS

PARTICIPANT INFORMATION SHEET
AND INFORMED CONSENT FORM
(for those who used the hospital courtyard garden)

1. **Title of study** : **Post Occupancy Evaluation of courtyard design in the Malaysian hospitals: Evaluating the environmental and restorative aspects.**

2. **Name of Investigator** : Madihah binti Mat Idris (Pelajar Doktor Falsafah).
3. **Name of Institution** : School of Architecture, The University of Sheffield, The Arts Tower, Western Bank, Sheffield, S10 2TN.
4. **Name of Sponsor** : Ministry of Higher Education Malaysia (SLAB/SLAI)

5. **Introduction:**

   You are invited to participate in a research study because you are one of the users in the courtyard of this hospital. The details of the research trial are described in this document. It is important that you understand why the research is being done and what it will involve. Please take your time to read through and consider this information carefully before you decide if you are willing to participate. Ask the study staff if anything is unclear or if you like more information. After you are properly satisfied that you understand this study, and that you wish to participate, you must sign this informed consent form in the last page of this document.

6. **Do I have to take part?**
   Your participation in this study is voluntary. You do not have to be in this study if you do not want to. You may also refuse to answer any questions you do not want to answer. If you volunteer to be in this study, you may withdraw from it at any time. If you do not wish to take part in the survey, this will not affect you in anyway and will not cause any bad feeling.

7. **Who has reviewed and given approval for this study?**
   This study has been reviewed and approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia and the School of Architecture's ethics Committee, the University of Sheffield.

8. **What is the purpose of the study?**
   The study aims to investigate how the different types of courtyards that have been included in the planning of Malaysian hospitals after 1998 are used and perceived by building occupants and visitors. and how they are currently performing in relation to their intended environmental and restorative roles. Hence, the results from this research will assist designers to improve the quality of courtyards design in the Malaysian hospital in future and reinforce the guidelines for effective courtyards design of both environmental and restorative aspects in Malaysian hospitals.

9. **Why you have been invited to take part?**
   As part of the research we would like to conduct a survey with the people who use the courtyards in the hospital which include patients, staffs and visitors. You are invited to take part in this survey because you are one of the user of the courtyard in this hospital. The intention of the survey is to understand your preference, experiences and satisfaction level on the quality of courtyard garden in the hospitals on both the environmental and restorative aspects. Your participation in this survey would allow researcher to develop a design criteria and guidelines that will assist the designers to improve the quality of courtyard design in Malaysia to meet the need and preference of the intended users.

In addition, a participant observation on the user of the courtyard in this hospital using a video recording tools will be conducted in the courtyard area. The aim of the video recording is to records the user activities in the courtyard area to examine the type of activities and the pattern of use in the courtyard area. It is important to note that the video camera will be located at certain distance to avoid recording any accidental capture of user's identifiable images to preserve the identity of the participants. All the data will be kept anonymous and the still images will be blurred for the future use of the study.

10. What are my responsibilities when taking part in this study?

If you decided to take part in the study, you will have to answer a survey that will take approximately 1-20 minutes. The survey session will be conduct at a place and times which are convenient to you. All the personal information about you will be kept anonymised. It is important to note that, during this study, all the users in the courtyard area will be filmed to examine the types of activities by the user during the day. Also, you have the right to inform the researcher if you do not want your image that has been recorded in the video camera to be used in the future research.

11. Can I withdraw from this study?

You can withdraw from the study at any time without having to provide any reason. You have the right to answer any part of the survey questions or not to answer provide the answer. If you withdraw, any data collected from you up to your withdrawal will still be used for the study. If you decide that you do not want the data collected from you to be used in the research, all the data related with you will not be used in the research and those data will be deleted from the archive.

12. What are the possible benefits of taking part?

There may or may not be any benefits to you. However, we hope that the feedbacks of your preference on the courtyard setting in the hospital will further inform the designers to improve the quality of courtyards design in the Malaysian hospital in future in which it also provides benefit to the user well-being. In addition, it is also hope that outcome will be able to identify the positive and negative aspects of courtyard design in Malaysian for the future improvement.

13. What are the potential risks of taking part?

There is no harmful risk of taking part in this survey. If you feel uncomfortable to take part in this survey due to unfavourable circumstances, you have the right to deny the participation in this study.

14. What should I do if I want to take part?

If you wish to participate in the study you need to read the information sheet carefully and sign the consent form. Then, you will be given a survey to answer. It is important that you answer all of the questions asked by the study staff honestly and completely. You also will be given a copy of the information sheet and the consent form for you to keep.

15. Will what I say in this study be kept confidential?

All information collected from you during the course of this research will be kept strictly confidential and will only be accessible to the researcher. All the data will be saved on a computer which is password protected and the hard copies will be securely stored in the locked cabinet in the office of School of Architecture, The University of Sheffield. All data collected as part of this research will be kept securely in hardcopy or softcopy form for 5 years. If the data is no longer needed it will be destroyed or deleted from the achieves.

16. What will happen to the results of the research study?

This study will form part of a Ph.D. thesis. It is important to note that the survey data and the video recording of the observational study will only be used for analysis and for the illustrations in conference presentations and lectures. Data such as the identifiable still images of participants in any part of the video will also be blurred or masked appropriately using photo effects before being used in research and public presentations. We will ensure that these data will be used only for academic purpose and will not be used for another purpose without the participants' written permission.

Due to the nature of this research it is very likely that other researchers may find the data collected to be useful in answering future research questions. We will ask for your explicit consent for your data to be shared in this way and if you agree, we will ensure that the data collected about you is untraceable back to you before allowing others to use it. In addition, the outcome of this research will only be disseminated to the public after underwent a review and received an approval from the Secretary, Medical Research & Ethics Committee, Ministry of Health Malaysia.

17. Who is organising and funding the research?

This research is being organised by the School of Architecture, University of Sheffield and is being funding by the Ministry of Higher Education Malaysia (MOH) for the duration from October 2016 until September 2019.

18. Who should I call if I have questions?

If you have questions about this study and the interview, please contact Madihah binti Mat Idris, School of Architecture, The University of Sheffield, The Arts Tower, Western Bank, Sheffield, S10 2TN. Email: mimadihah1@sheffield.ac.uk. Telephone no.: +44 (0) 7565208284 (UK) / +6013 2002865 (MY).

19. What do I do if I have any issues of complaints?

If you are not happy with any aspects of the study and wish to speak with someone other than the researcher, you can contact my supervisors at the details provided below:

Dr. Magda Sibley	Email: m.sibley@sheffield.ac.uk
Prof. Karim Hadjri	Email: k.hadjri@sheffield.ac.uk

Also, if you have any questions about your rights as a participant in this study, please contact: The Secretary, Medical Research & Ethics Committee, Ministry of Health Malaysia, at telephone number 03-2287 4032.

Thank you for taking time to read this information sheet.

PARTICIPANT INFORMATION SHEET – NON-USERS

PARTICIPANT INFORMATION SHEET
AND INFORMED CONSENT FORM
(For those who do not use the hospital courtyard garden)

1. **Title of study** : **Post Occupancy Evaluation of courtyard design in the Malaysian hospitals: Evaluating the environmental and restorative aspects.**

2. **Name of Investigator** : Madihah binti Mat Idris (Pelajar Doktor Falsafah).
3. **Name of Institution** : School of Architecture, The University of Sheffield, The Arts Tower, Western Bank, Sheffield, S10 2TN.
4. **Name of Sponsor** : Ministry of Higher Education Malaysia (SLAB/SLAI)

5. **Introduction:**

   You are invited to participate in a research study because you are among the patients, the staffs or the visitors who do not use the courtyard in this hospital. The details of the research trial are described in this document. It is important that you understand why the research is being done and what it will involve. Please take your time to read through and consider this information carefully before you decide if you are willing to participate. Ask the study staff if anything is unclear or if you like more information. After you are properly satisfied that you understand this study, and that you wish to participate, you must sign this informed consent form in the last page of this document.

6. **Do I have to take part?**
   Your participation in this study is voluntary. You do not have to be in this study if you do not want to. You may also refuse to answer any questions you do not want to answer. If you volunteer to be in this study, you may withdraw from it at any time. If you do not wish to take part in the survey, this will not affect you in anyway and will not cause any bad feeling.

7. **Who has reviewed and given approval for this study?**
   This study has been reviewed and approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia and the School of Architecture's ethics Committee, the University of Sheffield.

8. **What is the purpose of the study?**
   The study aims to investigate how the different types of courtyards that have been included in the planning of Malaysian hospitals after 1998 are used and perceived by building occupants and visitors. and how they are currently performing in relation to their intended environmental and restorative roles. Hence, the results from this research will assist designers to improve the quality of courtyards design in the Malaysian hospital in future and reinforce the guidelines for effective courtyards design of both environmental and restorative aspects in Malaysian hospitals.

9. **Why you have been invited to take part?**
   As part of the research we would like to conduct a survey with the patients, the staffs and the visitors who do not use the courtyards in the hospital. You are invited to take part in this survey because you are one of the building occupants or the visitors who do not use the courtyard in this hospital. The intention of the survey is to understand the perception of the non-user on the quality of courtyard garden in the hospitals and to investigate any barrier that existed in the utilisation of the courtyard space. Your participation in this survey would allow researcher to develop a design criteria and guidelines that will assist the designers to improve the quality of courtyard design in Malaysia in future.

10. What are my responsibilities when taking part in this study?

If you decided to take part in the study, you will have to answer a survey that will take approximately 1-15 minutes. The survey session will be conduct at a place and times which are convenient to you. All the personal information about you will be kept anonymised.

11. What should I do if I want to take part?

If you wish to participate in the study you need to read the information sheet carefully and sign the consent form. Then, you will be given a survey to answer. It is important that you answer all of the questions asked by the study staff honestly and completely. You also will be given a copy of the information sheet and the consent form for you to keep.

12. Can I withdraw from this study?

You can withdraw from the study at any time without having to provide any reason. You have the right to answer any part of the survey questions or not to answer provide the answer. If you withdraw, any data collected from you up to your withdrawal will still be used for the study. If you decide that you do not want the data collected from you to be used in the research, all the data related with you will not be used in the research and those data will be deleted from the archive.

13. What are the possible benefits of taking part?

There may or may not be any benefits to you. However, we hope that the feedbacks of your preference on the courtyard setting in the hospital will further inform the designers to improve the quality of courtyards design in the Malaysian hospital in future in which it also provides benefit to the user well-being. In addition, it is also hope that outcome will be able to identify the positive and negative aspects of courtyard design in Malaysian for the future improvement.

14. What are the potential risks of taking part?

There is no harmful risk of taking part in this survey. If you feel uncomfortable to take part in this survey due to unfavourable circumstances, you have the right to deny the participation in this study.

15. Will what I say in this study be kept confidential?

All information collected from you during the course of this research will be kept strictly confidential and will only be accessible to the researcher. All the data will be saved on a computer which is password protected and the hard copies will be securely stored in the locked cabinet in the office of School of Architecture, The University of Sheffield. All data collected as part of this research will be kept securely in hardcopy or softcopy form for 5 years. If the data is no longer needed it will be destroyed or deleted from the achieves.

16. What will happen to the results of the research study?

This study will form part of a Ph.D. thesis. It is important to note that the survey data that collected from you will be used only for analysis and for the illustrations in conference presentations and lectures.We will ensure that these data will be used only for academic purpose and will not be used for another purpose without the participants' written permission.

Due to the nature of this research it is very likely that other researchers may find the data collected to be useful in answering future research questions. We will ask for your explicit consent for your data to be shared in this way and if you agree, we will ensure that the data collected about you is untraceable back to you before allowing others to use it. In addition, the outcome of this research will only be disseminated to the public after underwent a review and received an approval from the Secretary, Medical Research & Ethics Committee, Ministry of Health Malaysia.

17. Who is organising and funding the research?

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If you have questions about this study and the interview, please contact Madihah binti Mat Idris, School of Architecture, The University of Sheffield, The Arts Tower, Western Bank, Sheffield, S10 2TN. Email: mimadihah1@sheffield.ac.uk. Telephone no.: +44 (0) 7565208284 (UK) / +6013 2002865 (MY).

19. What do I do if I have any issues of complaints?

If you are not happy with any aspects of the study and wish to speak with someone other than the researcher, you can contact my supervisors at the details provided below:

Dr. Magda Sibley	Email: m.sibley@sheffield.ac.uk
Prof. Karim Hadjri	Email: k.hadjri@sheffield.ac.uk

Also, if you have any questions about your rights as a participant in this study, please contact: The Secretary, Medical Research & Ethics Committee, Ministry of Health Malaysia, at telephone number 03-2287 4032.

Thank you for taking time to read this information sheet.

PARTICIPANT INFORMATION SHEET – DESIGNERS

PARTICIPANT INFORMATION SHEET

1. **Title of study** : **Post Occupancy Evaluation of courtyard design in Malaysian hospitals: Evaluating the environmental and restorative aspects.**

2. **Name of Investigator** : Madihah binti Mat Idris (PhD- Architecture student)
3. **Name of Institution** : School of Architecture, The University of Sheffield, The Arts Tower, Western Bank, Sheffield, S10 2TN.
4. **Name of Sponsor** : Ministry of Higher Education Malaysia (SLAB/SLAI)

5. **Introduction:**

   You are invited to participate in a research study because you are the architect or the landscape architect who involved in designing the courtyard of the case study hospitals. The details of the research trial are described in this document. It is important that you understand why the research is being done and what it will involve. Please take your time to read through and consider this information carefully before you decide if you are willing to participate. Ask the researcher if anything is unclear or if you like more information. After you are properly satisfied that you understand this study, and that you wish to participate, you must sign this informed consent form in the last page of this document.

6. **Do I have to take part?**
   Your participation in this study is voluntary. You do not have to be in this study if you do not want to. You may also refuse to answer any questions you do not want to answer. If you volunteer to be in this study, you may withdraw from it at any time. If you do not wish to take part in the interview session, this will not affect you in anyway and will not cause any bad feeling.

7. **Who has reviewed and given approval for this study?**
   This study has been reviewed and approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia and the School of Architecture's ethics Committee, the University of Sheffield.

8. **What is the purpose of the study?**
   The study aims to investigate how the different types of courtyards that have been included in the planning of Malaysian hospitals after 1998 are used and perceived by building occupants and visitors. and how they are currently performing in relation to their intended environmental and restorative roles. Hence, the results from this research will assist designers to improve the quality of courtyards design in the Malaysian hospital in future and reinforce the guidelines for effective courtyards design of both environmental and restorative aspects in Malaysian hospitals.

9. **Why you have been invited to take part?**
   As part of the research we would like to interview the architects and the landscape architects who involve in the design planning of the hospitals particularly on the layout and design of the courtyard garden. Your participation would allow researcher to understand on design intention of the designers on the design requirements and aspects of consideration in designing the courtyard space in the hospital. Your experience and knowledge is important in informing this study.

10. What are my responsibilities when taking part in this study?

If you decided to take part in this study, you will be interviewed by the researcher approximately around 1-40 minutes. The interview session will be agreed to date and time which are convenient to you. The interview will be tape recorded for transcription and analysis purpose, and the data related about you will be anonymised.

11. What should I do if I want to take part?

If you wish to participate in the study, you need to read the information sheet carefully and sign the consent form. Then, the interview session will be conducted, and our discussion will be record using an audio tape recorder. You also will be given a copy of the information sheet and the consent form for you to keep.

12. Can I withdraw from this study?

You can withdraw from the study at any time without having to provide any reason. You have the right to stop the interview session at any time and you have the right if you do not to answer the question during the interview. If you withdraw, any data collected from you during the interview up to your withdrawal will still be used for the study. If you decide that you do not want the data collected from you to be used in the research, all the data related with you will not be used in the research and those data will be deleted from the archive.

13. What are the possible benefits of taking part?

There may or may not be any benefits to you. However, we hope that the outcome will be able to identify the positive and negative aspects of courtyard design in Malaysian hospitals which will further assist you and other designers to improve the quality of courtyards design in the Malaysian hospital in future. We also hope that the finding of this study will further helps to develop new design guidelines for the courtyard design in Malaysian hospitals that include both environmental and restorative aspects.

14. What are the potential risks of taking part?

There is no harmful risk of taking part in this interview session. If you feel uncomfortable to take part in this interview session due to unfavourable circumstances, you have the right to deny the participation in this study.

15. Will what I say in this study be kept confidential?

All information collected from you during the interview session will be kept strictly confidential and will only be accessible to the researcher. All the data will be saved on a computer which is password protected and the hard copies will be securely stored in the locked cabinet in the office of School of Architecture, The University of Sheffield. All data collected as part of this research will be kept securely in hardcopy or softcopy form for 5 years. If the data is no longer needed it will be destroyed or deleted from the achieves.

16. What will happen to the results of the research study?

This study will form part of a Ph.D. thesis. It is important to note that the data that collected from you during the interview session will be used only for analysis and for the illustrations in conference presentations and lectures. We may use quotes from you when writing up the study which will be presented anonymously. If you wish to receive an information on the results of the study, we will send you a short report detailing the outcomes. We will ensure that the data will be used only for academic purpose and will not be used for another purpose without the participants' written permission.

Due to the nature of this research it is very likely that other researchers may find the data collected to be useful in answering future research questions. We will ask for your explicit consent for your data to be shared in this way and if you agree, we will ensure that the data collected about you is untraceable back to you before allowing others to use it. In addition, the outcome of the research will only be disseminated to the public after underwent a review and received an approval from the Secretary, Medical Research & Ethics Committee, Ministry of Health Malaysia.

17. Who is organising and funding the research?

This research is being organised by the School of Architecture, University of Sheffield and is being funding by the Ministry of Higher Education Malaysia (MOH) for the duration from October 2016 until September 2019.

18. Who should I call if I have questions?

If you have questions about this study and the interview, please contact Madihah binti Mat Idris, School of Architecture, The University of Sheffield, The Arts Tower, Western Bank, Sheffield, S10 2TN. Email: mimadihah1@sheffield.ac.uk. Telephone no.: +44 (0) 7565208284 (UK) / +6013 2002865 (MY).

19. What do I do if I have any issues of complaints?

If you are not happy with any aspects of the study and wish to speak with someone other than the researcher, you can contact my supervisors at the details provided below:

Dr. Magda Sibley	Email: m.sibley@sheffield.ac.uk
Prof. Karim Hadjri	Email: k.hadjri@sheffield.ac.uk

Also, if you have any questions about your rights as a participant in this study, please contact: The Secretary, Medical Research & Ethics Committee, Ministry of Health Malaysia, at telephone number 03-2287 4032.

Thank you for taking time to read this information sheet.

APPENDIX 5: Approval letter from the SSOA Ethical Committee Boards

Actual study in Malaysia

Downloaded: 28/06/2017
Approved: 27/04/2017

Madihah Binti Mat Idris
Registration number: 160129564
School of Architecture
Programme: Postgraduate Research Project

Dear Madihah Binti

PROJECT TITLE: OPTIMISATION OF THE QUALITY OF COURTYARDS IN MALAYSIAN HOSPITALS: EVALUATING ITS ENVIRONMENTAL AND RESTORATIVE PERFORMANCE (APPLICATION FOR THE ACTUAL AND PILOT STUDY IN MALAYSIAN HOSPITALS)
APPLICATION: Reference Number 013349

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 27/04/2017 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 013349 (dated 11/04/2017).
- Participant information sheet 1028753 version 5 (10/04/2017).
- Participant information sheet 1029506 version 1 (11/04/2017).
- Participant information sheet 1029507 version 1 (11/04/2017).
- Participant information sheet 1029505 version 1 (11/04/2017).
- Participant consent form 1028754 version 2 (11/04/2017).
- Participant consent form 1029510 version 1 (11/04/2017).
- Participant consent form 1029504 version 1 (11/04/2017).
- Participant consent form 1029502 version 1 (11/04/2017).

The following optional amendments were suggested:

A statement needs to be made about the ethical implications of the observational behavioural research. A notice needs to be posted on the premises about research done on the courtyard (either video survey, interviews , etc) in order to inform all those who are using the courtyard. The filming angle needs to be adjusted to not record identifiable personal details (faces, etc.) otherwise consent forms are required for all those filmed. Updates are needed to information sheets and consent forms as noted above, including information about the future use of collected data. A statement clarifying the protocol of selecting participants will be added.

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Yours sincerely

Chengzhi Peng
Ethics Administrator
School of Architecture

Pilot study in the UK

The University Of Sheffield.

Downloaded: 15/05/2017
Approved: 12/05/2017

Madihah Binti Mat Idris
Registration number: 160129564
School of Architecture
Programme: Postgraduate research proggramme

Dear Madihah Binti

PROJECT TITLE: OPTIMISATION OF THE QUALITY OF COURTYARDS IN MALAYSIAN HOSPITALS: EVALUATING ITS ENVIRONMENTAL AND RESTORATIVE PERFORMANCE (APPLICATION FOR A PILOT STUDY IN THE FIRTH COURT BUILDING)
APPLICATION: Reference Number 013746

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 12/05/2017 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 013746 (dated 13/04/2017).
- Participant information sheet 1029553 version 1 (13/04/2017).
- Participant information sheet 1029552 version 1 (13/04/2017).
- Participant consent form 1029555 version 1 (13/04/2017).
- Participant consent form 1029554 version 1 (13/04/2017).

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Yours sincerely

Cheryl Armitage
Ethics Administrator
School of Architecture

APPENDIX 6: Approval from the Ethical committee boards in Malaysia and the hospital directors

Approval From Malaysian Medical Research Ethic Committee (MREC) Committee Board. Malaysian Ministry of Health

Received approval on 4th November 2017.

JAWATANKUASA ETIKA & PENYELIDIKAN PERUBATAN
(*Medical Research & Ethics Committee*)
KEMENTERIAN KESIHATAN MALAYSIA
d/a Institut Pengurusan Kesihatan
Jalan Rumah Sakit, Bangsar
59000 Kuala Lumpur

Tel.: 03-2287 4032/2282 0491/2282 9085
03-2282 9082/2282 1402/2282 1449
Faks: 03-2282 0015

Ruj.Kami:KKM/NIHSEC/ P17-1640(5)
Tarikh: 01-November-2017

Madihah Binti Mat Idris
University Of Sheffield

Dato'/ Tuan/ Puan,

SURAT KELULUSAN ETIKA:NMRR-17-2112-37156 (IIR)
POST-OCCUPANCY EVALUATION OF THE COURTYARD DESIGN IN MALAYSIAN HOSPITALS: EVALUATING THE ENVIRONMENTAL AND RESTORATIVE ASPECTS

Lokasi kajian:

Dengan hormatnya perkara di atas adalah dirujuk.

2. Jawatankuasa Etika & Penyelidikan Perubatan (JEPP), Kementerian Kesihatan Malaysia (KKM) tiada halangan, dari segi etika, ke atas pelaksanaan kajian tersebut. JEPP mengambil maklum bahawa kajian tersebut hanya melibatkan pengumpulan data melalui:

- **i. Survey**
- **ii. Pemerhatian**

3. Segala rekod dan data subjek adalah **SULIT** dan hanya digunakan untuk tujuan kajian ini dan semua isu serta prosedur mengenai *data confidentiality* mesti dipatuhi.

4. Kebenaran daripada Pegawai Kesihatan Daerah/ Pengarah Hospital dan Ketua-Ketua Jabatan atau pegawai yang bertanggungjawab disetiap lokasi kajian di mana kajian akan dijalankan mesti diperolehi sebelum kajian dijalankan. YBhg. Dato' / Tuan / Puan perlu akur dan mematuhi keputusan tersebut. Sila rujuk kepada garis panduan Institut Kesihatan Negara mengenai penyelidikan di Institusi dan fasiliti Kementerian Kesihatan Malaysia (Pindaan 01/2015) serta lampiran *Appendix 5* untuk templet surat memohon kebenaran tersebut.

5. Adalah dimaklumkan bahawa kelulusan ini adalah sah sehingga **31-Oktober-2018**. YBhg. Dato'/ Tuan/ Puan perlu menghantar dokumen-dokumen seperti berikut selepas mendapat kelulusan etika. Borang-borang berkaitan boleh dimuat turun daripada laman web Jawatakuasa Etika & Penyelidikan Perubatan (JEPP) (http://www.nih.gov.my/mrec).

i. ***Continuing Review Form*** selewat-lewatnya dalam tempoh 1 bulan (30 hari) sebelum tamat tempoh kelulusan ini bagi memperbaharui kelulusan etika.

ii. ***Study Final Report*** pada penghujung kajian.

iii. Mendapat kelulusan etika sekiranya terdapat pindaan keatas sebarang dokumen kajian/ lokasi kajian/ penyelidik.

6. Sila ambil maklum bahawa sebarang urusan surat-menyurat berkaitan dengan penyelidikan ini haruslah dinyatakan nombor rujukan surat ini untuk melicinkan urusan yang berkaitan.

Sekian terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menurut perintah,

....

(DATIN DR NORIAH BINTI BIDIN)
Timbalan Pengerusi
Jawatankuasa Etika & Penyelidikan Perubatan
Kementerian Kesihatan Malaysia
mrecsec@nih.gov.my
03-2282 9085

AA/Approval2017/MRECshare

http://online.epu.gov.my/oriDBv2/login/default.asp

Approval from the MREC board for adding two alternatives case study sites as a backup plan

JAWATANKUASA ETIKA & PENYELIDIKAN PERUBATAN
(*Medical Research & Ethics Committee*)
KEMENTERIAN KESIHATAN MALAYSIA
d/a Institut Pengurusan Kesihatan
Jalan Rumah Sakit, Bangsar
59000 Kuala Lumpur

Tel.: 03-2287 4032/2282 0491/2282 9085
03-2282 9082/2282 1402/2282 1449
Faks: 03-2282 0015

Ref :KKM.NIHSEC.P17-1640(7)
Date: 23-February-2018

Madihah Binti Mat Idris
University Of Sheffield

Dear Sir/ Mdm,

AMENDMENTS FOR STUDY: NMRR-17-2112-37156 (IIR)
Protocol No :
POST-OCCUPANCY EVALUATION OF THE COURTYARD DESIGN IN MALAYSIAN HOSPITALS: EVALUATING THE ENVIRONMENTAL AND RESTORATIVE ASPECTS

Your amendment submission dated 19-February-2018 is referred.

2. Amendments of the following have been received and reviewed with reference to the above study:

Documents received and reviewed with reference to the above study:
1. Covering Letter to MREC: Version 4, dated 19-02-2018
2. Amendment Application Form: Version 1, dated 19-02-2018
3. Study Proposal : Version 2, dated 19-02-2018, Ammendment on page 14.
- Addition of site (hospital Shah Alam and Hospital Sungai Buloh)

The Medical Research & Ethics Committee, Ministry of Health Malaysia operates in accordance to the International Conference of Harmonization Good Clinical Practice Guidelines.

Comments (if any):

Decision by Medical Research & Ethics Committee:
(√) Approved via Expedited Review
(   ) Disapproved

Date of Decision: 23 -February-2018

....
DR HJH SALINA BT ABDUL AZIZ
Chairperson
Medical Research & Ethics Committee
Ministry of Health Malaysia

JAWATANKUASA ETIKA & PENYELIDIKAN PERUBATAN
(*Medical Research & Ethics Committee*)
KEMENTERIAN KESIHATAN MALAYSIA
d/a Institut Pengurusan Kesihatan
Jalan Rumah Sakit, Bangsar
59000 Kuala Lumpur

Tel.: 03-2287 4032/2282 0491/2282 9085
03-2282 9082/2282 1402/2282 1449
Faks: 03-2282 0015

Ruj.Kami: KKM/NIHSEC/ P17-1640 (9)
Tarikh: 24-October-2018

MADIHAH BINTI MAT IDRIS
UNIVERSITY OF SHEFFIELD

Dato'/ Tuan/ Puan,

Annual Ethical Renewal for 2018

NMRR-17-2112-37156 (IIR)
Protocol No :
POST-OCCUPANCY EVALUATION OF THE COURTYARD DESIGN IN MALAYSIAN HOSPITALS: EVALUATING THE ENVIRONMENTAL AND RESTORATIVE ASPECTS

With reference to the 'Continuing Review Form' submitted 01-October-2018, we are pleased to inform that the conduct of the above study has been granted approval (via Expedited Review by Chairperson) for a year by the Medical Research & Ethics Comittee, Ministry of Health Malaysia. Please note that the approval is valid until 23-October-2019. To renew the approval, a completed 'Continuing Review Form' has to be submitted to MREC **within 1 month** before the expiry of the approval.

The Medical Research & Ethics Committee, Ministry of Health Malaysia operates in accordance to the International Council for Harmonization of Technical Requirement for Pharmaceutical for Human Use (ICH)

Thank you

"BERKHIDMAT UNTUK NEGARA"

Yours sincerely,

(DR HJH SALINA ABDUL AZIZ)
Chairman
Medical Research & Ethics Committee
Ministry of Health Malaysia

Approval from The Malaysian Economic Planning Unit (EPU)

Received approval on 22 December 2017

UNIT PERANCANG EKONOMI
ECONOMIC PLANNING UNIT
Jabatan Perdana Menteri
Prime Minister's Department
Blok B5 & B6, Kompleks B
Kompleks Jabatan Perdana Menteri
Pusat Pentadbiran Kerajaan Persekutuan
62502 Putrajaya
MALAYSIA

Tel : 603-8000 8000
Faks (Fax) : 603-8888 3755
Laman Web (Web) : www.epu.gov.my

Ruj. Tuan:
Your Ref.:

Ruj. Kami: UPE 40/200/19/3485
Our Ref.: (5)

Tarikh:
Date: 3 January 2018

Ms. Madihah binti Mat Idris
No.1, Jalan 3/3
43650 Bandar Baru Bangi
Selangor
Email : mimadihah1@sheffield.ac.uk

APPLICATION TO CONDUCT RESEARCH IN MALAYSIA

With reference to your application, I am pleased to inform that your application to conduct research in Malaysia has been approved by the **Research Promotion and Co-ordination Committee, Economic Planning Unit, Prime Minister's Department.** The details of the approval are as follows:

Researcher's name	:	**MADIHAH BINTI MAT IDRIS**
Passport No./ I.C No	:	
Nationality	:	**MALAYSIAN**
Title of Research	:	**"POST OCCUPANCY EVALUATION OF COURTYARD DESIGN IN MALAYSIAN HOSPITALS: EVALUATING THEIR ENVIRONMENTAL AND RESTORATIVE ROLES"**
Period of Research Approved	:	**3 years (4.1.2018 – 3.1.2021)**

2. Please take note that the study should avoid sensitive issues pertaining to local values and norms as well as political elements. At all time, please adhere to the conditions stated by the code of conduct for researchers as attached.

3. The issuance of the research pass is also subject to your agreement on the following:

a) to ensure submission of a brief summary of your research findings on completion of your research;

b) to submit three (3) copies of your final dissertation/publication; and

c) to renew your research pass annually.

4. Thank you for your interest in conducting research in Malaysia and wish you all the best in your future research endeavor.

Yours sincerely,

(MUHAMMAD JAWAD BIN TAJUDDIN)
Macroeconomics Section
for Director General
Economic Planning Unit
Prime Minister's Department
Email: jawad.tajuddin@epu.gov.my / oridb@epu.gov.my
Tel : 03 88723254
Fax : 03 88883798

ATTENTION

This letter is only to inform you the status of your application and **cannot be used as a research pass.**

c.c.:

Ketua Setiausaha
Kementerian Kesihatan Malaysia
Blok E1, E3 , E6 , E7 & E10, Kompleks E
Pusat Pentadbiran Kerajaan Persekutuan
62590, Putrajaya
(u.p.: YBrs. Tuan Haji Md Jalal bin Bongkik
Pengarah
Bahagian Perkhidmatan Kejuruteraan)

2

http://online.epu.gov.my/oriDBv2/login/default.asp

Researchers' pass

H1-HOSPITAL - Approval letter from the hospital director
Received approval on 4 March 2018

هوسڤيتل سلطان إسماعيل

No ruj kami: Bil (01) /PENT/PNT/1003 JLD 13
Tarikh : 4 Mac 2018

Madihah Binti Mat Idris
School of Architecture
The University of Sheffield
S10 2TN Western Bank, Sheffield
United Kingdom (UK)

(edaran menerusi emel : mimadihah@sheffield.ac.uk)

Puan,

MAKLUMBALAS PERMOHONAN MENJALANKAN KAJIAN BERKENAAN 'COURTYARD' ATAU TAMAN DI

Dengan segala hormatnya saya merujuk kepada perkara di atas.

2. Sukacita dimaklumkan, pihak pengurusan (HSIJB) telah mempertimbangkan semula permohonan pihak puan untuk menjalankan kajian berkenaan *'courtyard'* di hospital ini.

3. Justeru itu, pihak puan adalah diminta mematuhi peraturan-peraturan yang berkuatkuasa sepertimana yang dimaklumkan menerusi sesi pertemuan dan perbincangan bersama wakil pengurusan hospital pada 4 Mac 2018 jam 11.00 pagi bertempat di Bilik Mesyuarat Sri Kasturi, Bahagian Pengurusan Aras 3,

4. Sehubungan itu, sebarang pertanyaan lanjut sila hubungi Pn. Nurul Atikah Binti Mohd Salleh di talian 07-3565000 sambungan 2408. Kerjasama puan berhubung perkara di atas didahului dengan ucapan terima kasih.

Sekian.

"BERKHIDMAT UNTUK NEGARA"
"PENYAYANG, BEKERJA BERPASUKAN DAN PROFESIONALISME ADALAH BUDAYA KERJA KITA"

Saya yang menurut perintah,

(DR. KHAIRUL RIZAL BIN OTHMAN)
Timbalan Pengarah Hospital (Perubatan) I

Johor Bahru

-MIN PRO/HSIJB-

Kami Sedia Membantu
Penyayang • Profesionalisme • Kerja Berpasukan

(Sila catatkan rujukan surat ini apabila menjawab)

APPENDIX 5 (b)

MAKLUMBALAS PERMOHONAN KEBENARAN PENGGUNAAN KAWASAN 'COURTYARD'/TAMAN [ ] UNTUK PENYELIDIKAN.

Tajuk Penyelidikan : Post Occupancy evaluation of the courtyard design in Malaysian hospitals: Evaluating the environmental and restorative aspects.

Nama dan Jabatan Ketua Penyelidik : Madihah binti Mat Idris (Ph.D Student). School of Architecture,The University of Sheffield,The Arts Tower, Western Bank, Sheffield, S10 2TN.

Pihak hospital/institusi dengan ini membuat keputusan seperti berikut : -

- [✓] Membenarkan projek penyelidikan dijalankan
- [ ] Tidak membenarkan projek penyelidikan dijalankan

"BERKHIDMAT UNTUK NEGARA"

Saya yang menurut perintah

....	....
DATO' DR. GHAZALI ISMAIL)	**(DR KHAIRUL RIZAL BIN OTHMAN)**
Ketua Unit Pusat Penyelidikan Klinikal	Timbalan Pengarah (Perubatan)

< Timbalan Pengarah (Pengurusan) : Pn Muliati binti Mustafa >
< Ketua Jabatan School of Architecture, University of Sheffield: Professor Karim Hadjri >

H2-HOSPITAL - Approval letter from the hospital director

Received approval on 20 December 2017

[redacted]

CRC
MINISTRY OF HEALTH MALAYSIA
Research that matters to patients
Telefon : 03-89475467
Fax : 03-89475467
MULTI MEDIA SUPER CORRIDOR

Ruj kami : [redacted]P/CRC/710/11/9(349)
Tarikh : 07hb.Dis, 2017

Tuan,

KELULUSAN MENJALANKAN PENYELIDIKAN DI [redacted]

Dengan segala hormatnya merujuk kepada perkara di atas,

2. Sukacita dimaklumkan bahawa Jawatankuasa Pusat Penyelidikan Klinikal (CRC) [redacted] telah meluluskan permohonan penyelidikan tuan seperti yang berikut :

Penyelidik:	**Madihah bt Mat Idris**
NMRR ID:	**NMRR-17-2112-37156 (IIR)**
Tajuk:	**Post-occupancy evaluation of the courtyard design in Malaysian hospitals: evaluating the environmental and restorative aspects.**
Tarikh Penyelidikan:	**01hb. Nov, 2017**
Penyelia:	**En. Mohamed Faizal bin Buang (Timbalan Pengarah Pengurusan)**

3. Penyelidikan tuan adalah tertakluk kepada kelulusan *Medical Research Ethics Committee* (MREC) dan *National Medical Research Register* (NMRR), Kementerian Kesihatan Malaysia (MOH).

4. Sila kemukakan **Laporan Akhir** kepada Pusat Penyelidikan Klinikal (PPK) [redacted] sebaik sahaja penyelidikan tamat .

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

"PENYAYANG, BEKERJA BERPASUKAN DAN PROFESIONALISMA ADALAH BUDAYA KERJA KITA"

Saya yang menurut perintah,

PROF. DR. GOH BAK LEONG
Ketua
Pusat Penyelidikan Klinikal
[redacted]

APPENDIX 5 (b)

MAKLUMBALAS PERMOHONAN KEBENARAN PENGGUNAAN KAWASAN LAMAN (COURTYARD) [redacted] UNTUK MENJALANKAN PENYELIDIKAN

Tajuk Penyelidikan : Post Occupancy evaluation of the courtyard design in Malaysian hospitals: Evaluating the environmental and restorative aspects.

Nama dan Jabatan Ketua Penyelidik : Madihah binti Mat Idris (Ph.D Student). School of Architecture,The University of Sheffield,The Arts Tower, Western Bank, Sheffield, S10 2TN.

Pihak hospital/institusi dengan ini membuat keputusan seperti berikut : -

- [x] Membenarkan projek penyelidikan dijalankan
- [ ] Tidak membenarkan projek penyelidikan dijalankan

"BERKHIDMAT UNTUK NEGARA"

Saya yang menurut perintah

PROF DR. GOH BAK LEONG
B.Med.Sc.(UKM), MD, MRCP(UK), FRCP(Glasg)
(No Pendaftaran Penuh: MMC No: 30349)
Pakar Perunding Kanan Nefroligi Grad Khas B
Ketua Jabatan Nefrologi
[redacted]

……………………………………………

(PROF. DR. GOH BAK LEONG)
Ketua Unit Pusat Penyelidikan Klinikal
[redacted]

DR. ROHANA BINTI JOHAN
(MPM FULL REGISTRATION: 29304)
HOSPITAL DIRECTOR

……………………………………………

(DR. ROHANA BINTI JOHAN)
Pengarah [redacted]

S.K.
< Ketua Jabatan School of Architecture, University of Sheffield: Prof Karim Hadjri >

H3 HOSPITAL – Approval letter from a hospital director

Received approval on 19 December 2017

Telefon : 04-4457333
Telefaks : 04-4480092

Ruj Tuan :
Ruj Kami : (31) dlm. H /PEN QA 1.8 Jld. 2
Tarikh : 19.12.2017

Madihah Binti Mat Idris
Ph.D-Arhitecture
The University of Sheffield, UK

Puan,

KEBENARAN UNTUK MENJALANKAN KAJIAN DI KAWASAN LAMAN / 'COURTYARD' DI HOSPITAL

Adalah saya dengan hormatnya merujuk kepada berkenaan perkara di atas.

2. Sehubungan dengan itu, pihak Pengurusan tiada halangan dan memberikan kebenaran puan untuk menjalankan kajian tersebut di Hospital 11 Disember 2017 hingga 28 Mac 2018.

3. Walaubagaimanapun, segala maklumat yang diperolehi adalah sulit dan bertujuan untuk pendidikan sahaja.

Sekian, terima kasih.

" BERKHIDMAT UNTUK NEGARA"
" MUAFAKAT KEDAH"

Saya yang menurut perintah,

(DR. NORAINI BINTI ABD. RAHMAN)
Timbalan Pengarah Perubatan II
No. MPM : 27167
b/p Pengarah

Zielaz/Unit Latihan/HSAH

"Penyayang, Bekerja Berpasukan dan Profesionalisme adalah Budaya Kerja Kita"

MAKLUMBALAS PERMOHONAN KEBENARAN PENGGUNAAN KAWASAN LAMAN (COURTYARD) HOSPITAL [redacted] UNTUK MENJALANKAN PENYELIDIKAN

Tajuk Penyelidikan : Post Occupancy evaluation of the courtyard design in Malaysian hospitals: Evaluating the environmental and restorative aspects.

Nama dan Jabatan Ketua Penyelidik : Madihah binti Mat Idris (Ph.D Student). School of Architecture,The University of Sheffield,The Arts Tower, Western Bank, Sheffield, S10 2TN.

Pihak hospital/institusi dengan ini membuat keputusan seperti berikut : -

- [x] Membenarkan projek penyelidikan dijalankan
- [ ] Tidak membenarkan projek penyelidikan dijalankan

"BERKHIDMAT UNTUK NEGARA"

Saya yang menurut perintah

....
(DR. VIJAYA KUMAR A/L L. SUPPAN)
Ketua Unit Pusat Penyelidikan Klinikal
[redacted]

DR. ZAINAL BIN HJ. CHE MEE
No. Pend. Penuh MPM: 26165
Pengarah Hospital

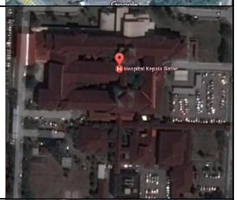
....
(DR. ZAINAL BIN HJ. CHE MEE) [redacted]
Pengarah [redacted]

S.K.
< Ketua Jabatan School of Architecture, University of Sheffield: Prof Karim Hadjri >

APPENDIX 7: List of 10 hospitals excluded in the selection of the case study hospitals (1990-1998)

Criteria of exclusion:

- Last century hospitals utilised a standard design of nucleus concept hospital.
- Type of hospitals: Non specialist hospital and district hospital.
- Designed by the private sector consultant and Public Work Department (PWD)
- Some hospital have no involvement from the landscape architects.
- Low rise building.
- No of Beds : Range from 80-600 beds

Hospital	Involvement of the landscape architect	Courtyard Criteria	Years	No. of beds	Overall layout plan
1. **Hospital Tengku Ampuan Jemaah, Sabak bernam** Follow a standard drawing – nucleus concept	No	Open type courtyard (between building block)	1990-1994	83	
2. **Hospital Port Dickson** Follow a standard drawing – nucleus concept.	No	Open type courtyard (between building block)	1994	110	
3. **Hospital Kepala batas** District hospital	Yes	4 enclosed courtyard No massive garden design	1994	108	
4. **Hospital Segamat** Follow a standard drawing – nucleus concept.	No	Open type courtyard (between building block)	1995	314	
5. **Hospital Seberang Jaya** Follow a standard drawing – nucleus concept.	No	Open type courtyard (between building block)	1995	314	
6. **Hospital Langkawi** District hospital	Yes	Four enclosed courtyards No massive garden design	1994-1998	110	
7. **Hospital Slim River** District hospital	Yes	4 Enclosed courtyards No massive garden design	1994-1998	140	

APPENDIX 8: List of 10 potentials case study hospitals selected during the exploratory case study survey

From a total of 104 hospitals that were surveyed, 10 potential case study hospitals were selected during the exploratory case study survey based on the following criteria:

- The hospital were built after 1998 (the date that hospitals in Malaysia were required to incorporate a healing garden by MOH).
- The HCG is designed by the architect and landscape architect.
- Type of hospitals: a government funded public hospital (specialist hospital).
- A large building complex.
- No. of beds: range between 300-1000 beds.

Out of ten potential case study hospitals, only 3 case study hospitals (H1, H2 and H3 hospitals) were selected based on the criteria explained in Chapter 3, Section 3.4.3.

Hospital	Involvement of the landscape architect	Courtyard Criteria	Years of operation	No. of beds	Overall layout plan
1. H1-HOSPITAL **(Case study 1)** **Type: specialist hospital**	**Yes**	**Large enclosed courtyard**	**2007**	**704**	
2. H2-HOSPITAL **(Case study 2)** **Type: specialist hospital**	**Yes**	**4 enclosed courtyards** **3 semi-enclosed courtyards**	**2005**	**620**	
3. Hospital Selayang Type: specialist hospital	**Yes**	Courtyard	2006	960	
4. Hospital Ampang	**Yes**	Enclosed courtyard	2006	562	

5. Hospital Sultan Haji Ahmad Shah	**Yes**	Enclosed courtyard	2006	500	
6. Hospital Sultanah Bahiyah	**Yes**	Courtyard around the main multi-level building	2007	1084	
7. H3-HOSPITAL **(Case study 3)** **Type: specialist hospital**	**Yes**	**4 enclosed courtyards.**	**2007**	**628**	
8. Hospital Putrajaya	**Yes**	2 small semi-enclosed courtyards	2013	341	
9. Hospital Shah Alam ***	**Yes**	Enclosed courtyard	2015	300	
10. Hospital Sungai Buloh ***	**Yes**	Enclosed courtyard	1999	620	

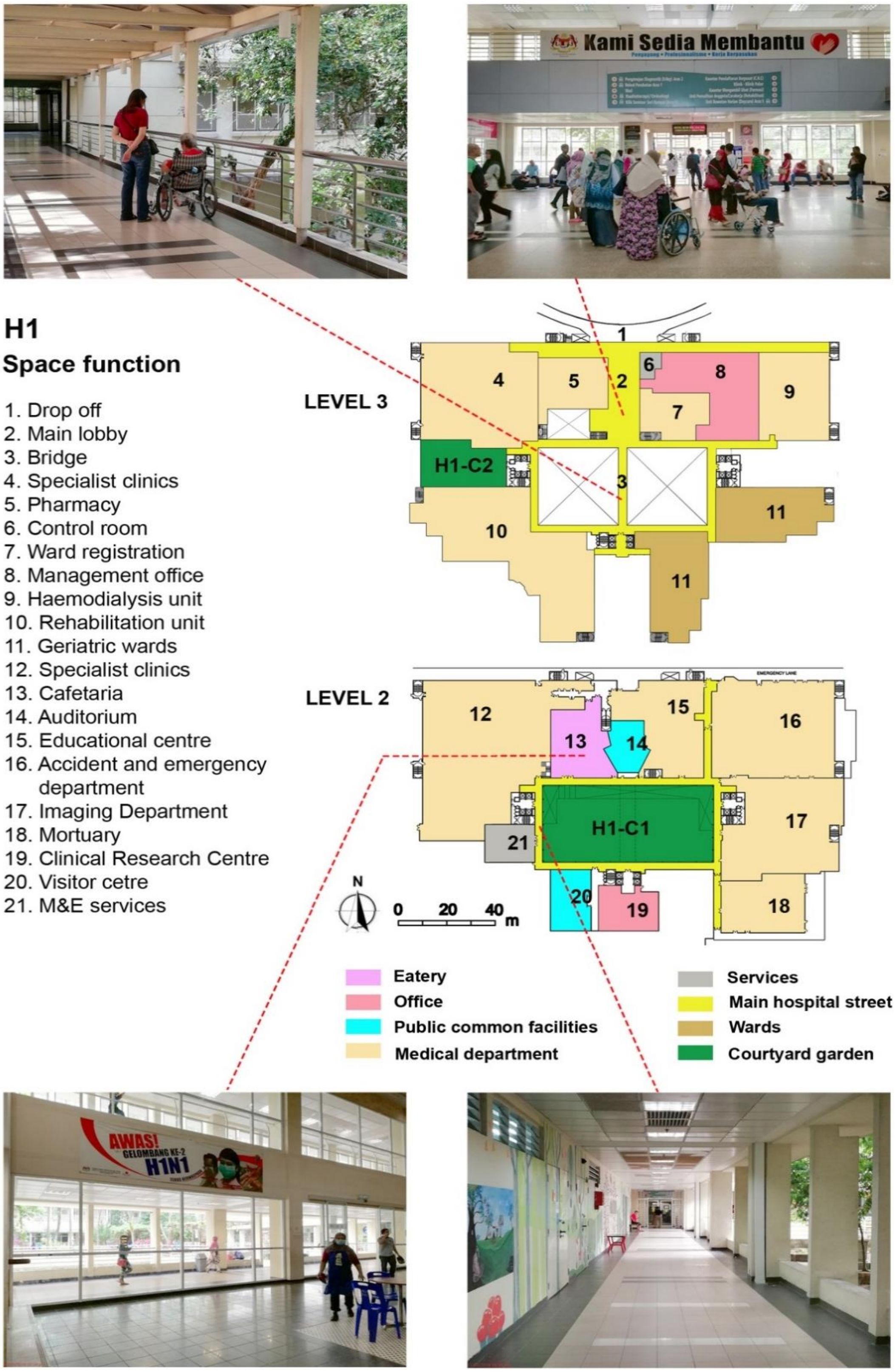
*** Alternatives hospitals were selected as a backup plan during the fieldwork stage

Source of pictures: Available at: www.googlemap.com [Accessed on 20 December 2016].

APPENDIX 9: A floor plan of the three representative hospitals

H1-hospital

A floor plan indicating the space functions in Level 2 and 3 of the H1 hospital



Source: Author (2018)

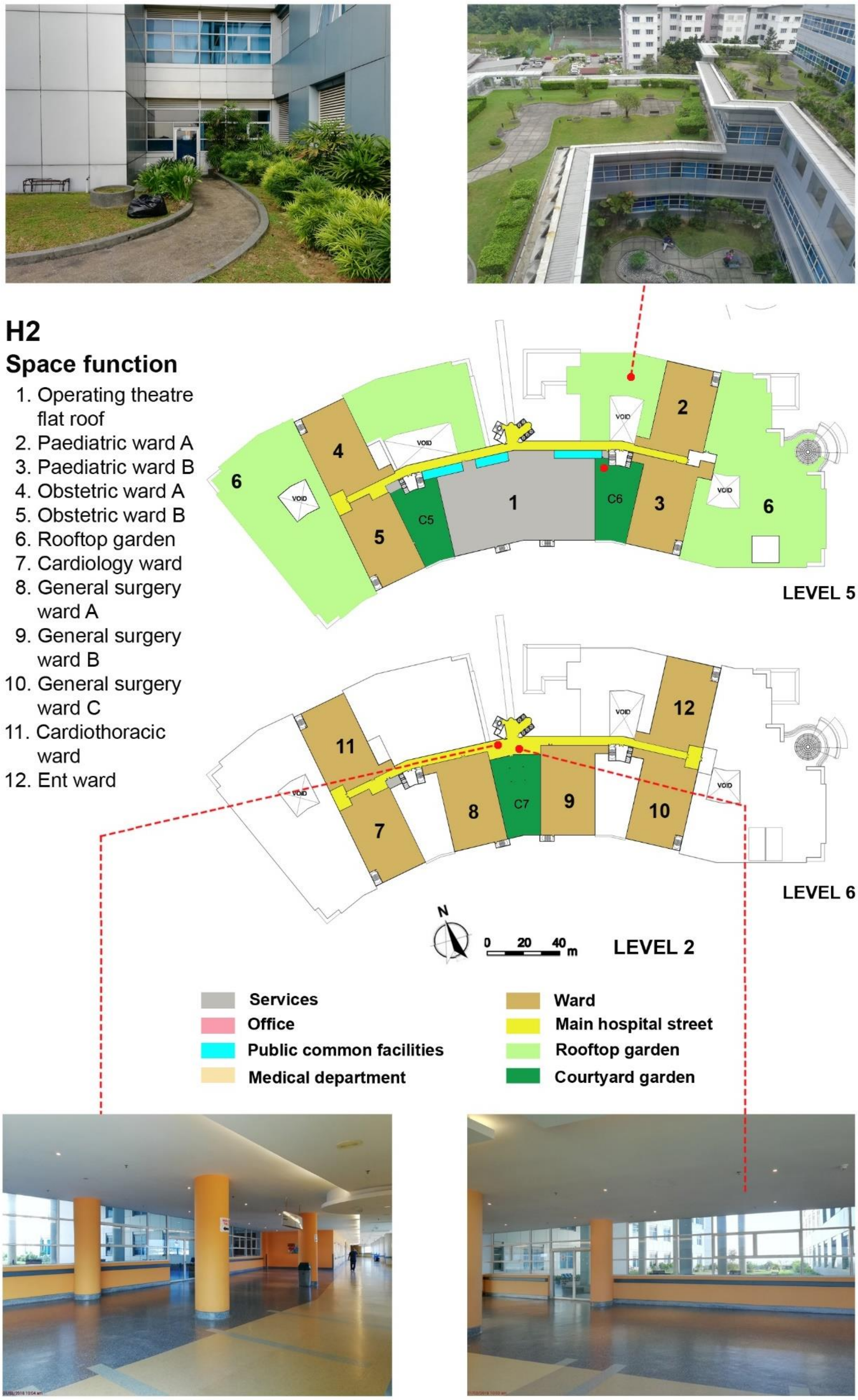
H2-hospital

A floor plan indicating the space functions in **Level 2** of the H2 hospital

Source: Author (2018)

H2-hospital

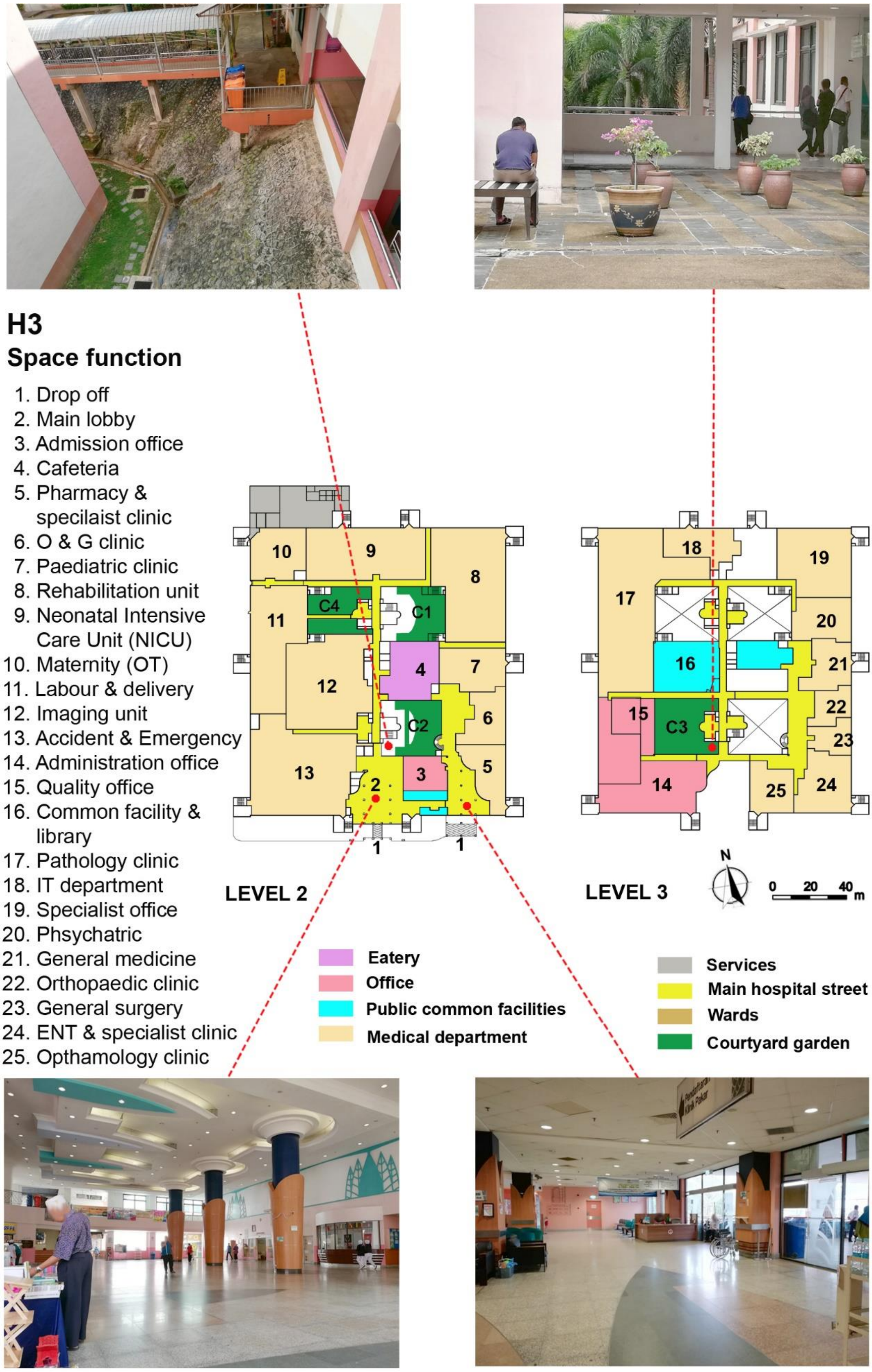
A floor plan indicating the space functions in **Level 5 and 6** of the H2 hospital



Source: Author (2018)

H3-hospital

A floor plan indicating the space functions in **Level 2 and 3** of the H3 hospital



8

Source: Author (2018)

APPENDIX 10: A pilot study in the Firth court building, Sheffield, UK

A short pilot study was carried out on April 2017, in a Firth court building, Sheffield, with the aim to test the tools and instruments used for the actual study. The reasons for this was to familiarise the researcher with the procedures for setting up the video cameras and to detect any technical issues that may arise and be improved before commending actual fieldwork in Malaysia. The pilot test involved two methods: i) a video recording (observation on users' activities); and ii) a survey with the courtyard users.

The 2 hours video-based observation in the courtyard garden of the Firth court building started from 11.00 am to 1.00 pm and a total of 278 user-observations were recorded. The video data were analysed and recorded in the relevant table according to the types of users, types of activities and time spent. Several activities that were recorded included: seating, drinking, having lunch, chatting with friend(s), walking through, and smoking. The pilot study revealed several difficulties in the video recording procedures and several suggestions were pointed out for improvement in the actual study (See Table 1).

Table 1: Summary of the problems in the video-based observation and suggestions for improvement in a future study

<table>
<tr><th>No</th><th>Problems</th><th>Suggestion for future improvement</th></tr>
<tr><td>1.</td><td>Camera lens limitation:
Some of the scenes were not fully covered if only one video camera (C1) is used to record the overall site activities due to the camera lens limitation.

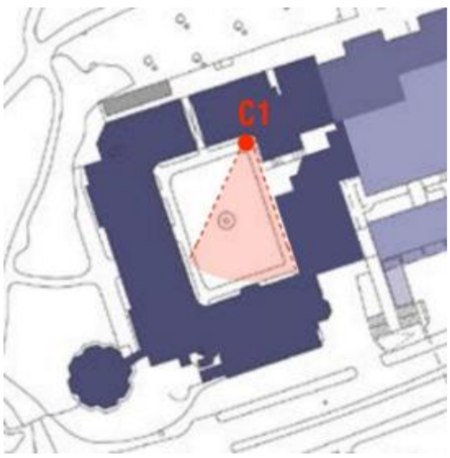



Figure 1: This indicates the overall scene captured by only 1 video camera.</td><td>• By placing two video cameras (C1 and C2) at different sides of the courtyard, the activities taking place to either side can be fully captured.

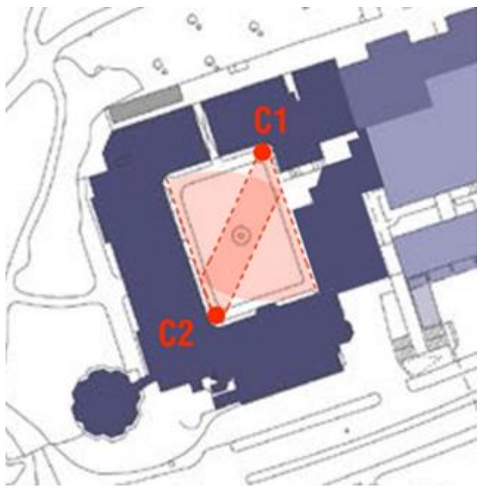



Figure 2: This indicates the overall scene captured by the two video cameras located at different corners of the courtyard.</td></tr>
</table>

		• For the actual study in Malaysia, it was important to have a clear understanding of the setting in terms of the layout and the possible site barriers so that there is a clear sense of what needs to be filmed and to ensure the practicality of the tools that will be used in the fieldwork.
2.	**Obstructed views:** Some of the scenes were obstructed by the shrubs and trees at the centre of the courtyard.	• Other data sources including self-observation and field notes should be used to map other on-site activities that might be missed out during filming to overcome the limitations of the video data.
3.	**Identification of the type of users:** Difficulty in identifying the types of users (e.g. staff, students or visitors) from the video data.	• Self-observation and a survey on the type of users should be done to overcome the weaknesses and limitations of video recording as a data collection tool.
4.	**Batteries lifespan:** The longevity of the battery of the video camera only lasted for 2 hours and 22 minutes.	• For the 8 hours of video recording in the actual site in Malaysia, three additional backup batteries needed to be prepared for each video camera.
5.	**Insufficient number of research assistants:** Insufficient number of research assistants to monitor the camera.	• Research assistants were hired to monitor each video cameras to ensure the continuity and functionality of the 8 hour video recording process in the actual study.

In addition, a short pilot test survey was conducted with a total of 10 respondents (5 students, 3 staff and 2 visitors). The main goal of this short pilot survey was to test the proposed instruments at an early stage in the research and improve the survey questions. This pilot study provided insight on the duration required for respondents to complete the survey (i.e. 15-20 minutes to answer all 20 survey questions), the order of the questions, and the choice of words in the survey. Several discussions on the outcome of the pilot study were carried out with the supervisors and other experts in related fields (e.g. outdoor thermal comfort). Several improvements were made to the survey question in terms of the survey structure and the types of survey questions.

APPENDIX 11: A preliminary study in H3 hospital, Malaysia

A pilot test study was conducted at the H3 hospital after approval from the both the Medical Research Ethic Committee (MREC) and the hospital director were obtained which aimed to test the survey question, and the practicality of the data collection protocol of this study.

CHECK THE SURVEY QUESTIONS

No. of respondents for pilot study.

- Users: **5**
- Non-users: **5**

Pilot test

i) Self-administered questionnaire takes more time to complete and tended to get more incomplete response from the respondents.
At first, the respondents were given survey forms and pens to complete the form on his/her own. However, the researcher found that this method required a long time for each respondent to complete the survey and most of them preferred the researcher to write their responses on behalf of them, especially older people. Respondents also tended to skip the open-ended questions. Some of them provided the answers.

ii) Survey in Malay Language is preferable by the respondents.
The respondents were asked by the researcher to choose either the English version or Malay Version. A majority of the respondents preferred to answer the Malay version survey compared to the English version.

iii) Respondents do not understand the 360 images of the hospital courtyards.
The survey question that illustrated the 360 images of courtyards hospitals was difficult to understand by the respondents because the pictures appeared quite confusing.

C1:

C2:

Improvement for the actual fieldwork

i) Face to face surveys are easier to obtain a complete response from the respondents.
This technique was used because the researchers can ask the survey questions to the respondents and assist them in answering the surveys. It provides a better way for the researcher to immediately clarify the questions if the respondents find the questions to be confusing and ambiguous. This technique also offers better data quality as the researcher can ensure that respondents do not skip the open-ended questions.

ii) A Malay version survey was used for both group (users and non-users).
The survey used was the translated Malay version as most of the respondents (i.e. Indian, Chinese and Malay) can understand Malay and only a minority understood English. Thus, only the Malay version was used.

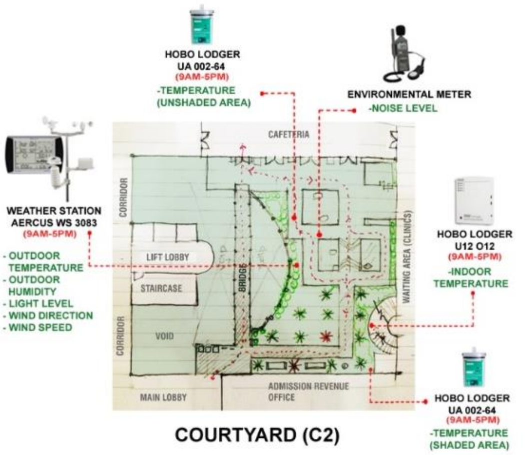
iii) The image for the survey question has been revised and tested to ensure the respondents understand the illustration.
The 360º image of the courtyard of the hospital has been changed from to an image of courtyard to an **eye level view**. Many respondents can understand the illustrations.

TEST THE PROCEDURES FOR THE FIELD MEASUREMENT	

i) Limitation of the equipment to collect environmental data.

Number of equipment use in the study				
Equipment				
Unit	1 no	2 no	3 no	2 no

<u>Aercus weather station WS3083</u>
The weather station was used for this study to record the environmental data for the **8 hours from 9 am until 5 pm for each courtyard.**



Location of the equipment in the courtyard (H3-C2).

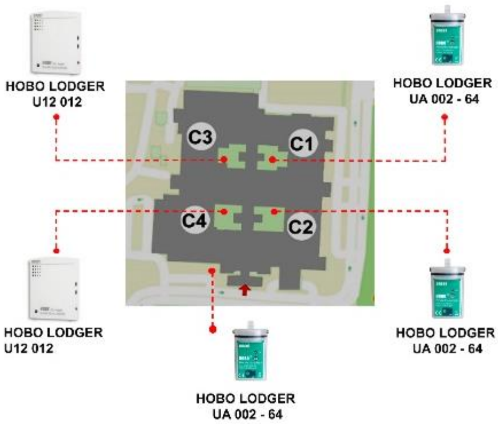
i) Use the weather station to record the environmental data of each courtyard area on a different day.

Only one weather station used. Weather data were collected at each courtyard (C1, C2, C3 and C4) on 4 different days. This environmental data was recorded at the same time that the surveys were distributed to the courtyard users.

ii) Record the outdoor temperature and light level in the courtyard area and outside of the hospital building on the same days and times.

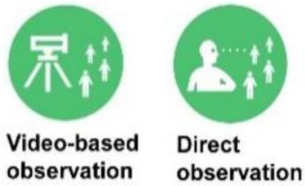
A) Planning for H3- hospital (4 courtyards)

Four hobo lodgers were used to record the **temperature** in each courtyard area (**C1, C2, C3 & C4)** at the **same time and day.** 1 hobo lodger was placed outside the hospital at the same time and day.



This was to provide a result of the differences in the average **temperature** at each courtyard area.

<table>
<tr>
<td>TEST THE PROCEDURE AND THE PRACTICALITY THE VIDEO-BASED OBSERVATION

- 8 hours video recording (9am - 5pm).</td>
<td>
</td>
</tr>
<tr>
<td>i) The location of the poster notice near to courtyard entrance might affect people's reactions to use or visit the courtyard area because they know they will be filmed.

Therefore, the poster notice was relocated at the corner of the courtyard area away from the courtyard entrance. Due to this, people carried out their activities as normal and only subsequently reacted to the notice.</td>
<td>i) The location of the poster notice is located at a location away from the entrance to the courtyard area.

This was to ensure that people would not refrain from using the courtyard area because of the notice of filming.

</td>
</tr>
<tr>
<td>ii) Monitoring the video camera is important to ensure all the activities on site were recorded.

The equipment used for video recording:
- 2 video cameras
- 2 tripods
- 8 lithium rechargeable batteries (4 batteries for each video camera)
- 2 (32 GB) SD card – to store the video data.</td>
<td>ii) The research assistant should always monitor the video camera to ensure the recording can be done within 8 hours and all activities can be recorded.

Monitoring the batteries:
- The battery should be changed every 2 hours.

<table>
<tr><td>Duration</td><td colspan="4">8 hours recording</td></tr>
<tr><td>Recording time</td><td>9am-11</td><td>11am-1pm</td><td>1-3pm</td><td>3-5pm</td></tr>
<tr><td>Time to change the battery</td><td>-</td><td>11pm</td><td>1pm</td><td>3pm</td></tr>
</table>

Monitoring SD cards storage:

The memory of the SD cards was full after 4 hours of recording. The data on the SD card needed to be transferred onto the hard drive at 1 pm before it could be used to record the next 4 hours starting from 1 pm to 5 pm.</td>
</tr>
</table>

APPENDIX 12: A checklist of HCG specifications

Hospital ID :__________
Date:____ / ____ / _______
Codes : H1 H2 H3

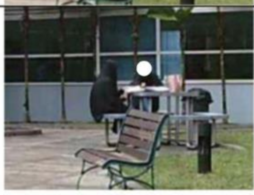
COURTYARD DESIGN SPECIFICATIONS				
COURTYARD PHYSICAL CONDITION			**YES**	**NO**
Form	Square			
	Rectangular			
	Others			
Shape	Fully enclosed			
	Semi-Enclosed	3 sided enclosed		
		2 sided enclosed		
		Others		
Height	____________ mm			
Size of the courtyard space	____________m2			
No. of Floor				
Orientation	North/South			
	East/West			
	North East / South West			
	North West / South East			
Shading devices	Cantilevered roof			
	Overhang			
Additional structure	Bridge			
	Covered walkway			
Windows/ opening	What types of opening:			
	Provide natural ventilation into the adjacent spaces			
	Provide day lighting into the indoor spaces			
SPACE PLANNING AND USAGE			**YES**	**NO**
Space functions	Close to the cafeteria			
	Close to the main entrance			
	Close to office			
	Close to specialist clinic			
	Close to the wards			
	Others:			

Location	Ground floor		
	Upper floor		
Accessibility	Easy access to the courtyard area		
	Is it restricted to access		
	Access for wheelchair users		
Visibility	Courtyard is visible from the indoor spaces.		
Wayfinding	Courtyard is easy to find		
Usage	The frequency of use is high		
Type of users	Courtyard is used by patient, staff and visitors		

LANDSCAPE ELEMENTS		**YES**	**NO**
Hardscape	Provide different variety of seating Comments:		
	Provide water features: Comments:		
Vegetation	Provide variety of vegetation Comments:		
	Shrubs		
	Canopies trees		
	Flowering plants		
	Herbs plants		

Comments:

APPENDIX 13: Sample of snapshots from the video recording

H2-C3 H2	**VIDEO-BASED OBSERVATION DATE: 23/1/2018 – TUE (WEEKDAY)**							
ACTIVITIES		IMAGES	Users	Gender	Age	Time start	Time finish	Time spent
Sit and reading			V	M	OA	9.00am	9.26am	26 min
Clean rubbish			S	M	YA	9.30am	9.33am	3 min
Sit and talking Reading			V V	F F	MA YA	10.14am	10.52am	38 min
Sit and eating			V	M	YA	10.15am	10.20am	5min
REHABILITATION PROGRAM	Preparation and waiting		S S S	F F F	YA YA MA	10.25am	10.52am	27 min (1 hour 17 mins)
REHABILITATION PROGRAM	Physical exercise		P P P	M M M	OA OA MA	10.57am	11.00am	3 min
REHABILITATION PROGRAM	Walking around Standing					11.00am	11.30am	30 min
REHABILITATION PROGRAM	Check blood pressure & breathing		V	F	MA	11.30am	11.47am	17 min
Sit and eat			V V (k)	M M	MA C	14.10am	14.20min	10min

H3-C2 H3	**VIDEO-BASED OBSERVATION** **DATE: 12/1/2018 (FRIDAY) - WEEKEND**						
ACTIVITIES	IMAGES	User s	Gender	Age	Time start	Time finish	Time spent
Sitting and eating		V V	F M	MA MA	12.00pm	12.35pm	35 min
Walking around with a child		V V (k)	F M	MA C	12.15pm	12.35pm	20 min
Playing beside slope area		V (k) V (k)	M F	C C	15.28pm	15.38pm	10 min
Walking around with kid Playing around	 	V V (k)	M F	OA C	15.34pm	15.42pm	8 min
Use a phone		V	M	YA	15.35pm	15.45	10 min
Sit on a bench Eating Sit on the floor Playing around	 	V V (k) V (k) V (k)	F M F F	YA C C C	15.40	3.59pm	19 min

APPENDIX 14: Historical overview of courtyard hospitals in Western and Islamic region

APPENDIX 15: A detailed specification of the equipment used in this study

<u>**Equipment 1:** Multifunction portable 4-in-1 Environmental Meter</u>

It can measure:

- Air temperature
- Air relative humidity
- Sound level
- Light level

Description:

This hand-held 4-in-1 portable environmental meter is a cost-effective tool to measure the environmental data. It has score professional application for professional use. It measures sound levels(dB), humidity levels, light levels (Lux) and temperature (via Type K thermocouple). The LCD display has large digits and function indicators. It has semiconductor sensors in the probe for humidity and ambient temperature measurements.

Features detachable humidity and light sensors, tripod connector and fast measurement rate (1.5 times per second).

Detail specifications:

Temperature	
Measurement range:	-20°C to +750°C (-4°F to +1382°F)
Resolution:	0.1°C/ 1°C, 0.1°F / 1°F
Accuracy:	±3% reading / ±2°C (at -20°C + ~200°C) ±3.5% reading / ± 2°C (at -20°C + ~750°C)
Relative humidity	
Measurement range:	25% to 95% RH
Resolution:	0.1% RH. 0.1 C
Accuracy:	±5% RH (at -25°C, 35% ~95% RH)
Light	
Measurement range:	0 to 20,000Lux
Resolution:	0.01 Lux
Accuracy:	±5%rdg +10dgts
Sound	
Measurement range:	A LO (low) - Weighting: 35-100dB A HI (High) - Weighing: 65-130dB
Resolution:	0.1 dB
Accuracy:	±3.5 dB at 94 dB, 1KHZ sine wave
Microphone:	Electric condenser microphone
Photo detector:	Long life silicon photo diode with filter
Storage temperature:	-10°C to +60°C (+14°F to +140°F)
Storage humidity:	< 80% RH
Power:	1 x 9V battery (supplied)
Dimensions:	251mm (H) x 63.8mm (W) x 40mm (D)
Weight:	250g

Equipment 2: HOBO U12 012 - Temperature/Relative Humidity/Light/External Data Logger

It can measure:

- Air temperature
- Air relative humidity
- Light level

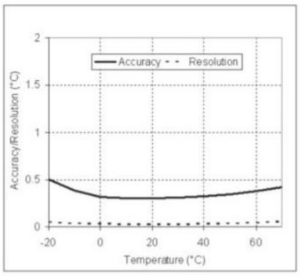
Description:

The HOBO U12 Temperature/Relative Humidity/Light/ External Data Logger is a four-channel logger with 12- bit resolution and can record up to 43,000 measurements or events. The external channel accepts a wide range of Onset and third-party sensors/transducers with a 0-2.5 VDC output, including external temperature, AC current, pressure, air velocity, and kW sensors.

- 12-bit resolution provides high accuracy
- Large memory for long-term deployments or fast sampling
- Programmable and push button start
- Direct USB interface for fast data offload
- Compatible with Onset's HOBO U-Shuttle for convenient data transport
- Compatible with HOBOware and HOBOware Pro for logger setup, graphing, and analysis

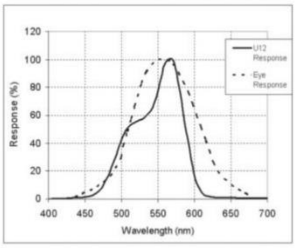
Detail specification:

Measurement Range
Temperature: -20° to 70°C (-4° to 158°F)
RH: 5% to 95% RH
Light intensity: 1 to 3000 footcandles (lumens/ft2) typical; maximum value varies from 1500 to 4500 footcandles (lumens/ft2)
External input channel (see sensor manual): 0 to 2.5 VDC; 0 to 5 VDC (with CABLE-ADAP5) and 0 to 10 VDC (with CABLE-ADAP10)



Plot A

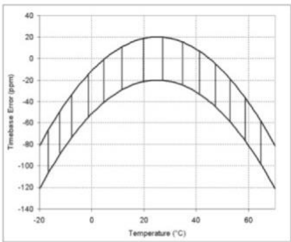
Accuracy
Temperature: ± 0.35°C from 0° to 50°C (± 0.63°F from 32° to 122°F), see Plot A
RH: ± 2.5% from 10% to 90% RH typical, to a maximum of ±3.5% including hysteresis at 25°C (77°F); below 10% and above 90% ±5% typical
Light intensity: Designed for indoor measurement of relative light levels, see Plot B for light wavelength response
External input channel (see sensor manual): ± 2 mV ± 2.5% of absolute reading



Plot B

Resolution
Temperature: 0.03°C at 25°C (0.05°F at 77°F), see Plot A.
RH: 0.05%
External Input Channels: 0.6 mV

Drift
Temperature: 0.1°C/year (0.2°F/year)
RH: <1% per year typical
Response Time in airflow of 1m/s (2.2 mph)
Temperature: 6 minutes, typical to 90%
RH: 1 minute, typical to 90%
Time accuracy:
± 1 minute per month at 25°C (77°F), see Plot C
Operating temperature
Logging: -20° to 70°C (-4° to 158°F)
Launch/readout: 0° to 50°C (32° to 122°F), per USB specification
Battery life: 1 year typical use
Battery Type: CR2032
Memory
64K bytes (43,000 12-bit measurements)



Plot C

Materials: Polypropylene case; stainless steel screws; Buna-N o-ring
Weight: 46 g (1.6 oz)
Dimensions: 58 x 74 x 22 mm (2.3 x 2.9 x 0.9 inches)
The CE Marking identifies this product as complying with the relevant directives in the European Union (EU).

Equipment 3: WS3083 Professional Wireless Weather Station

Base station and transmitter unit

It can measure:

- Air temperature (outdoor and indoor)
- Air humidity (outdoor and indoor)
- Wind speed
- Wind direction

Example how the weather station was used in previous study to record the environmental data in outdoor

Source: Geoghegan et al. (2014)

Description:

The WS3083 Professional Wireless Weather station includes a base station (receiver), a transmitter unit which can record both the environmental data both outdoor and indoor data. The Base Station allows the internal storage of up to 4,080 complete sets of weather data with time and date. These data sets are stored in non-volatile ring buffer memory (EEPROM) and will not be lost in the event of an interruption of power supply (e. g. change of batteries).

Detail specifications:

Outdoor data	
Transmission distance in open field:	U to 100m (line of site)
Frequency:	433 MHZ
Temperature range:	-40°C to +60°C
Resolution:	0.1°C
Measuring range relative humidity:	10% to 99%
Resolution:	1%
Rain volume display	0 - 9,999mm
Resolution:	0.3mm (if rain volume < 1,000mm)
	1mm (if rain volume > 1,000mm)
Wind speed:	0 - 160 kph
Resolution:	0.1 km/h
Light:	0 - 400k Lux
Resolution:	1 Lux
Measuring interval thermal-hygro sensors:	48 sec
Measuring interval UV and Light sensors:	60 sec
Waterproof level:	IPX 3
Indoor data	
Measuring interval pressure / temperature:	48 sec
Indoor temperature range:	0°C to +60°C
Resolution	0.1°C
Measuring range relative humidity:	10% to 99%
Resolution:	1%
Measuring range air pressure:	300-1, 100hPa (8.85-32.5 in Hg)
Resolution:	0.1hPa
Alarm duration:	120 sec
Power consumption:	
Base station:	
Remote sensor:	3 X AA 1.5 Batteries
	2 X AA 1.5 batteries

Equipment 4: HOBO Pendant Temperature/Light Data Logger 64K-UA-002-64

It can measure:

- Air temperature (Ta)
- Light intensity

Description:

This miniature data logger can record temperature and relative light levels. Complete with waterproof casing, this product is designed for indoor, outdoor, and underwater deployment.

This model can store approximately 52,000 measurements of 10-bit readings. It is recommended to use a solar radiation shield for accurate temperature measurement in sunlight.

- Low-cost temperature with alarm indication or light intensity
- Waterproof housing for wet or underwater use
- Data readout in less than 30 seconds via fast Optic USB interface
- This data logger operates in outdoor and underwater environments.

An example of how the loggers was attached to the trees to measure hourly air temperature in outdoor environment

Source: Blumroeder et al. (2019)

Source: Chaput and Gajewski (2014)

Detail specification:

Measurement Range
Temperature: -20° to 70°C (-4° to 158°F)
Light: 0 to 320,000 lux (0 to 30,000 lumens/ft2)

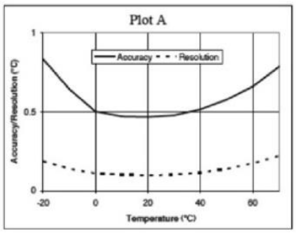
Accuracy
Temperature: ± 0.53°C from 0° to 50°C (± 0.95°F from 32° to 122°F), see Plot A in manual
Light intensity: Designed for measurement of relative light levels, see Plot D for light wavelength response

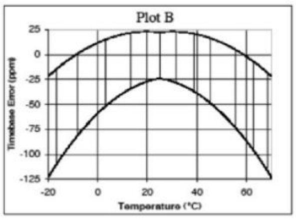
Resolution
Temperature: 0.14°C at 25°C (0.25°F at 77°F), see Plot A in manual
Drift: Less than 0.1°C/year (0.2°F/year)

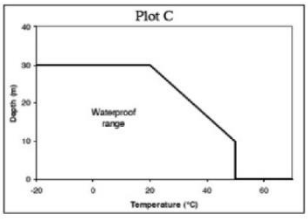
Response Time
Airflow of 2 m/s (4.4 mph): 10 minutes, typical to 90%
Water: 5 minutes, typical to 90%
Time accuracy: ± 1 minute per month at 25°C (77°F), see Plot B in manual

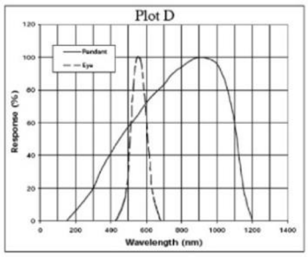
Operating Range
In water/ice: -20° to 50°C (-4° to 122°F)
In air: -20° to 70°C (-4° to 158°F)
Water depth rating: 30 m from -20° to 20°C (100 ft from -4° to 68°F), see Plot C in manual
NIST traceable certification: Available for temperature only at additional charge; temperature range -20° to 70°C (-4° to 158°F)

Battery life: 1 year typical use
Battery Type: CR2032
Memory
UA-002-64: 64K bytes (approximately 28K combined temperature and light readings or events)
Materials: Polypropylene case; stainless steel screws; Buna-N o-ring
Weight: 18 g (0.6 oz)
Dimensions: 58 x 33 x 23 mm (2.3 x 1.3 x 0.9 inches)
The CE Marking identifies this product as complying with the relevant directives in the European Union (EU).









APPENDIX 16: A summary of reviews of outdoor thermal comfort research in various region and hot humid climate

Table 1: A previous studies on outdoor thermal environment **in a various region of a different climatically context.**

OUTDOOR ENVIRONMENT – OTHER CLIMATIC REGIONS			
AUTHOR (YEAR)	**CASE STUDIES**	**METHODS AND NO OF CASE STUDIES**	**FINDINGS**
Johansson et al. (2018) (Johansson and Yahia, Moohammed Wasim ArroyoIvette; Bengs, 2018)	**Ecuador** (Warm humid climate) **Case study:** 5 public places on both dry and rainy days: • Park • Waterfront • Square • Square • Pedestrian arcade	**Methods:** Field measurement Subjective assessment (9-point TSV scale and 3-point Mc-intyre scale) **Microclimatic parameter:** • Globe temperature • Air temperature • Relative Humidity • Wind speed • Solar radiation • Sky view factors (Fisheye photos) **Sample:** N=544 Dry season (N=343) Rainy season (N=201)	This study aims to examine the impact of urban microclimatic conditions on people's thermal sensation and compare two thermal indices, PET and SET. **Findings:** People in Ecuador perceived the outdoor thermal comfort as too warm. Thus, this study suggested to enhance the urban design by providing shade and ventilation. **Preferred conditions:** People in warm climates preferred more cooling, shade, more wind and less humidity and solar radiation. **Adaptation:** People in warm climates were found to seek shaded places (e.g. sit under trees, pergola shaded area). People were observed to use umbrellas, wear a cap and use notebooks to covers their faces from direct solar radiation.
Krüger and Rossi (2011)	**Brazil** Open outdoor spaces (Streets surrounded by buildings and vegetation).	**Methods:** • Field measurement (10am-3pm) (Summer and winter) • Subjective assessment (7-point TSV scale) **Microclimatic parameter:** • Globe temperature • Air temperature • Relative Humidity • Wind speed • Solar radiation **Instrument:** Micrometeorological instruments fixed on two tripods connecting to data loggers. **Sample:** Passers-by pedestrian street (N=1654)	**Findings:** This study found that air movement contributed to the increase in neutral temperatures and improve thermal discomfort impacted by the heat during the summer. This study found that people were less sensitive to the heat and to the cold, which contradicted previous findings by Nikolopoulou and Lykoudis (2007). This could be because the elderly used higher quality clothing with which enhanced their thermal comfort to adapt to the cold weather. **Critics:** The sample were randomly selected from among the group of volunteers. The distribution of the data group was not equal and thus the results could not be generalised to a larger population.

Thorsson et al. *(*2007)	**Japan** Open park Two case study sites: • Matsudo Station square • Matsudo Central park	**Methods:** • Field measurement (Carried out simultaneously in two sites) • Subjective assessment (survey interview) (Winter/spring - March) (Spring /summer - May) (Utilised a 9-point TSV scale) • Observation **Instrument:** • Several micrometeorological instruments fixed on two tripods connecting to data loggers. Placed at 1.1 m height **Microclimatic parameter:** • Air temperature • Globe temperature • Surface temperature • Relative humidity • Wind velocity • Solar radiation **Sample:** N=1142 Park: N=541 Square: N=601	**Findings:** **Time spent:** A higher numbers of visitors stayed more than 10 minutes in the park compared to the square. **TSV and time spent:** The results showed that those who felt the thermal conditions as acceptable (either slightly cool, comfortable or slightly warm) were found to spend longer time in both the park (21 minutes) and in the square (19 minutes). The **time spent** in both the square and park decreased to an average of 11 minutes when they felt discomfort (thermal conditions fell outside the acceptable comfort conditions (-1, 0, +1). The study also found that less people were seeking for shade while sitting in square than in the park. The researcher assumed that the possible reason for this was because these people had just come out from the building or from transportation.
Nikolopoulou and Lykoudis (2007)	**Greece** Open spaces in Urban Mediterranean 2 case studies: • Karaiskaki square (80 X 100 sqm) • Seashore of Alimos (200 X 100 sqm)	**Methods:** • Field measurement • Subjective assessment (Seasonal survey interview) • Observation **Microclimatic parameter:** • Air temperature • Relative humidity • Wind speed • Solar radiation **Sample:** N=1503 Summer (N=360) Winter (N=418) Spring N=307)	This study focused on the importance of the enhancement of the microclimatic conditions which impacted on how people utilised the space (i.e. part of the findings from the RUROS project). **Findings:** **Thermal sensitivity:** The study also found that the elderly (>65 years old) reported the highest sensitivity to the summer heat. **Preferences:** It was found that visitors preferred to sit in a sunlit area in autumn and winter. Whereas, in summer visitors preferred to sit in a shaded area. The most **influential factors** which influenced the usage of outdoor spaces was the air temperature and solar radiation. When the temperature increased significantly, it contributed to thermal discomfort and reduced the level of occupancy in the outdoor areas. **Level of occupancy:** In the late afternoon in summer, the level of occupancy was high. Whereas, in autumn and winter, the occupancy during the daytime was 300-400% higher than in summer.

Nikolopoulou and Steemer (2001)	**UK** Four case study sites City centre of Cambridge, UK • Urban square • Street • Park	**Methods:** • Field measurement (Spring, summer and winter - 1997) • Subjective assessment (survey interview) (Utilised a 5-point TSV scale) • Observation (3 weekends and 3 weekdays) **Microclimatic parameters:** **Instrument:** A portable mini met station placed next to the respondents **Sample:** N=1431	This study examined the influence of the microclimatic characteristics of outdoor spaces on the users' behaviours and space usage. **Findings:** The study found that warm conditions and the presence of sunlight influenced space utilisation. The use of outdoor spaces increased as the global temperature increased in all four different sites. The result showed that the majority felt comfortable when feeling warm or cool compared to neutral which suggested that people enjoyed feeling warm in winter and feeling cool in summer. During the winter, people appreciated more the open spaces which evidenced a warmer condition and preferred to sit under the sunlight. Whereas, in summer, people sought shade areas when the temperature reached 25ºC. This study suggested that the design of outdoor spaces was important because it can influence users' thermal comfort and thus impact on the use of the space.
Hoppe and Seidl (1991)	**Italy** At different locations along the beach (120m distance)	**Methods:** • Used official environmental data from nearby MET station • Field measurement • Using PET indices **Microclimatic parameters:** Air temperature Wind velocity Solar radiation **Sample:** Not reported	**Findings:** The results showed that thermal comfort was improved at the locations close to the waterside compared to the location at 120m distance from the waterside. The occurrence of maximum air temperature was recorded at the beach during the afternoon compared to early morning. **Critics:** • No subjective assessment was carried out. Moreover, the study could not be generalised because it was conducted at a single beach area.
Mayer and Höppe (1987)	**Germany** Three urban open spaces (Munich) Case 1: Street Canyon (Asphalt and granite surface) Case 2: Street Canyon (Asphalt and granite surface) Case 3: Rectangular backyard (Grass and trees)	**Methods:** Field measurement Used both PMV and PET indices to calculate thermal comfort **Microclimatic parameters:** Air temperature Air humidity Wind velocity Solar radiation Surface temperature **Sample:** Not reported	This study aimed to examine thermal comfort and investigate factors which influenced the microclimate of the different urban open spaces. **Findings:** The study found that, based on both the PMV and PET indices, there was significant difference in the thermal comfort conditions of the selected urban open spaces.

Table 2: Findings of previous studies on outdoor thermal environments in **a hot humid climate.**

OUTDOOR ENVIRONMENT – HOT HUMID CLIMATE REGION			
AUTHOR (YEAR)	**CASE STUDIES**	**METHODS AND NO. OF CASE STUDIES**	**FINDINGS**
Heng and Chow (2019)	**Singapore** One case study site: Urban botanical garden	**Methods:** • **Field measurement** (8 days 2013 / 2014) • **Subjective assessment** (Surveys) - TSV (7-point ASHRAE scale) - Thermal preference (3-point McIntyre Scale) - Humidity, wind speed and solar radiation sensation (5-point scale) **Microclimatic parameters:** • Globe temperature • Air temperature • Relative humidity • Wind speed • Solar radiation **Instruments:** Micrometeorological equipment (The instrument was placed 1.3 metres above ground level) **Sample:** N=1508 (valid surveys)	**Findings:** **The study found that the majority of the respondents felt comfortable in the urban park.** • This study suggests that the neutral temperature is 26.2°C, and the acceptable thermal temperatures range between 21.6°C to 31.6°C. The preferred temperature is 24.2°C. • This study found a lower neutral and preferred temperature recorded in the urban park compared to other previous outdoor thermal comfort studies carried out in the same climatic context.
Sharmin et al. (2019; 2015)	**Bangladesh** Urban outdoor area in the city of Dhaka **Six case study sites:** • Two formal residential areas (Diverse building height with narrow street) • Two traditional residential areas (Uniform 6 storey apartments and wider street)	**Methods:** • Field measurement (August 2012- 9.00am-6.00pm) • **Subjective assessment** (Surveys) - TSV (7-point ASHRAE scale) - Thermal preference (3-point McIntyre Scale) - Humidity, wind speed and solar radiation sensation (5-point scale) **Microclimatic parameters:** • Globe temperature • Air temperature • Relative humidity • Wind speed • Solar radiation • Surface temperature	**Findings:** • This study found that the microclimates of the different urban forms showed a significant association with global temperature, mean radiant temperature and wind speed. • This study revealed that the microclimate is influenced by urban geometry (i.e. building height, street patterns) of the different sites. • This study suggests that appropriate consideration of urban geometry can provide desirable shaded areas in urban areas and increase ventilation in the urban area. • This study found a significant correlation between the microclimatic conditions and TSV.

	• One commercial area (high rise area). • One educational area (open arrangement with mid-rise building)	• Sky view factors (SVF) **Instruments:** Micrometeorological equipment (The instrument was placed 1.5 metres above the ground) **Sample:** N=1286	• The results showed that 79% of the respondents voted 'slightly warm', 'warm' and 'hot'. Whereas, 21% of the respondents voted for 'neutral' and 'cooler'. • This study proposed the acceptable comfort range for Dhaka with a neutral range between 19.5ºC and 32.5ºC.
Ali and Patnaik (2018)	**India** Open urban area in the city of Bhopal 5 green urban parks • 2 lake fronts • 2 city centre markets • An open area with a grass surface	**Methods:** • Field measurement (12.30-4.00pm) • Subjective assessment (Surveys - TSV- 4-point scale **Microclimatic parameters:** • Globe temperature • Air temperature • Relative humidity • Wind speed • Solar radiation **Instruments:** Micrometeorological equipment (The instrument was placed 1.5 metres above the ground) **Sample:** (80 respondents for each site)	**Findings:** • This study found that the density of the tree canopy influenced the thermal comfort index PET. • This study showed that the global temperature has a significant impact on thermal comfort sensation. • Although the results of the thermal sensation scale showed that people felt hot in all three different sites, the results regarding thermal comfort sensation showed that they rated the park as 'comfortable', the lake front as 'comfortable' and 'slightly comfortable'. In contrast, in the market lanes, people reported that they felt 'uncomfortable'. • This study suggested that the presence of greenery and urban canopies are important elements in reducing the air temperature and improving people thermal comfort in urban areas.
Koerniawan and Gao (2015)	**Indonesia** 3 theme parks	**Methods:** • Field measurement (7.00am-5.00pm) • Using PET index to calculate thermal comfort (Rayman software) • TSV- 9-point scale **Microclimatic parameters:** • Globe temperature • Air temperature • Relative humidity • Wind speed • Solar radiation • Surface temperature • Sky view factors **Instruments:** Micrometeorological equipment (The instrument was placed 1.5 metres above the ground)	**Findings:** • This study suggested the additional amount of greenery in an outdoor environment to reduce solar radiation and decrease the surrounding air temperature in an urban theme park. • This study found that shade areas were preferred by people in the theme park. The results showed an increase in outdoor thermal comfort among people staying in a shaded area. • This study suggested that the location and the design concept of the theme park highly influenced the microclimatic conditions of the site and its thermal comfort.

Yang et al. (2013)	**Singapore** 13 typical resting outdoor area in the Shenton and Bedok areas. August 2010-May 2011	**Methods:** • Field measurement (August 2010, May 2011) • Subjective assessment (Surveys - TSV (7-point ASHRAE scale) - Thermal preference (3-point McIntyre Scale) - Humidity, wind speed and solar radiation sensation (5-point scale) **Microclimatic parameters:** • Globe temperature • Air temperature • Relative humidity • Wind speed • Solar radiation **Sample:** N=2036	**Findings:** • This study found that the solar sensation votes had a significant correlation with TSV followed by the WSV. • The results showed that TSV increased as the sun sensation votes increased. Whereas, TSV decreased as WSV increased. • This study suggested that the reason for staying did not have a significant influence on people's thermal sensation. • This study found a thermal neutrality of 28.7ºC and a preferred temperature of 26.5ºC. The acceptable operative temperature was between 26.3ºC to 31.7ºC. **Behaviour adaptation:** • People were observed to use a hat and move to a shaded area to adapt to the outdoor thermal environment.
Ng and Cheng (2012)	**China** Hong Kong	**Methods:** • Field measurement (Summer: 7-9pm) (Winter:12-2pm) (August, 2006) • Subjective assessment (Surveys) - TSV- 7-point scale - Humidity, wind speed and solar radiation sensation (5-point scale) **Microclimatic parameters:** • Globe temperature • Air temperature • Relative humidity • Wind speed • Solar radiation **Instrument:** Micrometeorological equipment fixed on a tripod **Sample:** N=2702 (n=1567- Summer) (n=1135 - Winter)	This study investigated people's perceptions of thermal comfort in an outdoor urban area in Hong Kong. **Findings:** • This study suggested that air temperature, solar radiation and wind speed are among the influential determinants of people's thermal sensation in the outdoor environment. • This study revealed that for people who sat under a shade area, a wind speed range of 0.9-1.3 m/s was required to achieve a comfortable thermal sensation (neutral). • This study suggested providing shade for pedestrians in an urban open spaces to reduce exposure to solar radiation and enhance thermal comfort. • This study suggested increasing greenery, including the variety and types of vegetation such as green canopies, shrubs, flower beds and grass to reduce thermal heat in urban areas.

APPENDIX 17: Respondents' positive and negative comments about the HCGs

Table 1: Number of responses received related to users' evaluation of the likes, dislikes and suggestion for improvement of the HCG

Aspect investigated		H1-C1 N=46	H2-C3 N=36	H3-C2 N=38	TOTAL N=120	Comments
NUMBER OF RESPONSES RECEIVED	**Positive aspects** (Liked)	114	74	58	**246**	• The frequency of liked response received from the H1-C1 regarding the physical design, microclimatic conditions, experience and activities is higher compared to the H2-C3 and H3-C2.
	Negative aspects (Dislikes)	46	38	51	**135**	• More dislikes responses received from the H3-C2 respondents compared to H1-C1 and H2-C3.
	Suggestion for improvements	90	74	100	**264**	• More suggestions for add and changes regarding the landscape elements, maintenance new facilities and HCG planning received from the H3-C2 compared to the other case study sites.
MISSING RESPONSES	**Positive aspects** (Liked)	1	1	-	**2**	• The majority of the respondents, like the case study HCG.
	Negative aspects (Dislikes)	13	12	4	**29**	• More respondents tended to express their dislikes regarding the H3-C2 compared to the H1-C1 and H2-C3
	Suggestion for improvements	3	5	-	**8**	• All respondents in H3-C2 provide suggestion for improvement regarding the HCG.

Table 2: Overall percentage of the responses on users' evaluation of the likes, dislikes and suggestion for improvement of the HCG

Aspect investigated		H1-C1 N=46	H2-C3 N=36	H3-C2 N=38	Comments
LIKES	Physical design	42%	44%	**47%**	• The most frequent responses in the three case study sites is related to the physical design. • A higher number of responses received in H1-C1 regarding the liked of the microclimatic conditions in the HCG compared to the H2-C3 and H3-C2.
	Microclimatic conditions	**31%**	12%	19%	
	Experiences	15%	26%	**31%**	
	Activities	12%	**18%**	3%	
DISLIKES	Physical design	46%	**71%**	55%	• H2-C3 has the highest disliked responses related to the physical design aspects compared to the H1-C1 and H3-C2. • Whereas, the respondents in H1-C1 was found to have more complaints related to the maintenance aspect compared to the physical design aspects.
	Maintenance	**54%**	29%	45%	
SUGGESTION	Landscape elements	52.2%	50%	**62%**	• More than half of the respondents from all three case study sites provide suggestion related to the improvement and changes related to the landscape elements in the HCG. • H1-C1 received more suggestion related to the maintenance of the HCG compared to the other case study sites. • More suggestion related to the HCG planning and new facilities received from the H2-C3 compared to the other case study sites.
	Maintenance	**34.4%**	12.2%	19%	
	New facilities	8.9%	**27%**	15%	
	HCG planning	4.4%	**10.8%**	4%	

Table 3: Users' evaluation of the **positive aspects** of the HCG – Main findings

LIKES Aspect investigated		**H1-C1 N=46**	**H2-C3 N=36**	**H3-C2 N=38**	**Comments**
PHYSICAL DESIGN	Greenery	**43.5%** (20)	19.4% (7)	34.2% (13)	A higher liked response regarding the greenery in H1-C1 and H3-C2 received compared to the H2-C3. This could be because the H1-C1 has more greenery and range of variety canopy trees. H3-C2 also have some palms trees that bring the greenery in the HCG.
	Pleasant view	32.6% (15)	**42%** (15)	13.2 (5)	A high percentage of response in H2-C3 that mentioned regarding the pleasant view in the HCG compared to the H3-C2. The presence of the black stains on the wall and pavement and the lack of greenery in the H3-C2 can be the reason that makes it look less pleasant compared to another HCGs.
	Seating area	**13%** (6)	8.3 (3)	-	Most of the respondents who visit the HCG are looking for a place to sit. More users mentioned they like the H1-C1 and H2-C3 because of the availability of seating area. While none of the respondents in H3-C2 mentioned they like the seating area in H3-C2.
	Cleanliness	6.5% (3)	16.7 (6)	15.8 (6)	In all three HCGs, only a few respondents mentioned that the HCGs look clean.
	Spacious	6.5% (3)	-	5.3% (2)	Compared to H2-C3, some respondents in both H1-C1 and H3-C2 mentioned that they liked the HCG because of its spaciousness. One of the respondents in H2-C3 said they dislike because it is too small.
MICROCLIMATIC CONDITIONS	Fresh air	41.3% (19)	11.1% (4)	-	Only some respondents in H1-C1 and H2-C3 mentioned that they like the fresh air in the HCG. None of the respondents in H3-C2 said about the fresh air.
	Well shaded	6.5% (3)	-	-	Only in H1-C1, the users mentioned that they liked the HCG because it is well-shaded by the canopies.
	Comfortable environment	**23.9%** (11)	13.8% (5)	15.8% (6)	Comparing to H2-C3 and H3-C2, a higher number of respondents mentioned that they liked the comfortable environment in the H1-C1.
	Sunlight	4.3% (2)	-	-	Surprisingly, some respondent in H1-C1 mentioned that they like the presence of morning sunlight in the HCG.
EXPERIENCE	Calmer mood	28.2% (13)	**42%** (15)	42.2% (16)	Some of the respondents in all the three case study HCGs mentioned that they like the HCG because it makes them felt calmer while spending time in the HCG.
	Quietness	6.5% (3)	8.3% (3)	2.6% (1)	Some of the respondents in all the three case study sites mentioned that they liked the quietness in the HCGs.
	Safe	2.2% (1)	-	2.6% (2)	Some respondent in H1-C1and H3-C2 mentioned they liked the HCG because they felt safe in the HCG.
	Religious connection	2.2% (1)	-	-	One respondent in H1-C1 mentioned that she likes to be in the HCG because by looking the trees it reminds her to do 'zikr' (i.e. an act of remembering God) which make her more connected to God.
	Refresh minds	-	2.8% (1)	-	One respondent mentioned that he liked the H2-C3 because it helps him to refresh his mind while spending time in the HCG.
ACTIVITIES	Rest and relaxed	10.8% (5)	19.4% (7)	5.3% (2)	Some respondents in all the three-case study mentioned that they like the HCG because it offers them an alternative place for them to rest and relaxed.
	Escape from indoor	4.3% (2)	13.8% (5)	-	Some respondents in H1-C1 and H2-C3 mentioned they liked the HCG because it provides a place for them to escape from an indoor hospital.
	Outdoor learning for Children	6.5% (3)	-	-	Some respondents in H1-C1 mentioned that the variety of herb plants in the H1-C1 are suitable for outdoor learning for the children.
	Outdoor therapy for patients	-	2.8% (1)	-	The staff in the H2-C3 mentioned that she liked the H3-C2 because it offers a place to conduct an outdoor therapy program with the rehabilitation patients.
	Meeting people	4.3% (2)	-	-	Some respondents in H1-C1 mentioned that they liked the HCG because it offers a place for them to meet people.
	Play area for children	4.3% (2)	-	-	H1-C1 offers a place for the children to play around while their parents visited their family members in the wards.

Table 4: Users' evaluation of the **negative aspects** of the HCG – Main findings

DISLIKE Aspect investigated		H1-C1	H2-C3	H3-C2	Comments
MAINTENANCE	Unfunctional water fountain	26.1% (12)	-	-	A higher number of respondents dislike the fact that the existing water fountain not functioned for some time.
	Dirty seating	-	-	18.4% (10)	The availability of a good condition of the seating area is problematic in the H3-C2 in which many respondents express dislike regarding the unclean state of benches in the HCG.
	Unsafe railing around the slope	-	-	13.2% (5)	Parents are those who concern about the safety of their child in the H3-C2. They mentioned on the wide gap between the balustrades that did not meet the safety requirement. The children might fell into the slope area.
	HCG - lack of care	10.8% (5)	13.8% (5)	5.3% (2)	Some respondents in all the three case study sites mentioned that the HCG is lack of care. The response related to the dissatisfaction with the plantings is associated with the untrimmed grass, unfertilised plants and unrepaired planting label in H1-C1.
	Expose electrical cable	2.2% (1)	5.6% (2)	-	The respondents in H1-C1 mentioned that they concerned about the safety in the HCG, whereas there is expose electrical cable in the water fountain that can pose a danger if the children play with it. A similar concern regarding the safety in the H2-C3 is related to the exposed electrical cable of broken lighting features is unsafe for a child.
	No grass	-	-	2.6% (1)	The respondent in H3-C2 complaint regarding the slippery surface of a non-grass area in the HCG, which is unsafe for kids to play around.
	Unclean fallen leaves	13% (6)	-	5.3% (2)	H3-C2 only have small trees and potted plants. No response received in the H3-C2, regarding the unclean fallen leaves as reported H1-C1 and H3-C2.
	The presence of the crow	2.2% (1)	-	-	One respondent in H1-C1 mentioned on the presence of the crow
	Unsafe sharp plants	-	2.8% (1)	-	One respondent dislike the sharp plants in the HCG
	Noise from the air -condenser	-	2.8% (1)	-	The respondent complained regarding the sound that comes from the air-condenser in the HCG which is very discomfort.
	Leaking problem of the air condenser	-	-	2.6% (1)	One respondent in H3-C2 complained about the leakage problem from the air condenser in the HCG, which has caused the seating area underneath it wet.
	Unmaintained existing pond	-	-	2.6% (1)	One respondent in H3-C2 criticised the bad condition of an existing pond in the HCG which need to be upgraded and maintained.
PHYSICAL DESIGN	No water features	-	22.2% (8)	-	Only in H2-C3 mentioned regarding the absence of the water features in the HCG. In H1-C1 there is water fountain provided, however it not functioned. In H3-C2 there is existing shallow pond (without water), which was not in good condition.
	Poor layout design	-	**16.7%** (6)	-	Only the respondents in H2-C3 mentioned that the layout is poor and need to be redesigned.
	Lack of seating	13% (6)	-	29% (11)	A higher number of responses received in H3-C2 regarding the lack of seating in the HCG. This could be because there were only two benches which are not in good condition provided in this HCG. Although the H1-C1 has a variety of seating area provided, some respondent in H1-C1 still mentioned on the lack of seating area in the HCG.

	No covered roof seating area	4.3% (2)	**13.8%** (5)	5.3% (2)	All respondents in H2-C3 mentioned they dislike the HCG because no covered roof seating was provided in these HCGs.
	The unfixed broken wooden bench	-	2.8% (1)	-	One respondent in H2-C3 mentioned that the wooden benches in the HCG are broken and need to be fixed.
	Unsuitable steel benches	-	2.8% (1)	-	One respondent in H2-C3 complaint regarding the steel bench in the HCG which he thinks that it is unsuitable as it became too hot and uncomfortable to sit during a sunny day.
	Lack of choice of plantings	-	2.8% (1)	15.8% (6)	A higher number of responses received in H3-C2 regarding the lack of choice of plantings. Only one respondent mentioned that H2-C3 has less variety of planting. None of the respondents mentioned that H1-C1 has less choice of plantings.
	Less / No flowering plants	8.7% (4)	8.3 (3)	7.9% (3)	Although none of the respondent in H1-C1 mentioned about less choice of planting, however, some of the respondents mentioned that there is lack of flowering plants in the HCG.
	Lack of shaded canopy trees	-	-	5.3% (2)	Some respondents in H3-C2 mentioned that there is a lack of canopy trees in the HCG that can help to provide shade to the ground area.
	Area are too small	-	2.8% (1)	2.6% (1)	Few respondents complained about the size of H2-C3 and H3-C2 in which they think that the HCG is smaller.
	No playground	8.7 (4)	-	2.6& (1)	Only in H1-C1 and H3-C2 mentioned about the need of the playground in the HCG. The respondents in H3-C2 did not mention about the playground might be because there is another option of HCG in the H2 hospital that provides a playground area for children.
	Too many pathways	-	-	2.6% (1)	One respondent is unsatisfied with the pathway design in H3-C2 in which it is too many pathway directions that sometimes make him confused.
	Access restriction	-	2.8% (1)	-	The only respondent in H2-C3 mentioned regarding some of the doors attached to the rehabilitation centre that often locked and inaccessible. It can only be accessed from one door that is attached to the main hospital street. H1-C1 and H3-C2 have several entrances or doors that allows users to pass through to go to another department unit in the hospital.

APPENDIX 18: Users' satisfactions with the overall planning and performance of the HCG (Cross-tabulation and Chi-Square test).

1. Landscape elements

Satisfaction with landscape elements by degree of satisfaction with the overall layout and planning of the HCG

CLOSELY RELATED	Overall layout and planning of the HCG						Row total	
	Very satisfied /Satisfied		Slightly satisfied		Dissatisfied / Very dissatisfied			
	N	%	N	%	N	%	N	%
Landscape elements								
Very satisfied /Satisfied	40	53.3	10	45.5	2	8.7	52	43.3
Slightly satisfied	7	9.3	7	31.8	1	4.3	15	12.5
Dissatisfied / Very dissatisfied	28	37.3	5	22.7	20	87.0	53	44.2
Column Total	46	100	36	100	38	100	120	100
Chi-Square test	Significance: .000 Contingency Coefficient = .442 Cramer's V = .348							

Satisfaction with landscape elements by the overall performance rating of the HCG

CLOSELY RELATED	Overall performance rating of the HCG						Row total	
	Very Good/ Excellent		Good		Fair/ Poor			
	N	%	N	%	N	%	N	%
Landscape elements								
Very satisfied /Satisfied	19	82.6	22	39.3	11	26.8	52	43.3
Slightly satisfied	2	8.7	9	16.1	4	9.8	15	12.6
Dissatisfied / Very dissatisfied	2	8.7	25	44.6	26	63.4	53	44.2
Column Total	46	100	36	100	38	100	120	100
Chi-Square test	Significance: .000 Contingency Coefficient =.394 Cramer's V = .303							

2. Wall condition

Satisfaction with the wall condition around the HCG by degree of satisfaction with the overall layout and planning of the HCG

CLOSELY RELATED	Overall layout and planning of the HCG						Row total	
	Very satisfied /Satisfied		Slightly satisfied		Dissatisfied / Very dissatisfied			
	N	%	N	%	N	%	N	%
Wall condition								
Very satisfied /Satisfied	38	50.7	4	18.2	3	13.0	45	37.5
Slightly satisfied	12	16.0	11	50.0	3	13.0	26	21.7
Dissatisfied / Very dissatisfied	25	33.3	7	31.8	17	73.9	49	40.8
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .000 Contingency Coefficient = .429 Cramer's V = .335							

Satisfaction with the wall condition around the HCG by the overall performance rating of the HCG

CLOSELY RELATED	**Overall performance rating of the HCG**						Row total	
	Very Good/ Excellent		Good		Fair/ Poor			
	N	%	N	%	N	%	N	%
Wall condition								
Very satisfied /Satisfied	16	69.6	20	35.7	9	22	45	37.5
Slightly satisfied	3	13.0	14	25.0	9	22	26	21.7
Dissatisfied / Very dissatisfied	4	17.4	22	39.3	23	56.1	49	40.8
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .004 Contingency Coefficient = .339 Cramer's V = .254							
Kendall s Tau correlation test	Correlation coefficient: .298 Significance: .000							

3. Access from the main entrance to the HCG

Satisfaction with the accessibility from the main entrance to the HCG by degree of satisfaction with the **overall layout and planning of the HCG**

CLOSELY RELATED	**Overall layout and planning of the HCG**						Row total	
	Very satisfied /Satisfied		Slightly satisfied		Dissatisfied / Very dissatisfied			
	N	%	N	%	N	%	N	%
Accessibility from the main entrance to the HCG								
Very satisfied /Satisfied	65	86.7	12	54.5	14	60.9	91	75.8
Slightly satisfied	3	4.0	7	31.8	2	8.7	12	10.0
Dissatisfied / Very dissatisfied	7	9.3	3	13.6	7	30.4	17	14.2
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .000 Contingency Coefficient = .393 Cramer's V = .302							

Satisfaction with the accessibility from the main entrance to the HCG by **the overall performance** rating of the HCG

NOT RELATED	**Overall performance rating of the HCG**						Row total	
	Very Good/ Excellent		Good		Fair/ Poor			
	N	%	N	%	N	%	N	%
Accessibility from the main entrance to the HCG								
Very satisfied /Satisfied	18	78.3	44	78.6	29	70.7	91	75.8
Slightly satisfied	1	4.3	5	8.9	6	14.6	12	10.0
Dissatisfied / Very dissatisfied	4	17.4	7	12.5	6	14.6	17	14.2
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .703 Contingency Coefficient =.134 Cramer's V = .095							

4. Visibility to the HCG from the adjacent space

Satisfaction with the visibility to the HCG from the adjacent space by degree of satisfaction with the overall layout and planning of the HCG

CLOSELY RELATED	Overall layout and planning of the HCG						Row total	
	Very satisfied /Satisfied		Slightly satisfied		Dissatisfied / Very dissatisfied			
	N	%	N	%	N	%	N	%
Visibility to the HCG from the adjacent space								
Very satisfied /Satisfied	68	90.7	16	72.7	13	56.5	97	80.8
Slightly satisfied	5	6.7	5	22.7	4	17.4	14	11.7
Dissatisfied / Very dissatisfied	9	2.7	1	4.5	6	26.1	9	7.5
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .000 Contingency Coefficient = .382 Cramer's V = .292							

Satisfaction with the visibility to the HCG from the adjacent space by the overall performance rating of the HCG

NOT RELATED	Overall performance rating of the HCG						Row total	
	Very Good/ Excellent		Good		Fair/ Poor			
	N	%	N	%	N	%	N	%
Visibility to the HCG from the adjacent space								
Very satisfied /Satisfied	21	91.3	45	80.4	31	75.6	97	80.8
Slightly satisfied	2	8.7	7	12.5	5	12.2	14	11.7
Dissatisfied / Very dissatisfied	0	0.0	4	7.1	5	12.2	9	7.5
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .462 Contingency Coefficient =.171 Cramer's V = .123							

5. Number of entrances

Satisfaction with the visibility to the HCG from the adjacent space by degree of satisfaction with the overall layout and planning of the HCG

RELATED	Overall layout and planning of the HCG						Row total	
	Very satisfied /Satisfied		Slightly satisfied		Dissatisfied / Very dissatisfied			
	N	%	N	%	N	%	N	%
Number of entrances								
Very satisfied /Satisfied	56	74.7	10	45.5	12	52.2	78	65
Slightly satisfied	6	8.0	7	31.8	4	17.4	17	14.2
Dissatisfied / Very dissatisfied	13	17.3	5	22.7	7	30.4	25	20.8
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .022 Contingency Coefficient = .295 Cramer's V = .219							

Satisfaction with the visibility to the HCG from the adjacent space by the overall performance rating of the HCG

	Overall performance rating of the HCG						Row total	
	Very Good/ Excellent		Good		Fair/ Poor			
	N	%	N	%	N	%	N	%
Number of entrances								
Very satisfied /Satisfied	21	91.3	45	80.4	31	75.6	97	80.8
Slightly satisfied	2	8.7	7	12.5	5	12.2	14	11.7
Dissatisfied / Very dissatisfied	0	0.0	4	7.1	5	12.2	9	7.5
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .462 Contingency Coefficient =.171 Cramer's V = .123					**NOT RELATED**		

6. Wayfinding to the HCG

Satisfaction with the wayfinding to the HCG by degree of satisfaction with the overall layout and planning of the HCG

RELATED	Overall layout and planning of the HCG						Row total	
	Very satisfied /Satisfied		Slightly satisfied		Dissatisfied / Very dissatisfied			
	N	%	N	%	N	%	N	%
Wayfinding to the HCG								
Very satisfied /Satisfied	51	68.0	7	31.8	13	56.5	71	59.2
Slightly satisfied	8	10.7	6	27.3	2	8.7	16	12.3
Dissatisfied / Very dissatisfied	16	21.3	9	40.9	8	34.8	33	27.5
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .030 Contingency Coefficient = .286 Cramer's V = .211							

Satisfaction with the wayfinding to the HCG by the overall performance rating of the HCG

NOT RELATED	Overall performance rating of the HCG						Row total	
	Very Good/ Excellent		Good		Fair/ Poor			
	N	%	N	%	N	%	N	%
Wayfinding to the HCG								
Very satisfied /Satisfied	12	52.2	33	58.9	26	63.4	71	59.2
Slightly satisfied	5	21.7	7	12.5	4	9.8	16	13.3
Dissatisfied / Very dissatisfied	6	26.1	16	28.6	11	26.8	33	27.5
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .735 Contingency Coefficient = .128 Cramer's V = .091							

7. Access to different department via the HCG

Satisfaction with the access to different department via the HCG by degree of satisfaction with the overall layout and planning of the HCG

RELATED	Overall layout and planning of the HCG						Row total	
	Very satisfied /Satisfied		Slightly satisfied		Dissatisfied / Very dissatisfied			
	N	%	N	%	N	%	N	%
Access to different department via the HCG								
Very satisfied /Satisfied	53	70.7	8	36.4	13	56.5	74	61.7
Slightly satisfied	10	13.3	9	40.9	5	21.7	24	20.0
Dissatisfied / Very dissatisfied	12	16.0	5	22.7	5	21.7	22	18.3
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .033 Contingency Coefficient = .283 Cramer's V = .209							

Satisfaction with the access to different department via the HCG by the overall performance rating of the HCG

NOT RELATED	Overall performance rating of the HCG						Row total	
	Very Good/ Excellent		Good		Fair/ Poor			
	N	%	N	%	N	%	N	%
Access to different department via the HCG								
Very satisfied /Satisfied	16	69.6	33	58.9	25	61.0	74	61.7
Slightly satisfied	3	13.0	14	25.0	7	17.1	24	20.0
Dissatisfied / Very dissatisfied	4	17.4	9	16.1	9	61.0	22	18.3
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .700 Contingency Coefficient = .134 Cramer's V = .096							

8. Access for a wheelchair user

Satisfaction with the access for a wheelchair user by degree of satisfaction with the overall layout and planning of the HCG

NOT RELATED	Overall layout and planning of the HCG						Row total	
	Very satisfied /Satisfied		Slightly satisfied		Dissatisfied / Very dissatisfied			
	N	%	N	%	N	%	N	%
Access for a wheelchair user								
Very satisfied /Satisfied	51	68.0	10	45.5	15	65.2	76	63.3
Slightly satisfied	8	10.7	4	18.2	2	8.7	14	11.7
Dissatisfied / Very dissatisfied	16	21.3	8	36.4	6	26.1	30	25.0
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .041 Contingency Coefficient = .179 Cramer's V = .129							

Satisfaction with the access for a wheelchair user by the overall performance rating of the HCG

NOT RELATED	Overall performance rating of the HCG						Row total	
	Very Good/ Excellent		Good		Fair/ Poor			
	N	%	N	%	N	%	N	%
Access for a wheelchair user								
Very satisfied /Satisfied	16	69.6	36	64.3	24	58.5	76	63.3
Slightly satisfied	3	13.0	4	7.1	7	17.1	14	11.7
Dissatisfied / Very dissatisfied	4	17.4	16	28.6	10	24.4	30	25.0
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .530 Contingency Coefficient = .160 Cramer's V = .115							

9. Location close to a cafeteria

Satisfaction with the access for a location close to a cafeteria by degree of satisfaction with the overall layout and planning of the HCG

NOT RELATED	Overall layout and planning of the HCG						Row total	
	Very satisfied /Satisfied		Slightly satisfied		Dissatisfied / Very dissatisfied			
	N	%	N	%	N	%	N	%
Location close to a cafeteria								
Very satisfied /Satisfied	63	84.0	17	77.3	18	78.3	98	81.7
Slightly satisfied	7	9.3	3	13.6	2	8.7	12	10.0
Dissatisfied / Very dissatisfied	5	6.7	2	9.1	3	13.0	10	8.3
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .848 Contingency Coefficient = .106 Cramer's V = .076							

Satisfaction with the access for a location close to a cafeteria by the overall performance rating of the HCG

NOT RELATED	Overall performance rating of the HCG						Row total	
	Very Good/ Excellent		Good		Fair/ Poor			
	N	%	N	%	N	%	N	%
Location close to a cafeteria								
Very satisfied /Satisfied	21	91.3	45	80.4	32	78.0	98	81.7
Slightly satisfied	2	8.7	7	12.5	3	7.3	12	10.0
Dissatisfied / Very dissatisfied	0	0.0	4	7.1	6	14.6	10	8.3
Column Total	46	100	36	100	38	100	120	100
Chi-square test	Significance: .288 Contingency Coefficient = .200 Cramer's V = .144							

APPENDIX 19: Users' perceptions of the importance of landscape elements in the HCG (Cross-tabulation & Chi-square test)

Demographic factors and perceived importance of water feature

Demographic characteristic (N=120)		WATER FEATURE						Chi-square (p - value)
		Important / Very Important		Moderately important		Off little important / Not important		
		N	%	N	%	N	%	
Type of users	Patient	9	56.3	4	25.0	3	18.8	0.37 (p =.985)
	Staff	12	60.0	5	25.0	3	15.0	
	Visitor	45	53.6	22	26.2	17	20.2	
Gender	Female	36	49.3	22	30.0	15	20.5	2.62 (p = .270)
	Male	30	63.8	9	19.1	8	17.0	
Age	Young adult (18-35 years)	34	57.6	15	25.4	10	16.9	6.10 (p = .412)
	Middle age adults (36-55 years)	21	45.7	13	28.3	12	26.1	
	Older age adults (55-64 years old)	9	81.8	2	18.2	0	0.0	
	Senior (65 years and older)	2	50.0	1	25.0	1	25.0	
Ethnicity	Malay	52	53.0	27	27.6	19	19.4	6.08 (p = .414)
	Chinese	3	75.0	0	0.0	1	25.0	
	Indian	6	46.2	4	30.8	3	23.1	
	Other	5	100	0	0.0	0	0.0	

Demographic factors and perceived importance of green plants

Demographic characteristic (N=120)		GREEN PLANTS						Chi-square (p - value)
		Important / Very Important		Moderately important		Off little important / Not important		
		N	%	N	%	N	%	
Type of users	Patient	15	93.8	0	0.0	1	6.3	8.26 (p =.082)
	Staff	19	95.0	1	5.0	0	0	
	Visitor	83	98.8	1	1.2	0	0	
Gender	Female	70	95.9	2	2.7	1	1.4	1.98 (p =.371)
	Male	47	100	0	0.0	0	0.0	
Age	Young adult (18-35 years)	58	98.3	0	0.0	1	1.7	4.28 (p = .639)
	Middle age adults (36-55 years)	44	95.7	2	4.3	0	0.0	
	Older age adults (55-64 years old)	11	100	0	0.0	0	0.0	
	Senior (65 years and older)	4	100	0	0.0	0	0.0	
Ethnicity	Malay	96	98.0	2	2.0	0	0.0	8.72 (p = .190)
	Chinese	4	100	0	0.0	0	0.0	
	Indian	12	92.3	0	0.0	1	7.7	
	Other	5	100	0	0.0	0	0.0	

Demographic factors and perceived importance of the seating area

Demographic characteristic (N=120)		SEATING AREA						Chi-square (p-value)
		Important / Very Important		Moderately important		Off little important / Not important		
		N	%	N	%	N	%	
Type of users	Patient	13	81.3	1	5.3	2	12.5	5.87 (p = .209)
	Staff	19	95.0	0	0.0	1	5.0	
	Visitor	73	86.9	9	10.7	2	2.4	
Gender	Female	64	87.7	6	8.2	3	4.1	.005 (p =.998)
	Male	41	87.2	4	8.5	2	4.3	
Age	Young adult (18-35 years)	52	88.1	4	6.8	3	5.1	6.14 (p = .408)
	Middle age adults (36-55 years)	40	87.0	5	10.9	1	2.2	
	Older age adults (55-64 years old)	10	90.9	1	9.1	0	0.0	
	Senior (65 years and older)	3	75.0	0	0.0	1	25.0	
Ethnicity	Malay	86	87.8	9	9.2	3	3.1	7.02 (p =. 319)
	Chinese	4	100	0	0.0	0	0.0	
	Indian	11	84.6	0	0.0	2	15.4	
	Other	4	80.0	1	20.0	0	0.0	

Demographic factors and perceived importance of the flowering shrubs

Demographic characteristic (N=120)		FLOWERING SHRUBS						Chi-square (p- value)
		Important / Very Important		Moderately important		Off little important / Not important		
		N	%	N	%	N	%	
Type of users	Patient	15	93.8	0	0.0	1	6.3	8.27 (p =.082)
	Staff	19	95.0	1	5.0	0	0.0	
	Visitor	83	98.8	1	1.2	0	0.0	
Gender	Female	71	97.3	1	1.4	1	1.4	.743 (p = .690)
	Male	46	97.9	1	2.1	0	0	
Age	Young adult (18-35 years)	58	98.3	0	0.0	1	1.7	4.28 (p =.639)
	Middle age adults (36-55 years)	44	95.7	2	4.3	0	0.0	
	Older age adults (55-64 years old)	11	100	0	0.0	0	0.0	
	Senior (65 years and older)	4	100	0	0.0	0	0.0	
Ethnicity	Malay	96	98.0	2	2.0	0	0.0	8.72 (p =.190)
	Chinese	4	100	0	0.0	0	0.0	
	Indian	12	92.3	0	0.0	1	7.7	
	Other	5	100	0	0.0	0	0.0	

Demographic factors and perceived importance of pedestrian walkway

Demographic characteristic **(N=120)**		**PEDESTRIAN WALKWAY**						**Chi-square (p- value)**
		Important / Very Important		Moderately important		Off little important / Not important		
		N	%	N	%	N	%	
Type of users	Patient	15	93.8	0	0.0	1	6.3	5.23 (p = .265)
	Staff	19	95.0	0	0.0	1	5.0	
	Visitor	83	98.8	1	1.2	0	0.0	
Gender	Female	71	97.3	1	1.4	1	1.4	.743 (p = .690)
	Male	46	97.9	0	0	1	2.1	
Age	Young adult (18-35 years)	57	96.6	0	0.0	2	3.4	3.69 (p = .718)
	Middle age adults (36-55 years)	45	97.8	1	2.2	0	0.0	
	Older age adults (55-64 years old)	11	100	0	0.0	0	0.0	
	Senior (65 years and older)	4	100	0	0.0	0	0.0	
Ethnicity	Malay	96	98.0	1	1.0	1	1.0	3.49 (p =.745)
	Chinese	4	100	0	0.0	0	0.0	
	Indian	12	92.3	0	0.0	1	7.7	
	Other	5	100	0	0.0	0	0.0	

Demographic factors and perceived importance of grass

Demographic characteristic **(N=120)**		**GRASS**						**Chi-square (p-value)**
		Important / Very Important		Moderately important		Off little important / Not important		
		N	%	N	%	N	%	
Type of users	Patient	15	93.8	0	0.0	1	6.3	3.69 (p = .449)
	Staff	19	95.0	1	5.0	0	0	
	Visitor	77	91.7	6	7.1	1	1.2	
Gender	Female	65	89.0	6	8.2	2	2.7	3.35 (p =.188)
	Male	46	97.9	1	2.1	0	0.0	
Age	Young adult (18-35 years)	53	89.8	4	6.8	2	3.4	5.78 (p = .447)
	Middle age adults (36-55 years)	44	95.7	2	4.3	0	0.0	
	Older age adults (55-64 years old)	11	100	0	0.0	0	0.0	
	Senior (65 years and older)	3	75	1	25.0	0	0.0	
Ethnicity	Malay	90	91.8	7	7.1	1	1.0	4.86 (p = .562)
	Chinese	4	100	0	0.0	0	0.0	
	Indian	12	92.3	0	0.0	1	7.7	
	Other	5	100	0	0.0	0	0.0	

APPENDIX 20: Users' preferences of the HCG images

Table 1: Chi square test and cross-tabulation users' preferences of courtyard gardens images by the demographic data (Question 14)

QUESTION 14: **Which images of the courtyard garden you like the most?** **(N=120)**		**IMAGE A**		**IMAGE B**		**IMAGE C**		**Chi-square (p - value)**
								
Demographic data		**N**	**%**	**N**	**%**	**N**	**%**	
Type of users	Patient	1	6.3	**10**	**62.5**	5	31.3	X^2:16.12 **(p =.003)** C=.344
	Staff	6	30	**12**	**60**	2	10	
	Visitor	3	3.6	**61**	**72.6**	20	23.8	
Gender	Female	4	5.5	**55**	**75.3**	14	19.2	X^2:3.76 (p = .152) C=.174
	Male	6	12.8	**28**	**59.6**	13	27.7	
Age	Young adult (18-35 years)	5	8.5	**43**	**72.9**	11	18.6	X^2:15.93 **(p = .014)** C=.342
	Middle age adults (36-55 years)	5	10.9	**31**	**67.4**	10	21.7	
	Older age adults (55-64 years old)	0	0.0	**9**	**81.8**	2	18.2	
	Senior age adults (65 years & older)	0	0.0	0	0.0	**4**	**100**	
Ethnicity	Malay	7	7.1	**71**	**72.4**	20	20.4	X^2:15.4 **(p = .017)** C=.337
	Chinese	0	0.0	**4**	**100**	0	0.0	
	Indian	1	7.7	**8**	**61.5**	4	30.8	
	Other	2	40	0	0.0	**3**	**60**	

Table 2: Chi square result of the reason for image preferences (Question 14)

QUESTION 14: **Continue>>** **Why you choose this image?** **(N=120)**		**IMAGE A**		**IMAGE B**		**IMAGE C**		**Chi-square (p - value)**
								
Reason for image preferences		**N**	**%**	**N**	**%**	**N**	**%**	
Landscape elements	Greenery	4	6.3	42	66.7	17	27.0	p =.381
	Seating area	1	3.6	26	92.9	1	3.6	X^2:9.77 **p =.008** C=.274
	Water features	1	3.6	26	92.6	1	3.6	X^2:9.77 **p =.008** C=.274
	Flowering plants	0	0.0	1	16.7	5	83.3	X^2:13.43 **p =.001** C=.317
	Walkway	2	18.2	8	72.7	1	9.1	p =.301
Atmosphere	Comfortable environment	3	18.8	9	56.3	4	25.0	p =.235
	Cheerful environment	0	0.0	4	66.7	2	33.3	p =.650
	Calm environment	1	5.6	14	77.8	3	16.7	p =.690
	Pleasant view	2	7.4	22	81.5	3	11.1	p =.246
	Safe environment	1	50	1	50	0	0	p =.091
	Fresh air	0	0	3	60	2	40	p =.547
Planning	Spacious	4	26.7	8	53.3	3	20.0	X^2:7.58 **p =.023** C-.244
	Well-designed	0	0.0	18	78.3	5	21.7	p =.257
	Well-shaded	1	11.1	4	44.4	4	44.4	p =.220
	Multilevel garden	0	0.0	2	100	0	0.0	p =.636
	Rest area	0	0.0	8	88.9	1	11.1	p =.376
	Exercise area	0	0.0	1	100	0	0.0	p =.799
	Play area	0	0.0	1	100	0	0.0	p =.799
Maintenance	Well-maintained	0	0.0	4	80	1	20	p =.764
	Cleanliness	0	0.0	5	100	0	0	p =.313

Percentage of responses	IMAGE A		IMAGE B		IMAGE C		Row total	
	N	%	N	%	N	%	N	%
Landscape elements	8	6	102	75	25	19	135	100
Atmosphere	11	12	61	69	17	19	89	100
Planning	1	2.2	34	76	10	22	45	100
Maintenance	0	0	9	90	1	10	10	100
Column total	20	20	206	310	53	70	279	100

Table 3: Total number of responses related to the preferences of images (Question 14)

							
Total responses (N=120)		**IMAGE A**		**IMAGE B**		**IMAGE C**	
Responses	**f**	**Responses**	**f**	**Responses**	**f**	**Responses**	**f**
Greenery	63	Spacious	4	Greenery	42	Greenery	17
Water features	28	Greenery	4	Water features	26	Well designed	5
Pleasant view	27	Comfortable	3	Pleasant view	22	Flower	5
Seating area	24	Pleasant view	2	Seating area	22	Comfortable	4
Well designed	23	Walkway	2	Well-designed	18	Well shaded	4
Calm	18	Water features	1	Calm	14	Pleasant view	3
Comfortable	16	Seating area	1	Comfortable	9	Spacious	3
Spacious	15	Well shaded	1	Spacious	8	Calm	3
Walkway	11	Safe	1	Rest area	8	Cheerful	2
Well shaded	9	Calm	1	Walkway	8	Fresh air	2
Rest area	9			Clean	5	Well maintained	1
Cheerful	6			Well-maintained	4	Seating area	1
Flower	6			Well shaded	4	Rest area	1
Well-maintained	5			Cheerful	4	Walkway	1
Fresh air	5			Fresh air	3		
Clean	5			Multilevel garden	2		
Multilevel garden	2			Exercise area	1		
Safe	2			Play area	1		
Exercise area	1			Flower	1		
Play area	1			Safe	1		
Total	**279**	**Total**	**20**	**Total**	**206**	**Total**	**53**

Table 4: Chi Square test and cross-tabulation users' preferences of courtyard gardens images by the demographic data (Question 15)

Question 15: **Which images of the courtyard garden you like the most?** **(N=120)**		**IMAGE 1**		**IMAGE 2**		**IMAGE 3**		**IMAGE 4**		**IMAGE 5**		**IMAGE 6**		**Chi-square (p - value)**
														
Demographic data		**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	
Type of users	Patient	5	20.0	9	12.5	8	14.0	2	5.3	9	19.6	4	11.1	Image 1: p=.476 Image 2: p=.807 Image 3: p=.471 Image 4: p=.208 Image 5: p=.258 Image 6: p=.542
	Staff	3	12.0	11	15.3	7	12.3	7	18.4	8	17.4	8	22.2	
	Visitor	17	68.0	52	72.2	42	73.7	29	76.3	29	63.0	24	66.7	
Gender	Female	13	52.0	43	59.7	36	63.2	21	55.3	26	56.5	27	75.0	Image 1: p=.309 Image 2: p=.760 Image 3: p=.620 Image 4: p=.395 Image 5: p=.446 **Image 6: (X^2:4.33, p=.037, C=187)**
	Male	12	48.0	29	40.3	21	36.8	17	44.7	20	43.5	9	25.0	
Age	Young adult (18-35 years)	14	56.0	39	54.2	29	50.9	15	39.5	21	45.7	19	52.8	Image 1: p=.151 Image 2: p=.101 Image 3: p=.272 **Image 4: (X^2: 9.74, p=.021, C=.274)** Image 5: p=.303 Image 6: p=.200
	Middle age adults (36-55 years)	9	36.0	27	37.5	22	38.6	14	36.8	16	34.8	16	44.4	
	Older age adults (55-64 years old)	0	0.0	3	4.2	6	10.5	8	21.1	7	15.2	1	2.8	
	Senior age adults (65 years & older)	2	8.0	3	4.2	0	0.0	1	2.6	2	4.3	0	0.0	
Ethnicity	Malay	20	80.0	62	86.1	44	77.2	34	89.5	36	78.3	29	80.6	Image 1: p=.992 **Image 2: (X^2:6.06, p=.015, C=.219)** Image 3: p=.471 Image 4: p=.354 Image 5: p=.499 Image 6: p=.961
	Chinese	0	4.0	2	2.8	3	5.3	1	2.6	2	4.3	1	2.8	
	Indian	3	12.0	4	5.6	10	17.5	3	7.9	7	15.2	4	11.1	
	Other	1	4.0	4	80.0	0	0.0	0	0.0	1	2.2	2	5.6	

Table 5: Frequency of responses related to the reason of image preferences (Question 15)

Ranking: 1		2		3		4		5		6	
IMAGE 2		IMAGE 3		IMAGE 5		IMAGE 4		IMAGE 6		IMAGE 1	
											
Responses	**f**	**Responses**	**f**	**Responses**	**f**	**Responses**	**f**	**Responses**	**f**	**Responses**	**f**
Greenery	30	Water features	44	Flower	32	Seating	14	Play area	32	Well-shaded	8
Comfortable	18	Calm	32	Pleasant view	9	Pleasant view	7	Safe	4	Calm	6
Well-shaded	16	Greenery	14	Calm	9	Comfortable	7	Comfortable	2	Rest area	5
Calm	13	Comfortable	8	Greenery	5	Rest area	6	Well shaded	2	Greenery	5
Shaded	12	Seating	8	Well-designed	4	Greenery	6	Calm	2	Pleasant	4
seating	10	Pleasant view	7	Comfortable	4	Well-	5	Pleasant view	1	view	3
Pleasant view	6	Rest area	3	Cheerful	4	maintained	5	Spacious	1	Water	3
Walkway	5	Well-designed	2	Well-	3	Clean	4	Greenery	1	features	3
Rest area	5	Cheerful	2	maintained		Calm	3			Comfortable	2
Seating	4	Fresh air	2	Spacious	3	Water features	3			Safe	1
Well-designed	4	Well shaded	1	Water features	2	Well-shaded	3			Seating	1
Spacious	3	Refreshing	1	Well-shaded	2	Walkway	3			Well-	1
Clean	2	Privacy	1	Refreshing	2	Safe	2			designed	
Well-	2	Walkway	1	Fresh air	2	Well-designed	2			Fresh air	
maintained		Flower	1	Walkway	2	Spacious	1			Walkway	
Fresh air	2			Rest area	1	Quietness	1				
Safe	1			Sunlight	1	Fresh air	1				
Water features	1			Clean	1	Privacy	1				
Quietness	1			Curvy Wall	1	Formal	1				
Cheerful	1										
Sunlight	1										
Total	**136**	**Total**	**127**	**Total**	**87**	**Total**	**74**	**Total**	**45**	**Total**	**42**
Ranking	**1**		**2**		**3**		**4**		**5**		**6**
Percentage of votes (%)	**60**		**48**		**38**		**32**		**30**		**23**
Total respondents: N=120											
Total responses: **511 responses**											

Table 6: Total number of responses related to the reason of image preferences (Question 15)

							
Total responses (N=120)		**H1-C1 (N=46)**		**H2-C3 (N=36)**		**H3-C2 (N=38)**	
Responses	**f**	**Responses**	**f**	**Responses**	**f**	**Responses**	**f**
Calm	64	Calm	24	Calm	22	Calm	20
Greenery	60	Greenery	23	Greenery	19	Greenery	19
Water features	53	Water features	22	Water features	18	Comfortable	14
Comfortable	40	Pleasant view	15	Comfortable	15	Water features	13
Pleasant view	37	Play area	14	Pleasant view	13	Seating	13
Flower	33	Comfortable	13	Well shaded	13	Play area	11
Play area	32	Flower	12	Rest area	13	Pleasant view	10
Well shaded	30	Well shaded	10	Flower	12	Well-shaded	9
Seating	29	Seating	9	Well-designed	7	Flower	9
Rest area	20	Shaded	7	Play area	7	Well-	6
Well-designed	13	seating	4	Seating	7	maintained	6
Walkway	13	Walkway	4	Safe	7	Spacious	5
Shaded	12	Clean	3	Walkway	6	Well-designed	4
seating	12	Well-	3	Fresh air	5	Rest area	4
Safe	10	maintained	3	Cheerful	4	Safe	3
Well-	10	Rest area	2	Clean	4	Walkway	2
maintained	9	Spacious	2	Shaded seating	3	Shaded	1
Spacious	8	Refreshing	2	Privacy	2	seating	1
Clean	7	Cheerful	1	Well-maintained	1	Quietness	1
Fresh air	3	Fresh air	1	Refreshing	1	Cheerful	1
Cheerful	2	Well designed	1	Quietness	1	Fresh air	
Refreshing	2	Sunlight	1	Sunlight	1	Clean	
Sunlight	2	Safe		Spacious	1		
Privacy	1	Curvy wall		Formal	1		
Quietness	1						
Formal							
Curve wall							
Total	511	**Total**	176	**Total**	183	**Total**	152

APPENDIX 21: Cross-tabulation related to the users' sensation votes

Table 1: Demographic data and Thermal sensation votes (TSV)

Demographic characteristic (N=120)		**Thermal sensation votes** Cold (-3)		Cool (-2)		Slightly cool (-1)		Neutral (0)		Slightly warm (+1)		Warm (+2)		Hot (+3)		**Total**		**Chi-square (p - value)**
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
Type of users	Patient	0	0	0	0	2	12.5	11	68.8	3	18.8	0	0	0	0	16	13.3	X^2=8.50 (p = .386)
	Staff	0	0	0	0	1	5.0	15	75.0	3	15.0	1	5.0	0	0	20	16.7	
	Visitor	0	0	5	6.0	20	23.8	49	58.3	8	9.5	2	2.4	0	0	84	70.0	
Gender	Female	0	0	3	4.1	11	15.1	45	61.6	12	16.4	2	2.7	0	0	73	60.8	X^2=5.34 (p = .254)
	Male	0	0	2	4.3	12	25.5	30	63.8	2	4.3	1	2.1	0	0	47	39.2	
Age	Young age (18-35 years old)	0	0	2	3.4	11	18.6	37	62.7	8	13.6	1	1.7	0	0	59	49.2	X^2=6.94 (p = .862)
	Middle age adults (36-55 years old)	0	0	2	4.3	11	23.9	27	58.7	5	10.9	1	2.2	0	0	46	38.3	
	Older age adults (55-64 years old)	0	0	1	9.1	0	0.0	8	72.7	1	9.1	1	9.1	0	0	11	9.2	
	Senior age adults (65 years and older)	0	0	0	0	1	25	3	75	0	0	0	0	0	0	4	3.3	
Ethnicity	Malay	0	0	5	5.1	22	22.4	57	58.2	11	11.2	3	3.1	0	0	98	81.7	X^2=7.77 (p = .803)
	Chinese	0	0	0	0	0	0	4	100	0	0	0	0	0	0	4	3.3	
	Indian	0	0	0	0	1	7.7	10	76.9	2	15.4	0	0	0	0	13	10.8	
	Other	0	0	0	0	0	0	4	80	1	20	0	0	0	0	5	4.2	

***There is no significant relationship between thermal sensation votes with the types of users, gender, age and ethnicity.

Table 2: Crosstabulation between TSV with the different case study HCGs

(N=120)		**Thermal sensation votes** Cold (-3)		Cool (-2)		Slightly cool (-1)		Neutral (0)		Slightly warm (+1)		Warm (+2)		Hot (+3)		**Total**		**Chi-square (p - value)**
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
Types of HCG	H1-C1	0	0	2	4.3	15	32.6	26	56.5	3	6.5	0	0	0	0	46	38.3	X^2=18.39
	H2-C3	0	0	2	5.6	2	5.6	25	69.4	7	19.4	0	0	0	0	36	30	**(p=.018)**
	H3-C2	0	0	1	2.6	6	15.8	24	63.2	4	10.5	3	7.9	0	0	38	31.7	C=.365
Total		0	0	5	4.2	23	19.3	75	62.5	14	11.7	3	2.5	0	0	120	100	

Table 3: Percentage of acceptable thermal sensation across the three representative hospitals (N=120)

N=120	Thermal sensation votes	N	**Total**
Acceptable	Slightly cool (-1)	23	**93.3%** (n=112)
	Neutral (0)	75	
	Slightly warm (+1)	14	
Unacceptable	Cold (-3)	0	**6.7%** (n=8)
	Cool (-2)	5	
	Warm (+2)	3	
	Hot (+3)	0	

Table 4: Crosstabulation between thermal preference (TPV) with the different case study HCGs

(N=120)		**Thermal preference votes** Want cooler (-1)		No change (0)		Want warmer (+1)		**Total**		**Chi-square (p - value)**
		N	%	N	%	N	%	N	%	X^2=7.518
Types of HCG	H1-C1	12	26.1	33	71.7	1	2.2	46	38.3	(p= .111)
	H2-C3	15	41.7	21	58.3	0	0.0	36	30	
	H3-C2	20	52.6	18	47.4	0	0.0	38	31.7	C=.243

Table 5: Crosstabulation between humidity sensation votes (HSV) with the different case study HCGs

(N=120)		Humidity sensation votes												Chi-square (p - value)
		Very damp (-2)		Damp (-1)		OK (0)		Dry (+1)		Very Dry (+2)		Total		
		N	%	N	%	N	%	N	%	N	%	N	%	*X²= 18.39*
Types of HCG	H1-C1	2	4.3	15	32.6	26	56.5	3	6.5	0	0.0	46	38.3	**(p= .018)**
	H2-C3	2	5.6	2	5.6	25	69.4	7	19.4	0	0.0	36	30.0	
	H3-C2	1	2.6	6	15.8	24	63.2	4	10.5	3	7.9	38	31.7	C=.365

Table 6: Crosstabulation between wind sensation votes (WSV) with the different case study HCGs

(N=120)		Wind sensation votes												Chi-square (p - value)
		Stale (-2)		Little wind (-1)		OK (0)		Windy (+1)		Too windy (+2)		Total		
		N	%	N	%	N	%	N	%	N	%	N	%	*X²= 21.774*
Types of HCG	H1-C1	7	15.2	11	23.9	13	28.3	13	28.2	2	4.3	46	38.3	**(p= .005)**
	H2-C3	12	33.3	11	30.6	9	25.0	4	11.1	0	0.0	36	30	
	H3-C2	10	26.3	18	47.4	10	26.3	0	0.0	0	0.0	38	31.7	C=.392

Table 7: Crosstabulation between TSV with the **time spent in the HCG**

(N=120)		Thermal sensation votes																Chi-square (p - value)
		Cold (-3)		Cool (-2)		Slightly cool (-1)		Neutral (0)		Slightly warm (+1)		Warm (+2)		Hot (+3)		Total		
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
Time spent in the HCG	< 5 min	0	0	0	0	2	25	5	62.5	1	12.5	0	0	0	0	8	6.7	*X²*=8.162
	5-10 min	0	0	0	0	1	5.0	15	75	3	15	1	5	0	0	20	16.7	(p= .772)
	11-30 min	0	0	**3**	**6.8**	**9**	**20.5**	25	56.8	5	11.4	2	4.5	0	0	44	36.7	
	>30 min	0	0	**2**	**4.2**	**11**	**22.9**	30	62.5	5	10.4	0	0	0	0	48	40	

Table 8: Crosstabulation between TSV with the **feeling of comfortable in the HCG** (Question 18)

(Question 18) (N=120)		Thermal sensation votes																Chi-square (p - value)
		Cold (-3)		Cool (-2)		Slightly cool (-1)		Neutral (0)		Slightly warm (+1)		Warm (+2)		Hot (+3)		Total		
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
Feeling comfortable in the HCG	Strongly disagree / Disagree	0	0	0	0	0	0	4	80	0	0	1	20	0	0	5	4.2	*X²*=15.12 (p = .057)
	Neutral (Neither agree nor disagree)	0	0	2	13.3	1	6.7	9	60.0	2	13.3	1	6.7	0	0	15	12.5	
	Agree / Strongly agree	0	0	3	3.0	22	22	62	62	12	12	1	1.0	0	0	**100**	**83.3**	

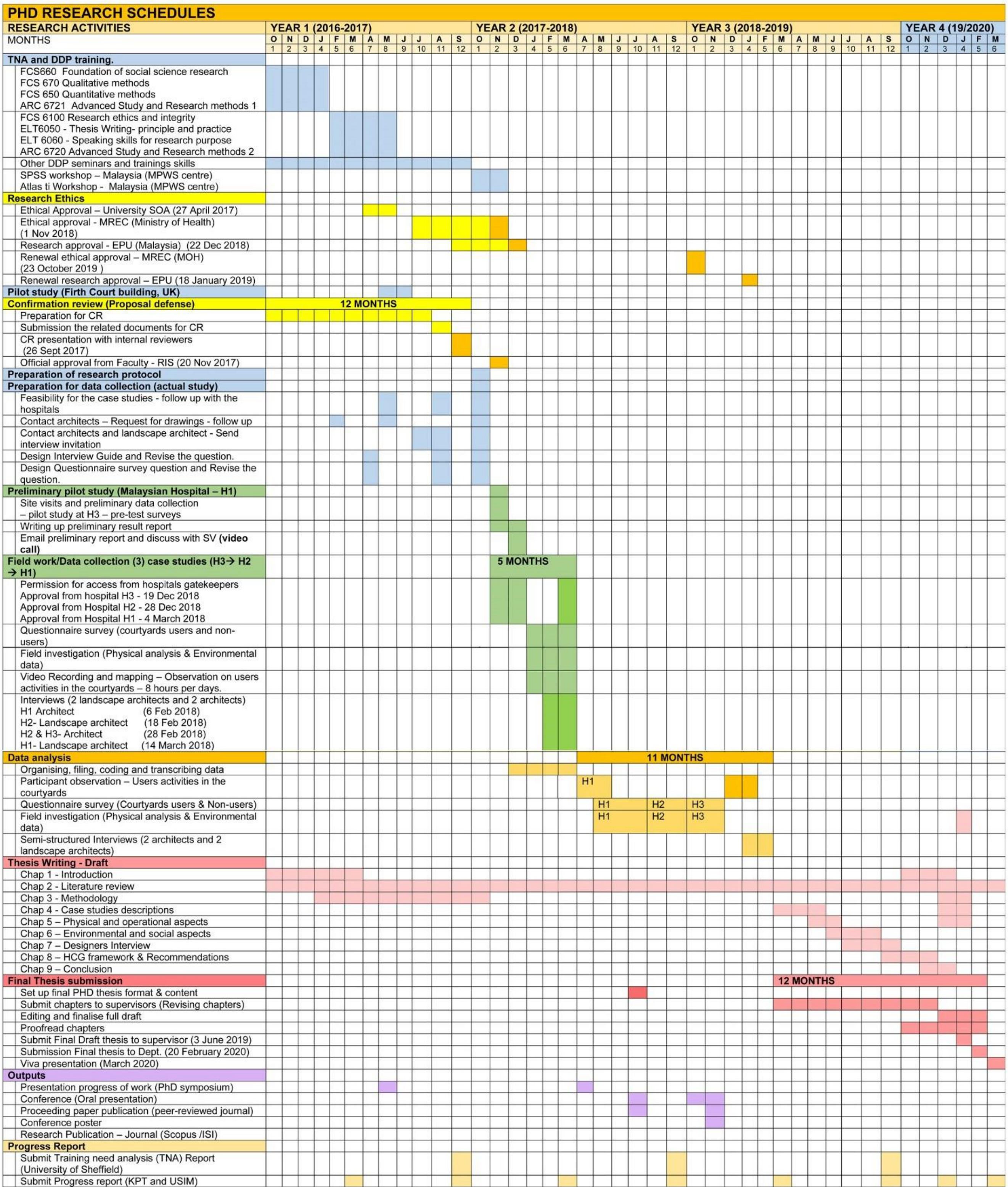
From a total 120 respondents in all three representative HCGs, **83.3% felt comfortable,** 4.2% uncomfortable, 12.5% undecided (neutral).

Table 9: Crosstabulation between TSV with TPV.HSV and WSV

(N=120)		Thermal sensation votes (TSV)																Chi-square (p - value)
		Cold (-3)		Cool (-3)		Slightly cool (-1)		Neutral (0)		Slightly warm (+1)		Warm (+2)		Hot (+3)		Total		
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
Thermal preference votes (TPV)	Want cooler	0	0	2	40	5	21.7	**30**	**40**	8	57.1	2	66.7	0	0	47	39.2	*X²= 6.47*
	No change	0	0	3	60	18	**78.3**	**44**	**58.7**	6	42.9	1	33.3	0	0	72	60	**(p= .594)**
	Want warmer	0	0	0	0	0	0	1	1.3	0	0	0	0	0	0	1	0.8	
	Total	0	0	5	100	23	100	75	100	14	100	3	100	0	0	120	100	
Humidity sensation votes (HSV)	Very damp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*X²= 15.82*
	Damp	0	0	2	40	5	21.7	14	18.7	0	0	0	0	0	0	21	17.5	**(p= .200)**
	OK	0	0	3	60	15	65.3	51	68	8	57.1	2	66.7	0	0	79	65.8	
	Dry	0	0	0	0	3	13	8	10.7	6	42.9	1	33.3	0	0	18	15	
	Very Dry	0	0	0	0	0	0	2	2.6	0	0	0	0	0	0	2	1.7	
	Total	0	0	5	100	23	100	75	100	14	100	3	100	0	0	120	100	
Wind sensation votes (WSV)	Stale	0	0	1	20	2	8.7	21	28	5	35.7	0	0	0	0	29	24.2	*X²= 17.79*
	Little wind	0	0	2	40	8	34.8	23	30.7	6	42.9	1	33.3	0	0	40	33.3	**(p= .336)**
	OK	0	0	1	20	6	26.1	21	28	2	14.3	2	66.7	0	0	32	26.7	
	Windy	0	0	1	20	7	30.4	9	12	0	0	0	0	0	0	17	14.2	
	Too much wind	0	0	0	0	0	0	1	1.3	1	7.1	0	0	0	0	2	1.7	
	Total	0	0	5	100	23	100	75	100	14	100	3	100	0	0	120	100	

The study showed that among those feeling neutral or comfortable, (58.7%, n=44) preferred no change while only (40%, n=30) preferred a cooler environment, and only one respondent preferred warmer conditions (1.3%, n=1) (See page 243)

APPENDIX 22: Timeline of PhD research



List of conferences participated:

- MANIFESTOS conference 2018 - SSOA (Oral presentation) - 27 April 2018
- AICE-SHEFFIELD 2018 – Environment-Behaviour Proceeding Journal (Oral presentation and publication in a peer-reviewed journal) - 14 July 2018
- RIBA CONFERENCE – Research Matters (Pecha-Kucha presentation- presenter) - 18-19 October 2018
- ACOL ISTANBUL 2018 – Environment-Behaviour Proceeding Journal (Oral presentation and publication in peer-reviewed journal) - 3-4 November 2018
- WRDTC Welcome Event – Poster research exhibition - 12 November 2018

Future peer-reviewed journal to be submitted:

- HERD: Health Environments Research & Design Journal
- Building and Environment
- Journal of Environmental Psychology

Submission to Research Services: 18.Feb.2020
Viva date: 25 March 2020 - Pass with minor corrections - Online system via Blackboard Collaboration
Examiners: Dr Sura Al-Maiyah and Dr Sally Salome Shahzad