Window View Quality:
Investigation of Measurement Method
and Proposed View Attributes

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Declaration of Originality

I, the author, hereby declare that to the best of my knowledge, the content of this thesis is my own work.

I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and the sources have been duly acknowledged.

I am aware of the University's guidance on the use of unfair means. This work has not been previously submitted for an award of degree at this or any other university.

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Abstract

Previous studies have demonstrated that a room with good view to the outside can provide its occupants with certain psychological benefits. However, the characteristics that constitute a good (or bad) window view have remained unclear. From literature review, it was hypothesised in this study that the quality of a window view is attributed to seven factors: proportion of greenery, number of visual layers, view elements, balance of view, diversity of view, openness of view and depth of view.

To test these hypotheses, 12 urban and sub-urban scenes were selected; 62 subjects were recruited to perform on-site viewing and evaluation of the selected scenes. The method of the view quality evaluation was based on real scenes viewed through "virtual windows" as defined by a portable viewing box, which was set up on site by the researcher. The viewing box enabled the observer to view the actual scenes as if viewing the same scenes through a physical window of 1.2 metres by 1.2 metres in size. Instead of the conventional "view satisfaction" level used in the previous studies, the rating scale for this experiment employed two different dimensions of affective quality – i.e., "pleasantness" of view (POV) and "excitingness" of view (EOV) as the basis for the verbal descriptors, which were anchored to a 4-point and a 10-point numeric scales.

The results of the first experiment were used to test the view quality predictions made using the seven view attributes. In addition, the experiment results were used to test whether there was a significant difference in the subjects' evaluations of view quality between the 4-point and 10-point scale formats after both primary scale data were rescaled into a common 101-point scale.

A second experiment was carried out to test the hypothesis that there is a significant difference in the perceived window view quality between actual-view and image-view modes. The second experiment was a systematic replication of the first: photographic images of the selected 12 window views were displayed on computer screen for a different group of 62 subjects to evaluate the view quality of the scenes using the same questionnaires for the first experiment.

Stepwise multiple regression and ordinal logistic regression analyses were conducted on the 10-point and 4-point scale data respectively to formulate prediction models of view quality. Results show that among the seven proposed view attributes, "view elements", "balance of view" and "openness of view" were significant predictors of view quality in the linear model of POV. "Depth of view" appeared to be the poorest predictor of view quality – neither linear nor monotonic relationship could be established between this attribute and the view quality. "View elements" and "openness of view" were also significant predictors in the ordinal logistic model of POV. Validation of the proposed linear prediction model for POV was conducted using correlation analyses and one sample t-tests that compared the predicted view quality with a set of out-of-sample view evaluation data from a third experiment, which involved an independent group of 40 subjects.

The outcomes of analysis show that there is no significant difference in the mean POV (EOV) scores between the rescaled 4-point and rescaled 10-point ratings – whether the evaluation is carried out in actual or image viewing mode. In terms of scale reliability, the 4-point and 10-point scales in most cases showed moderate to excellent internal consistencies. Whether it is for actual or image view, 10-point scale appeared to have higher internal consistency and interrater reliability in most cases compared to the 4-point scale. Overall, the results confirm the construct validity of the rating scales (either 4-point or 10-point scales) that were used in the assessment of actual or image view quality. The results suggest that 10-point scale is probably too fine for the purpose of evaluating window view quality, whilst 4-point scale is perhaps too coarse to achieve a sufficient discriminating power between the scale points. The optimum number of response categories on a rating scale for evaluating window view quality may be either 6 or 8. The study shows that there is no significant difference in the perceived view qualities between actual and image views. However, POV (EOV) ratings of the actual views generally have larger variances compared to that of the image views, probably because the subjects were affected by other visual cues when looking at the window views in real space, which contrasted with window views in pictorial space.

Keywords: View attribute, assessment method, scale format, mode of view, stepwise regression, prediction model.

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List of Abbreviations

BSI	-	British Standards Institution
CI	-	Confidence Interval
CIBSE	-	Chartered Institution of Building Services Engineers
DF	-	Degrees of freedom
EOV	-	Excitingness of View
FOV	-	Field of View
ICC	-	Intraclass Correlation Coefficient
IQR	-	Inter-Quartile Range
MLR	-	Multiple Linear Regression
MOE	-	Margin of Error
MRT	-	Mass Rapid Transit
OLR	-	Ordinal Logistic Regression
POV	-	Pleasantness of View
SD	-	Standard Deviation
SE	-	Standard Error
SPSS	-	Statistical Package for the Social Sciences (a statistical software with the brand name "IBM SPSS Statistics")
WVQ	-	Window View Quality

CHAPTER 1
Introduction

1.1 Introduction

The main purpose of this chapter is to introduce the PhD thesis, provides a brief background of the research, and states the aim and objectives of the research as well as an overview of the methodology. In addition, this chapter mentions the scope and limitations of the present research, and provides a summary of the contributions to knowledge. The chapter ends with a guide pertaining to the structure of this thesis and the key findings of this research.

1.2 Background

Traditionally a window serves multifunctional purposes. Apart from being a source of daylight and a ventilator of fresh air for the internal spaces of a building, a window provides view to the outdoors. Window is therefore a source of information on the weather and generally about what is happening outside, providing the building occupants with an indication of where they are in time and space. The benefits of window view have been studied by several researchers over the years in various contexts. The provision of a visual connection with the outside world through the window is much desired psychologically. The presence of window with a good view and an access to sufficient daylight has been associated with the increased satisfaction of workers with their work environment (Boyce et al. 2003). Previous studies show that an interesting window view has a tendency in reducing glare discomfort compared to a similar window of equal luminance but with a less interesting view (Tuaycharoen and Tregenza 2007; Kim et al. 2012). A view of outdoors is a contributor to well-being, especially if it is nature or an attractive view (Kaplan 2001; Veitch and Galasiu 2012; Lottrup et al. 2015). There were also past studies which suggested that there are positive effects of daylight and outdoor views in terms of reducing the hospital patients' average length of stay (Ulrich 1984; Choi et al. 2012; Joarder and Price 2013; Wang et al. 2019).

Although the psychological benefits of a good window view appear well established, the attributes of a good (or bad) window view and the methods of measuring view quality have yet to be explored extensively. Markus (1967), Ludlow (1976), Hellinga and Hordijk (2014), as well as Matusiak and Klöckner (2016) have carried out some important studies pertaining to view attributes and methods of evaluating window view quality. Knowledge gap can be identified in two areas. Firstly, there is a lack of specific indicators of view quality. Previous studies mostly used "view satisfaction" level as an indicator of view quality. According to the view assessment method adopted by CIBSE, view quality is rated based on four levels: "unacceptable", "acceptable", "good" and "excellent" (Pilechihaa et al. 2020). The problem with an evaluation based on satisfaction level is that it is does not provide sufficient information on the affective quality (such as "pleasantness" or "excitingness") attributed to the view observed in reference to a circumplex model of affect (Russell and Pratt 1980; Russell et al. 1981; Posner et al. 2005). Secondly, there is a lack of prediction models for assessing window view quality. The major challenges of developing such prediction models are in identifying view attributes that are good predictors, and the quantification of view attributes that appear to be qualitative variables.

Previous research has shown that view preference is closely related to the size, shape and position of the window through which it is seen (Keighly 1973a, 1973b; Collins 1976). If window geometry can be manipulated by the architect to capture good view, the psychological benefits of window view will be enhanced. To derive an optimum window design to achieve this goal in practice requires a methodical approach to assessing the view quality objectively. However, it is still unclear to researchers how to assess view quality using a reliable and valid prediction model. Therefore, it is important for the present research to further investigate the method of measuring view quality and propose view attributes that are potentially robust predictors of view quality. The view attributes and prediction model established in this study may provide the architect in practice with a preliminary idea of the range of window designs that are likely to fulfill the "view out" function.

1.3 Aim and objectives

The overall aim of this study is to develop a method for measuring window view quality, which can be used as a general guide by the architects in future when specifying the sizes, shapes and positions of windows in the design process. To achieve this aim, the following five objectives were developed:

Objective 1: To identify the potential attributes of window view quality.

Objective 2: To investigate the associations between the proposed view attributes and window view quality.

Objective 3: To compare the reliability and validity of two different rating scale formats, i.e. 4-point and 10-point, for the subjective evaluation of window view quality.

Objective 4: To compare the perceived quality of window view between two different modes of viewing, i.e. actual view and image view.

Objective 5: To develop a prediction model for the objective assessment of window view quality.

1.4 Overview of research process

A detailed discussion of method for this PhD research is presented in Chapter 3. This section provides a brief overview of the research process for the thesis. Figure 1.1 presents a flow diagram of the research process, which primarily integrates with the research methodology: literature review, experiments (actual view and image view), objective assessment of view attributes, data analysis and development of a prediction model of window view quality (WVQ).

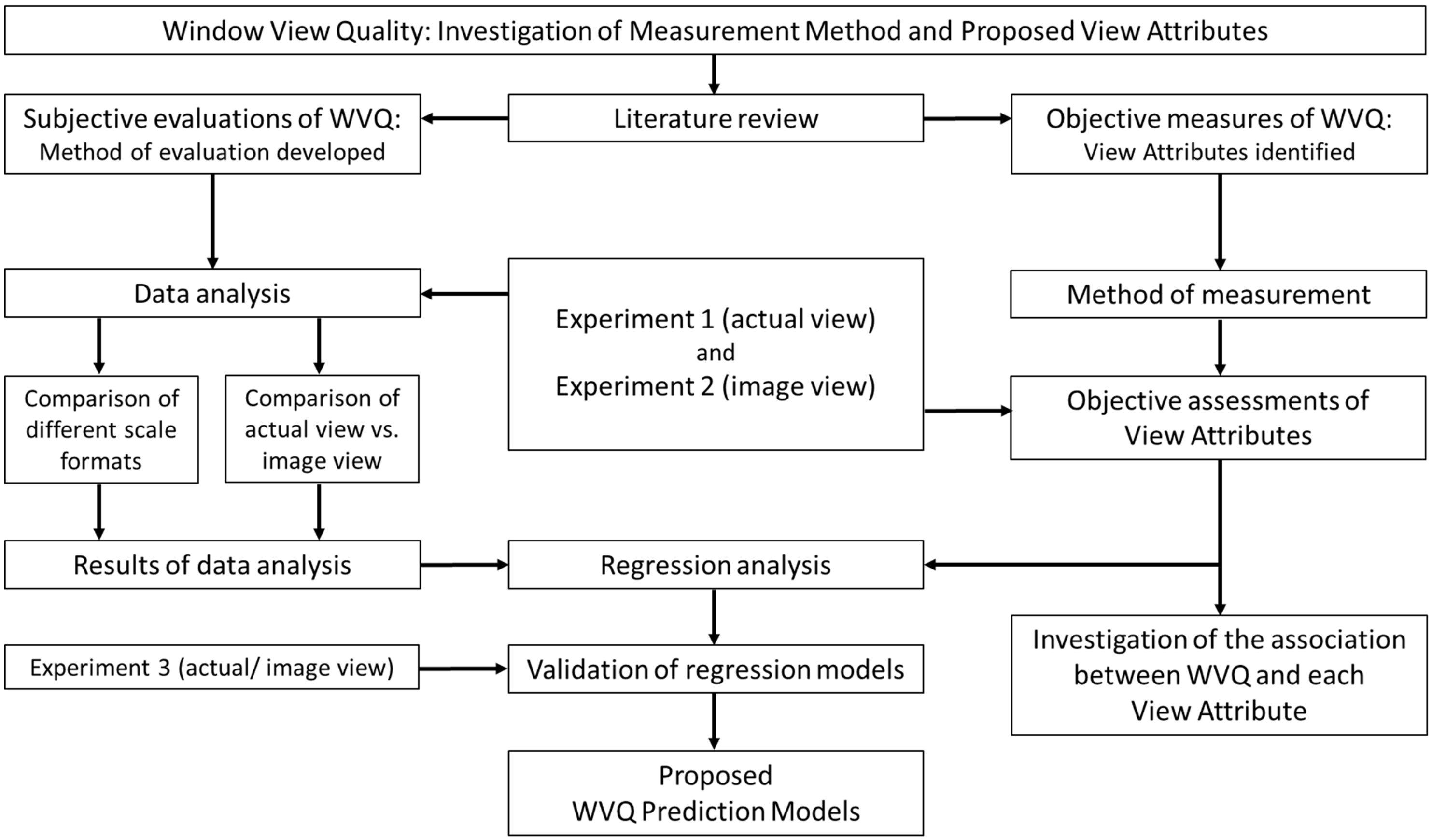


Figure 1.1: Flow diagram of the research process

This research started with a literature survey. The compilation of primary literature (Markus 1967; Ludlow 1976; Hellinga and Hordijk 2014; Matusiak and Klöckner 2016) suggested that there was an existing knowledge gap in the methodical approach to the assessment of view attributes, which can be used as predictors of window view quality. Experimental studies were subsequently planned and implemented to collect data from the subjective evaluations of views. The experiments began with selection of views: 12 urban and sub-urban scenes as viewed from seven elevated MRT train stations in Kuala Lumpur were selected and photographed. Photomontage method was adopted to make the images a more realistic depiction of window views. The researcher analysed the views based on methods derived from literature review. After that, a survey questionnaire was designed: 4-point and 10-point rating scales were used to generate data for comparison in terms of reliability and validity of scales. The first experiment was on-site viewing of the selected scenes involving 62 subjects using a portable viewing box created by the researcher. The subjects were to evaluate the "pleasantness of view" (POV) and "excitingness of view" (EOV). The second experiment was a systematic replication of the first: photographic images of the selected 12 window views were displayed on computer screen for another group of subjects (62 persons) to evaluate the view qualities (POV and EOV) of the scenes, so that the perceived view quality from actual and image views was compared and analysed. With the data collected from the first two experiments and the results of the objective assessment of view attributes, regression analyses were performed to establish a prediction model. Subsequently, a third experiment that used a different set of views (16 views) was carried out to collect external data for the validation of the prediction model.

1.5 Scope and limitation of the research

The current work, given the time and resource constraints, focuses primarily on one geographical area only – i.e., Kuala Lumpur. The 12 selected views were all from this same region despite that there was a variety of attributes and differences between urban and sub-urban characters between the 12 scenes. The first and the final scenes in the evaluation were viewed from two different sites that were approximately 20 km apart. Furthermore, the sample size of scenes selected and used in this study (12 views) was too small, and therefore did not suffice to represent the population (all other urban or sub-urban scenes in the world). Throughout the period of the on-site view experiment (five weekends), between 10.00 am and 1.00 pm on each day of experiment, it was mostly sunny, hence weather was assumed to be a constant in the experiment. To study the effects of weather condition on the perceived view quality, future research can use a fixed view with variable weather conditions and seasons.

In addition, the view experiment in this study did not include views that were extreme in character, for instance, a natural scenery of sublime beauty or a repulsive view of urban slums behind a polluted river. The experiment also did not include views that contain iconic architecture. Future research may consider including these as part of the sample of views.

1.6 Summary of the contributions to knowledge

The purpose of this research is to provide the architects with a prediction model for window view quality, and at the same time provide the research community with information on the method of assessing view attributes as well as the method of setting up window view experiments to collect subjective evaluation data. The measurement of window view quality discussed in this study is intended to be a methodological contribution to the research of window view quality.

One of the major differences between this research and the previous studies is that this window view research is based on actual on-site viewing but in a controlled manner – i.e., same set of views to be evaluated by each subject under the same conditions. The "virtual windows" with real scenes were derived from a portable viewing box that was set up on each of the sites at MRT train stations for the subjects' viewing. This method enabled a group of subjects to view each of the 12 selected scenes consecutively, from one station to another, with ease.

Another major difference between this research and the previous studies is the design of the view evaluation questionnaires which consist of two versions of rating scale – i.e., 4-point (31 sets) and 10-point (31 sets), which were shuffled and randomly distributed to the subjects for each viewing of scene. The purpose of shuffling the questionnaires for random distribution to the subjects was to reduce the possible bias in the rating. This random split-sample approach created two sets of data (4-point and 10-point scale data) within one experiment. The same questionnaire was also used in the second experiment, which was a view quality evaluation based on image displayed on computer screen. With this random split-sample method, the data were compared "within experiment" (4-point scale vs. 10-point scale) and "between experiments" (Experiments 1 vs. 2). And because 4-point and 10-point scales were used in the real-view experiment, two types of regression analyses were conducted for the same experiment to compare results – i.e., ordinary logistic regression for the 4-point scale data, and stepwise multiple regression for the 10-point data.

This research used "pleasantness" and "excitingness" dimensions as the verbal anchors on the numeric rating scale. These affective descriptors were based on the circumplex model of affective quality, which was developed by Russell et al. (1981). By having two different dimensions of affect (emotion) as indicators of view quality evaluation rather than the conventional single-item "view satisfaction" level used in previous studies, the experiment results uncovered more about how the subjects felt about the views instead of merely a satisfied-unsatisfied range. Perhaps future research can incorporate other affective dimensions from the circumplex model into the subjective evaluation of views.

A novel approach was used in the view analysis of this research: digital image of each view was pixelated into larger cells for the ease of estimating the area of each visual layer that appeared in the scene. This method enabled the assessment of "greenery proportion" and "openness of view" to be performed quickly, because measurement of natural elements was rather difficult due to the geometrical complexity. However, for view attributes that require visual details for better judgement such as "view elements" (aesthetic impression) and "diversity of view", the assessments were still based on the original images rather than the pixelated images.

1.7 Structure of the thesis

This thesis is organised into eight chapters. This section provides an overview of each of the following chapters.

Chapter 1 is an introduction to the thesis.

Chapter 2 presents the outcomes of literature review to identify the potential view attributes for the objective measures of window view quality as well as the potential response formats of rating scales for the subjective evaluations of window view quality.

Chapter 3 explains the method of assessing the proposed view attributes, the experimental design and the procedures of Experiment 1 (actual view) and Experiment 2 (image view).

Chapter 4 discusses the results of Experiment 1 (actual view) and Experiment 2 (image view), which include the subjects' evaluation on the quality of the 12 selected window views using two different response formats of rating scales (10-point scale vs. 4-point scale) and in two different viewing modes (actual view vs. image view).

Chapter 5 focuses on the comparison of reliability and validity between two different response formats of rating scales – i.e., 10-point and 4-point scales that were used in both Experiment 1 (actual view) and Experiment 2 (image view).

Chapter 6 discusses the comparison of window view quality evaluations under two different modes of view – i.e., actual view and image view, to determine whether there is any difference in the perceived view quality of the same window view when the evaluation is carried out under the two different modes of view.

Chapter 7 discusses the tests of view quality predictions using the seven view attributes established from literature review, and discusses the development of a prediction model for window view quality.

Chapter 8 concludes this thesis with a summary and discussions on the key findings of the research and recommendations for further research.

1.8 Key findings

The key findings of this PhD research are summarised as follows:

Seven view attributes have been identified from the literature review – i.e., proportion of greenery, number of visual layers, view elements (aesthetic impression of elements), balance of view, diversity of view, openness of view and depth of view. Definitions and scale of measurements of these proposed view attributes are summarised in Table 3.3 (Chapter 3).

When compared on a 101-point common scale, there is no significant difference in the mean POV (or EOV) scores between the rescaled 4-point and rescaled 10-point ratings on most of the window views – whether the evaluation is carried out in actual or image viewing mode. This suggests that 4-point and 10-point scales should serve the same purpose as the response formats of a rating scale for measuring window view quality in either actual view or image view. However, the 4-point scale data should not be used to establish a linear prediction model of the view quality as the 4-point scale data demonstrated severe departure from normality. In comparison, the 10-point scale data may be treated as continuous interval-level data and used to establish a linear prediction model.

In terms of scale reliability, the 4-point and 10-point scales in most cases show moderate to excellent internal consistencies. Whether used in the evaluation of actual view or image view, the 10-point scale appears to have higher internal consistency and interrater reliability in most cases compared to the 4-point scale. Either the 4-point or 10-point scale appears to have higher interrater reliability when the view evaluation is carried out based on actual view compared to image view.

Overall, the correlations between POV and EOV rating scores using either 4-point or 10-point scale range from moderate to very strong, which is evidence for convergent validity. The results generally confirm the construct validity of the rating scales – i.e., 4-point and 10-point scales that are used in the assessment of actual or image view quality.

The results suggest that 10-point scale is probably too fine (too many scale points) for the purpose of evaluating window view quality, whereas the 4-point scale is perhaps too coarse (too few scale points) to achieve a sufficient discriminating power between the scale points. Considering that an effective rating scale for evaluating window view quality should provide a direction information (positive or negative impression of the view), thus avoiding a neutral category at the centre – the optimum number of response categories for rating scale used for view quality evaluation may be 6 or 8.

There was no significant difference in the mean POV (EOV) ratings between the actual view and the image view. However, either POV or EOV ratings in actual-view mode had larger variances compared to that in image-view mode. Difference in depth perception between actual view and image view does not significantly affect the perceived qualities of window views (measured in terms of POV or EOV). Therefore, the Alberti's window hypothesis is still valid in the view quality evaluation of window views.

The following trends were observed in the analyses of the seven view attributes:

1. "Proportion of greenery" that was not extremely high (below 20%) had a significant and positive monotonic relationship with view quality in terms of EOV. Greenery proportion had a large effect size on EOV under this condition.

2. "Number of visual layers" had a significant and positive monotonic relationship with EOV provided that the aesthetical quality of view was not negative.

3. "View elements" had a significant and positive linear association with view quality (either POV or EOV), and had a large effect size on either view quality. "View elements" had a significant and positive monotonic relationship with view quality (POV).

4. "Balance of view" had a significant and negative linear association with view quality (EOV). It is predicted that a view will appear to be less exciting when the view has a higher degree of balance; and a view will appear to be more exciting when the view has a lower degree of balance.

5. "Diversity of view" had a significant and negative linear association with view quality in terms of POV, and had a large effect size on POV – on condition that the views were not extremely open.

6. "Openness of view" had a significant and positive monotonic relationship with view quality (EOV), and had a large effect size on EOV. If none of the views had negative aesthetical quality, "openness of view" had a very large effect size on EOV. Under the same condition, "openness of view" was found to have a significant and positive linear association with view quality (POV), and had a large effect size on POV.

7. "Depth of view" had neither linear nor monotonic relationship with view quality in the analyses. Probably this view attribute was confounded by other factors.

A view quality prediction model was derived using a stepwise multiple regression as below:

$$Q_{POV} = 0.45VE - 6.63BV + 0.25OV + 10.08$$

where Q_{POV} is the predicted view quality, value between 1 – 10, measured in the "pleasantness" dimension of affective quality. "View elements" (VE), "balance of view" (BV) and "openness of view" (OV) are the predictors in this POV model.

A view quality prediction model was derived based on ordinal logistic regression (OLR) using 4-point scale data:

(i) "View elements" ($B = 0.305$, $p < 0.001$, $Exp(B) = 1.357$)

(ii) "Openness of view" ($B = 0.511$, $p = 0.002$, $Exp(B) = 1.668$)

"View elements" and "openness of view" were two common predictors between OLR (4-point scale) and stepwise multiple regression (10-point scale) for the prediction of view quality (POV). However, "balance of view" was a significant predictor of view quality (POV) in the MLR model but not the OLR model. "Proportion of greenery", "number of visual layers", "diversity of view" and "depth of view" were not significant predictors of view quality (POV) at the 0.05 level in either MLR or OLR model.

Prediction model for EOV evaluation based on either stepwise multiple regression (10-point scale) or ordinal logistic regression (4-point scale) cannot be validated in this study.

External validation using evaluation data from Experiment 3 showed that the proposed prediction model (POV) was not a robust model even though it was able to predict POV ratings of 10 out of the 16 views (or 62.5% of the cases). Therefore, a larger sample of window views that cover a wider range of value in each of the predictors is needed in further studies to improve the generalisability of the prediction model.

CHAPTER 2

Literature Review

2.1 Introduction

The first chapter has introduced the present research. This chapter discusses the outcomes of literature review to identify the potential view attributes for the objective measures of window view quality as well as the potential response formats of rating scales for the subjective evaluations of window view quality. This chapter comprises four major parts. The first part highlights the existing literature on the relationships between window preferences and view satisfaction. The second part discusses the attributes of window view proposed in the past studies. The third part reviews the methods of subjective evaluation used in the previous studies particularly on the indicators of view quality, the response formats of rating scale and the use of pictures as a mode of viewing. The fourth part discusses the research questions and the hypotheses to be tested in this study.

2.2 Background

Numerous studies have been carried out pertaining to window preference and view quality. The existing literature on this subject matter may be divided into three broad categories: the first category focused on the optimum geometrical design of windows that provide view satisfaction; the second category focused on view contents that promote better mental health and well-being; the third category focused on the view attributes that can be used as predictors of window view quality. The present study is in the third category.

Although a large window that occupies the whole or most part of the window wall can provide the best external view, the sizing of window aperture in the architectural design process needs to consider energy consumption: large windows can result in more energy waste compared to smaller windows. Therefore, it is essential to know whether there is a more moderate size of window aperture that fulfils the desire for good view while meeting the demand for energy conservation (Collins 1976). Researchers have been interested in the relationships between view satisfaction and the optimum size and shape of window and room. Markus (1967) emphasised that a window view should be analysed in terms of its information content, especially based on the "horizontal stratification" – i.e. a view can be divided in three layers, each has its own purpose: the sky is the source of light and keeps occupants in touch with weather, time of day and year; a view of the landscape or city gives information about the environment on a large scale; and a view of the ground gives information about human activities in the immediate vicinity. For this reason, Markus (1967) suggested that the ideal window design should demonstrate a strong vertical emphasis, especially a window that reaches from floor to ceiling, so that the window offers a lot more to the viewer compared to a predominantly horizontal window. However, this proposition was not supported by Keighley (1973a), Ludlow (1976), Roessler (1980), Dogrusoy and Tureyen (2007), who argued that visual requirements appear to be best satisfied by horizontal apertures – the dimensions of which are determined by the elevation of the skyline.

Ne'eman and Hopkinson (1970) pointed out that the critical minimum size of the window is governed more by the information content provided by the external view rather than the amount of daylight that penetrates the room, the level of interior artificial lighting or the viewing position in the room; the experimental study also confirmed that this critical minimum size should not be smaller than one-sixteenth of the room's floor area. Keighly (1973b) suggested that, in addition to the influence of the external view, view satisfaction is affected by the area and proportion of the window and the number and width of the mullions; the highest view satisfaction is given by large horizontal apertures occupying some 60 – 75% of the width of window wall. Ludlow (1976) suggested that view content has a significant effect on the preferred size and shape of windows and the preferred size of window is between 50 – 80% of the area of window wall. In contrast to the information content theory, Butler and Steuerwald (1991) argued that, although larger windows are preferred for desirable scenes, window preferences are influenced by the function of the room as well as the room size – i.e., preferred window size is not a constant proportion of the wall size but a larger proportion is preferred for smaller rooms, and the preferred window shape is much less horizontal in small rooms.

A majority of the existing literature on window preference and view quality addressed the issues concerning the psychological reactions to the external views and how these reactions associate with the cognitive, behavioural and emotional well-being of the building occupants. Research has shown that visual connection with the outside world is a source of job satisfaction and improved work attitude. Finnegan and Solomon (1981) conducted a study which demonstrated that workers in a windowless environment were found to be significantly less positive than the workers in a windowed environment in terms of job satisfaction, interest value of the job and physical working conditions. Musselwhite (2018) suggested that visual connection with the outside world can make older people with limited mobility feel happier. A window view is important, as explained by Aries et al. (2010), because it provides information about time and weather, reduces the feeling of claustrophobia, and contributes positively to the eye health by providing a distant horizon at which to gaze. In addition, windows that provide a view out as well as daylight can reduce stress and hence reduce the demand for health services (Boyce et al. 2003). A view of outdoors is a contributor of well-being particularly if it is a nature or an attractive view that include the sky (Veitch and Galasiu 2012). Previous experimental studies have provided evidence that the glare sensation of occupants can vary with their subjective impression on the window views even under the same luminous conditions (Kim et al. 2012). A bright window with an interesting view is associated with less glare discomfort than a similar window of the same mean luminance but with a view of less interest (Tuaycharoen and Tregenza 2007).

Several studies have shown that a window view of natural scene can help inpatients reduce the length of stay in hospital after surgery (Ulrich 1984; Verderber 1986; Wang et al. 2019), whereas poorly windowed rooms and windowless rooms are found to have negative impact on the inpatients' health, although windows are only one small part of the larger equation of factors that affect satisfaction and health condition (Verderber and Reuman 1987). Numerous studies suggested that people tend to prefer window views that have greenery (gardens or landscape areas) because the view of natural elements contributes to visual satisfaction and mental well-being (Kaplan 1993, 2001;

Lottrup et al. 2015; van Esch et al. 2019), although the findings in Matusiak and Klöckner (2016), and Musselwhite (2018) did not support greenery as a significant predictor of view quality. Ozdemir (2010) pointed out that occupants in offices that have more open and natural views rate their room satisfaction more highly, and suggested that windows should occupy at least 20 – 30% of the window wall. This is consistent with Ulrich (1984) and Kaplan (1993) on window view: what can be seen from the window is of great importance in determining a person's satisfaction with a room. Tennessen and Cimprich (1995) suggested that people who have more natural views from their windows would have a stronger capacity to direct attention than those with less natural or built views. Leather et al (1998) found that a view of natural elements (trees, vegetation, plants and foliage) helps to buffer the negative impact of job stress on intention to quit and have a marginal effect on general well-being. An exploratory electroencephalography (EEG) experiment conducted by Olszewska-Guizzo et al. (2018) indicated that having a green window view can potentially contribute to the mental health and well-being of urban dwellers who live in high-rise apartment buildings. Van dan Berg et al. (2016) explained that fractal complexity may be a crucial ingredient that explains why viewing nature is more appealing and restorative than viewing buildings.

Although the preference for and the benefits of good window views appear well established, the characteristics that constitute a good (or bad) window view are less well understood. To have a more in-depth understanding on this subject matter, potential "view attributes" (the characteristics that determine the view quality) need to be identified and then tested in regression analyses to determine whether they are significant predictors of window view quality.

In a previous study, Matusiak and Klöckner (2016) investigated the associations between view quality and seven view attributes: view depth (maximum view distance), number of visual layers, aesthetical scene quality, viewing angle, fragmentation of view, greenery and composition of view. Through an ordinal regression analysis, it was concluded that the first three attributes have significant impacts on the perceived view quality. Among these three attributes, aesthetical scene quality – which was determined by the most important objects seen from the window (e.g., buildings, a group of trees), has the strongest impact on view quality. It was also found that aesthetical scene quality has a strong correlation with the composition of the scene.

In another past study, Hellinga and Hordijk (2014) concluded that when the qualities of sample unobstructed window views are assessed objectively based on a set of view attributes (view character, natural green, visual layers, natural water, traffic, diversity of view, condition and complexity of dominant buildings) under a predefined scoring system, the aggregate scores obtained from such assessment are positively correlated with the mean subjective ratings of view quality obtained from the questionnaire survey of the same scenes. Even though the study highlighted the collective impact of the view attributes, it did not report the effect of individual view attribute on the perceived view quality, which deserved further investigation.

Concerning the subjective rating of view quality, three different types of scale have been used in the previous studies. Linear numeric scale with bipolar verbal anchors appears to be the most popular choice so far – Kaplan (2001), Aries (2010) and Ozdemir (2010) used a five-point scale; Hellinga and Hordijk (2014) used an 11-point scale. Semantic differential scale was used by Ludlow (1976) – the subjective rating on window view consisted of 55 items, each was a five-point scale with bipolar verbal anchors (e.g., "pleasant – unpleasant" and "exciting – unexciting") represented by a horizontal bar with five equal segments but without any numeric annotation. Adjectival rating scale comprising four categories of response was used by Markus (1967) as well as Matusiak and Klöckner (2016); the former adopted "mean", "rather poor", "adequate" and "plentiful" as the response categories whilst the latter used a different set of adjectives – i.e., "not satisfactory", "satisfactory", "good" and "excellent." While the linear numeric scale and semantic differential scale produce data that are measurable at an interval level or a ratio level (under the normality assumption), data generated from an adjectival scale can only be measured at an ordinal level as the perceptual distances between any two adjacent points on the ordinal scale are deemed to be arbitrary.

In the subjective evaluation of window view quality, it is important to consider the setting of window view. There were two approaches to view setting in the previous studies of view quality assessment. The first approach was experimental view setting –

i.e., the scenes were pre-selected based on a variety of viewing criteria, and essentially all subjects in the sample were required to observe the same set of views; the room or space in which the observer performed the viewing was a controlled environment. In the past studies, scaled models with projected images of views were used by Ne'eman and Hopkinson (1970), Keighly (1973a, b), Ludlow (1976), Butler and Steuerwald (1991). In another study, Roessler (1980) used a scaled model with a window-like aperture, which allowed the observed external environment to change when it was placed in different rooms. These model studies in laboratory settings helped the researchers determine the preferred size and shape of window in the design process. Test rooms were used by Tuaycharoen and Tregenza (2007) to carry out experiments involving real windows that faced different directions and at different levels of the same building. Ozdemir (2010) used 18 rooms that have identical lengths and widths, and window sizes, but different window view characteristics. Simulated window in a test room was used by Kim et al. (2012) to conduct an experiment in a laboratory space with a display screen that rendered various window views and luminance conditions.

The second approach was non-experimental view setting – i.e., the scenes were observed from original windows in the existing circumstances at the subject's workplace, home or hospital patient room where the subject responded to a survey questionnaire on window view quality. In the past studies, questionnaire surveys on window view quality have been carried out by several researchers using non-experimental view setting: Ludlow (1976), Aries (2010), Matusiak and Klöckner (2016) on office buildings, Verderber and Reuman (1987) on hospital rehabilitation rooms, as well as Tennessen and Cimprich (1995) on university dormitory rooms. One of the limitations of the non-experimental approach is that the effects of environmental cues on a subject while performing the view out of window are unknown, and there is a lack of factual basis to assume that these effects on each subject in the study are constant. In another study, Hellinga and Hordijk (2014) conducted a questionnaire survey using 23 photographs of scenes instead of the actual window views. Kaplan (2001) used a combination of real views and photographs in questionnaire surveys – participants were asked to rate each of the photographs in terms of similarity to the actual view from their apartment. However, the expedient method of using photographic images in lieu of real views as the bases of view quality evaluation requires further validation. Table 2.1 presents a summary of methods used in the previous studies for the measurement of window view attributes.

2.3 Attributes of window view

View attributes are the underlying characteristics that determine the quality of a view. If the view attributes are measured and quantified, they can be construed as the independent variables in a regression model that predicts the view quality (dependent variable). From the existing literature, it is hypothesised that the quality of a window view can be predicted using a number of view attributes identified based on previous studies. Seven attributes have been identified in this study: proportion of greenery (natural landscape), number of visual layers, view elements (aesthetic impression of elements), balance (composition), diversity, openness and depth of view. The association between each of these attributes and the view quality deserves further investigation.

2.3.1 Proportion of greenery

From the previous studies, natural green (e.g., green foliage, growing plants or vegetation) and waters (e.g., river, lake or sea) in a window view appears to be an important factor that contributes to view satisfaction and a sense of well-being. In Kaplan (2001), the method of "similarity rating" was used – i.e. participants rated each selected scene based on photograph in terms of its similarity to the view from their window at home using a 5-point scale ("not at all like my view" to "very much like my view"), as well as their preference for the view, which was also based on a 5-point scale ("not at all" to "like it very much"). It was established in Kaplan (2001) that views of greenery and natural elements played an important role in people's satisfaction with nature and their neighbourhood – all nature contents collectively accounting for 41% of the variance.

Table 2.1: Methods used in previous studies for the measurement of window view attributes (in a chronological order).

Researcher	Method	Variables	
		Dependent variable (Outcome variable)	**Independent variables (Predictor variables)**
Markus (1967)	Field survey: use of view-photograph as picture plane with room perspective	View satisfaction (4-point scale)	- Window size - Room size and shape - Observer's distance from window - Information content: visual layers (horizontal stratification)
Ne'eman and Hopkinson (1970)	- Model room (scale 1:12) with adjustable window - Full-scale observation in a room (to check the model assessments)	Subjective minimum acceptable window size (width) that provides view satisfaction	- Height of window - Number of windows - Size of room - Outside view - Weather and daylight levels
Keighly (1973a)	Experiment 1: - Model room (scale 1:12) with a variable geometry window to be controlled by subjects	Preferred shape and location of window aperture occupying 20% of window wall	- Skyline height
Keighly (1973b)	Experiment 2: - Model room (scale 1:12) with 30 templates each comprising a different configuration of window apertures	Acceptability (satisfaction) of window arrangement (5-point scale)	- Window area - Window height - Mullion width

Table 2.1 (continued)

Researcher	Method	Variables	
		Dependent variable (Outcome variable)	**Independent variables (Predictor variables)**
Ludlow (1976)	(i) Affective appraisal of window view quality through a questionnaire survey (5-point scale)	(i) View quality - based on bipolar affective descriptors (emotional response)	(i) Factors: - Complexity - Stratification - Spatial quality - Dynamic properties - Privacy - Naturalness
	(ii) A model study in laboratory setting to determine the preferred size and shape of window for each of the 16 separate views (projected images).	(ii) Preferred size and shape of window for each of the 16 views	(ii) Factor: - View content
Roessler (1980)	Experiment using a 1:10 scale model of an office room lit by daylight, which allows the setting of five parameters.	Psychological dimensions of feelings: - Enclosure and restraint - Privacy - Distraction by the exterior	Parameters: - Mean horizontal illuminance of artificial light (6 levels) - Depth of room (2 levels) - Direction of view into model (2 levels) - Window width (4 levels) - External environment seen through window (3 levels)

Table 2.1 (continued)

Researcher	Method	Variables	
		Dependent variable (Outcome variable)	**Independent variables (Predictor variables)**
Ulrich (1984)	Data analysis was carried out based on the records of patients and their recovery data between 1972 and 1981 in a selected hospital.	Patients' speed of recovery, measured in terms of: - Length of postoperative hospital stay - Number of moderate/ strong analgesic doses	View character: - "Built" view (brick wall) vs. natural view (trees and greenery)
Verderber and Reuman (1987)	In a hospital-based rehabilitation therapy setting, data were collected through: - Questionnaire - A comprehensive survey of the actual length of time occupants were in various rooms	- Staff – well-being indicators (morale at work, productivity, job satisfaction, rate of staff turnover) - Patients – health status indicators (length of stay, intensity of therapy programme, rate of progress)	Person-window constructs that measure patterns of use-involvement with window and view attributes: - Proximity to aperture - View content - Screen use - Window to wall area ratio - Sill height above floor - Daylight exposure
Butler and Steuerwald (1991)	Experiments using a 1:12 scale model.	Window size preference	- Room size - Quality of view (most pleasant / moderately pleasant / least pleasant)

Table 2.1 (continued)

Researcher	Method	Variables	
		Dependent variable (Outcome variable)	**Independent variables (Predictor variables)**
Tennessen and Cimprich (1995)	Tests of directed attention conducted in university dormitory rooms with windows of different view categories.	Capacity to direct attention (measured by performance)	View categorisation: "all natural", "mostly natural", "mostly built", "all built."
Leather et al. (1998)	Questionnaire survey to investigate the effects of windows in the workplace	- Job satisfaction - Intention to quit - General well-being	- General level of illumination (in lux) - Sunlight penetration (maximum sun patch as a percentage of floor area) - View (percentage of rural view)
Kaplan (2001)	Questionnaire survey via mail. Two approaches to assess the view by rating – i.e. verbal descriptions and photographs, both using 5-point scale.	- Satisfaction with residential environment - Measures of well-being	View from home in terms of three content domains: - Built components - Natural elements - Weather
Tuaycharoen and Tregenza (2007)	Experiments were conducted in test rooms with windows that faced different directions and were at different storeys of the same building.	- Level of discomfort glare	Experiment 1: - Interest of a scene (in a numerical score) Experiment 2: - View character (natural / man-made objects) - Number of visual layers

Table 2.1 (continued)

Researcher	Method	Variables	
		Dependent variable (Outcome variable)	**Independent variables (Predictor variables)**
Aries et al. (2010)	Questionnaire survey to explore the relationships between office employees and their environment to predict physical and psychological discomfort.	- Physical and psychological discomfort (5-point scale) - Sleep quality (yes/ no, 7 items) - Environmental utility (satisfaction: 5-point scale) - Light quality (satisfaction: 5-point scale) - Impression (office conditions) (5-point scale) - Seasonality (mood changes) (5-point scale)	- View quality (5-point scale) - View type (nature/ urban) - Window distance (3 levels) - Social density (3 levels)
Ozdemir (2010)	Questionnaire survey conducted in 18 rooms that have identical lengths and widths, and window sizes, but different window view characteristics.	User's: - Room satisfaction - Perceived spaciousness - Perceived room brightness - Window view satisfaction	Window view characteristics: - Openness - Naturalness
Raanaas et al. (2011)	Longitudinal quasi-experiment at a rehabilitation centre; responses were measured using questionnaires.	Self-reported: - Physical health - Mental health - Emotional state - Subjective well-being	- Window view conditions ("panoramic", "partially blocked", "blocked")

Table 2.1 (continued)

Researcher	Method	Variables	
		Dependent variable (Outcome variable)	**Independent variables (Predictor variables)**
Kim et al. (2012)	Experiment conducted in a laboratory space with a simulated window that rendered various window views and luminance conditions.	- Level of discomfort glare	- Subjective impression of window view – evaluated using semantic scales on 27 variables, which were represented by four components (factor analysis)
Hellinga and Hordijk (2014)	The mean view quality ratings of 23 pictures in a questionnaire survey were compared to the "view quality score" – i.e. the aggregate score of view attributes that were determined objectively.	- Window view quality - (11-point scale: from 0 – "very bad view" to 10 – "very good view")	View attributes: - View character - Natural green - Visual layers - Natural water - Traffic - Diversity of view - Condition and complexity of dominant buildings

Table 2.1 (continued)

Researcher	Method	Variables	
		Dependent variable (Outcome variable)	**Independent variables (Predictor variables)**
Lottrup et al. (2015)	A questionnaire study focusing on office workers' view satisfaction to investigate the possible relationships between window view, and work ability and job satisfaction in the context of workplace.	(i) Office workers' view satisfaction (ii) Office workers' work ability and job satisfaction	(i) Content of window view (Buildings/ signs; cars/ traffic; sky; trees; mowed lawn; flowers; park-like environment; wild self-seeded natural environment; other; no view to outdoor environment) (ii) Office workers' view satisfaction
Li and Sullivan (2016)	A randomised controlled experiment was conducted in three classrooms that were identical in terms of room size, window size, lighting and furniture, but different window views.	Participants': - Attentional functioning - Stress level	Window view conditions: - No window - Barren view (as reference) - Greenery view
Matusiak and Klöckner (2016)	Questionnaire survey: participants evaluated the quality of window view at their respective workplace using a 4-point scale; the data were used in an ordinal regression analysis to develop a prediction model of window view quality.	- Window view quality (4 categories: "Not satisfactory", "Satisfactory", "Good", "Excellent")	View attributes: - Maximum view distance - Number of visual layers - Aesthetical scene quality - Viewing angle (n.s.) - Fragmentation of view (n.s.) - Greenery (n.s.) - Composition of view

Table 2.1 (continued)

Researcher	Method	Variables	
		Dependent variable (Outcome variable)	**Independent variables (Predictor variables)**
Olszewska-Guizzo et al. (2018)	An exploratory electroencephalography (EEG) experiment to investigate how window views taken from different floors of a high-rise block with varying extents of green cover affected the healthy residents; photographs as a representation of the real window views in the laboratory setting.	The participant's brain activity (alpha and beta rhythms).	Window view conditions: - Floor level at which the window views were captured (3^{rd} / 6^{th} /12^{th} / 24^{th}) - Green cover categories ("minimal" (<20%), "medium" (30 – 40%), "high" (>50%)
Wang et al. (2019)	- Questionnaire survey - Review of medical charts	- Dosage of PCA (patient-controlled analgesia) use - Perceived pain (BPI)	- Daylight exposure - Window view (% natural content) - Satisfaction of window view - Interaction of daylight and window view

In Ozdemir (2010), naturalness (greenery content) of window views was assessed by selected landscape architects. Twelve experts rated the pictures of window views taken from the eye level while standing inside the rooms. Expert reviewers scored the naturalness of the window views on a 5-point scale (1 = natural, 5 = built). Assessments of views were based on characteristics such as view of a parking lot, another building or a green space, and presence and characteristics of vegetation (type of tree and shrubs, height of trees), season and time of day. It was established in Ozdemir (2010) that naturalness of window view and occupants' satisfaction with those views are correlated in both seasons ($R = 0.51$, $p < 0.05$ in winter and $R = 0.52$, $p < 0.05$ in summer), and that naturalness has no relationships with both perceived spaciousness and room satisfaction.

In Hellinga and Hordijk (2014), the extent of greenery content in a view was assessed based on a score system: "natural landscape" (4 points), "built view" (0 point; if contained natural green, 2 points), and "natural water" (2 points). It was shown that the presence of natural landscape, natural green and natural water in a view, combined with other attributes, contributed positively to the aggregate scores – i.e., "view quality scores", which was found to be positively correlated with the mean subjective rating of the view. However, the correlation between greenery proportion and view quality was not explored.

In Lottrup et al. (2015), greenery content in a view was not quantified but characterised in ten possible response categories: "buildings/signs", "cars/traffic", "sky", "trees", "mowed lawn", "flowers", "park-like environment", "wild self-seeded natural environment", "other", and "I have no view of the outdoor environment from my workstation". View satisfaction was evaluated using a 5-point adjectival scale with the response categories being "very satisfied", "satisfied", "neither satisfied nor dissatisfied", "dissatisfied" and "very dissatisfied". It was found that a "park-like environment" (green landscaped area) had the highest positive effect on view satisfaction (Odds Ratio = 8.08; $p < 0.001$).

In Matusiak and Klöckner (2016), the proportion of the view that contained greenery (grass, bushes, single trees or forest) was measured in three levels, each assigned with a fixed value indicating the nearest proportion: “no greenery” (0.00), “greenery makes about 10 – 50% of the landscape visible in the picture” (0.50) and “50% or more of the landscape” (1.00). Contrary to previous studies, through an ordinal regression analysis the proportion of greenery was found to have no significant effect on the view quality when the other predictors in the equation were controlled.

In Olszewska-Guizzo et al. (2018), the extent of green cover in a view was assessed based on three categories – i.e. “minimal” (below 20%), “medium” (30 – 40%) and “high” (above 50%). Through an exploratory electroencephalography (EEG) experiment, it was shown that having a green window view can potentially contribute to the mental health and well-being of urban dwellers living in high-rise apartments.

2.3.2 Number of visual layers

Markus (1967) was the first known researcher who emphasised the importance of horizontal stratification as one of the main characteristics of window view. This concept of three visual layers in horizontal stratification was subsequently adopted as the principle of window view provision, which was stipulated in the British Standard (BS 8206-2:2008) as well as in the code of practice for daylighting and window design published by the Chartered Institution of Building Services Engineers (CIBSE) (2014) – it was held that window views which incorporate all three layers in the following are “the most completely satisfying” (BSI 2008):

1. Upper (distant) layer, being the sky and its boundary with the natural or man-made scene.

2. Middle layer, being the natural or man-made objects themselves.

3. Lower (close) layer, being the nearby ground.

In Matusiak and Klöckner (2016), a view consisted of three layers (as in Markus 1967), and the number of view layers was found to have a strong impact on the view quality based on the results of ordinal regression analysis ($B = 0.598$, $p = 0.023$).

However, Hellinga and Hordijk (2014) suggested that there were four layers instead of three – i.e., the ground, nearby buildings or greenery, distant city or landscape, and the sky. In the view quality assessment, each layer that was present in the view was given one point, contributing to the aggregate "view quality score."

2.3.3 View elements (aesthetic impression of elements)

In Hellinga and Hordijk (2014), aesthetic impression of view elements was measured based on five levels of condition and complexity of dominant buildings – i.e., "poorly maintained buildings" (-1 point), "old buildings, complex architecture" (1 point), "old buildings, simple architecture" (0 point), "modern buildings, complex architecture" (0 point), and "modern buildings, simple architecture" (-1 point). The total net score contributed to the aggregate "view quality score."

In contrast, Ludlow's (1976) method of assessment stated that the preferred aesthetical quality of a window view should be of "medium complexity and highly resolved." An optimum complexity (not too complex and not too simple) provides visual interest without confusion or boredom; and any uncertainty within the view in terms of being unable to resolve the total structure of the view (e.g., being unable to see the boundaries and determine the form of any visual element) should be avoided. Ludlow (1976) found that complexity (resolution of content) accounted for 7% of variance in view satisfaction. This finding is supported by Van den Berg et al. (2016) that natural environments tend to be characterised by intermediate levels of visual complexity, which easily attracts attention in a moderate and pleasant way; most built environments and man-made objects are either highly complex or lacking in visual complexity, thus unable to capture attention at all. Nadal et al. (2010) suggested that a scene's overall level of visual complexity is not only determined by the quantity of elements that are present in the scene, but also by the extent to which visual information is structured and ordered across scale levels.

In Matusiak and Klöckner (2016), the attributes for a positive evaluation of the aesthetical scene quality were buildings or trees based on their age, maintenance or upkeep, moderate complexity and historical significance; and landscapes based on the coherence, legibility, moderate complexity and mystery. This attribute was treated as a qualitative measure in four levels (1 = "very poor", 2 = "poor", 3 = "good", 4 = "very good"); it was evaluated by a research team rather an individual person in order to reduce the degree of subjectivity. Through an ordinal regression, it was established in Matusiak and Klöckner (2016) that "aesthetical scene quality" had a positive monotonic relationship with view quality, and it was the predictor with the strongest impact on view quality (B = 1.025, p = 0.003). Human preference for aesthetically valuable landscape elements, buildings and trees was confirmed in that study.

2.3.4 Balance of view (composition)

The existing literature of view balance is limited. However, if the subject matter of window view is explored as a two-dimensional image using the concept of "Alberti's window" (Edgerton 2006; Wijntjes 2014), previous studies of composition and balance in art works may be a useful source of method for the assessment of view balance: analyses of "centre of mass" in art photographs (McManus et al. 2011) and "barycentre pattern" in paintings (Park 2019). According to Vartanian et al. (2005), balance is a function of composition in visual arts – i.e., different composition can lead to different perceived balance.

In Matusiak and Klöckner (2016), the composition of the view was a qualitative measure that was assessed based on two criteria: the balance between the left-right and top-down parts of the picture and the presence of obstructing elements in the scene; a view with good composition should be well balanced and without any obstructing element especially in the central part of the view. There were four levels of measurement (1 = "very poor"; 2 = "poor"; 3 = "good"; 4 = "very good"). It was established that the two qualitative parameters – i.e., "composition of the scene" and the "aesthetical quality of the scene" were strongly correlated with each other and with the perceived view quality.

2.3.5 Diversity of view

The diversity of a window view is dependent upon the variety of objects that are distinctly perceivable in a scene. In Roessler (1980), a study was conducted to determine the effect of window views with three different levels of diversity (from high to low) – i.e., "townscape", "busy road" and "façade of opposite building" on the psychological dimensions of enclosure and restraint, privacy and distraction by the exterior. However, in that assessment of external environment seen through window, the level of diversity was simply represented by the character of view rather than a set of quantifiable criteria.

In Hellinga and Hordijk (2014), "diversity of view" was one of the attributes that contributed to the aggregate "view quality score." Higher score was given to a scene with higher diversity – i.e., 0 point for "low diversity", 1 point for "medium diversity" and 2 points for "high diversity." A questionnaire study carried out by Hellinga and Hordijk (2014) suggested that diversity of view was associated with the perceived view quality, and it was determined by the amount of information content in the view. However, the method of assessing the "information content" was rather subjective – it was based on the relative amount of "information content" in the selected 23 pictures used in the study.

2.3.6 Openness of view

The openness of a window view is determined by the proportion of sky and distant landscape layers observable in the scene. In Ozdemir (2010), openness of window view was assessed by selected landscape architects – 12 experts rated the pictures of window views taken from the eye level while standing inside the rooms. Expert reviewers scored the openness of the window views on a 5-point scale (1 = open, 5 = closed). Assessments of views were based on characteristics such as view of a parking lot, another building or a green space, and presence and characteristics of vegetation (type of trees and shrubs, and height of trees), season and time of day. The results in Ozdemir (2010) indicated that openness of window view and perceived brightness were highly associated in both winter ($R = -0.75$, $p < 0.05$) and summer ($R = -0.72$, $p < 0.05$); openness of window view and room satisfaction were also associated in both winter ($R = 0.46$, $p < 0.05$) and summer ($R = 0.63$, $p < 0.05$).

In Raanaas et al (2011), a study was conducted to find out how openness of window view affects the physical health and well-being of the subjects. Window view conditions were categorised in three levels – i.e., “panoramic”, “partially blocked” and “blocked.” Responses to the satisfaction of window view were measured using 5-point scales (0 = not at all; 4 = very much). It was found that patients with a panoramic window view to nature were most satisfied, and those with a blocked view were least satisfied. The results support the previous findings that open natural scenes were preferred over scenes dominated or blocked by buildings.

2.3.7 Depth of view

In Matusiak and Klöckner (2016), the relationship between view depth and view quality was studied. View depth was defined in Matusiak and Klöckner (2016) as the distance (measured in kilometres) from the window to the most distant visible element of the landscape, which was estimated based on the city map. It was established through an ordinal regression that view depth had a strong positive impact on the perceived view quality ($B = 0.293$, $p = 0.001$).

In Ludlow (1976), the association between “spatial quality” (concerning the feelings of freedom in the sense of the absence of physical constraints in the visual field) and the view quality was studied using a questionnaire survey based on a multi-item 5-point semantic differential scale (e.g., from “close” to “distant”; from “restricted” to “spacious”). The results showed that “spatial quality” accounted for 3.5% of the variance; far and mid distant views were preferred to near views; a range of spatial sequences were preferred to one class of distance. However, the “spatial quality” mentioned in Ludlow (1976) appeared to be an attribute that incorporated both depth and openness of a view.

2.4 Subjective evaluation of window view quality

Conventionally, window view quality is determined by asking viewers to rate the scene that is being observed because viewers' perception is the best yardstick for measuring view quality. However, the subjective evaluation of view quality has its limitations: firstly, the perception of window view is highly complex and affects all sensory modalities (Ludlow 1976) – it is difficult to evaluate only the visual perception; secondly, in order to obtain an accurate rating of a window view, a number of subjects (based on a minimum sample size) are required to perform the viewing and rating so that the mean or median value of the rating can be determined from the sample, but this can be a laborious task for the researcher if he were to get a group of subjects to do these for every window view that is of interest to him.

From the existing literature, the most common criterion of the subjective evaluation of view quality is "view satisfaction." However, a measurement of view quality based on level of satisfaction has its limitation: it does not provide information concerning the affective (emotional) quality that is attributed to the view observed. When the measurement criterion is "view satisfaction", it is only possible for us to conclude that View A is more (or less) satisfying than View B, but we cannot tell which affective quality attributed to View A that makes it more (or less) satisfying than View B. Therefore, a "lexicon" for view quality based on affective descriptors needs to be developed so that it can be used to construct questionnaires for the purpose of evaluating window view quality.

There are numerous literatures pertaining to the affective appraisal of visual elements. One of the established models is the Rusell's model of affect, which is comprised of two principal components of 21 clusters of affective descriptors of environments (Rusell and Pratt 1980; Rusell 1981). Figure 2.1 presents the two-dimensional representation of the affective quality that is attributed to the environment. In the circumplex model of affect (Posner et al. 2005), it is assumed that a person possesses a semantic representation of emotions, which is the evaluable experience of the person towards the environment (Nasar 1994). For the purpose of view quality assessment, "pleasantness" and "excitingness" are two affective dimensions in the model that deserve further investigation to determine whether they are appropriate to be used as verbal anchors in a view quality rating scale.

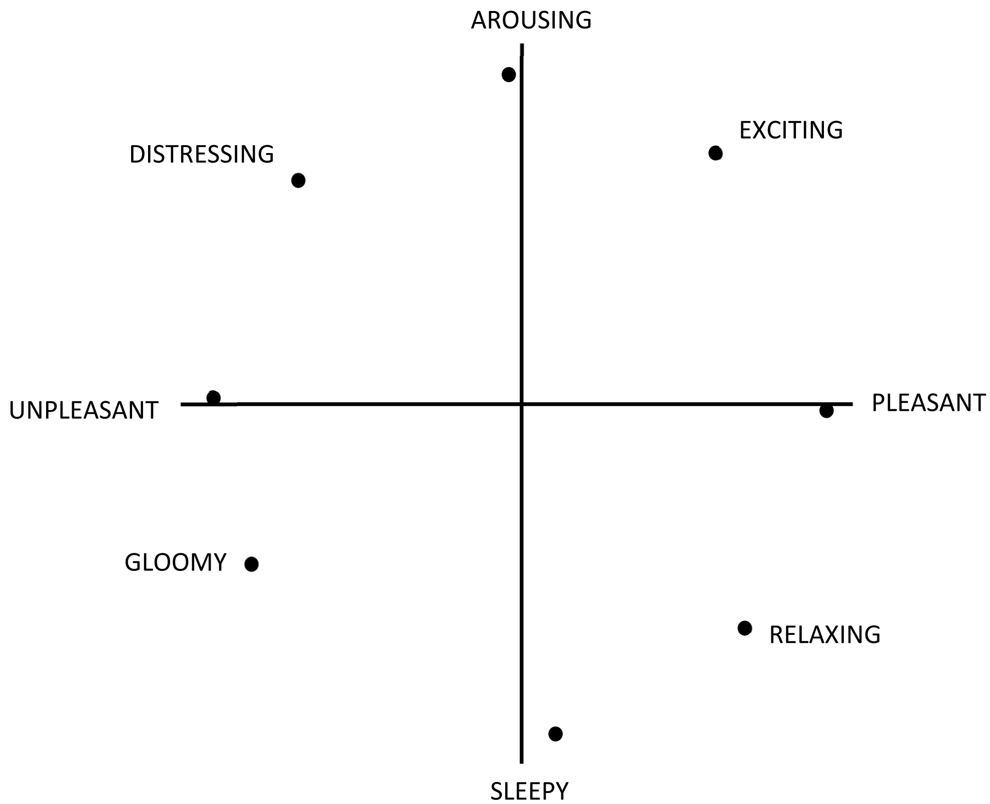


Figure 2.1: Two-dimensional representation of the affective quality attributed to environments (Russell et al. 1981).

2.4.1 Rating scale

Types of rating scale have been discussed in Section 2.2 of this Chapter. The discussion in this section focuses on various response formats of a rating scale for the subjective evaluation of view quality. In previous studies, five-point numeric scale was used by Kaplan (2001), Aries (2010) and Ozdemir (2010); 11-point numeric scale used by

Hellinga and Hordijk (2014); five-point semantic differential scale used by Ludlow (1976); four-point adjectival rating scale used by Markus (1967) as well as Matusiak and Klöckner (2016). In the research of rating scales, there is already a large number of existing literatures on scale format and its psychometric properties (Bendig 1954; Cox 1980; Alwin 1992; Preston and Colman 2000; Dawes 2008; Lee and Paek 2014; Harpe 2015; Lewis and Erdinç 2017).

An important question concerning measurement of view quality is whether there is an optimal number of response categories or scale points, or at least some point beyond which there are no further improvements in discrimination along an attitudinal continuum (Alwin 1992). Rating scale with dichotomous responses (two response categories) has been used widely in research but it is clearly not suitable for view quality evaluation because in addition to the direction information obtained from the two possible responses – i.e., either "satisfactory" or "unsatisfactory" (or any other bipolar responses), we need to know the intensity of the respondent's satisfaction (or dissatisfaction) with the view that is being evaluated. Three-point scales provide the respondent with the opportunity of taking a neutral position, hence it is prone to yielding superfluous midpoint responses (Neumann and Neumann 1981). Lee and Paek (2014) pointed out that when a rating scale is too "fine" (with a larger number of the scale points – for instance, 10 or higher), the respondents may not be able to discriminate the intervals between the adjacent points or may not even consider the scale points at the lower or higher end; hence in practice scale points between 4 and 6 seem to be a popular choice in many research.

Bendig (1954) found that between rating scales with 2, 3, 4 or 5 scale points, 4-point scale yields somewhat more reliable stimuli ratings than either a 3- or 5-point scale, with a 5-point scale being slightly more reliable than a 3-point scale. On respondents' preference of rating scales in terms of "ease of use", "quick to use" and whether it "allowed you to express your feelings adequately", Preston and Colman (2000) reported that overall, 2-, 3- and 4-point scales are least preferred, whereas 10-, 9- and 7-point scales are most preferred. Lee and Paek (2014) highlighted that while more scale points are associated with better reliability and validity estimates in some studies, others indicate that there is an optimal range rather than a single optimal point. For instance, Lewis and Erdinç (2017) suggested that in user experience research there is no difference between ratings from 7- and 11-point scales. In Dawes (2008), data from a 5-point and a 7-point numerical scales were rescaled to a common 10-point scale – the results indicated that there was no significant difference in the means and variances; this finding implies that 5-, 7- or 10-point scales are comparable for analytical tools such as confirmatory factor analysis.

According to Alwin (1992), there has been little consensus among researchers regarding the optimal number of scale points in rating tasks assessing subjective quantities because there are three different schools of thought: the first group are information theorists who believe that the more scale points the better since more bits of information are conveyed through the rating; the second group are cognitive theorists who suggest that there are some practical limits to the number of scale points beyond which the respondents may have difficulty in discriminating among a large number of scale points and in selecting the scale point that truly reflects the latent attitude; the third group are motivational theorists who argue that respondents may tend to "satisfice" rather than "optimise." Garner (1960) and Cox (1980) suggested that there is no single number of response categories or scale points that is appropriate under all circumstances. Therefore, the optimal number of scale points for the subjective evaluation of window view quality deserves further investigation.

There has been a controversy surrounding how data derived from rating scales should be analysed – many previous studies were based on continuous data when the rating scale responses were categorical (Lee and Paek 2014). Therefore, one of the main issues to be contemplated in this study is whether the data derived from the rating scales should be measured with ordinal or continuous scale (interval or ratio scale) because this will determine whether parametric data analysis techniques are appropriate for these rating data. Some researchers (Hensler and Stipak 1979; Casacci and Pareto 2015) suggested that data derived from rating scales should be treated as ordinal measure rather than interval measure because the distances between the numbers do not correspond to psychological reality, and we cannot say how much more of a quality one subject has than another (Mitchell and Jolley 2013). In an ordinal scale, the relative differences among values composing the scales are unequal in terms of what is being measured, permitting only a rank ordering of the scores (Harwell and Gatti 2001). Rhemtulla et al. (2012) argued that when parametric data analysis approach is used in analysing ordinal data, it may lead to biased parameter estimates, as well as incorrect standard errors and model test statistics, especially when the number of categories is small. However, Harpe (2015) argued that whether the data derived from rating scales should be treated as ordinal or continuous measure depends on the intent and the design of rating scale in survey questionnaires: when presented with numbers, humans tend to have a mental representation of numbers that seems to resemble a "mental number line", hence the intervals between two adjacent points on a numeric scale may actually be equal since they appear to be mapped to this mental number line – this is a useful concept that potentially allows us to treat responses as interval-level measures rather than simply as ordinal data. Nevertheless, Harpe (2015) suggested that nonparametric data analysis approaches should be considered for individual rating items with numerical response formats containing four or fewer scale points or for adjectival scales.

Therefore, in the subjective evaluation of view quality, there is a need to compare a four-point scale with that of a much finer scale (e.g., a 10-point scale) to fill the knowledge gap. On the issue of scale format, another important consideration is whether the number of scale points should be an odd or an even number. For subjective evaluation of view quality, it is useful to know the propensity ("direction") of the perceived quality (positive or negative). This can be achieved by omitting the neutral category and demanding in essence a forced-choice response (Fotios 2015). In this case, even-numbered scales such as a 10-point scale (1 – 10) which do not have a neutral point, have an added advantage of demanding the propensity (direction) information from the survey respondent, compared to odd-numbered scales such as an 11-point scale (0 – 10).

2.4.2 Mode of viewing: actual view vs. image view

Several previous studies have compared reality with pictures. The question of whether perceiving the picture of a scene is as veridical as perceiving the real scene has long been a subject of debate. The potential use of image mode of viewing is important for the research design in the subjective evaluation of window view quality. Pictures allow observers to perceive three-dimensional scene information in the convenient format of a two-dimensional surface with certain degree of "perceptual invariance" – i.e., the perceived shape in the picture is nearly invariant across a wide range of viewing angles (Vishwanath et al. 2005). If indeed the perception of pictorial images is the same as the perception of real scene, future research of window view quality evaluation can be based on photographs instead of actual scenes for practical reasons. To create a realistic effect, the pictorial images of scenes selected for such experimental study need to be superimposed with images of window frame and with proper digital rendering of daylight and shadow effects on the frame to match the sky condition of the scene. Markus (1967), who emphasised the importance of view content on window design in practice, suggested that ideally architects should obtain photographs of views in all directions and at all relevant heights from the site of the proposed building, and then superimpose on these pictures a perspective of window using photograph as a picture plane. However, the validity of this photomontage technique for the purpose of view quality evaluation requires further investigation.

The term "Alberti's window" refers to a real perspective method proposed by Leon Battista Alberti (1406 – 1472). Edgerton (2006) described "Alberti's window" as an "open frame gridded by perpendicular threads through which the artist should view the scene to be painted, and then transfer the coordinate details in scale onto his similarly gridded picture." The "Alberti's window hypothesis" (Wijntjes 2014) posited that when a real scene is viewed through a frame, such as window frame, the real scene is perceived as a picture in the frame. Cutting (2003) suggested that perceiving pictorial space is no different from perceiving environmental space. Gibson (1971) reasoned that a picture can be visually interpreted because pictures contain the same optical information for an observer as reality does, and that the invariants of visual perception are present in both pictures and reality. According to Hecht et al. (1999), in both real-world and pictorial viewing, the angles appeared flatter at larger distances.

From an experimental study conducted by Wijntjes (2014), it was established that the perception of the real space is more accurate and less ambiguous than pictorial space; the relative differences between these two spaces are curved, which contradicts the Alberti's window hypothesis. Wijntjes (2014) also found that under normal circumstances, the distribution of equally perceived depths is curved in real space, and relatively flat in pictorial space. Since the perception of depth in real space is different from pictorial space as reported in Wijntjes (2014), further research is required to determine whether there is any difference in the perceived quality of window view between the real-word and pictorial viewing.

2.5 Research questions and hypotheses

Based on the outcomes of literature review in this chapter, the key questions concerning the measurement of window view quality are as follows:

1. What are the view attributes that are good predictors of window view quality?
2. What is the association between each of the view attributes and the perceived view quality?
3. What is the most suitable response format of rating scale to be used for the subjective evaluation of window view quality?
4. Is there an optimum number of response categories or scale points for the evaluation of view quality?
5. Is there any difference in the perceived window view quality if it is compared between the actual view and the image view of the same scene?

Key literatures (between 1967 and 2019) that are related to the methods of view quality assessment and the view attributes (independent variables) have been studied (Table 2.1). View attributes have been identified through the literature review in this chapter. The proposed view attributes in the present study are proportion of greenery, number of visual layers, view elements (aesthetic impression of elements), balance of view, diversity of view, openness of view, and depth of view. It is hypothesised that these seven view attributes are associated with window view quality. This hypothesis is tested using regression methods in Chapter 7 (testing predictions of window view quality).

From literature review, two scale formats – i.e., 4-point and 10-point, have been identified for investigation in this study. It is hypothesised that there is a difference between these two scale formats in the evaluation of view quality. From the data analysis, we will determine which one is the better scale format for purpose of view quality evaluation, and whether there is any optimum number of scale points for the evaluation. A method of rescaling is adopted to compare the 4-point and 10-point data on a common 101-point scale. Means and variances of the rescaled rating scores are compared statistically to determine if there is any difference. This is discussed in Chapter 5.

According to the previous study (Wijntjes 2014), there is a difference in depth perception between real space and pictorial space. Therefore, it is hypothesised that perceiving a real window view is different from perceiving the image of the same view. This hypothesis is tested and discussed in Chapter 6.

This study intends to address the knowledge gap in research by exploring the relationships between view attributes and window view quality as well as the method of measuring these attributes and predicting the view quality. It is envisaged that the outcomes of this research not only fill the existing knowledge gap but also provide the architect with prediction models of view quality so that windows' shapes, sizes and positions can be manipulated in the design process to optimise the "view-out" function of windows.

2.6 Summary

The main outcomes of this chapter can be summarised as follows:

1. The existing literature on window view quality may be divided into three broad categories: optimum geometrical design of windows that provide view satisfaction, view contents that promote better mental health and well-being,

and view attributes that can be used as predictors of window view quality. The present study is in the third category.

2. Researchers have been interested in the relationships between view satisfaction and the optimum size and shape of window and room. The critical minimum size of the window is governed more by the information content provided by the external view rather than the amount of daylight that penetrates the room, the level of interior artificial lighting or the viewing position in the room (Ne'eman and Hopkinson 1970).

3. Although the preference for and the benefits of good window views appear well established, the characteristics that constitute a good (or bad) window view are less well understood. To have a more in-depth understanding on this subject matter, potential "view attributes" need to be identified and then tested in regression analyses to determine whether they are significant predictors of window view quality.

4. There are three different types of rating scale that have been used in the previous studies for the subjective rating of view quality: linear numeric scale with bipolar verbal anchors, semantic differential scale and adjectival rating scale.

5. There were two approaches to view setting in the previous studies of view quality assessment. The first approach was experimental view setting – i.e., the scenes were pre-selected based on a variety of viewing criteria, and essentially all subjects in the sample were required to observe the same set of views; the room or space in which the observer performed the viewing was a controlled environment. The second approach was non-experimental view setting – i.e., the scenes were observed from original windows in the existing circumstances at the subject's workplace, home or hospital patient room where the subject responded to a survey questionnaire on window view quality.

6. From the existing literature, it is established that the quality of a window view can be predicted using a number of view attributes. Methods used in previous studies for the measurement of window view attributes are summarised in Table 2.1.

7. A “lexicon” for view quality based on affective descriptors needs to be developed so that it can be used to construct questionnaires for the purpose of evaluating window view quality. For view quality assessment, “pleasantness” and “excitingness” are two affective dimensions in the Russell’s model of affective quality that deserve further investigation to determine whether they are appropriate to be used as verbal anchors in a view quality rating scale.

8. In the subjective evaluation of view quality, there is a need to compare the reliability and validity of a four-point scale with that of a much finer scale (e.g., a 10-point scale) to fill the knowledge gap.

9. The use of image mode of viewing is important for the research design in the subjective evaluation of window view quality. Since the perception of depth in real space is different from pictorial space as reported in Wijntjes (2014), further research is required to determine whether there is any difference in the perceived quality of window view between the real-word and pictorial viewing.

10. The proposed view attributes in the present study are proportion of greenery, number of visual layers, view elements (aesthetic impression of elements), balance of view, diversity of view, openness of view, and depth of view. It is hypothesised that these seven view attributes are associated with window view quality.

CHAPTER 3
Method

3.1 Introduction

From the literature review in Chapter 2, a knowledge gap is identified. This chapter discusses the method and experiment design to reduce the knowledge gap. The first part of this chapter explains the method of assessing the proposed view attributes. The second part is a discussion on the experimental design including selection of views and assessment of the view attributes, design of questionnaire and determination of sample size for subjective evaluation of the selected views. The third and fourth parts of this chapter explain the procedures of Experiment 1 (actual view) and Experiment 2 (image view) respectively. The results of the two experiments are presented in Chapter 4. The comparison of different scale formats for the experiments is discussed in Chapter 5, whilst the comparison of the different modes of viewing is discussed in Chapter 6. Through regression analyses, the results of objective assessment of window view quality (where view attributes are the independent variables) are used to predict the subjective evaluation of window view quality (based on ratings by the subjects). The relationships between the proposed view attributes and window view quality are explored by using the data collected from the experiments and the outcomes of objective assessment. The predictions of window view quality in the form of regression models as well as the validation of prediction models are discussed in Chapter 7.

3.2 Method of assessment of view attributes

The paradigm of an "objective assessment" of window view quality is based on the premise that the quality of a window view is attributed to a number of measurable factors, which are named as "view attributes" in this study. Seven view attributes have been identified from the literature review (Chapter 2): proportion of greenery, number of visual layers, view elements, balance of view, diversity of view, openness of view and depth of view. In the present study, all the view attributes, except depth of view, are assessed based on two-dimensional images of the views. Depth of view is estimated from satellite maps; in the cases where no reference object (e.g., mountain and building) can be identified on the map, alternative methods (trigonometry or principle of lens optics) are used.

Numerous previous studies concerning the effect of window shape and size on view quality have been conducted (Ne'eman and Hopkinson 1970; Keighly 1973a, 1973b; Ludlow 1976; Roessler 1980; Verderber and Reuman 1987). The present study focuses on the knowledge gap – i.e., the effect of information content and the characteristics of view on the perceived quality of view. In order to study the impact of view attributes on view quality, window shape and size are held constant in all the sample views. Since the present window view study is conducted in Kuala Lumpur, the window shape and size are determined based on a typical window that the people in this region are familiar with, so that in window view survey, the influence of window shape and size on the subjects' view preference is minimised. Figure 3.1 shows the shape and size of a typical window design (1,200 mm by 1,200 mm) that is common in Kuala Lumpur. There are two popular variants to the same aperture size: top-hung casement window (Figure 3.1 (A)) which is normally used for commercial or institutional buildings, and side-hung casement window (Figure 3.1 (B)) which is typically used for residential buildings in this region. The standard sill height of window in this region is 900 mm from the floor level. Although the casement sash in the centre of the side-hung window apparently divides the view in half, the gestalt principles of perceptual grouping (Wagemans et al. 2012) suggest that observers tend to see a complete picture rather than two fragmented pictures. This is supported by the results in Matusiak and Klöckner (2016): fragmentation is not a significant predictor of window view quality. Therefore, it can be assumed that there is no significant difference in the quality of scene that is viewed through either a top-hung or a side-hung casement window of the same shape and size. The window view experiments in the present study are based on a square-shaped top-hung window of 1,200 mm by 1,200 mm (Figure 3.1(A)).

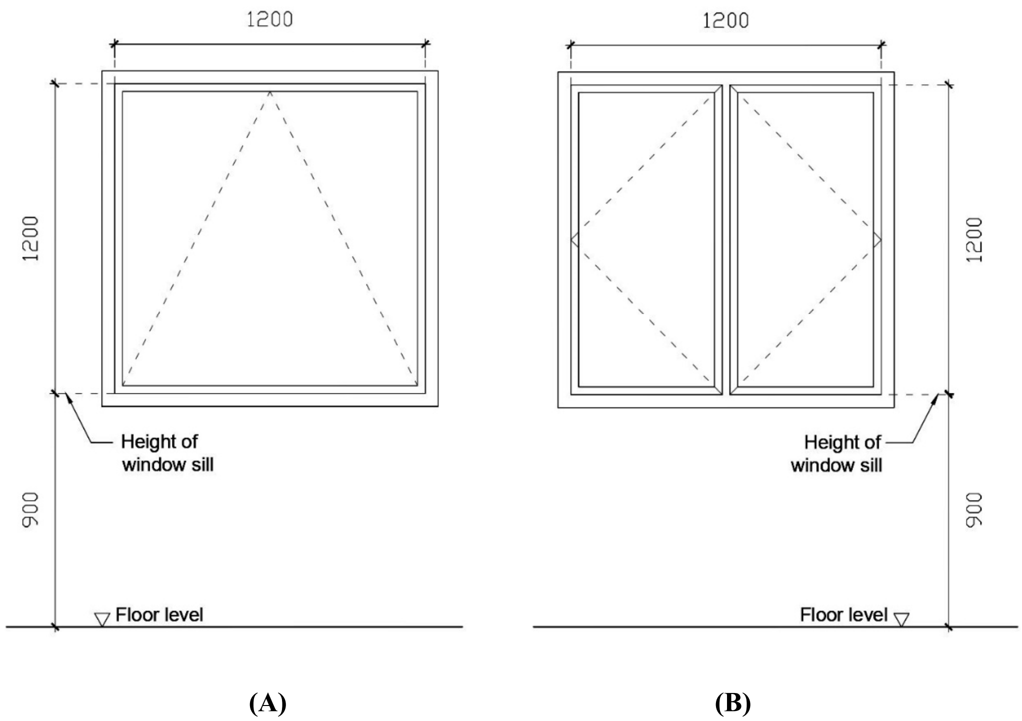


Figure 3.1: (A) Top-hung casement window; (B) Side-hung casement window.

In this study, real views are compared with pictorial views of the same scenes to determine whether there is any difference in the perceived view quality between the two different modes of viewing. For the viewing of pictorial images, a photomontage method is adopted to make the images a more realistic depiction of window views, as suggested by Markus (1967) and Ludlow (1976). Using this method, a digital perspective drawing of window frame (with depth) and part of the wall is superimposed on the picture of a view, followed by digital rendering of daylight and shadow on the window frame to match with the external condition of the window view. Figure 3.2 presents a template of window frame (and part of the wall) created by the researcher for photomontage application in this study. The window view image is intended to be observed at normal incidence. It is interesting to note that according to the theory of perceptual invariance (Vishwanath et al. 2005), even if the picture is viewed from a location other than normal incidence, there may be no perceivable difference in the shapes of objects in the picture.

Figure 3.2: A high-resolution image of an outdoor scene superimposed with a digital drawing of window frame and part of the wall.

When we analyse a window view that is based on a high-resolution digital photograph, it is often difficult to measure the area of each layer due to the fractal complexity of natural elements. However, the area of each layer that appear in the image can be estimated quickly using a proposed "blurred vision" approach – i.e., the image is pixelated using a computer software such as Photoshop. In the pixelation method used in this study, each of the window view images is pixelated and enhanced in three steps: first, the original image with the size of 2,848 pixels by 2,848 pixels is reduced to a size of 1,000 pixels by 1,000 pixels; second, the image is subdivided into 40 cells by 40 cells, where each cell contains 25 pixels by 25 pixels; third, the pixelated image is superimposed with a grid layer to match the cells. The enhancement using an additional grid layer is to make the cells more discernible, hence easier to be identified in the calculation of number of cells for each layer. Figure 3.3 shows a pixelated image (1,000 pixels by 1,000 pixels) of the scene with the addition of a grid layer (40 cells by 40 cells) as an enhancement. Bachmann

(2016) suggested that although the information content of an original image is depleted and degraded after the pixelation process, pixelated images as an experimental aid are used in the domain of pattern or form perception. In this pixelation method, pattern and form of objects serve as the basis for quick estimation of each layer's area. For view attributes that require visual details for better judgement such as "view elements" (aesthetic impression) and "diversity of view", the assessments are based on the original images rather than the pixelated images.

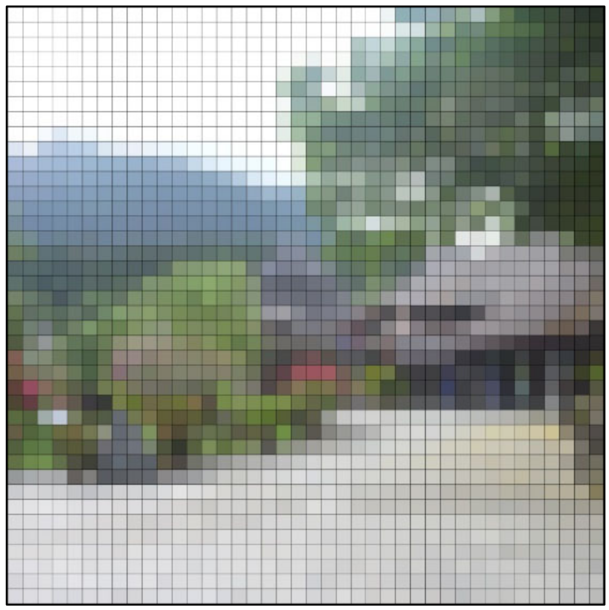


Figure 3.3: Pixelated image of the scene with the addition of a grid layer to match the cells.

To assess the "number of visual layers" and "openness of view" of this scene, colours are first applied on all perceivable layers in the pixelated image as shown in Figure 3.4: the layer in scarlet colour represents the sky layer; the layer below it ("X" - blue colour) represents the distant landscape layer; the layer at the bottom ("Y" - rose colour) represents the ground layer; the green layer ("Z") represents the opaque objects layer (which conceals part of any other layer) – i.e. plants, foliage and buildings in the vicinity. From Figure 3.4, it is apparent that four visual layers are present in the view. The sky layer that is not covered by other visual layers in this scene consists of 216 cells, whereas the distant landscape layer (X) contains 150 cells; ground layer (Y) contains 441 cells; opaque objects layer (Z) consists of 793 cells.

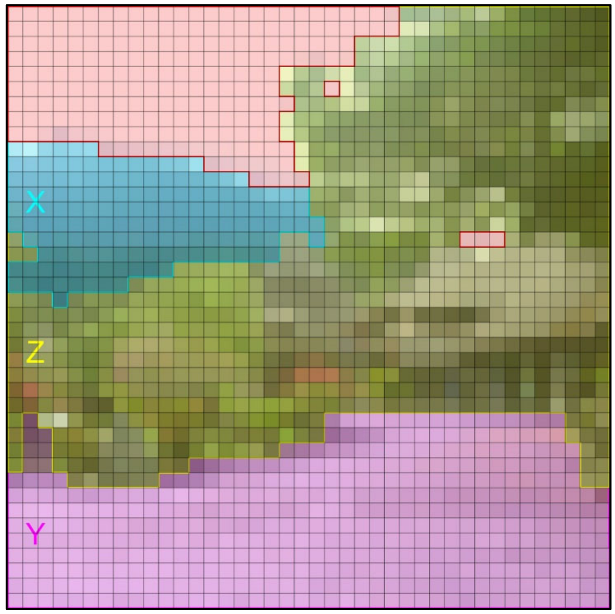


Figure 3.4: Pixelated image for the analysis of "number of visual layers" and "openness of view".

The weight of visual obstruction for each layer is defined as follows: 0 for sky (reference layer); 0.25 for distant landscape and buildings (X); 0.5 for ground (Y); 1 for opaque objects (Z). Conceptually, the weight of visual obstruction is the relative impact of a particular layer as a visual barrier between the observer and the sky. Visual obstruction factor (VOF) of a scene is the sum of weighted proportion of each layer – i.e.,

$$VOF = \frac{0.25X + 0.5Y + Z}{T}$$

where X, Y, Z are the number of cells in the pixelated image of view for each layer; T is the total number of cells (total 1,600 cells in this scene, which is comprised of 40 by 40 cells). In this case, visual obstruction factor (VOF) = 0.66. "Openness of view" (OV) is defined as 1 – VOF. Therefore, the relative openness of this view is estimated to be 0.34 (34%) as compared to other views.

To assess the “proportion of greenery”, a duplicate of the pixelated image of the scene is switched to monochromatic mode. Subsequently, all the cells that contain greenery elements (natural landscape) in the scene were cropped from the coloured pixelated image, rendered in a single-tone green colour and then superimposed on the monochromatic copy using the same grids (see Figure 3.5). The total number of cells that contain greenery in this case is 673, hence the “proportion of greenery” = 673/1600 = 0.42 (42%).

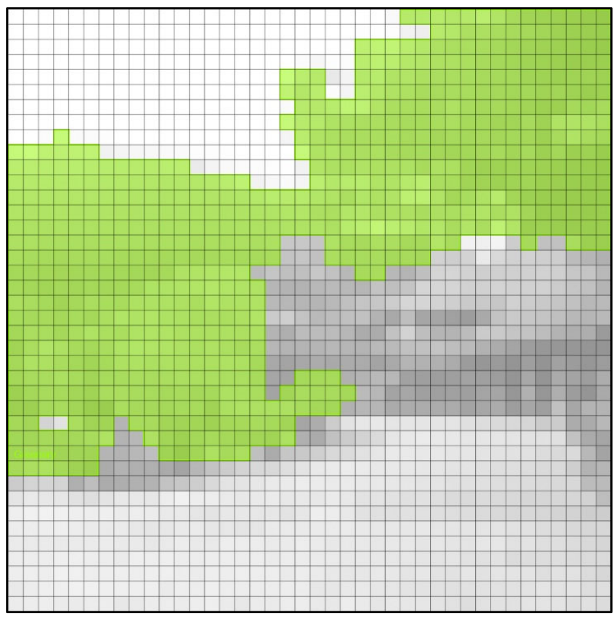


Figure 3.5: Pixelated image for the analysis of “proportion of greenery”.

In this study, “balance of view” (BV) is the level of proximity of the “point of balance” to the centre of view. It is defined by the following equation:

$$BV = \frac{D_{max} - D}{D_{max}}$$

where D is the distance between the “point of balance” and the centre of view; D_{max} is the maximum distance to the centre of view. This view has a dimension of 40 by 40 units (cells), hence $D_{max} = \sqrt{20^2 + 20^2} = 28.28$ units.

In this study, “point of balance” is defined as the perceived “centre of mass” in art photographs or other visual stimuli (McManus et al. 2011; Okumura and Yamanaka 2020). To determine the “point of balance” of a view (image), the steps are as follows:

1. To establish the “centre of view” by constructing a horizontal line and a vertical line, which divide the view (image) into four equal-sized quadrants. The horizontal and vertical lines define the x-axis and y-axis of the Cartesian coordinate system, in which the “centre of view” is at coordinate (0, 0).

2. To determine the position of “point of balance” in the view (image), we imagine the view as a three-dimensional artwork (sculpture) that has a mass, which is distributed based on the perceived weights of elements that constitute the artwork: an opaque element in the foreground (e.g., building or tree) is perceived to be heavier hence a larger “mass” compared to other elements in the background (e.g., distant landscape or the sky).

3. To indicate a point (x, y) that is the best estimate of the location of an imaginary fulcrum that supports this “artwork” on the underside thus achieving a balanced position. In order to minimise bias due to subjective judgement, 10 persons (two architects, one architecture lecturer and seven architecture graduates) are invited to join the researcher to assess the location of the “point of balance” (centre of mass). Each of the assessors studies the coloured image of the view (Figure 3.2), and then marks his perceived “point of balance” on the grids (at an intersection point) that overlay the pixelated image of view (monochromatic mode), which is displayed next to the original image on a computer screen. Figure 3.6 shows a compilation of “point of balance” locations given by the 11 assessors independently.

4. To calculate D (the distance between the “point of balance” and the centre of view) based on the mean x and y values of the point locations given by the assessors as shown in Table 3.1. “Point of balance” is derived as (3, -1.27).

$$D = \sqrt{3^2 + (-1.27)^2} = 3.26$$

5. To calculate the "balance of view" (BV), we insert the values of D and D_{max} into the equation as follows:

$$BV = \frac{28.28 - 3.26}{28.28} = 0.88$$

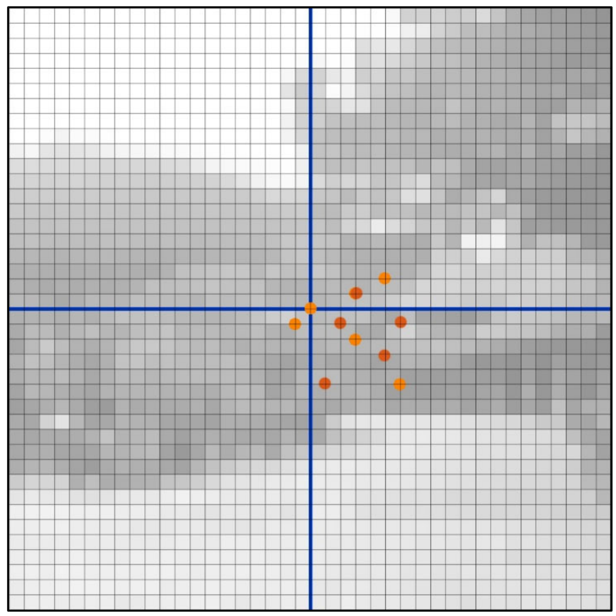


Figure 3.6: Pixelated image (monochromatic mode) for the analysis of "balance of view" – estimated locations of "point of balance" given by 11 assessors independently.

Table 3.1: Coordinates (x, y) of "point of balance" determined by 11 assessors.

Assessor ID	Displacement along x-axis	Displacement along y-axis
1	-1	-1
2	3	1
3	3	-2
4	6	-5
5	0	0
6	5	2
7	1	-5
8	6	-1
9	3	1
10	5	-3
11	2	-1
Mean	**3.00**	**-1.27**

"View elements" (aesthetic impression of elements) and "diversity of view" are assessed using the original image of the view (Figure 3.2). "View elements" in this study is defined as the total net score (which can be positive, zero or negative) on the aesthetic impression of all observable groups of elements in the view. The "groups" of elements are based on "verbal descriptors" of the observer – i.e., the interpretation of elements perceived by the observer (researcher) relies upon what he can describe in words. "Diversity of view" is measured by the number of groups of view elements in a scene. The typical groups of elements and the points assigned to each group are as follows:

(i) Natural green and/or natural waters depending on the aesthetic impression (1 - 4 points)

(ii) Features of buildings (old/modern, simple/complex architecture) (-2 to 2 points for each building)

(iii) Structures or objects depending on the aesthetic impression (-2 to 2 points for each structure or object)

(iv) Neutral natural elements (e.g., sky, ground) (0 point)

(v) Neutral man-made elements (e.g., vehicle, road, railway line) (0 point)

To assess the "view elements" of this window view (Figure 3.2), the researcher first evaluates the "diversity of view" by using the verbal descriptors to determine the number of groups of visual elements that constitute the window view:

Group 1 – "Sky"
Group 2 – "Distant landscape"
Group 3 – "Trees"
Group 4 – "Flowers and shrubs"
Group 5 – "Timber houses"
Group 6 – "Ground"

Since the assessment of “view elements” involves subjective judgement on aesthetical qualities, 10 persons (two architects, one architecture lecturer and seven architecture graduates) are invited to join the researcher to carry out independent assessments of this attribute in order to minimise bias in the evaluation. Each of these 11 assessors studies the digital image of the window view (Figure 3.2) that is displayed on a computer screen for 1 – 2 minutes and then independently evaluate the aesthetical quality of each group of elements (except the neutral groups) by using predefined rating scales – i.e., four-point scales (1 – 4) for natural greeneries such as “distant landscape”, “trees” and “flowers and shrubs”; five-point bipolar scales (-2 to 2) for built environment such as “timber houses”. The final “view elements” score is the median value of scores given by the 11 assessors. Table 3.2 presents the results of evaluation: the median score of “view element” is 6; “diversity of view” (number of groups of view elements) is 6.

To make a reasonable estimate on the “depth of view” for each window view, one of the three alternative methods can be used depending on the view context. The first method is to use a satellite map which is accessible online (e.g., Google satellite map). This method is useful if there is a landmark (e.g., a prominent building or a mountain) at the most distant location, which can be identified on the map. Since the scale is normally specified on the map, the “depth of view” (the distance between the observer and the most distant observable object) can be determined easily. For this view (Figure 3.2), the most distant mountain that could be seen was two kilometres away from the viewer – as estimated based on the satellite map. Therefore, the “depth of view” was 2.0 (km).

If satellite map is not available, or the prominent building cannot be located on the map, an alternative method to estimate depth of view is based on the principle of lens optics (see Figure 3.7). This method can be useful if there is an observable high-rise building or tall structure at the most distant location where its height can be estimated (based on number of storeys or the height of a reference object).

Table 3.2: Analysis of "view elements" (VE) and "diversity of view" (DV).

	View Elements (VE)										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**DV (No. of Groups)**
	Sky*	Distant landscape	Trees	Flowers & shrubs	Timber houses	Ground*	---	---	---	---	**6**
Assessor ID	(0)	(1 - 4)	(1 - 4)	(1 - 4)	(-2 to 2)	(0)					**VE Score**
1	0	2	1	4	2	0					9
2	0	1	4	4	2	0					11
3	0	1	1	3	-1	0					4
4	0	3	1	4	1	0					9
5	0	1	2	2	1	0					6
6	0	1	1	1	-1	0					2
7	0	1	1	1	2	0					5
8	0	2	3	4	2	0					11
9	0	1	4	4	1	0					10
10	0	1	1	1	0	0					3
11	0	1	2	2	0	0					5
										Median VE Score	**6**

* Neutral elements (natural or man-made) – given zero point by definition.

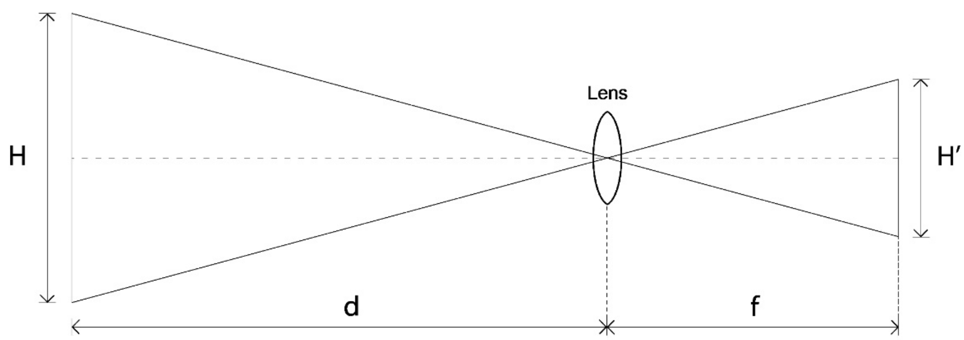


Figure 3.7: Focal length (f) and distance to field (d) in lens optics.

According to the principle of lens optics:

$$\text{Distance to field (d)} \approx \frac{\text{Focal length (f)} \times \text{Actual object height (H)}}{\text{Object height on sensor (H}')}$$

and we have:

$$\text{Object height on sensor (H}') = \frac{\text{Object height in pixels}}{\text{Image height in pixels}} \times \text{Physical height of sensor}$$

In the present study, Nikon D300S (DX Format) camera is used. With a focal length (f) set at 10 mm and physical height of sensor 15.8 mm, the estimated distance to field is given by the following (d and H in metres):

$$\text{Distance to field (d)} \approx 0.633 \times \text{H} \times \frac{\text{Image height in pixels}}{\text{Object height in pixels}}$$

Actual object height (H) can be estimated based on a typical floor-to-floor height of 3 metres; a 20-storey building is estimated to be 60 metres in height. The image or object height in number of pixels can be determined by checking the digital "properties" of the image using Microsoft Windows' applications. From the equation above, distance to field is the estimated "depth of view."

In the context where no prominent landmark is present in the view but the horizon is visible to the observer, an alternative method based on trigonometry may be used to estimate the depth of view (see Figure 3.8). From the Pythagoras theorem, we have:

$$d^2 + R^2 = (R + h)^2$$

where h is the height of observer (O) from sea level; d is the distance of observer to the horizon; R is the radius of the Earth (6,371 km). Simplifying the equation above, we have (d in km; h in metres):

$$d \approx 3.57\sqrt{h}$$

The maximum distance to the horizon, measured from the eye level of an observer standing on ground level ($h \approx 2\ m$) , is estimated to be 5 kilometres.

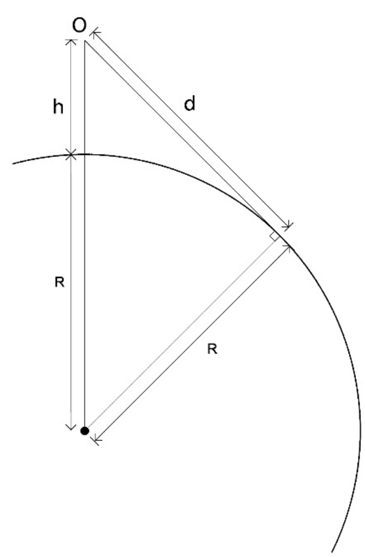


Figure 3.8: Diagrammatic section of the earth showing the distance (d) between the observer (O) and the horizon.

Among the seven view attributes discussed in this section, “view elements” (aesthetic impression of elements) and “balance of view” (composition of view) inevitably require some subjective judgements in the assessment process. However, the effect of subjective judgements is minimised as the assessment of these attributes involves not only the researcher but a team of assessors who are trained in architectural, urban or landscape design. When the team conducts assessment on “view elements”, the median score serves as the final assessment score (median is more robust against outliers as compared to mean). For “balance of view”, the distance between the “point of balance” and the centre of view is calculated based on the mean x and y values of the point locations (coordinates) given by a team of assessors. Table 3.3 presents a summary of the proposed view attributes and the scales of measurement (a comparison with two previous studies).

Table 3.3: Summary of proposed view attributes and the scale of measurement (in comparison with two previous studies).

Proposed view attributes	Scale of measurement	Definition of scale	Previous studies	
			Matusiak & Klöckner (2016)	Hellinga & Hordijk (2014)
Proportion of greenery (PG)	Ratio	Percentage of cells in the pixelated image of view that contains greenery or natural landscape elements.	Three levels, each assigned with a fixed value indicating the nearest proportion: "No greenery" (0.00), "greenery makes about 10–50% of the landscape visible in the picture" (0.50) and "50% or more of the landscape" (1.00).	The extent of greenery content in a view was assessed based on a score system: "Natural landscape" (4 points), "built view" (0 point; if contained natural green, 2 points), and "natural water" (2 points).
Number of visual layers (VL)	Interval	Number of view layers observable in the scene. Basic layers: Sky (1 layer) Distant landscape and buildings (1 layer) Ground (1 layer) Additional layer(s): Opaque objects (e.g., buildings, trees, foliage) that cover any of the three basic layers.	"Number of visual layers" (1 – 3).	Maximum four layers – i.e., the ground, nearby buildings or greenery, distant city or landscape, and sky. Each observable layer is given 1 point, contributing to the aggregate "view quality score."

Table 3.3 (Continued)

Proposed view attributes	Scale of measurement	Definition of scale	Previous studies	
			Matusiak & Klöckner (2016)	**Hellinga & Hordijk (2014)**
View elements (VE)	Ratio	Total net score (positive/ zero/ negative) on the aesthetic impression of all observable groups of elements in the view (based on verbal descriptors): - Natural green and/or natural waters depending on the aesthetic impression (1 - 4 points) - Features of buildings (old/modern, simple/complex architecture) (-2 to 2 points for each building) - Structures or objects depending on the aesthetic impression (-2 to 2 points for each structure or object) - Neutral natural elements (e.g. sky, ground) (0 point) - Neutral man-made elements (e.g. vehicle, road, railway line) (0 point) The final "view elements" score is the median value of scores given by a team of assessors (minimum 10 persons).	"Aesthetical scene quality" measured in four levels (ordinal): 1 = "very poor" 2 = "poor" 3 = "good" 4 = "very good"	Aesthetic impression of view elements was measured based on five conditions of dominant buildings: "Poorly maintained buildings" (-1 point) "Old buildings, complex architecture" (1 point) "Old buildings, simple architecture" (0 point) "Modern buildings, complex architecture" (0 point) "Modern buildings, simple architecture" (-1 point) The total net score contributed to the aggregate "view quality score."

Table 3.3 (Continued)

Proposed view attributes	Scale of measurement	Definition of scale	Previous studies	
			Matusiak & Klöckner (2016)	**Hellinga & Hordijk (2014)**
Balance of view (BV)	Ratio	$$BV = \frac{D_{max} - D}{D_{max}}$$ D is the distance between the "point of balance" (centre of mass) and the centre of view; D_{max} is the maximum distance to the centre of view. "Point of balance" is based on the mean x and y values of the point locations (coordinates) given by a team of assessors (minimum 10 persons).	"Composition" of view was a qualitative measure with four levels: 1 = "very poor" 2 = "poor" 3 = "good" 4 = "very good"	N/A
Diversity of view (DV)	Interval	Number of groups of view elements in the scene.	N/A	Diversity of view was measured in three levels: • Low – 0 point • Medium – 1 point • High – 2 points

Table 3.3 (Continued)

Proposed view attributes	Scale of measurement	Definition of scale	Previous studies	
			Matusiak & Klöckner (2016)	Hellinga & Hordijk (2014)
Openness of view (OV)	Ratio	Percentage of the sky that is not covered by other opaque layers in a scene. The weight of visual obstruction for each layer is defined as follows: Sky (reference layer): 0 Distant landscape and buildings (X): 0.25 Ground (Y): 0.5 Opaque object (Z): 1 Visual obstruction factor (VOF) of a scene is the sum of weighted proportion of each layer: $VOF = \frac{0.25X + 0.5Y + Z}{T}$ where X, Y, Z are the number of cells in the pixelated image of view for each layer; T is the total number of cells. OV = 1 – VOF	N/A	N/A

Table 3.3 (Continued)

Proposed view attributes	Scale of measurement	Definition of scale	Previous studies	
			Matusiak & Klöckner (2016)	Hellinga & Hordijk (2014)
Depth of view (DP)	Ratio	Distance (km) between the observer and the most distant visible element of the landscape.	Distance (km) from the window to the most distant visible element of the landscape, which was estimated based on the city map	N/A

3.3 Experiment design

The conceptual basis for this experimental study is that "window view" is a framed view to an outdoor scene. The definition of a "window view" may vary depending on the observer's viewing position in the room. When the observer stands (or sits) by the window and looks out, the distance between the window and the observer is close to zero – this is known as "window gazing" (Jütte 2016). When the observer stands away from the window but not too far apart, fulfilling the minimum "window ratio" (ratio between actual window width and the observer's distance from the window) in the range of 0.49 – 0.51 (Ne'eman and Hopkinson 1970), it is considered a framed view, which offers different viewing experience compared to "window gazing." If the observer stands further away from the window – i.e., when the "window ratio" is very much lower than 0.49, the window view appears *"more or less as a picture hung on the wall, framed by the window frame, and not as a three-dimensional reality"* (Markus 1967). The present experimental study focuses on the second type of window viewing mentioned above.

As discussed in the literature review (Chapter 2), one of the major challenges of subjective evaluation in window view surveys is to reduce the possible confounding to a minimum. According to Coolican (1999), there are three main features of a good experiment design: firstly, the independent variables are manipulated in a controlled manner; secondly, the control over the effects of all other extraneous variables is maintained so that they stay constant or are balanced; thirdly, changes in the dependent variable are measured. This experimental study has four primary objectives as follows:

(i) To compare the reliability and validity between different response formats of rating scales for the subjective evaluation of view quality.

(ii) To compare the perceived view quality between real views and pictorial views.

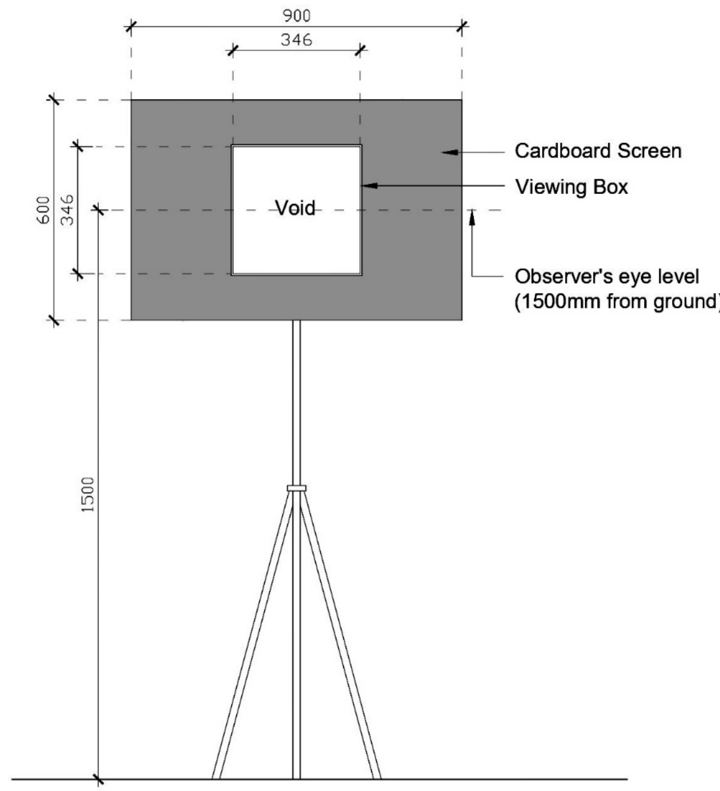
(iii) To explore the relationships between the perceived window view quality and the proposed view attributes.

(iv) To predict the subjective rating of window view quality based on the objective assessment of view attributes through regression analyses.

3.3.1 Method: Experiment 1 (actual views)

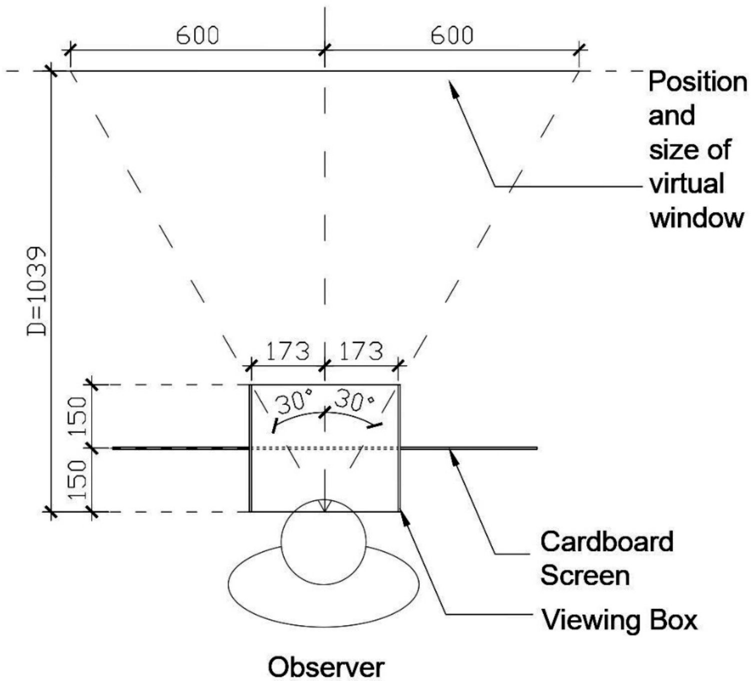
In Experiment 1, a total of 62 subjects were enrolled to perform on-site viewing and evaluation of 12 selected outdoor scenes. These scenes were viewed from the concourses of seven Mass Rapid Transit (MRT) stations located in the urban and sub-urban areas of Kuala Lumpur (see Appendix B1). The seven MRT stations were elevated from the ground level and located along the same railway line. The method of view quality evaluation is based on real scenes viewed through "virtual windows" defined by a portable viewing box as shown in Figures 3.9 and 3.10. The portable viewing box was made of lightweight foam core boards to ensure that it could be carried with ease from one location to the next throughout the experiment. Foam core boards of matt surface and in black colour were used as the material of the viewing box to minimise surface reflection caused by daylight. The viewing angles between the observer and the "virtual window" were 60 degrees horizontally and 60 degrees vertically, which were defined by the optimised aperture size of the viewing box, and consistent with human's central field of vision, which is about 60 degrees in each direction (Panero and Zelnik 1979) (see Appendix B2). The distance between the observer and the "virtual window" was 1,039 mm, hence the window ratio was 0.87 (above the minimum ratio 0.49 suggested by Ne'eman and Hopkinson, 1970). The viewing box enabled the observer to view the actual scenes on-site as if viewing the same scenes through a physical window of size 1,200 mm by 1,200 mm.

(A)

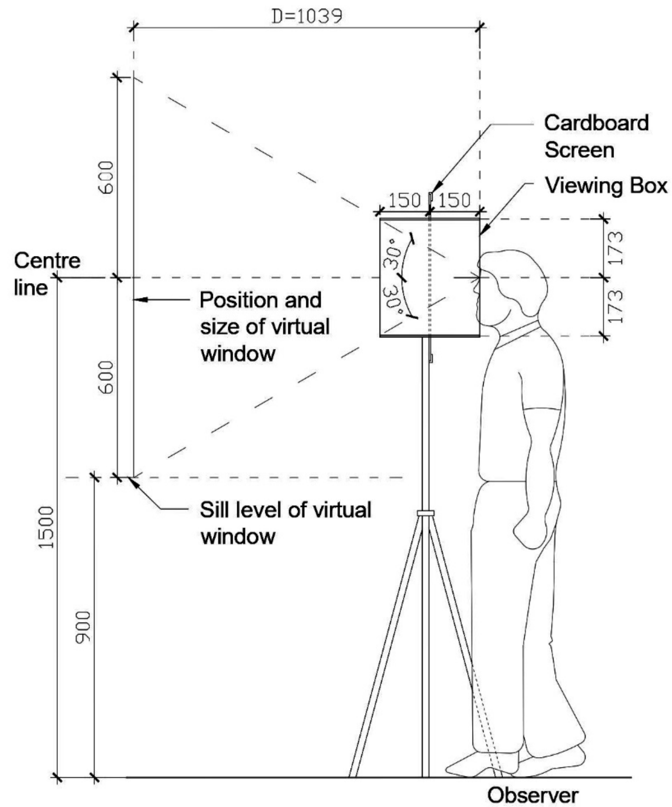


(B)

Figure 3.9: (A) Photograph of the proposed viewing box in the trial set up at a MRT station's concourse. (B) Front elevation of the proposed viewing box.



(A)



(B)

Figure 3.10: (A) Plan; and (B) Section of the proposed viewing box.

3.3.2 Method: Experiment 2 (image views)

Experiment 2 is a systematic replication of Experiment 1: photographic images of the selected 12 window views (from Experiment 1) were displayed on computer screen for another group of subjects (62 persons) to evaluate the view qualities of the scenes. Experiment 2 was conducted in an architecture studio within a university campus in Kuala Lumpur (see Figure 3.11).

Figure 3.11: Digital photograph of a window view displayed on the computer screen in Experiment 2 (image view).

3.3.3 Selection of views

Views from the elevated MRT stations were selected for Experiment 1 because of the following two reasons. Firstly, each of the subjects was able to evaluate the views one by one in a consecutive manner and completed the window view survey (12 views) within three hours, as the seven stations were on the same railway line. Secondly, the first site and the last site were about 20 kilometres apart, so there were more variety of views (from urban to sub-urban characteristics) with different characteristics, therefore suitable for the researcher to investigate the effects of different view attributes on the perceived view quality. Figure 3.12 presents the digital photographs of the 12 selected scenes. Each of these 12 images was subsequently superimposed with digital drawing of window frame and part of the wall for use in Experiment 2 (see Appendix C1).

The following are descriptions of the 12 selected views:

View 1 consists of a telecommunication tower and a billboard at the centre as well as highways, railway lines and part of the MRT station building, whilst the distant landscape comprises mountains and greeneries with some high-rise buildings.

View 2 has a distinct horizontal stratification comprising the sky, distant green landscape and trees with a group of isolated high-rise buildings in the background, railway lines and highways with traffic in the ground layer, and the soffit of roof projected above the window.

View 3 is obstructed on both sides by the louvre-screen walls of the MRT station building resulting in limited visual connection with the sky and the ground which consists of roads and car parks.

View 4 is dominated by green landscape that consists of a layer of trees with dense foliage in the background blocking visual connection with the distant location.

View 5 consists of a predominant metal-clad structure in close proximity located above the lower roof of the MRT station building as well as trees and green landscape in the background with some high-rise buildings in the remote area.

View 6 comprises mainly open parking space with a lower roof of the MRT station building in the foreground, vacant land in the background, and some buildings in the distant locations.

Figure 3.12: Photographs of the 12 selected views for Experiments 1 and 2.

View 7 comprises roads in the foreground and some trees in close proximity which have foliage obstructing a relatively large part of the background in which some apartment buildings are visible.

View 8 consists of the MRT station's lower roof that blocks the visual connection with the front road, and a row of low-rise shop-office buildings in the foreground, some medium and high-rise buildings in the background as well as mountains in the distant landscape.

View 9 has a clear skyline defined by mountain range in the background, terrace houses with trees and road in the midground, as well as the MRT station's lower roof in the foreground.

View 10 is dominated by two high-rise apartment buildings – one on each side, which block the visual connection with most part of the distant green landscape in the background.

View 11 has a foreground that mainly consists of rooftops of buildings in the vicinity, a midground that is dominated by high-rise office buildings on the right side, as well as a background that comprises distant green landscape and buildings.

View 12 has building rooftops and trees in the foreground but it is dominated by a cluster of high-rise office buildings in the midground, which obstruct the visual connection with the distant landscape.

3.3.4 Assessment of view attributes

View attributes of the 12 scenes were assessed using the methods discussed in Section 3.2 of this Chapter. To minimise the bias due to subjective judgement, 10 persons who were trained in architecture and urban design - i.e., two architects, one architecture lecturer and seven architecture graduates, were invited to join the researcher in an independent assessment of "view elements" and "balance of view", which were the two attributes that required subjective evaluation as part of the assessment. The results of assessment on the seven view attributes for the 12 selected views are as follows:

Proportion of greenery (PG) is the percentage of greenery in each image, which is determined by counting the number of green-coloured cells in relation to the total number of cells (1,600). Figure 3.13 shows that the greenery proportion in these 12 views ranges from 0% to 64%; two views have distinctively higher greenery proportions (View 4: 62%, and View 7: 64%) compared to the remaining ten views (0% to 21%). Among the 12 views, View 3 and View 8 have no greenery content (views which have less than 0.5% of greenery in this study are categorised as views without greenery). Table 3.4 presents a summary of assessments on “proportion of greenery.”

Number of visual layers (VL) is determined by the “layers” of visual elements that can be observed in a window view – e.g., sky, distant landscape, ground and opaque objects. The 12 window views in this study have either three or four visual layers. The relative “openness of view” ranged from 12% (View 3) to 65% (View 9). Figure 3.14 shows the pixelated images for the assessment of “number of visual layers” (VL) and “openness of view” (OV). Table 3.5 presents a summary of assessments on “number of visual layers” and “openness of view.”

Diversity of view (DV), which is measured by the number of groups of visual elements in a scene (1 group = 1 point), ranged from 3 points (View 4) to 10 points (View 1 and View 2) across the 12 views. View elements (VE), which is the net score of aesthetical impressions on all groups of visual elements in each view, is a subjective measure that is defined as the median of VE scores given by 11 assessors. Five views (Views 1, 5, 6, 8 and 12) have negative VE score; View 7 has a neutral VE score (0 point); the remaining six views have positive VE scores. View 9 has the highest VE score (3 points) whilst View 1 has the lowest (most negative) VE score (-3 points). The assessments of DV and VE are based on coloured images of the views shown in Figure 3.12 (see Appendix D2 for results of VE assessment on each view).

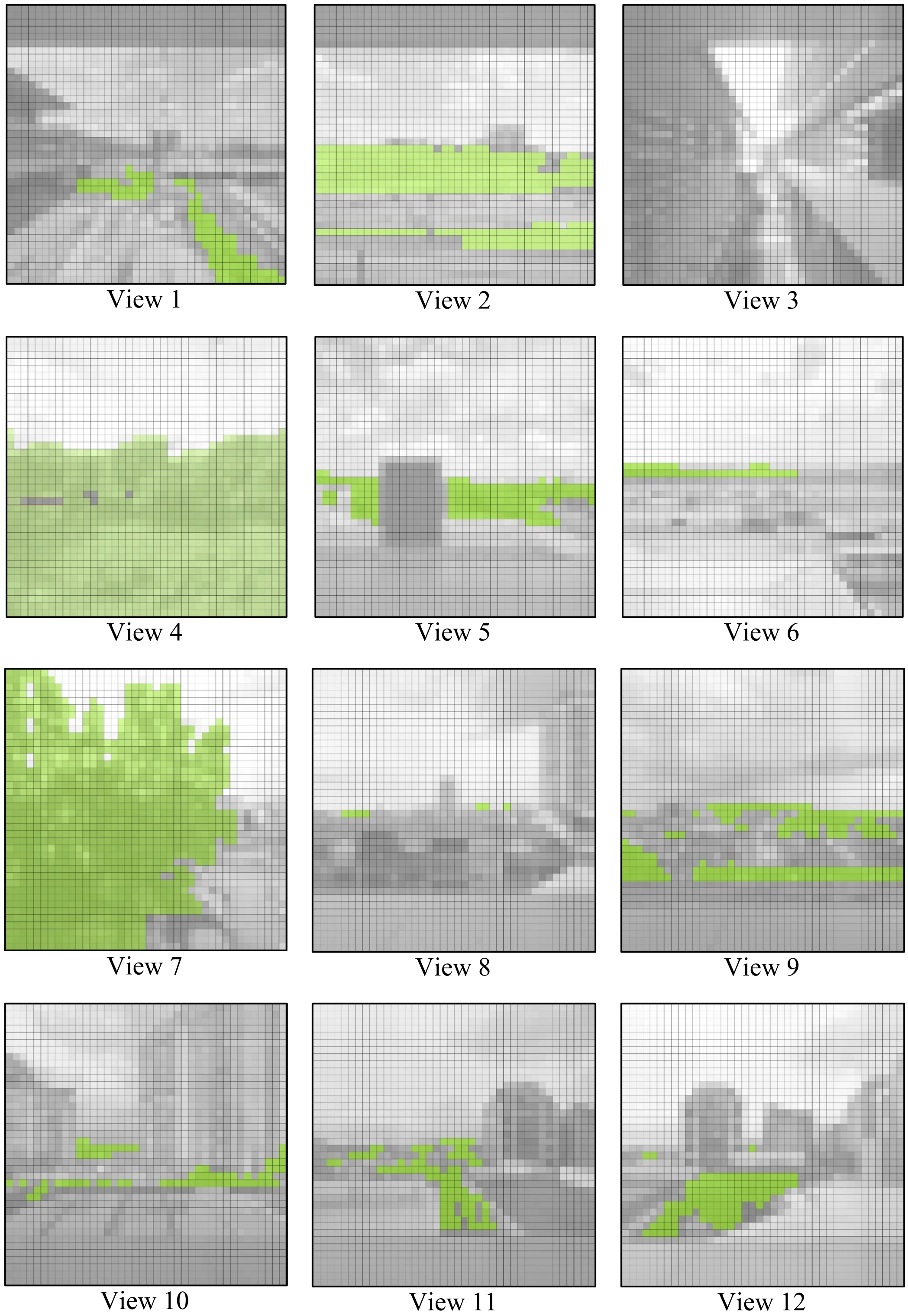


Figure 3.13: Pixelated images for the assessment of "proportion of greenery" (PG), which is based on the percentage of green-coloured pixels in each image.

Table 3.4: Summary of assessments on "proportion of greenery" (based on the number of cells in the pixelated image).

View No.	Greenery (natural landscape)		Buildings and/or hard landscape		Sky		Overall	
	No. of Cells	Percentage (%)	No. of Cells	Percentage (%)	No. of Cells	Percentage (%)	Total No. of Cells	Percentage (%)
1	98	6	1,060	66	442	28	1,600	100
2	332	21	726	45	542	34	1,600	100
3	0	0	1,507	94	93	6	1,600	100
4	989	62	12	1	599	37	1,600	100
5	126	8	706	44	768	48	1,600	100
6	32	2	825	52	743	46	1,600	100
7	1,023	64	279	17	298	19	1,600	100
8	7	0	955	60	638	40	1,600	100
9	172	11	647	40	781	49	1,600	100
10	69	4	1,237	77	294	18	1,600	100
11	79	5	862	54	659	41	1,600	100
12	96	6	922	58	582	36	1,600	100

Note: Percentage is rounded to the nearest integer. For a value below 0.5%, it is considered negligible.

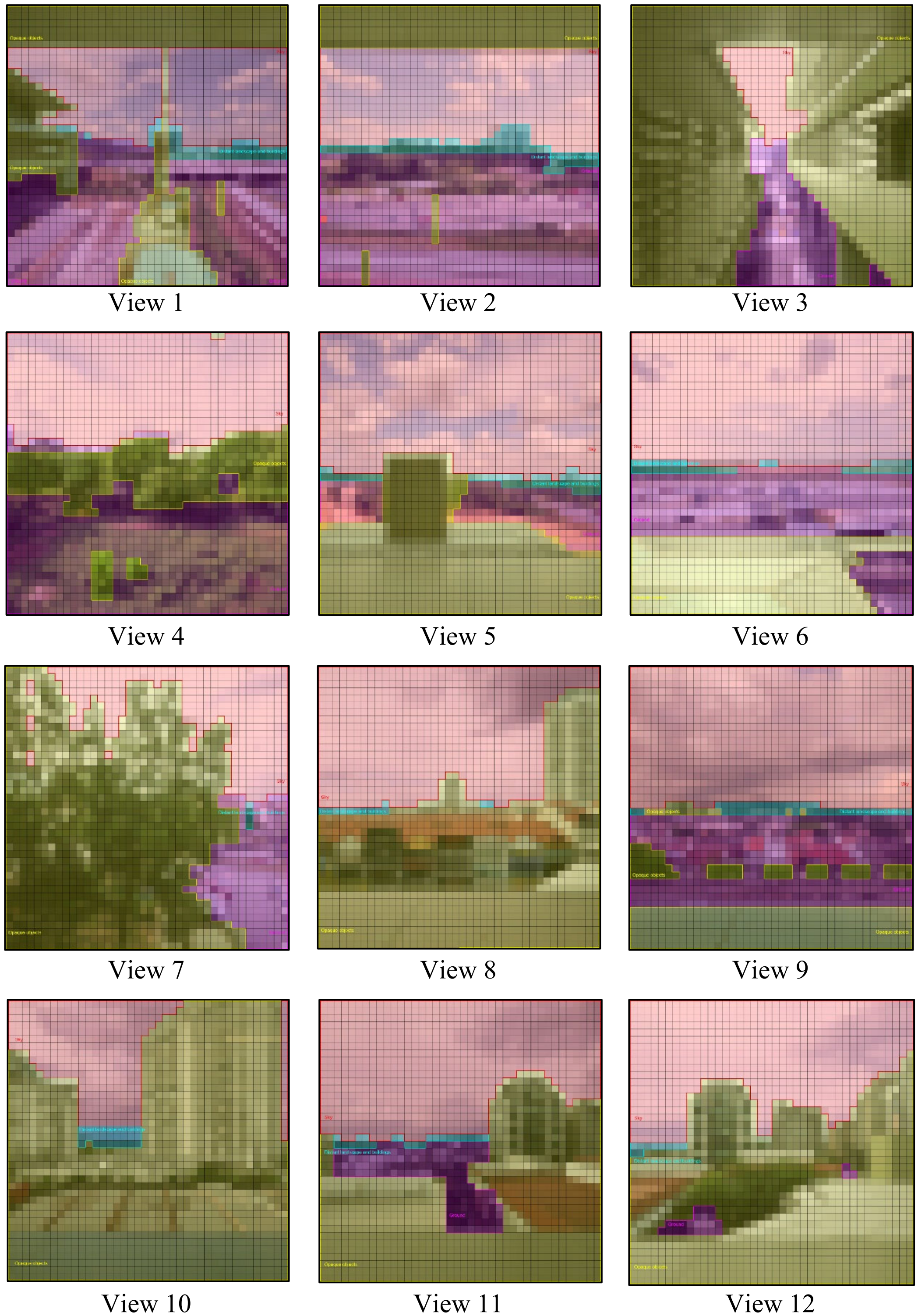


Figure 3.14: Pixelated images for the assessment of "number of visual layers" (VL) and "openness of view" (OV).

Table 3.5: Summary of assessments on "number of visual layers" and "openness of view" (based on the number of cells in the pixelated image).

	Visual Layer 1 Sky	Visual Layer 2 Distant landscape and buildings	Visual Layer 3 Opaque objects	Visual Layer 4 Ground	All Layers Total No. of Cells in Image = 1,600	Openness of View (10% per unit)	Number of Visual Layers
RW*	**0**	**0.25**	**1.00**	**0.50**			
View No.	**No. of Cells**	**No. of Cells**	**No. of Cells**	**No. of Cells**			
1	442	53	531	574	1,600	4.8	4
2	542	75	252	731	1,600	6.0	4
3	93	0	1312	195	1,600	1.2	3
4	599	0	351	650	1,600	5.8	3
5	768	48	599	185	1,600	5.6	4
6	743	40	375	442	1,600	6.2	4
7	298	4	1068	230	1,600	2.6	4
8	638	13	949	0	1,600	4.0	3
9	781	42	323	454	1,600	6.5	4
10	294	26	1280	0	1,600	2.0	3
11	659	24	769	148	1,600	4.7	4
12	582	10	982	26	1,600	3.8	4

* Note: Relative weight (RW) of visual obstruction. RW = 0 for sky (reference layer); RW = 0.25 for distant landscape and buildings (X); RW = 0.50 for ground (Y); RW = 1.00 for opaque objects (Z).

Balance of view (BV), which is the measure of composition of a view, is calculated based on the estimated locations (coordinates) of the "point of balance" (centre of mass) given by 11 assessors. BV of the 12 views in this study ranges from 0.70 (View 11) to 0.99 (View 3). The pixelated images (monochromatic mode) for the assessment of BV are shown in Figure 3.15, in which the orange-coloured dots are the estimated locations of the "point of balance" given by the assessors independently (see Appendix D2 for results of BV assessment on each view).

Depth of view (DP): Depths of the 12 views in this study are determined using satellite map, principle of lens optics or trigonometry. The estimated depths of view range from 0.1 km (View 3) to 10.7 km (View 6). Seven out of 12 views have medium depths of view in the range of 2 – 4 km; two views have extremely small depths (View 3: 0.1 km; View 4: 0.2 km); three views have large depths (View 1: 5 km; View 2: 8 km; View 6: 10.7 km).

A summary of assessments on the seven view attributes based on 12 selected views (Experiments 1 & 2) is presented in Table 3.7.

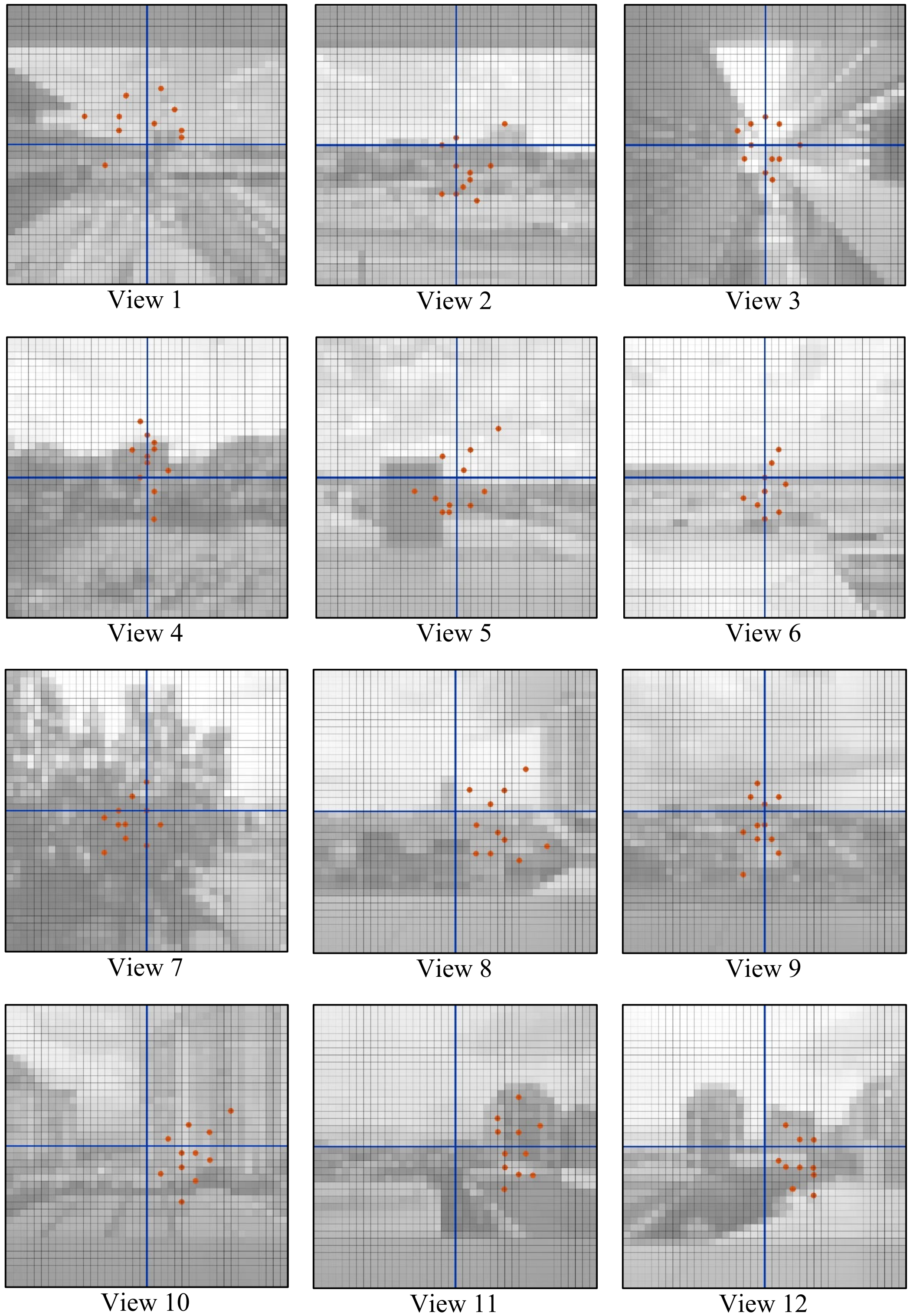


Figure 3.15: Pixelated images for the assessment of "balance of view" (BV). Orange-coloured dots are the estimated locations of "point of balance" given by 11 assessors independently.

Table 3.6: Summary of assessments on "depth of view".

View No.	Height of Observer from Ground (m)	Method 1 (Satellite Map)	Method 2 (Lens Optics)	Method 3 (Trigonometry)	Reference point / object
		Distance to the Furthest Mountain (km)	Distance to the Furthest Building(km)	Distance to Horizon (km)	
1	9	5.0			Mountains at Country Heights Damansara
2	9	8.0			Mountains at northwest of Sultan Azlan Shah Airport
3	9	0.1			Elevated railway track
4	9	0.2			Furthest trees
5	13		3.3		Distance of furthest building estimated using lens optics principle
6	9			10.7	Distance to horizon
7	9	3.0			Mountains at Kota Damansara Community Forest Reserve
8	13	3.0			Mountains at Kota Damansara Community Forest Reserve
9	13	2.0			Mountains at Bukit Kiara forest reserve
10	13	3.0			Mountains at Bukit Damansara
11	13		2.4		Distance of furthest building estimated using lens optics principle
12	13		2.2		Distance of furthest building estimated using lens optics principle

Table 3.7: Summary of assessments on seven view attributes based on 12 selected views (Experiments 1 & 2).

View No.	Proportion of Greenery (10% per unit)	Number of Visual Layers	View Elements (Net Score)	Balance of view (0 – 1)	Diversity of View (Score)	Openness of View (10% per unit)	Depth of View (km)
1	0.6	4	-3	0.87	10	4.8	5.0
2	2.1	4	1	0.86	10	6.0	8.0
3	0.0	3	1	0.99	7	1.2	0.1
4	6.2	3	2	0.92	3	5.8	0.2
5	0.8	4	-2	0.97	7	5.6	3.3
6	0.2	4	-1	0.94	8	6.2	10.7
7	6.4	4	0	0.89	7	2.6	3.0
8	0.0	3	-2	0.77	6	4.0	3.0
9	1.1	4	3	0.93	8	6.5	2.0
10	0.4	3	1	0.77	6	2.0	3.0
11	0.5	4	2	0.70	6	4.7	2.4
12	0.6	4	-1	0.80	8	3.8	2.2

3.3.5 Questionnaire design

In this experimental study, one common set of survey questionnaire was designed for use in Experiment 1 (actual view) and Experiment 2 (image view). This enabled the data collected from the two experiments to be compared with each other, so that the researcher could test the hypothesis that there is a difference in the perceived view quality between the real view and the pictorial view.

There are two objectives in the design of this questionnaire. The first objective is to collect general opinions (not related to any specific view) of the subjects concerning the perceived importance of window at their workplace or home, and their view preference – i.e., the most desired elements that they would like to see when viewing out of window. The second objective is to collect subjective evaluations that are specific to the 12 selected views. The subjective evaluations consist of two parts: the first part is a rating of the view quality based on two different indicators of view satisfaction; the second part is a survey on the subjects' preference of view context (to investigate whether the perceived view quality is influenced by the view context), and the subjects' perceived dominant features (to investigate whether there is a "consensus" between all the subjects on what they perceive in each view).

Existing literatures have been reviewed (see Chapter 2) to determine the indicators of view quality to be adopted for the purpose of rating in this experimental study. The verbal anchors of rating scale used in this study are based on the circumplex model of affective quality, which was developed by Russell et al. (1981). The model is comprised of two dimensions – i.e., the "pleasantness" dimension ("pleasant – unpleasant") represented by the horizontal axis, and the "arousing" dimension ("arousing – sleepy") represented by the vertical axis. A 45-degree rotation of the axes produced two other independent bipolar dimensions – i.e., "exciting – gloomy" and "relaxing – distressing." Between these four dimensions that are related to environmental perception, "pleasantness" and "excitingness" dimensions are more closely related to the study of window views because semantically, the phrase "a pleasant view" or "an exciting view" is more commonly used in our daily life to describe the quality of an outdoor scene. Therefore, the subjects are likely to find these two sets of verbal anchors in the rating scale easy to understand.

In this study, it is hypothesised that the “pleasantness” and “excitingness” dimensions are two indicators of window view quality, hence in the questionnaire design, “pleasantness of view” (POV) and “excitingness of view” (EOV) are two items that require subjective ratings from the survey respondents.

From the literature review (Chapter 2), there is a need to compare a 4-point scale with a much finer scale, such as a 10-point scale, to fill the knowledge gap. Therefore, 10-point and 4-point scales with bipolar verbal anchors are used in the view quality evaluations of the present study. Two different sets of verbal anchors are used in the linear numeric scale – i.e., “Least pleasant” – “Most pleasant” and “Most boring” – “Most exciting” (see Figure 3.16). When a subject views a particular scene in this study and then selects one of the response categories in the rating scale on the degree of “pleasantness” or “excitingness”, the responses received are discrete numbers. Table 3.8 presents the proposed indicators of window view quality for subjective evaluations and the types of rating scale (in comparison with two previous studies).

1	2	3	4	5	6	7	8	9	10

Least pleasant   Most pleasant

1	2	3	4	5	6	7	8	9	10

Most boring   Most exciting

(A)

1	2	3	4

Least pleasant   Most pleasant

1	2	3	4

Most boring   Most exciting

(B)

Figure 3.16: **(A)** 10-point scale with bipolar verbal anchors; **(B)** 4-point scale with bipolar verbal anchors

Table 3.8: Proposed indicators of window view quality for subjective evaluations and the types of rating scale (in comparison with two previous studies).

Proposed indicators of window view quality for subjective evaluations	**Types of rating scale**	**Previous studies**	
		Matusiak & Klöckner (2016)	**Hellinga & Hordijk (2014)**
"Pleasantness of view" (POV) Experiment 1: - 12 actual views through a portable viewing box that is set up on-site. Experiment 2: - 12 image views displayed on computer screen.	Linear numeric scale with bipolar verbal anchors ("Least pleasant" – "Most pleasant"): (i) 10-point scale (1 – 10) (ii) 4-point scale (1 – 4)	Indicator: "View quality" - based on windows at subjects' workplaces. Scale of measurement: Four categories of response (with descriptions): - "Not satisfactory" - "Satisfactory" - "Good" - "Excellent"	Indicator: "View quality" - based on pictures of 23 views. Scale of measurement: Numeric scale (11-point) with bipolar verbal anchors: From 0 ("very bad view") to 10 ("very good view").
"Excitingness of view" (EOV) Experiment 1: - 12 actual views through a portable viewing box that is set up on-site. Experiment 2: - 12 image views displayed on computer screen.	Linear numeric scale with bipolar verbal anchors ("Most boring" – "Most exciting"): (i) 10-point scale (1 – 10) (ii) 4-point scale (1 – 4)		

This rating scale (whether the 10-point or the 4-point version) is designed as such that the boxes which contain the scale numbers are of equal size and are arranged in equal intervals. Therefore, the data derived from this rating scale may be treated as interval-level instead of ordinal-level measures. Harpe (2015) suggested that when presented with numbers, humans have a mental representation of numbers that seems to resemble a "mental number line", which is naturally a continuous measure (ratio- or interval-level). However, whether parametric analysis approaches are appropriate, normality tests are required to be carried out on these data to determine if there is any serious departure from normal distribution. This is discussed in Chapter 4 (results). Appendix D1 contains a copy of the survey questionnaire used in Experiment 1 (actual view) and Experiment 2 (image view) for window view evaluation.

3.3.6 Sample size calculation and power analysis

The subjects for Experiment 1 (actual view) and Experiment 2 (image view) were enrolled through social media based on the availability and willingness to participate in the study. Therefore, it was a convenience sampling. To estimate the required sample size, the variances of respondents' ratings on the 12 selected window views were first studied. A pilot experiment involving 18 participants was carried out. The test participants evaluated the 12 window views on-site and completed the self-administered questionnaires after viewing each scene. The means and variances of the respondents' ratings (POV) using a 10-point scale for all the 12 views were analysed. The variances of POV ratings were found to range from 1.174 (View 2) to 11.211 (View 6). Assuming the respondents' ratings in each view were normally distributed. It is known that margin of error (MOE) = critical value (z-score) x standard error (SE), which can be expressed as:

$$MOE = z \cdot \frac{\sigma}{\sqrt{n}}$$

where a sample sized n of a population having an expected standard deviation of ratings, σ. Therefore, for the estimation of a mean rating of view quality (normal variable), the sample size (del Águila and González-Ramírez 2014) is given by:

$$n = \frac{z^2\sigma^2}{(MOE)^2}$$

Based on the 10-point rating scale (POV) in this study, the acceptable MOE was 1.0, thus it was estimated that the population mean rating using a 10-point scale should be within ±1.0 point of the sample mean rating at a 90% confidence interval in which $z = 1.645$. The highest variance obtained in the pilot experiment, i.e., $\sigma^2 = 11.211$, hence we have:

$$n = \frac{(1.645)^2(11.211)}{(1.0)^2} = 30.3$$

Therefore, the estimated sample size required for this experimental study was 31 (per group). From literature review, a minimum sample of 30 subjects per group is recommended for causal-comparative and true experimental studies (Gay et al. 2012). In this study, 62 volunteers were enrolled to take part in Experiment 1 (actual view) whilst another batch of 62 volunteers participated in Experiment 2 (image view). Using a split-sample approach, the 62 subjects in Experiment 1 (Experiment 2) were randomly divided into two groups (31 subjects per group) for 10-point and 4-point ratings of POV and EOV in each of the 12 window views.

To understand the size of effect that this sample size (31 per group) can reveal, G*Power software was used to analyse the power, sample size, effect size and critical significance level of this study: given any three of these elements, the fourth can be derived (Perugini et al. 2018). In power analysis, the statistical power of a null hypothesis test is the probability of that test reporting a statistically significant effect for a real effect of a given magnitude (Baguley 2004) – i.e., the probability of detecting an effect, given that the effect is there (see Appendix D3). Conventionally, in an *a priori* (prospective) power analysis the value of power as 0.80 (and of β as 0.20) considers the cost of a Type I error (probability = α) four times more serious than the cost of a Type II error (probability = β) when α is also set to its conventional value of 0.05 (thus β/α = 4) (Perugini et al. 2018). Therefore, the critical significance level (α) of 0.05 and statistical power (1- β) of 0.80 were selected for this study.

Given the α-level (0.05), sample size (31 per group), and desired level of power (0.80), there is a minimum effect size that can be significantly detected; effect sizes smaller than that value will not be significant (Albers and Lakens 2018). Sensitivity analyses were conducted using G*Power to compute the anticipated effect size based on the following hypotheses that were to be tested in this study:

1. Paired samples t-test on -

    - Hypothesis 1: There is a significant difference between mean POV rating and mean EOV rating in the evaluation of window view quality (see Chapter 4).

2. Independent samples t-test on -

    - Hypothesis 2: There is a significant difference in the mean POV (EOV) ratings between the rescaled 4-point and 10-point ratings (see Chapter 5).

    - Hypothesis 3: There is a significant difference in the mean POV (EOV) ratings of window view quality between the actual and image mode of viewing (see Chapter 6).

Effect size as the standardized mean difference between two conditions is expressed by Cohen's *d*: its values of 0.20, 0.50, and 0.80 are conventionally used to indicate a small, medium, and large effect size, respectively (Cohen 1992a; Perugini et al. 2018).

Power analysis on paired samples t-test, given an α-level of 0.05 (two-tailed), a total sample size of 31, and a desired power of 0.80, shows that the minimum effect size that can be significantly detected is 0.52 – i.e., effect sizes smaller than 0.52 will not be significant. Figure 3.17 presents a plot of effect size against total sample size for paired samples t-tests. Figure 3.18 presents a plot of power against effect size for paired samples t-tests, which shows that the probability of detecting an effect size of 0.4 (smaller than 0.52) in this case is only 58%.

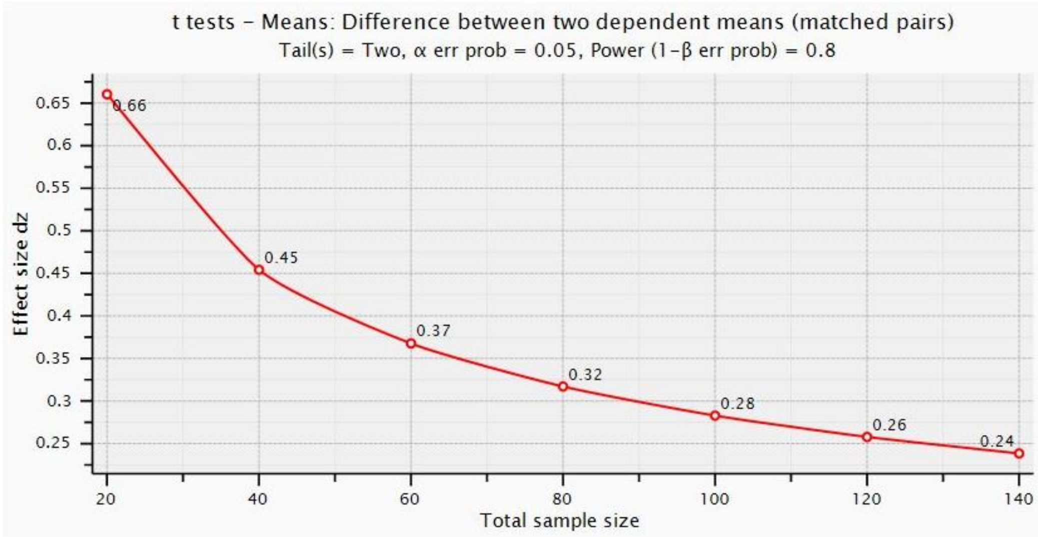


Figure 3.17: Plot of effect size against total sample size for paired samples t-tests by G*Power software (α = 0.05, two-tailed; power = 0.80).

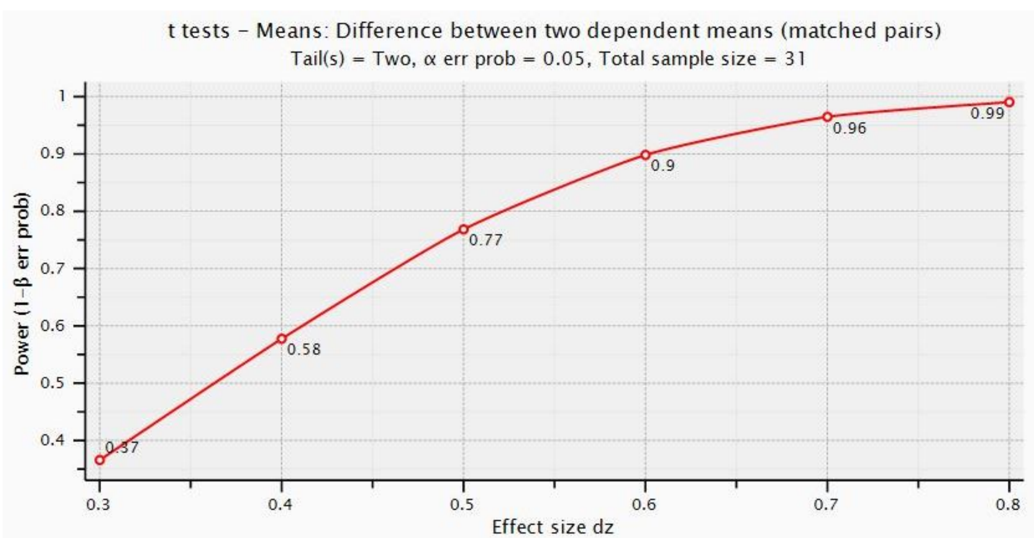


Figure 3.18: Plot of power against effect size for paired samples t-tests by G*Power software (α = 0.05, two-tailed; total sample size = 31).

From the power analysis on independent samples t-test, given that the total sample size is 62 (two groups of 31 subjects), drawing from a population where the effect size (Cohen's *d*) is 0.72, in 80% of the cases one should expect the independent t-test to come out as statistically significant, fixing α = 0.05 (two-tailed). Figure 3.19 presents a plot of effect size against total sample size for independent samples t-tests. With the same sample size, the probability of detecting a smaller effect size is greatly reduced: the plot in Figure 3.20 shows that the probability of detecting a medium effect size (0.5) is only 49%. Therefore, given an α-level of 0.05 (two-tailed), a total sample size of 62, and desired power of 0.80, the minimum effect size (*d*) that can be significantly detected in an independent samples t-test is 0.72 – effect sizes smaller than this value will not be significant. Table 3.9 presents a summary of power analysis (sensitivity analysis) for determining the minimum effect size (*d*) in this study.

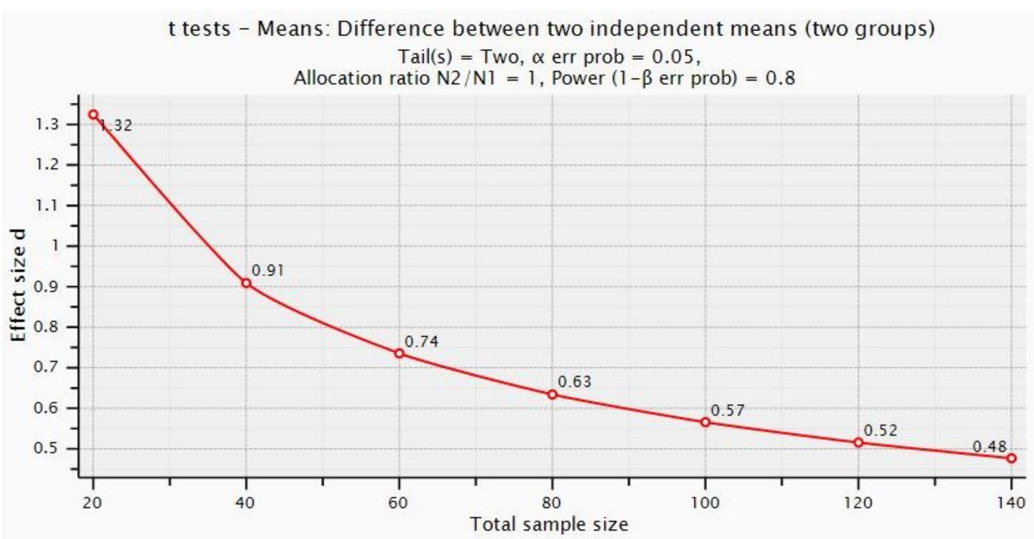


Figure 3.19: Plot of effect size against total sample size for independent samples t-tests by G*Power software (α = 0.05, two-tailed; power = 0.80).

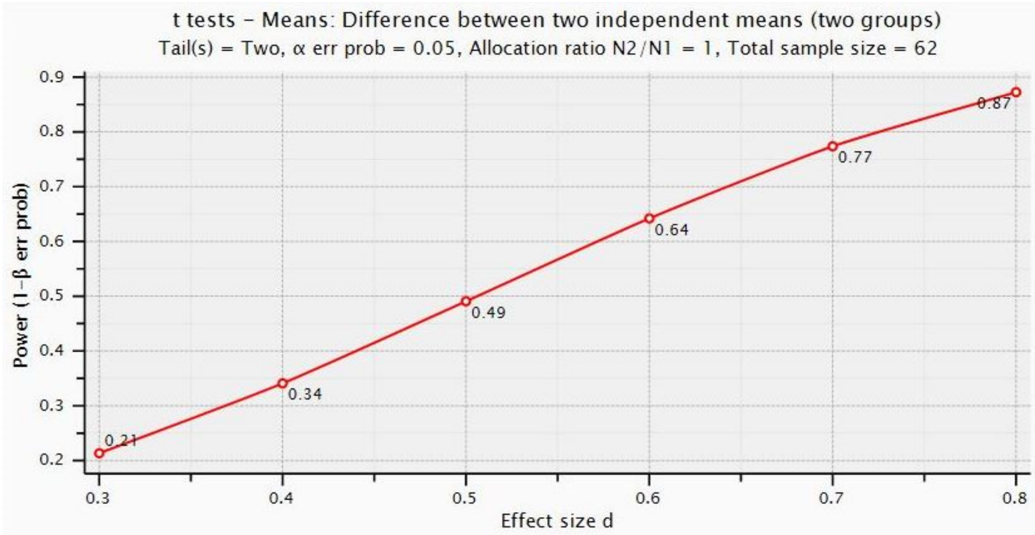


Figure 3.20: Plot of power against effect size for independent samples t-tests by G*Power software ($\alpha = 0.05$, two-tailed; total sample size = 62).

Table 3.9: Summary of power analysis (sensitivity analysis) for determining the minimum effect size, *d*.

Statistical test	Parameters	Effect size, *d*
Paired samples t-test (i) Hypothesis 1 (POV vs EOV)	Alpha level, $\alpha = 0.05$ (2-tailed) Power, $(1- \beta) = 0.80$ Total sample size, n = 31	0.52 (Effect sizes smaller than 0.52 will not be significant)
Independent samples t-test (ii) Hypothesis 2 (4-point vs 10-point rating scales) (iii) Hypothesis 3 (Actual view vs image view)	Alpha level, $\alpha = 0.05$ (2-tailed) Power, $(1- \beta) = 0.80$ Total sample size, n = 62 (Sample size group 1 = 31) (Sample size group 2 = 31)	0.72 (Effect sizes smaller than 0.72 will not be significant)

3.3.7 Overview of research methodology

An overview of the research methodology is presented in the form of a flowchart in Figure 3.21. Data of the subjective evaluations of window views in Experiment 1 (actual view) and the assessed values of selected view attributes were used in multiple linear regression (MLR) and ordinal logistic regression (OLR) to derive prediction models for window view quality of 10-point and 4-point scale respectively. Experiment 2 was a systematic replication of Experiment 1 to explore the differences in perceived view quality (POV and EOV) between the real and pictorial viewing of the same scenes. Using a different set of views, Experiment 3 served as an external validation of the prediction models derived from Experiment 1.

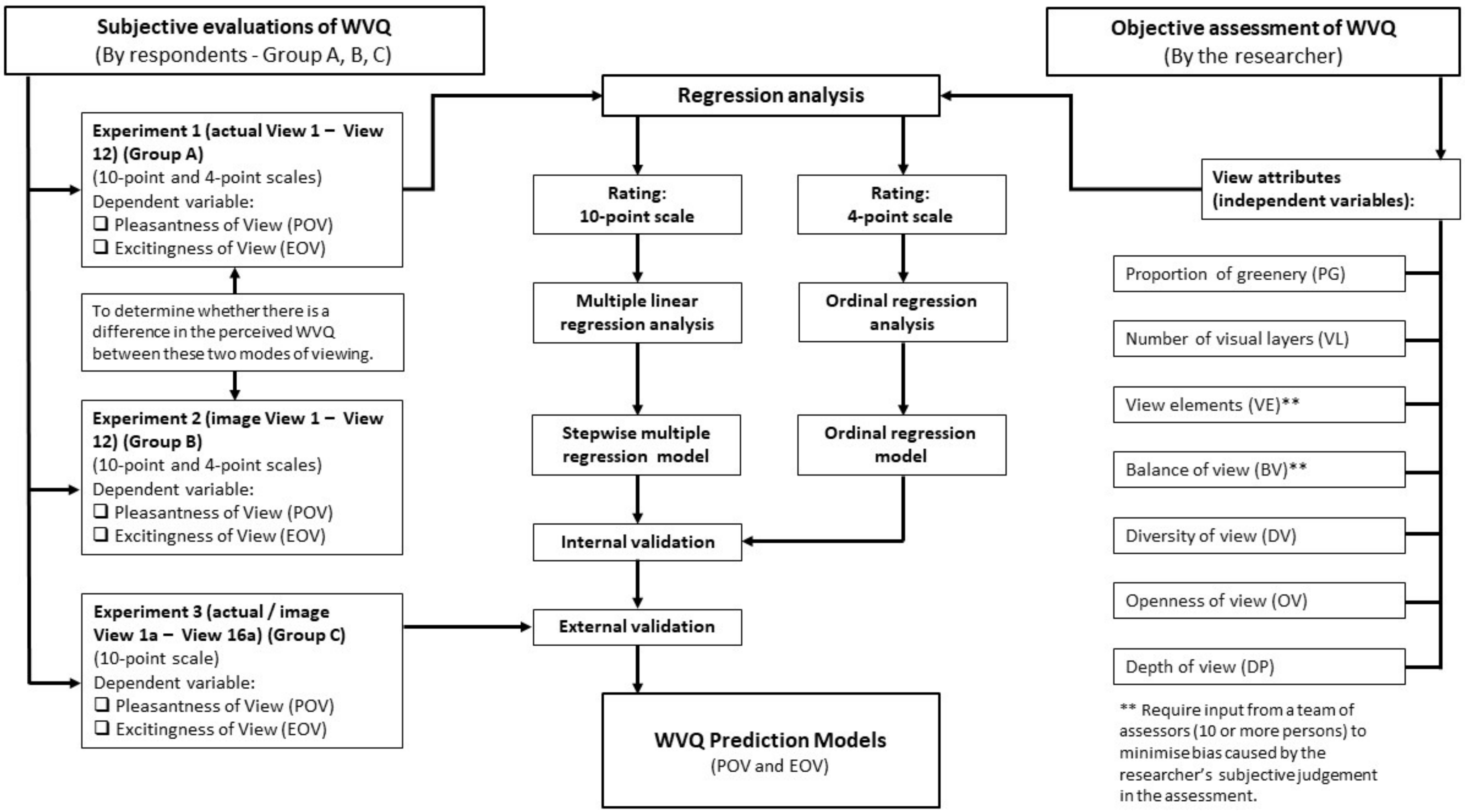


Figure 3.21: An overview of the methodology of this research for the measurement of window view quality (WVQ).

3.4 Procedure: Experiment 1 (actual view)

In Experiment 1, there were 62 subjects comprising male and female adults from a variety of backgrounds. The experiment was conducted on five consecutive weekends between 10.00 am and 1.00 pm. During the time of experiment, it was mostly sunny. On each day of the experiment, a group of subjects (2 – 15 persons each day) followed the researcher to travel by train from the first to the seventh MRT train station to evaluate all the 12 selected views (from the concourses of the stations) in the same sequence. A portable viewing box was carried by the researcher to each of the 12 sites for setting up on a steel easel. The researcher had previously marked on the floor of each site a fixed position for setting up the easel so that, with the centre of viewing box set at a constant height of 1,500 mm, the view defined by the viewing box was the same every time, compared to the pre-defined view. The viewing box was integrated with a rectangular black colour screen made of foam core board, which was intended to reduce the glare that could affect the viewing. The viewing box enabled the subject to view a real scene through a "virtual window", which was like viewing the same scene through a physical window of size 1,200 mm by 1,200 mm (with a sill height 900 mm) that was situated at 1,039 mm from him in a standing position (Figures 3.9 and 3.10).

On the day of experiment, a group of subjects were first briefed by the researcher in the first train station before the viewing experiment started. Each subject was asked to complete a window view survey questionnaire, which was about perception of the importance of windows in general and view preference. After that, the researcher shuffled the first stack of view evaluation questionnaires and randomly distributed them to the subjects. Some subjects received the 10-point scale version of questionnaires, whilst others received the 4-point scale version. After that, the subjects took turns to view the first scene through the viewing box that was set up at the site. The subject stood in front of the viewing box and adjusted his eye level to coincide with a horizontal white marker at the edge of the viewing box, which indicated the centre of aperture. That was to ensure the subject's eye level to be 1,500 mm from the ground. Each subject was asked to spend a minute to study the view through the viewing box (see Figure 3.22).

Figure 3.22: Photographs of subjects observing the scenes through the "viewing box" that was set up at the sites (concourses of MRT stations) for Experiment 1.

After viewing the first scene, each subject was required to complete the view evaluation questionnaire independently by indicating his response on the rating scale, preference of view context and perceived dominant features. The subject spent about 1 – 3 minutes to complete the evaluation of View 1 and then submitted the completed questionnaire to the researcher. When all subjects in that group completed viewing and evaluation of the first scene, the researcher led them to the second site (for View 2), set up the viewing box, and then shuffled the second stack of view evaluation questionnaires and distributed them to the subjects before the viewing started. The process continued in the same fashion until all the 12 views were evaluated on the same day by that group of subjects. In total there were 62 sets of view evaluation questionnaires in each stack (for each view), comprising 31 sets in 10-point scale format, and 31 sets in 4-point scale format. The purpose of shuffling the view evaluation questionnaires for random distribution to the subjects was to reduce the possible bias in the rating by avoiding the situation in which a subject evaluated all the 12 views using the same scale format (either 10-point or 4-point).

3.5 Procedure: Experiment 2 (image view)

In Experiment 2, the 12 selected views in the form of high-resolution digital photographs, which had been superimposed with digital drawing of window frame and part of the wall (see Appendix C1), were evaluated by a different group of subjects using the same survey questionnaire designed for Experiment 1. There were 62 subjects in Experiment 2, comprising male and female adults, of which 61 of them were university students. The experiment was conducted on seven weekdays, between 10.00 am and 4.00 pm, in an architecture studio within a university campus in Kuala Lumpur. None of the subjects in Experiment 2 had participated in Experiment 1. Neither any of the subjects was informed of any details about Experiment 1, including the locations of the views. Each subject was required to view and evaluate the 12 scenes in the form of digital images, which were displayed in sequence on a 27-inch full HD computer monitor, in the same order as Experiment 1. Figure 3.23 shows a subject viewing and evaluating the digital image of a scene that was displayed on the computer screen.

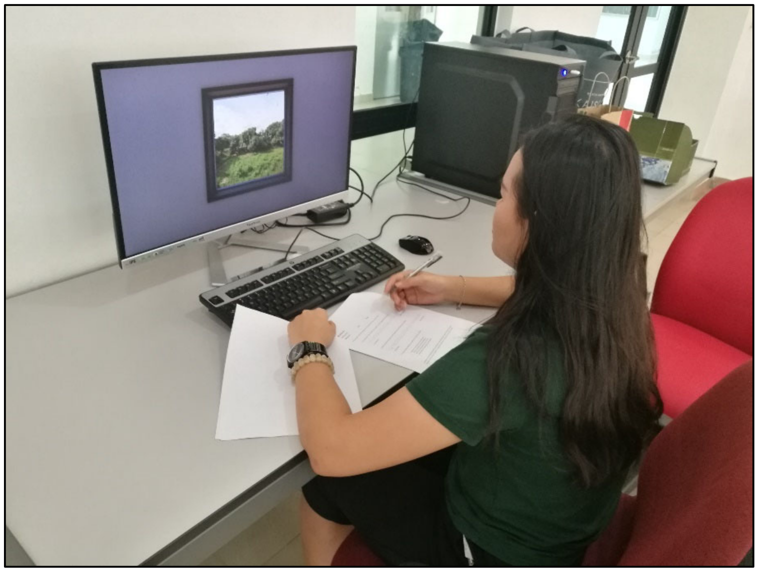


Figure 3.23: Photograph of a subject evaluating an image view in Experiment 2.

On the day of experiment, a group of subjects were first briefed by the researcher in the architecture studio before the viewing experiment started. Each subject was asked to manually complete a window view survey questionnaire, which was about perception of the importance of windows in general and view preference. After that, the researcher shuffled 12 stacks of questionnaires separately (each stack comprising 31 sets in 10-point scale format, and 31 sets in 4-point scale format). From each randomised stack, the researcher retrieved one set of questionnaires to compile a book that consisted of 12 sets of questionnaires, and then marked the view number (1 – 12) in sequence on each set for ease of identifying. Before the viewing started, each subject was given a book that comprised the 12 randomised sets of questionnaires (a mix of 10-point and 4-point scale formats). Subsequently, the subjects took turns to view all the 12 digital images one by one, in the same sequence as in Experiment 1. Each subject was required to spend one minute or so to view each image displayed on the screen, and then complete the evaluation questionnaire for that image as soon as the viewing was completed. There was only one computer screen used in this experiment, thus each subject had to complete the viewing and evaluation of all 12 views before the next subject took turn to do the same. The data collected from Experiments 1 and 2 were subsequently analysed using SPSS Statistics. The results of the data analyses are reported and discussed in Chapter 4.

3.6 Summary

The main outcomes of this chapter can be summarised as follows:

1. Photomontage method is used in this study to create images of window views in a more realistic manner.

2. Pixelation method is used in this study to estimate the area or proportion of each visual layer and object of interest contained in an image of window view.

3. This chapter has discussed the definitions and scales of measurement of the seven proposed view attributes: proportion of greenery, number of visual layers, view elements (aesthetic impression of elements), balance of view, diversity of view, openness of view, and depth of view (see Table 3.3).

4. Method of Experiment 1 (actual view): view quality evaluation is based on 12 real scenes viewed through "virtual windows" defined by a portable viewing box that is set up at the 12 different sites in sequence.

5. Method of Experiment 2 (image view): view quality evaluation is based on photographic images of the selected 12 views (from Experiment 1) that are displayed on computer screen.

6. Questionnaire design: linear numeric scale with bipolar verbal anchors is used. The proposed indicators of window view quality for subjective evaluations are based on the "pleasantness" and "excitingness" dimensions in the circumplex model of affective quality, which was developed by Russell et al. (1981).

"Pleasantness of view" (POV) and "excitingness of view" (EOV) are the two proposed indicators of the perceived window view quality (see Table 3.8). Two different scale formats are used in either Experiment 1 or Experiment 2: a 10-point scale (1 – 10) and a 4-point scale (1 – 4).

7. From a pilot experiment, the sample size required for this study was estimated to be 31 (per group). In this study, 62 volunteers were enrolled to take part in Experiment 1 (actual view) whilst another batch of 62 volunteers participated in Experiment 2 (image view). Using a split-sample approach, the 62 subjects in Experiment 1 (Experiment 2) were randomly divided into two groups (31 subjects per group) for 10-point and 4-point ratings of POV and EOV in each of the 12 window views.

8. Power analyses show that, given the α-level (0.05), sample size (31 per group), and desired level of power (0.80), the minimum effect sizes (Cohen's *d*) that can be significantly detected in this research are as follows:

   (i) For paired samples t-test (one group of 31 subjects), $d = 0.52$ (effect sizes smaller than 0.52 will not be significant).

   (ii) For independent samples t-test (two groups of subjects; 31 in each group), $d = 0.72$ (effect sizes smaller than 0.72 will not be significant).

CHAPTER 4

Results

4.1 Introduction

This chapter discusses the results of Experiment 1 (actual view) and Experiment 2 (image view). There are three parts: the first part is an analysis of data collected from Experiment 1 – i.e., profile of the test participants (subjects), their opinions on the importance of window at their workplace or home, their preferences of the contents of window view in general as well as the subjects' evaluation on the quality of the 12 selected window views in terms of "pleasantness of view" (POV) and "excitingness of view" (EOV) using two different scale formats (10-point and 4-point scales). The first part also analyses the subjects' perception on the suitable location of each window view, and the ranking of dominant features in the content of each view. The second part is an analysis of the same items in the first part mentioned above but based on the data from Experiment 2 (image view). The third part interprets and discusses the data collected and the descriptive statistics.

4.2 Results of Experiment 1 (Actual Views)

There were 62 subjects (31 males and 31 females) in Experiment 1 (see Appendix E1 on tabulation of rating data). Of the 62 subjects, 58 were in the age group of 18 – 40; four in the age group of 41 – 60. In terms of occupation: 50.0% were students; 32.3% of the subjects worked in the art and design field; 3.2% worked in engineering field, 14.5% worked in other fields (e.g., education and business). On the perceived importance of window at workplace or home, 61 subjects (98.4%) selected "important"; one subject (1.6%) selected "not important"; none of the subjects chose "no preference". Among those who perceived window as an important feature at workplace or home, 21.0% regarded "view" as the primary reason for the importance of window, compared to 37.1% for natural ventilation and 33.9% for daylight (see Figure 4.1). On the preferred contents of a window view in general as observed from the workplace or home, “greenery” was the most popular choice (54.8%), and “human activities” the least popular choice (1.6%) (see Figure 4.2).

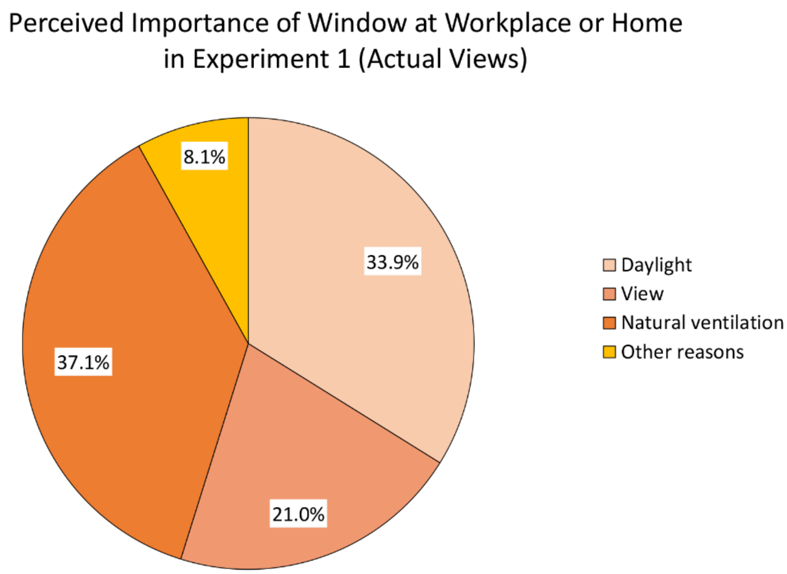


Figure 4.1: Percentage of subjects in Experiment 1 on the perceived importance of window at workplace or home.

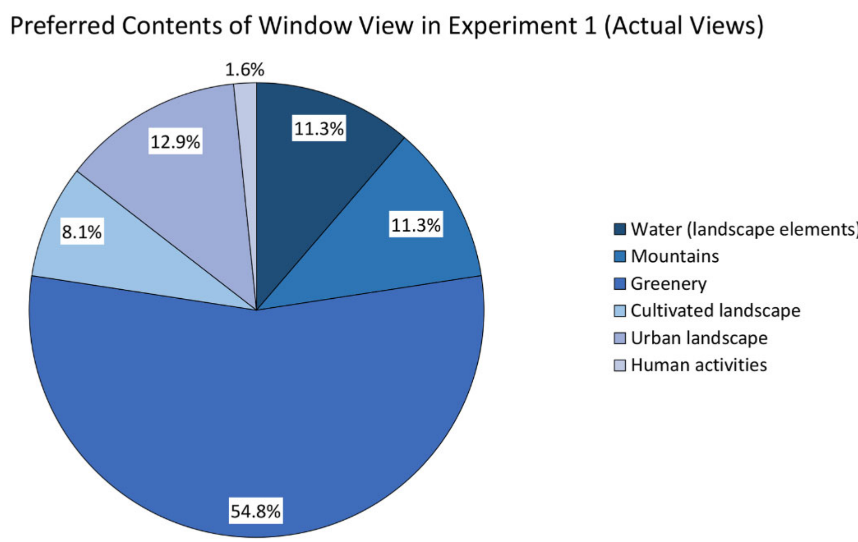


Figure 4.2: Percentage of subjects in Experiment 1 on the preferred contents of a window view (in general) as observed from the workplace or home.

4.2.1 View quality ratings: 10-point scale

Overall, the distribution of POV and EOV ratings in Experiment 1 (actual view) covered a wide range (see Figure 4.3). Each box in Figure 4.3 demonstrates the inter-quartile range (IQR), which indicates 50% of the distribution of subjects' ratings. Whiskers indicate the lower and upper bounds of the distribution corresponding to $(\mathrm{Q1} - 1.5 \cdot \mathrm{IQR})$ and $(\mathrm{Q3} + 1.5 \cdot \mathrm{IQR})$ respectively. Mild outliers are values below $(\mathrm{Q1} - 1.5 \cdot \mathrm{IQR})$ or above $(\mathrm{Q3} + 1.5 \cdot \mathrm{IQR})$. Extreme outliers are values below $(\mathrm{Q1} - 3 \cdot \mathrm{IQR})$ or above $(\mathrm{Q3} + 3 \cdot \mathrm{IQR})$.

For POV, Views 1, 6, 7 and 10 covered the full range of the 10-point scale; whilst for EOV, Views 6, 8, 9, 10 and 11 covered the full range of scale. Among the 12 views, View 6 (POV and EOV) demonstrated the largest inter-quartile range (IQR). View 4 (EOV) had the smallest IQR. There were two mild outliers in the EOV rating of View 3 at Category 8.

As the 10-point rating scale had an even number of response categories, response categories within the range of 1 to 5 were defined as "negative (unsatisfactory)" view quality with an incremental satisfaction from 1 to 5; response categories within the range of 6 to 10 were considered "positive (satisfactory)" view quality with an incremental satisfaction from 6 to 10.

From the box plots, median POV was either equal to or higher than median EOV in all the views. Views 2, 9, 10 and 11 had positive view quality in terms of median POV and EOV. Views 1, 3, 5 and 12 had negative view quality in terms of median POV and EOV. Views 4, 6, 7 and 8 had positive median POV but negative median EOV. The highest median view quality (POV and EOV) was in View 9 and View 11; the lowest median view quality (POV and EOV) was in View 3.

When the mean ratings were compared (see Figure 4.4), it was observed that View 9 had the highest mean POV (7.19) and EOV (6.42), whereas View 3 had the lowest mean POV (3.81) and EOV (3.26) among the 12 views.

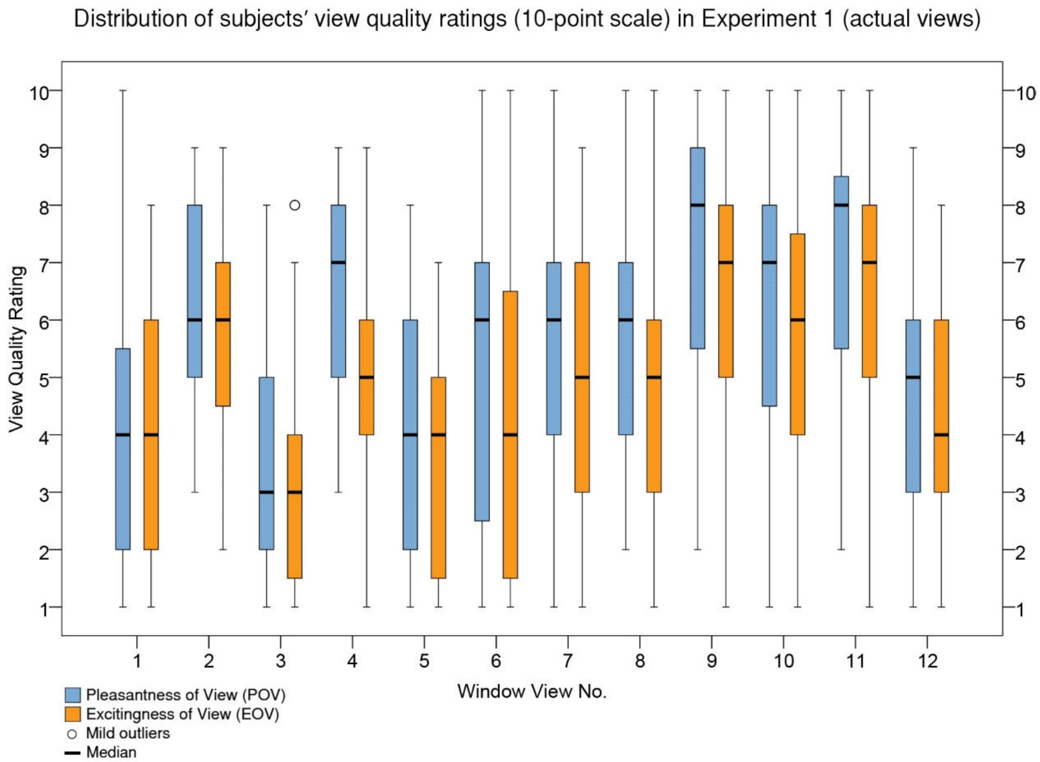


Figure 4.3: Box and whisker plots of POV and EOV ratings based on 10-point scale format in Experiment 1 (actual view) indicating the interquartile range, median, highest and lowest ratings for each of the 12 window views.

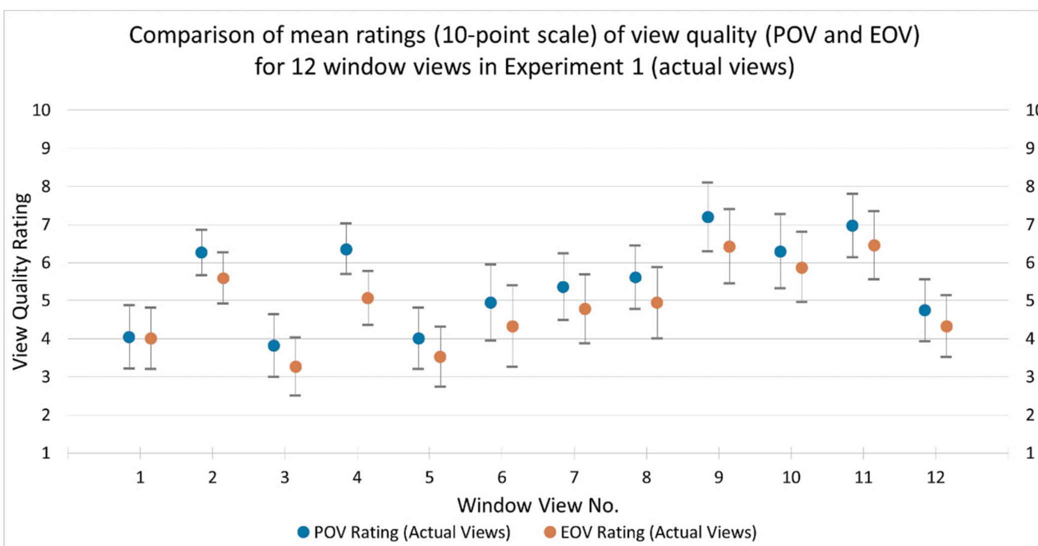


Figure 4.4: Comparison of POV and EOV mean ratings (10-point scale) and the corresponding 95% confidence intervals for each of the 12 window views in Experiment 1 (actual view).

4.2.2 Normality assessment of 10-point scale ratings (Experiment 1)

Normality assessment was performed on the distribution of the POV and EOV ratings based on statistical data and graphical information supplemented with a formal normality test – i.e., Shapiro-Wilk test, which provides a generally superior omnibus measure of non-normality (Shapiro et al. 1968) and has good power properties over a wide range of asymmetric (skewed) distributions (Yap and Sim 2011).

Figures 4.5 and 4.6 present histograms on the frequency of POV (EOV) rating (10-point scale) in each of the 12 window views in Experiment 1 (actual view).

From the visual assessment of these histograms, the ratings of views listed below seem to follow normal distribution:

POV : Views 1, 6, 7, 8, 10, 11 and 12.
EOV : Views 1, 2, 4, 7, 8, 9, 10, 11 and 12.

Tables 4.1 and 4.2 present the results of the measure of central tendency, measures of dispersion (in terms of skewness and kurtosis) and Shapiro-Wilk test, which are as follows:

1. Measure of central tendency: For POV, all views except View 6 and View 11 had median rating that lied within the 95% confidence interval of the mean. For EOV, all views had median rating that lied within the same interval.

2. Measures of dispersion: For POV, all views except View 9 had normal skewness [z-value between -1.96 and +1.96, which was based on the 0.05 level of significance (two-tailed)]; all views had normal kurtosis. For EOV, all views had normal skewness and kurtosis.

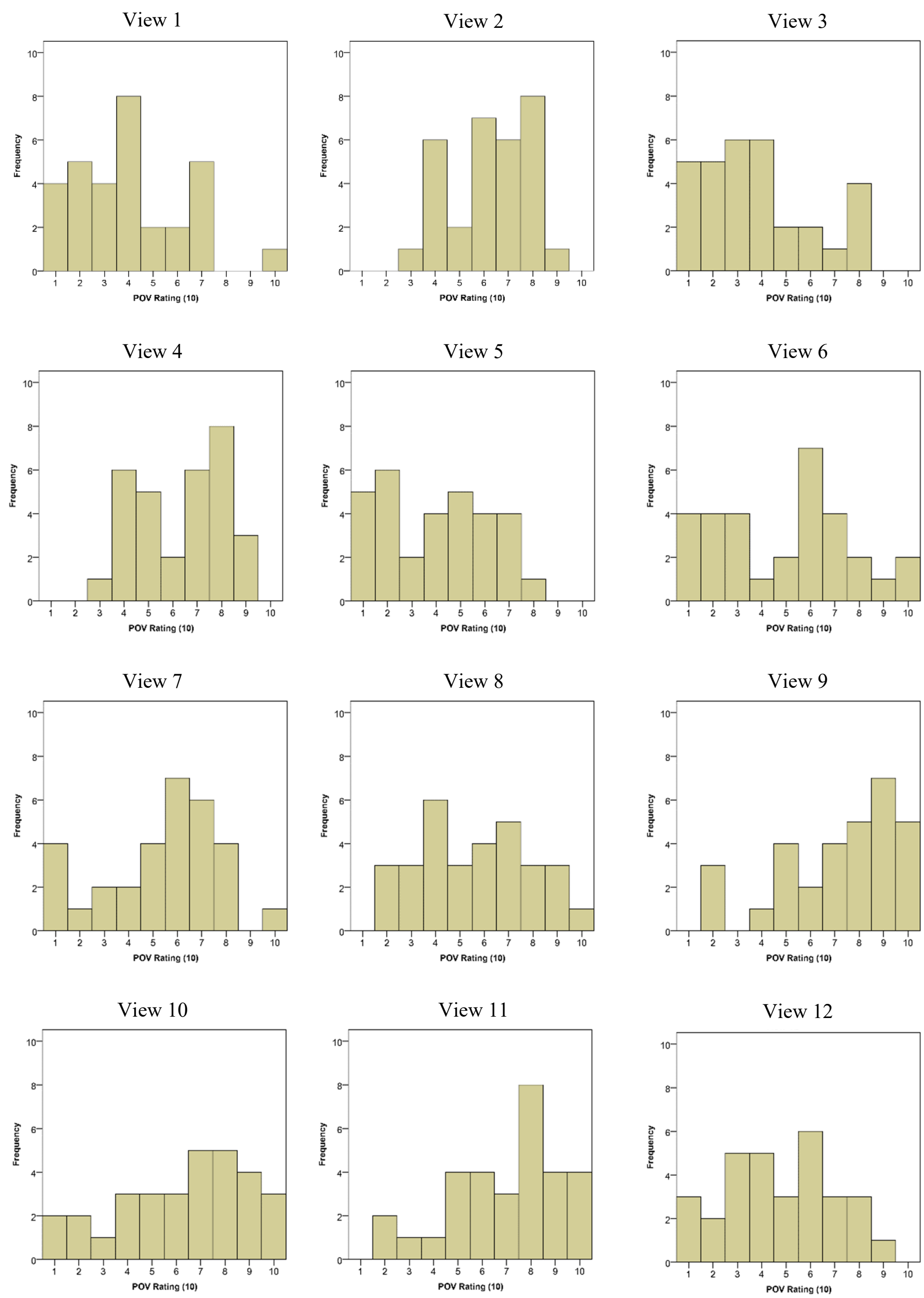


Figure 4.5: Histograms showing the frequency of POV rating (10-point scale) in each of the 12 window views in Experiment 1 (actual view).

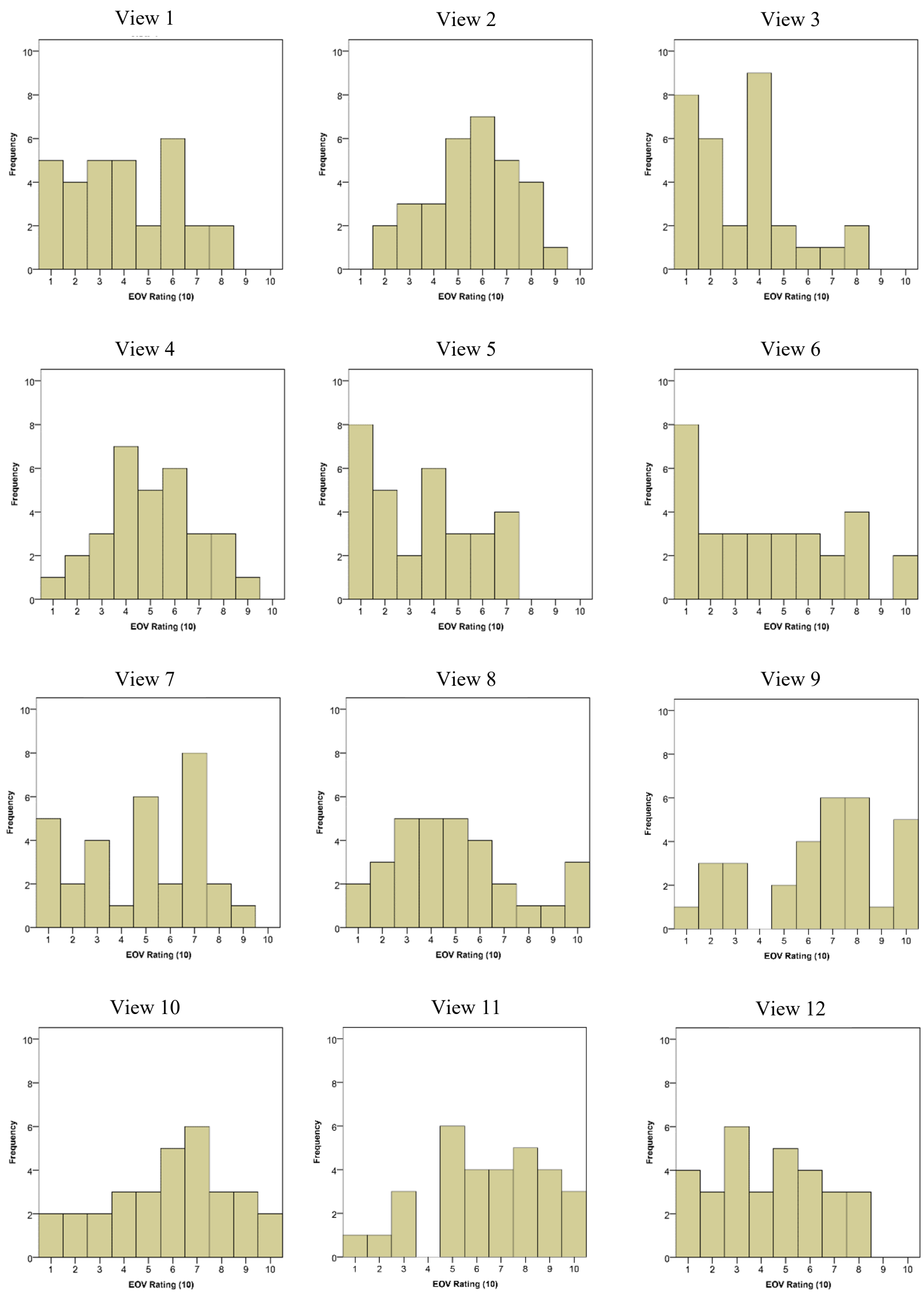


Figure 4.6: Histograms showing the frequency of EOV rating (10-point scale) in each of the 12 window views in Experiment 1 (actual view).

3. Shapiro-Wilk test: The null hypothesis was that the view quality rating (POV or EOV) was normally distributed in the population. For POV, Views 1, 2, 3, 4, 5, 7, 9 and 11 had p-values below 0.05, therefore we reject the null hypotheses of normal population distributions; Views 6, 8, 10 and 12 had p-values of 0.05 or above, therefore we retain the null hypothesis and conclude that these four views were normally distributed in the population. For EOV, Views 3, 5, 6, 7 and 9 had p-values below 0.05, therefore we reject the null hypotheses of normal population distributions; Views 1, 2, 4, 8, 10, 11 and 12 had p-values of 0.05 or above, therefore we retain the null hypothesis and conclude that these seven views were normally distributed in the population.

According to the results above, we conclude that, at the 0.05 level of significance, the view quality ratings (10-point scale) that fit normal distribution in Experiment 1 (actual views) are as below:

POV : Views 6, 8, 10 and 12.
EOV : Views 1, 2, 4, 8, 10, 11 and 12.

If the hypothesis were tested at the 0.01 level of significance the following view quality ratings, in addition to the above, would also fit normal distribution in Experiment 1 (actual view):

POV : Views 1, 2, 5, 7 and 11.
EOV : Views 7 and 9.

Central limit theorem stated that if the distribution of the parent population from which the samples are drawn is not normal, then the sampling distribution of the mean will be approximately normal when the size of samples increases (Russo 2003).

From the results above, we conclude that the view quality ratings (10-point scale) in Experiment 1 (actual view) generally follow a normal distribution. Therefore, in the subsequent analyses, parametric methods are applied on 10-point scale data.

Table 4.1: Normality assessment of POV rating (10-point scale) for Experiment 1 (actual view).

View	Central Tendency				Median	Measures of Dispersion						Normality Test			
	Mean rating		95% CI			Skewness			Kurtosis			Shapiro-Wilk Test			
	Stat.	SE	Lower	Upper		Stat.	SE	z-value	Stat.	SE	z-value	Stat.	df	p-value	
1	4.03	0.403	3.21	4.86	4	0.639	0.421	1.52	0.077	0.821	0.09	0.928	31	0.038	*
2	6.26	0.293	5.66	6.86	6	-0.348	0.421	-0.83	-0.998	0.821	-1.22	0.913	31	0.015	*
3	3.81	0.405	2.98	4.63	3	0.648	0.421	1.54	-0.568	0.821	-0.69	0.898	31	0.006	**
4	6.35	0.326	5.69	7.02	7	-0.213	0.421	-0.51	-1.330	0.821	-1.62	0.904	31	0.009	**
5	4.00	0.393	3.20	4.80	4	0.081	0.421	0.19	-1.289	0.821	-1.57	0.921	31	0.025	*
6	4.94	0.491	3.93	5.94	6	0.093	0.421	0.22	-1.014	0.821	-1.24	0.934	31	0.056	
7	5.35	0.429	4.48	6.23	6	-0.514	0.421	-1.22	-0.395	0.821	-0.48	0.924	31	0.030	*
8	5.61	0.411	4.77	6.45	6	0.102	0.421	0.24	-0.996	0.821	-1.21	0.953	31	0.192	
9	7.19	0.439	6.30	8.09	8	-0.842	0.421	-2.00	-0.151	0.821	-0.18	0.889	31	0.004	**
10	6.29	0.478	5.31	7.27	7	-0.516	0.421	-1.23	-0.660	0.821	-0.80	0.937	31	0.069	
11	6.97	0.408	6.13	7.80	8	-0.650	0.421	-1.54	-0.239	0.821	-0.29	0.927	31	0.036	*
12	4.74	0.402	3.92	5.56	5	0.002	0.421	0.00	-0.866	0.821	-1.05	0.959	31	0.276	

Note: * $p < 0.05$, ** $p < 0.01$

Table 4.2: Normality assessment of EOV rating (10-point scale) for Experiment 1 (actual view).

View	Central Tendency				Median	Measures of Dispersion						Normality Test			
	Mean rating		95% CI			Skewness			Kurtosis			Shapiro-Wilk Test			
	Statistic	SE	Lower	Upper		Statistic	SE	z-value	Statistic	SE	z-value	Statistic	df	p-value	
1	4.00	0.391	3.20	4.80	4	0.208	0.421	0.49	-1.060	0.821	-1.29	0.932	31	0.050	
2	5.58	0.330	4.91	6.26	6	-0.257	0.421	-0.61	-0.569	0.821	-0.69	0.958	31	0.261	
3	3.26	0.371	2.50	4.02	3	0.795	0.421	1.89	0.520	0.821	0.63	0.880	31	0.002	**
4	5.06	0.350	4.35	5.78	5	0.019	0.421	0.05	-0.436	0.821	-0.53	0.973	31	0.603	
5	3.52	0.385	2.73	4.30	4	0.291	0.421	0.69	-1.267	0.821	-1.54	0.887	31	0.004	**
6	4.32	0.521	3.26	5.39	4	0.408	0.421	0.97	-1.026	0.821	-1.25	0.905	31	0.009	**
7	4.77	0.442	3.87	5.68	5	-0.239	0.421	-0.57	-1.199	0.821	-1.46	0.914	31	0.016	*
8	4.94	0.459	4.00	5.87	5	0.577	0.421	1.37	-0.313	0.821	-0.38	0.938	31	0.071	
9	6.42	0.481	5.44	7.40	7	-0.504	0.421	-1.20	-0.699	0.821	-0.85	0.917	31	0.020	*
10	5.87	0.454	4.94	6.80	6	-0.322	0.421	-0.76	-0.637	0.821	-0.78	0.959	31	0.267	
11	6.45	0.435	5.56	7.34	7	-0.435	0.421	-1.03	-0.473	0.821	-0.58	0.951	31	0.161	
12	4.32	0.397	3.51	5.13	4	0.095	0.421	0.23	-1.065	0.821	-1.30	0.940	31	0.082	

Note: * $p < 0.05$, ** $p < 0.01$

4.2.3 View quality ratings: 4-point scale

Overall, the distribution of POV and EOV ratings in Experiment 1 (actual view) covered the full range of the 4-point scale except in View 1 (EOV), View 7 (EOV), View 9 (POV and EOV) and View 11 (POV) (see Figure 4.7). Among the 12 views, POV and EOV of Views 3, 5 and 6 as well as EOV of View 8 and View 10 demonstrated the largest IQR. View 9 (EOV) and View 11 (POV) had zero IQR with median Category 3.

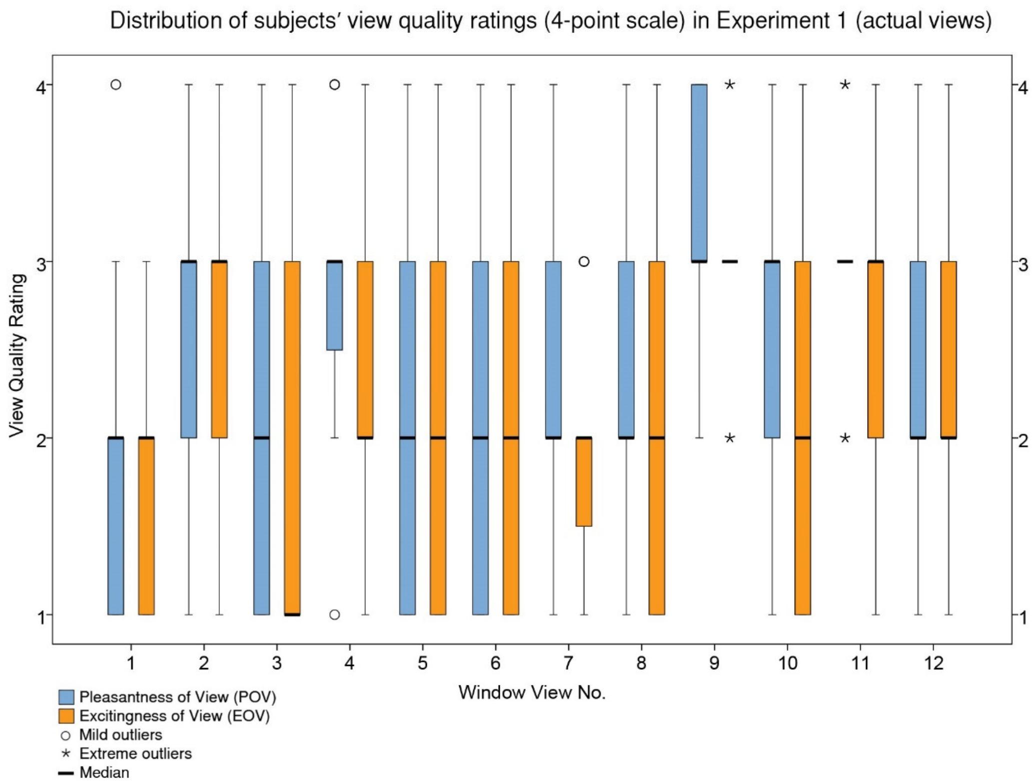


Figure 4.7: Box and whisker plots of POV and EOV ratings based on 4-point scale format in Experiment 1 (actual view) indicating the interquartile range, median, highest and lowest ratings for each of the 12 window views.

A relatively large number of outliers were observed in the following:

- View 1 (POV) – two mild outliers at Category 4 [Mild outliers are values below $(Q1 - 1.5 \cdot IQR)$ or above $(Q3 + 1.5 \cdot IQR)$].
- View 4 (POV) – one mild outlier at Category 1; and five mild outliers at Category 4.
- View 7 (EOV) – seven mild outliers at Category 3.
- View 9 (EOV) – seven extreme outliers at Category 2; and six extreme outliers at Category 4 [Extreme outliers are values below $(Q1 - 3 \cdot IQR)$ or above $(Q3 + 3 \cdot IQR)$].
- View 11 (POV) – six extreme outliers at Category 2; and six extreme outliers at Category 4.

Since the 4-point rating scale had an even number of response categories, Categories 1 and 2 were defined as "negative (unsatisfactory)" view quality with an incremental satisfaction from 1 to 2; Categories 3 and 4 were considered "positive (satisfactory)" view quality with an incremental satisfaction from 3 to 4.

From the box plots, median POV was either equal to or higher than median EOV in all the views. Views 2, 9 and 11 had positive view quality in terms of median POV and EOV. Views 1, 3, 5, 6, 7, 8 and 12 had negative view quality in terms of median POV and EOV. View 4 and View 10 had positive median POV but negative median EOV. The highest median POV was in Views 2, 4, 9, 10 and 11 at Category 3; the highest median EOV was in Views 2, 9 and 11 at Category 3. The lowest median POV was in Views 1, 3, 5, 6, 7, 8 and 12 at Category 2; the lowest median EOV was in View 3 at Category 1.

When the mean ratings were compared (see Figure 4.8), it was observed that View 9 had the highest mean POV (3.23) and EOV (2.97), whereas View 1 had the lowest mean POV (1.77) and View 3 had the lowest mean EOV (1.74) among the 12 views.

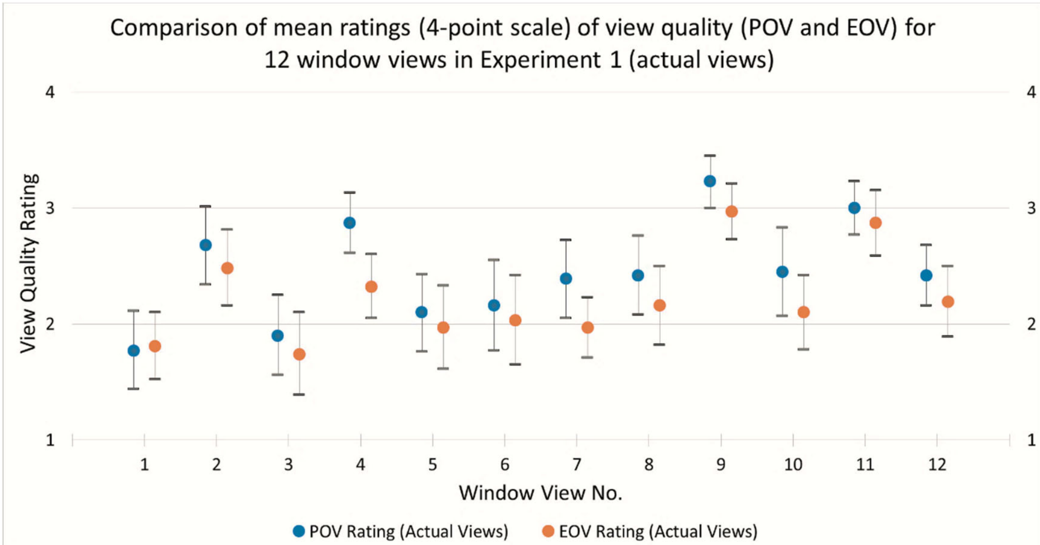


Figure 4.8: Comparison of POV and EOV mean ratings (4-point scale) and the corresponding 95% confidence intervals for each of the 12 window views in Experiment 1 (actual view).

4.2.4 Normality assessment of 4-point scale ratings

Figures 4.9 and 4.10 present histograms on the frequency of POV (EOV) rating (4-point scale) in each of the 12 window views in Experiment 1 (actual view).

From the visual assessment of these histograms, the ratings of views listed below seem to follow normal distribution:

POV : Views 2, 5, 7, 8 and 10.
EOV : Views 2, 11 and 12.

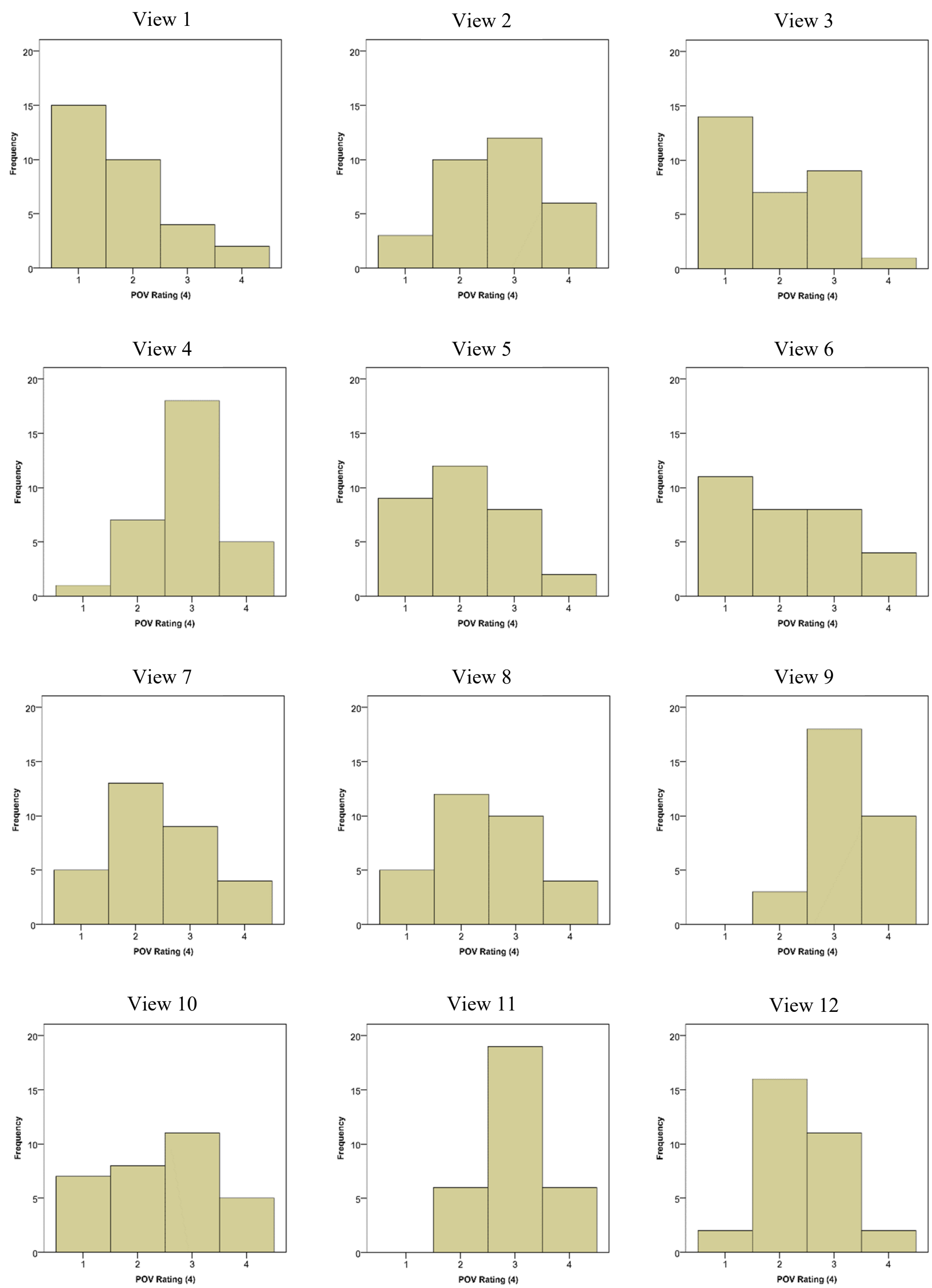


Figure 4.9: Histograms showing the frequency of POV rating (4-point scale) in each of the 12 window views in Experiment 1 (actual view).

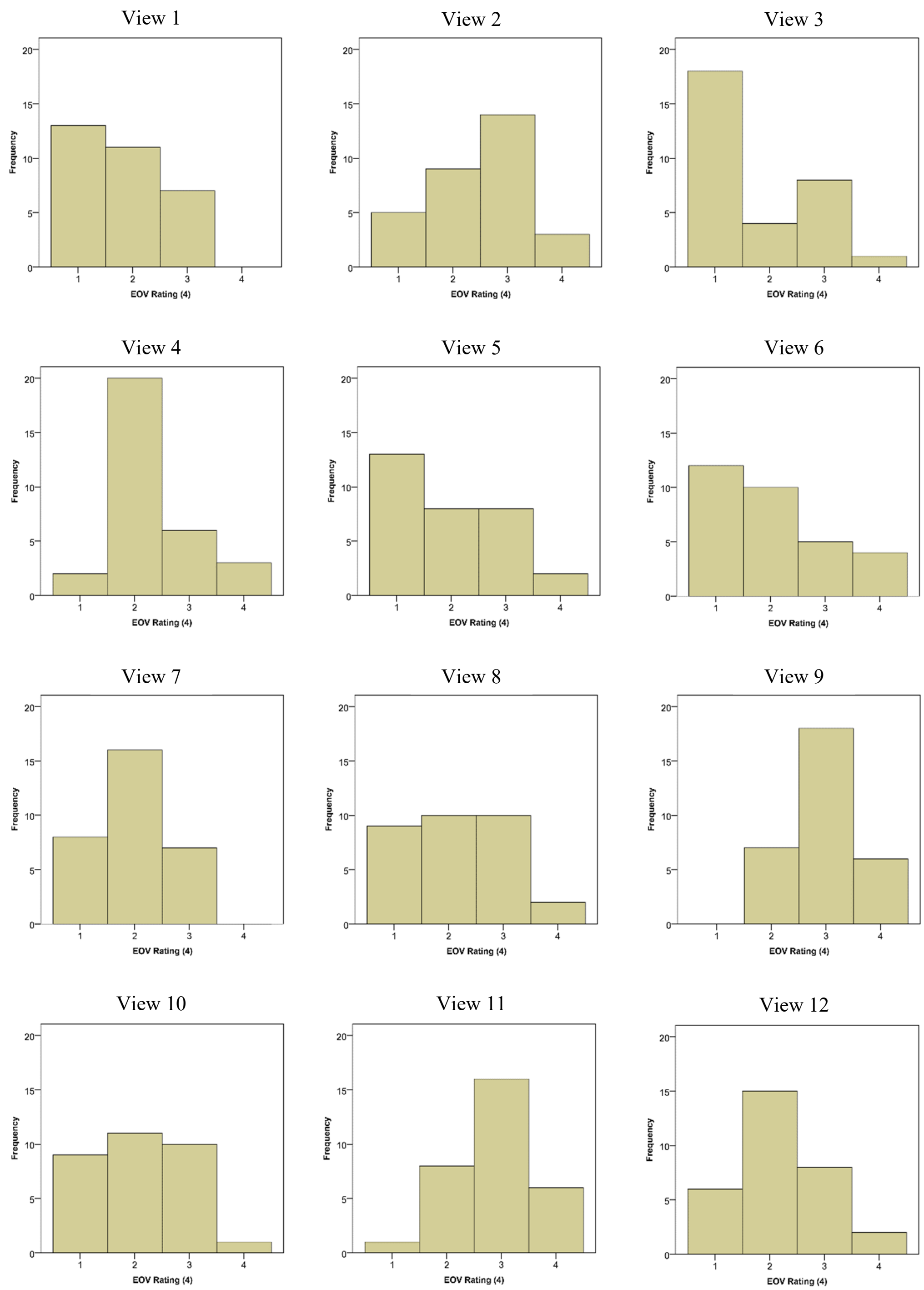


Figure 4.10: Histograms showing the frequency of EOV rating (4-point scale) in each of the 12 window views in Experiment 1 (actual view).

Tables 4.3 and 4.4 present the results of the measure of central tendency, measures of dispersion (in terms of skewness and kurtosis) and Shapiro-Wilk test, which are as follows:

1. Measure of central tendency: For POV, all views except Views 7, 8, 10 and 12 had median rating that lied within the 95% confidence interval of the mean. For EOV, all views except Views 2, 3 and 4 had median rating that lied within the same interval.

2. Measures of dispersion: For POV, all views except View 1 had normal skewness [z-value between -1.96 and +1.96, which was based on the 0.05 level of significance (two-tailed)]. For EOV, all views except View 4 had normal skewness; all views (POV and EOV) had normal kurtosis.

3. Shapiro-Wilk test: The null hypothesis was that the view quality rating (POV or EOV) was normally distributed in the population. For POV and EOV ratings, all 12 views had p-values below 0.01, therefore we reject the null hypothesis of normal population distributions. This shows that none of views (either POV or EOV) was significant, even if the hypothesis were tested at the 0.01 level.

From the results above, we conclude that none of the view quality ratings (4-point scale) of the 12 views in Experiment 1 (actual view) fits normal distribution. Therefore, in the subsequent regression analyses (Chapter 7), nonparametric methods are applied on 4-point scale data.

Table 4.3: Normality assessment of POV rating (4-point scale) for Experiment 1 (actual view).

View	Central Tendency				Median	Measures of Dispersion						Normality Test			
	Mean rating		95% CI			Skewness			Kurtosis			Shapiro-Wilk Test			
	Stat.	SE	Lower	Upper		Stat.	SE	z-value	Stat.	SE	z-value	Stat.	df	p-value	
1	1.77	0.165	1.44	2.11	2	1.031	0.421	2.45	0.279	0.821	0.34	0.784	31	0.000	***
2	2.68	0.163	2.34	3.01	3	-0.142	0.421	-0.34	-0.677	0.821	-0.82	0.880	31	0.002	**
3	1.90	0.169	1.56	2.25	2	0.457	0.421	1.09	-1.184	0.821	-1.44	0.799	31	0.000	***
4	2.87	0.129	2.61	3.13	3	-0.379	0.421	-0.90	0.407	0.821	0.50	0.828	31	0.000	***
5	2.10	0.163	1.76	2.43	2	0.372	0.421	0.88	-0.649	0.821	-0.79	0.864	31	0.001	**
6	2.16	0.192	1.77	2.55	2	0.361	0.421	0.86	-1.141	0.821	-1.39	0.848	31	0.000	***
7	2.39	0.165	2.05	2.72	2	0.218	0.421	0.52	-0.638	0.821	-0.78	0.879	31	0.002	**
8	2.42	0.166	2.08	2.76	2	0.117	0.421	0.28	-0.699	0.821	-0.85	0.883	31	0.003	**
9	3.23	0.111	3.00	3.45	3	-0.166	0.421	-0.39	-0.399	0.821	-0.49	0.768	31	0.000	***
10	2.45	0.185	2.07	2.83	3	-0.058	0.421	-0.14	-1.092	0.821	-1.33	0.875	31	0.002	**
11	3.00	0.114	2.77	3.23	3	0.000	0.421	0.00	-0.271	0.821	-0.33	0.782	31	0.000	***
12	2.42	0.129	2.16	2.68	2	0.301	0.421	0.71	0.063	0.821	0.08	0.833	31	0.000	***

Note: ** p < 0.01, *** p < 0.001

Table 4.4: Normality assessment of EOV rating (4-point scale) for Experiment 1 (actual view).

View	Central Tendency				Median	Measures of Dispersion						Normality Test			
	Mean rating		95% CI			Skewness			Kurtosis			Shapiro-Wilk Test			
	Stat.	SE	Lower	Upper		Stat.	SE	z-value	Stat.	SE	z-value	Stat.	df	p-value	
1	1.81	0.142	1.52	2.10	2	0.370	0.421	0.88	-1.289	0.821	-1.57	0.789	31	0.000	***
2	2.48	0.160	2.16	2.81	3	-0.252	0.421	-0.60	-0.622	0.821	-0.76	0.866	31	0.001	**
3	1.74	0.173	1.39	2.10	1	0.799	0.421	1.90	-0.906	0.821	-1.10	0.725	31	0.000	***
4	2.32	0.134	2.05	2.60	2	0.914	0.421	2.17	0.758	0.821	0.92	0.764	31	0.000	***
5	1.97	0.176	1.61	2.33	2	0.518	0.421	1.23	-0.940	0.821	-1.14	0.825	31	0.000	***
6	2.03	0.188	1.65	2.42	2	0.675	0.421	1.60	-0.696	0.821	-0.85	0.827	31	0.000	***
7	1.97	0.127	1.71	2.23	2	0.045	0.421	0.11	-0.877	0.821	-1.07	0.808	31	0.000	***
8	2.16	0.168	1.82	2.50	2	0.183	0.421	0.43	-0.965	0.821	-1.18	0.863	31	0.001	**
9	2.97	0.118	2.73	3.21	3	0.032	0.421	0.08	-0.502	0.821	-0.61	0.794	31	0.000	***
10	2.10	0.156	1.78	2.42	2	0.129	0.421	0.31	-0.994	0.821	-1.21	0.851	31	0.001	**
11	2.87	0.137	2.59	3.15	3	-0.254	0.421	-0.60	-0.135	0.821	-0.16	0.849	31	0.000	***
12	2.19	0.150	1.89	2.50	2	0.349	0.421	0.83	-0.213	0.821	-0.26	0.864	31	0.001	**

Note: ** $p < 0.01$, *** $p < 0.001$

4.2.5 Perception of suitable locations for window views

In the experimental study, the subjects were asked in the survey questionnaires to select the location which they would consider each view to be suitable. The objective of this analysis is to determine the level of concordance among the subjects on their perception of each view in terms of its suitability as a window view. There were four options offered to the subjects – i.e., home and workplace, workplace only, home only, neither home nor workplace. The results are summarised in Figure 4.11.

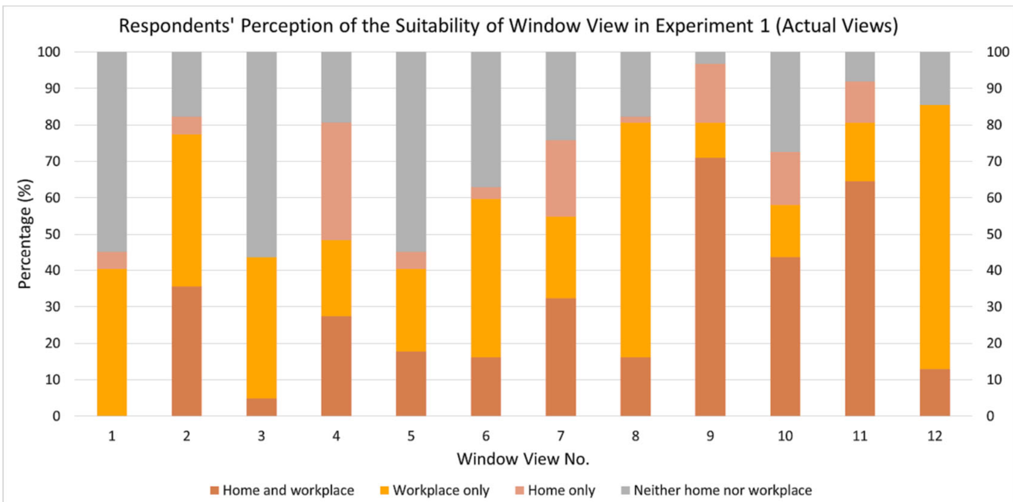


Figure 4.11: The respondents' perception of suitable locations for the window views in Experiment 1 (actual view).

For views that were perceived to be suitable for both home and workplace: View 1 was the least popular (0%), and View 9 the most popular (71.0%). This concurred with the fact that View 1 received one of the lowest mean POV rating (4.03) and View 9 received the highest mean POV rating (7.19) (10-point scale) in Experiment 1.

For views that were perceived to be suitable for workplace only: View 9 was the least popular (9.7%), and View 12 the most popular (72.6%). For View 8 and View 12, majority of the subjects (above 50%) selected "OK for my workplace but not my home". An explanation for this: shops and office buildings that were dominant in View 8 and View 12 were associated with work and commercial activities.

For views that were perceived to be suitable for home only: View 3 and View 12 were the least popular (0%), and View 4 the most popular (32.3%). Among the 12 views, View 4 received the highest proportion of subjects who selected "OK for my home but not my workplace". This is probably because View 4 had a relatively large proportion of greenery (62%) in the open landscape with abundant of trees in the background, which were associated with home environment rather than workplace.

For views that were perceived to be neither suitable for workplace nor home: View 9 was the least popular (3.2%), and View 3 the most popular (56.5%). For Views 1, 3 and 5, majority of the subjects (above 50%) selected "neither for my home nor my workplace". An explanation for this: both View 1 and View 5 consisted of a dominant negative view element (i.e., telecommunication tower and lift motor room respectively); and View 3 was exceptionally enclosed (openness of view was only 12%), thus relatively unpleasant.

4.2.6 Perception of dominant features in window views

The subjects were asked in the survey questionnaires to name three dominant features (using word descriptors) in each of the window views that they observed – starting from the most dominant to the least dominant. Upon completion of the survey, the researcher identified the most common dominant feature (ranked no. 1, 2 or 3) among the respondents in each of the 12 views, and then summarise the proportion of respondents who ranked this common feature according to the degree of perceived dominance – i.e., from "ranked no. 1" (the most dominant) to "not in the list" (the least dominant). The objective of this analysis to determine the level of concordance among the subjects on what they perceived to be the dominant features in each view. The most common dominant feature in each view is shown in Table 4.5. The results are presented in Figure 4.12.

Table 4.5: Most common dominant feature in the window views
for Experiment 1 (actual view).

View No.	Most common dominant feature perceived	View No.	Most common dominant feature perceived
1	Telecommunication tower	7	Trees
2	Trees	8	Shop-office buildings
3	MRT railway line	9	Mountains
4	Trees	10	High-rise apartment buildings
5	Trees	11	Trees and greenery
6	Parking lots	12	High-rise office buildings

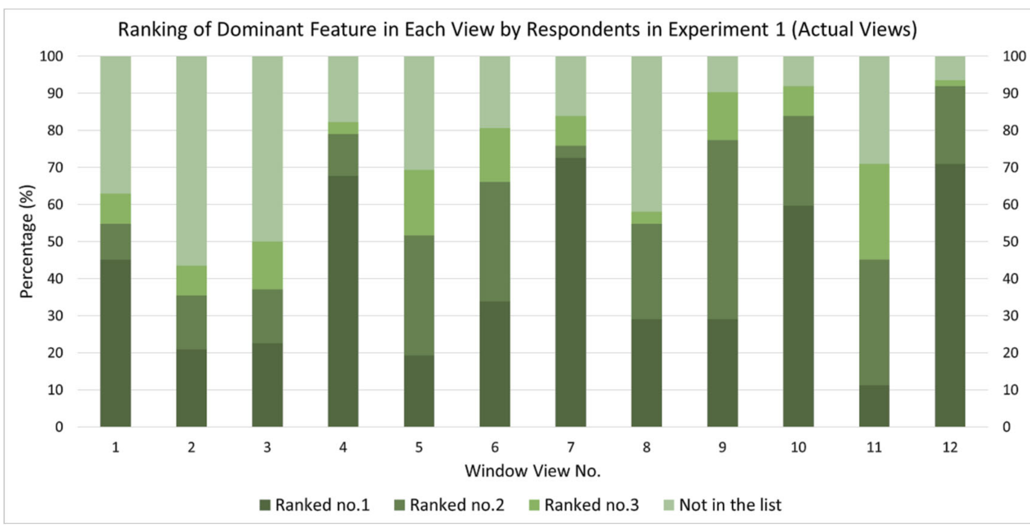


Figure 4.12: Proportion of respondents who ranked the most common dominant feature in each of the 12 window views in Experiment 1 (actual view).

From Figure 4.12, the proportion of respondents who ranked the most common feature as No. 1 (most dominant) was above 50% in Views 4, 7, 10 and 12. This implies that there was a high degree of agreement on what the subjects perceived as dominant in these four views. An explanation for this: View 4 and View 7 had the highest proportion of greenery (i.e., 62% and 64% respectively), and trees were the most dominant feature; View 10 and View 12 contained high-rise buildings that were perceived as the most dominant features.

4.2.7 Correlation and difference between POV and EOV ratings in Experiment 1 (actual view)

From the results of view quality evaluation on the 12 selected scenes in Experiment 1 (actual view), we compared the POV and EOV ratings given by the 31 subjects who used 10-point scale. Figure 4.13 illustrates the plots of mean POV against mean EOV ratings for the 12 views. Correlation analysis suggested a positive linear relationship that was extremely strong between the mean POV and mean EOV ratings across the 12 views, which was significant at the 0.001 level (R = 0.972, n = 12, p < 0.001).

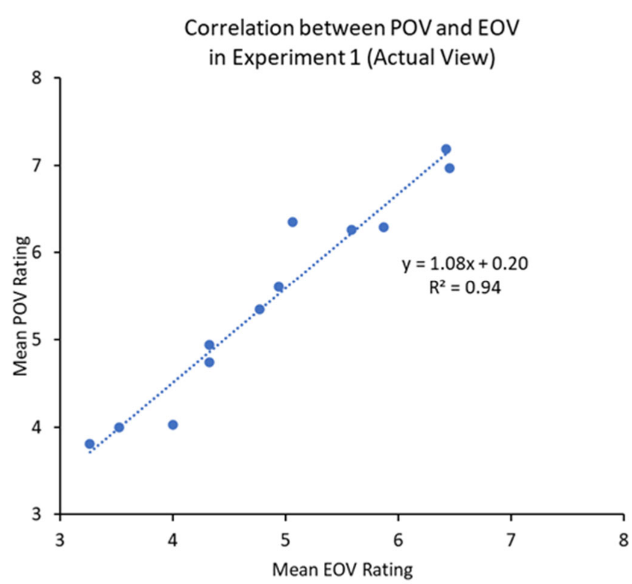


Figure 4.13: Mean POV ratings plotted against mean EOV ratings for Views 1 – 12 in Experiment 1 (actual view).

In order to find out whether the POV ratings were significantly different from the EOV ratings for all the 12 views in Experiment 1 (actual view), we established the null hypothesis and alternative hypothesis as below:

H_0: There is no significant difference between mean POV rating and mean EOV rating in the evaluation of window view quality (actual view).

H_1: There is a significant difference between mean POV rating and mean EOV rating in the evaluation of window view quality (actual view).

In this study, POV and EOV were two items in the evaluation of window view quality. Each subject evaluated POV and EOV for each of the 12 views. Based on the evaluation data collected in Experiment 1 (actual view), paired samples t-test was conducted to determine whether there was any statistical evidence that the mean difference between the POV and EOV ratings given by the subjects was significantly different from zero. To control the Type I error rate in this multiple testing, Bonferroni correction was applied to the critical level of significance. Since there were 12 cases for either view quality (POV or EOV), the new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042. If one or more of the 12 cases had a p-value smaller than 0.0042, then the null hypothesis was to be rejected.

Results of the analysis are summarised in Table 4.6. The results indicate that the mean difference between the POV and EOV ratings (10-point scale) given by the subjects was significantly different from zero at the corrected alpha level (0.0042) in Views 2, 4, 6 and 9. Therefore, the null hypothesis was rejected. This suggests that the subjects were able to differentiate POV from EOV in the evaluation of view quality (actual view).

Table 4.6: Results of paired samples t-test that compared view quality ratings between POV and EOV in Experiment 1 (actual view).

View	Mean difference (POV – EOV)	95% Confidence Interval of the Difference		t	df	p-value (2-tailed)		
		Lower	Upper					
1	0.032	-0.796	0.861	0.080	30	0.937		
2	0.677	0.358	0.997	4.329	30	**0.000**	***	#
3	0.548	-0.011	1.107	2.003	30	0.054		
4	1.290	0.697	1.883	4.444	30	**0.000**	***	#
5	0.484	0.119	0.849	2.706	30	0.011	*	
6	0.613	0.250	0.976	3.450	30	**0.002**	**	#
7	0.581	0.159	1.002	2.816	30	0.009	**	
8	0.677	0.068	1.287	2.271	30	0.031	*	
9	0.774	0.323	1.226	3.503	30	**0.001**	**	#
10	0.419	0.009	0.830	2.087	30	0.045	*	
11	0.516	0.034	0.998	2.188	30	0.037	*	
12	0.419	0.009	0.830	2.087	30	0.045	*	

Note: * $p < 0.05$, ** $p < 0.01$, ***$p < 0.001$, # Bold indicates p-value that is lower than the alpha level corrected by Bonferroni method (corrected alpha level: 0.0042).

In the cases of View 1 and View 3, the mean differences between the POV and EOV ratings were nonsignificant (even at the 0.05 level) probably because of the small sample size (i.e., 31), and it has been demonstrated in Chapter 3 that, with this sample size, cases with effect size (Cohen's d) smaller than 0.52 may not be significant. In this paired samples t-test, the effect sizes ($d = \frac{t}{\sqrt{N}}$) for View 1 and View 3 were 0.01 and 0.36 respectively.

From the outcome of analysis, the mean differences between POV and EOV were positive across all 12 views in Experiment 1 (actual view). This finding implied that each of the 12 selected views provided the viewers with higher degree of visual pleasure compared to visual excitement. This would not have been known if the rating scale was comprised of a single item such as “level of satisfaction”, which was conventionally used in past studies of window view quality (Chapter 2).

Evaluation of view quality based on a single indicator has its limitation: it does not provide information concerning the affective (emotional) quality that is attributed to the view observed. The two-item rating scale (comprising POV and EOV) used in this study was based on two affective dimensions – i.e., “pleasantness” and “excitingness” established in the circumplex model of affect (Rusell and Pratt 1980; Rusell 1981; Posner et al. 2005).

Evaluation data produced from the use of this rating scale can provide an insight into the cause of perceived poor quality of a window view – i.e., lack of visual pleasure or visual excitement (or both) in the scene. This information may be useful for the architect (or designer) who is working on a design proposal for the interior renovation of a room with window: if the mean rating of EOV is lower than POV, the architect can propose a more vibrant theme for the interior space (e.g., some dynamic colours for finishes and furnishings) to compensate for the lack of visual excitement provided by the window view; if the mean rating of POV is lower than EOV, then the architect can propose to plant some flowers and shrubs outside the window to compensate for the lack of visual pleasure provided by the original window view. However, further research is required to study the effectiveness of these proposals.

4.2.8 Comparison of view quality evaluations between two groups of subjects: males vs. females

Figure 4.14 presents a comparison on the mean view quality ratings (POV and EOV) between male and female subjects in the evaluation of 12 window views for Experiment 1 (actual view). To determine whether there was a significant difference in the mean POV (EOV) rating between male and female subjects, we established the null hypothesis and alternative hypothesis as below:

H_0: There is no significant difference in the mean POV (EOV) rating between male and female subjects.

H_1: There is a significant difference in the mean POV (EOV) rating between male and female subjects.

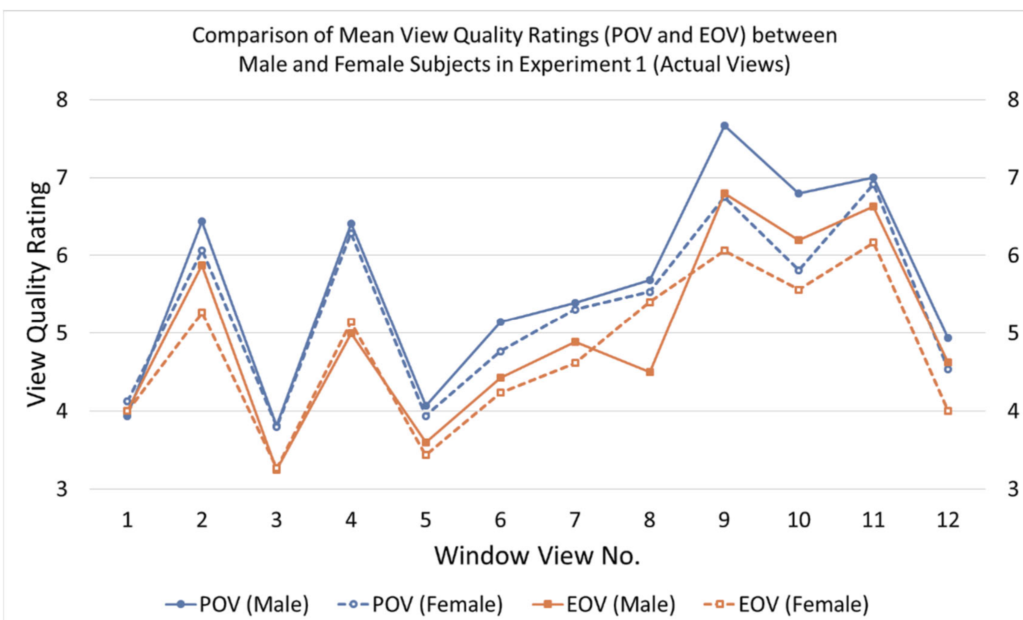


Figure 4.14: Comparison of mean view quality ratings (10-point scale) between male and female subjects in Experiment 1 (actual view).

An independent samples t-test was carried out to test whether the mean POV (EOV) rating (based on 10-point scale data) was significantly different between the two groups i.e., the male and female groups. To control the Type I error rate in this multiple testing, Bonferroni correction was applied to the critical level of significance. Since there were 12 cases for either view quality (POV or EOV), the new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042. If one or more of the 12 cases for POV (EOV) had a p-value smaller than 0.0042, then the null hypothesis for POV (EOV) was to be rejected.

The results, which are summarised in Table 4.7, show that there was no significant difference in the mean POV (EOV) rating between the male and female subjects for all 12 views. Therefore, the null hypothesis was retained for POV (EOV). This suggests that generally there was a consensus between the male and female groups in the evaluation of view quality (actual view). Note that for View 9 (POV and EOV), Levene's test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made in each of these cases.

Table 4.7: Results of independent samples t-test on the differences in view quality rating (10-point scale) between the male and female subjects in Experiment 1 (actual view).

View No.	Mean difference	95% Confidence Interval of the Difference		t	df	p-value (2-tailed)
		Lower	Upper			
View 1						
POV	-0.192	-1.867	1.484	-0.234	29	0.817
EOV	0.000	-1.627	1.627	0.000	29	1.000
View 2						
POV	0.371	-0.841	1.583	0.626	29	0.536
EOV	0.608	-0.748	1.964	0.918	29	0.366
View 3						
POV	0.013	-1.675	1.700	0.015	29	0.988
EOV	-0.017	-1.561	1.527	-0.022	29	0.983
View 4						
POV	0.126	-1.238	1.490	0.189	29	0.851
EOV	-0.143	-1.605	1.319	-0.200	29	0.843
View 5						
POV	0.129	-1.508	1.766	0.161	29	0.873
EOV	0.163	-1.438	1.763	0.208	29	0.837
View 6						
POV	0.378	-1.668	2.424	0.378	29	0.708
EOV	0.193	-1.985	2.371	0.181	29	0.857
View 7						
POV	0.081	-1.727	1.889	0.092	29	0.927
EOV	0.274	-1.586	2.133	0.301	29	0.766
View 8						
POV	0.154	-1.557	1.865	0.184	29	0.855
EOV	-0.900	-2.779	0.979	-0.979	29	0.335
View 9						
POV	0.917	-0.863	2.696	1.068	22.06	0.297
EOV	0.738	-1.231	2.706	0.773	24.32	0.447
View 10						
POV	0.988	-0.966	2.941	1.034	29	0.310
EOV	0.638	-1.236	2.511	0.696	29	0.492
View 11						
POV	0.083	-1.660	1.826	0.098	29	0.923
EOV	0.465	-1.383	2.313	0.515	29	0.611
View 12						
POV	0.404	-1.260	2.068	0.497	29	0.623
EOV	0.625	-1.012	2.262	0.781	29	0.441

Note: Levene's test suggests that equality of variance cannot be assumed for View 9 (POV or EOV).

4.2.9 Comparison of view quality evaluations between two groups of subjects: "view priority" group vs. "non-view priority" group

The current survey (Experiment 1) shows 21% of the subjects believed that outdoor view was the primary reason for the provision of windows at workplace or home, compared to 79% who believed that daylight, natural ventilation or other reasons justified the existence of windows. It was predicted that view quality ratings (POV or EOV on a 10-point scale) between the "view priority" group and the "non-view priority" group were significantly different. Figure 4.15 shows the comparison of mean view quality ratings (10-point scale) between the "view priority" group and the "non-view priority" group in Experiment 1 (actual views).

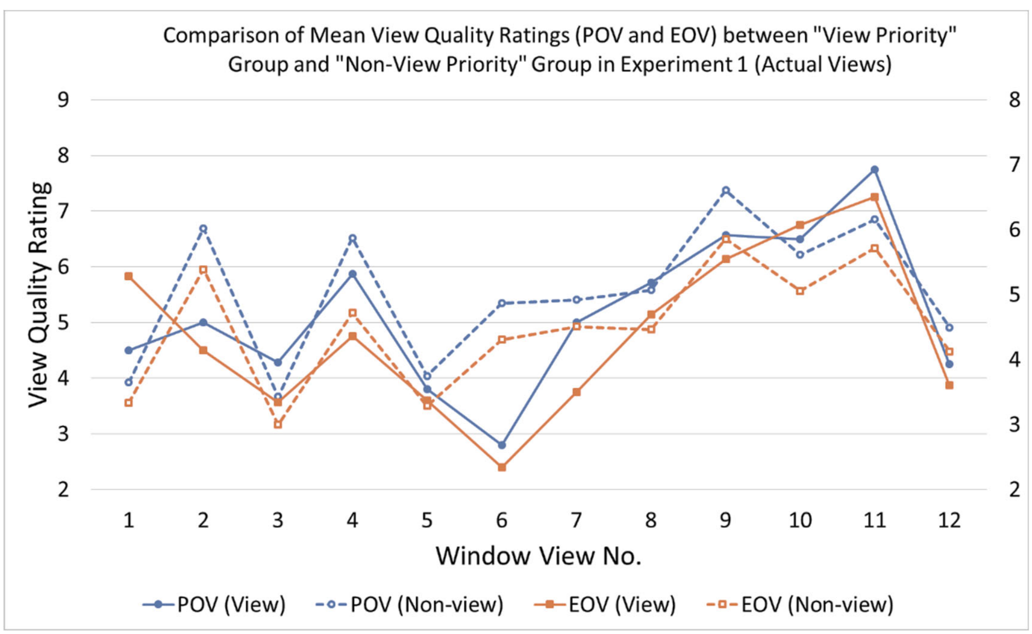


Figure 4.15: Comparison of mean view quality ratings (10-point scale) between the "view priority" group and the "non-view priority" group in Experiment 1 (actual views).

To find out whether there was any difference between the two groups, the null hypothesis and alternative hypothesis were defined as below:

H_0: There is no significant difference in the mean POV (EOV) rating between the "view priority" group and the "non-view priority" group.

H_1: There is a significant difference in the mean POV (EOV) rating between the "view priority" group and the "non-view priority" group.

An independent samples t-test was carried out to test whether the mean POV (EOV) rating (based on 10-point scale data) was significantly different between the two groups i.e., "view priority" group and "non-view priority" group. Bonferroni correction was applied to the critical level of significance to control the Type I error rate in this multiple testing (12 cases for POV and 12 cases for EOV). The new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042. If one or more of the 12 cases in POV (EOV) had a p-value smaller than 0.0042, then the null hypothesis for POV (EOV) was to be rejected.

The results, which are summarised in Table 4.8, show that there was no significant difference in the mean POV (EOV) rating at the corrected alpha level (0.0042) between the "view priority" group and "non-view priority" group for all 12 views. Therefore, the null hypothesis was retained for POV (EOV). This suggests that generally there was a consensus between the "view priority" group and the "non-view priority" group in the evaluation of view quality (actual view). Note that in the case of View 12 (POV), Levene's test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made in this case.

Table 4.8: Results of independent samples t-test on the differences in view quality rating (10-point scale) between the "view priority" group and "non-view priority" group in Experiment 1 (actual view).

View No.	Mean difference	95% Confidence Interval of the Difference		t	df	p-value (2-tailed)	
		Lower	Upper				
View 1							
POV	0.580	-1.530	2.690	0.562	29	0.578	
EOV	2.273	0.406	4.141	2.490	29	0.019	*
View 2							
POV	-1.696	-2.932	-0.460	-2.806	29	0.009	**
EOV	-1.457	-2.927	0.014	-2.026	29	0.052	
View 3							
POV	0.619	-1.384	2.622	0.632	29	0.532	
EOV	0.405	-1.434	2.244	0.450	29	0.656	
View 4							
POV	-0.647	-2.179	0.886	-0.863	29	0.395	
EOV	-0.424	-2.080	1.232	-0.524	29	0.605	
View 5							
POV	-0.238	-2.462	1.985	-0.219	29	0.828	
EOV	0.100	-2.076	2.276	0.094	29	0.926	
View 6							
POV	-2.546	-5.147	0.055	-2.002	29	0.055	
EOV	-2.292	-5.109	0.525	-1.664	29	0.107	
View 7							
POV	-0.407	-3.064	2.250	-0.314	29	0.756	
EOV	-1.176	-3.880	1.528	-0.889	29	0.381	
View 8							
POV	0.131	-1.915	2.177	0.131	29	0.897	
EOV	0.268	-2.013	2.549	0.240	29	0.812	
View 9							
POV	-0.804	-2.964	1.357	-0.761	29	0.453	
EOV	-0.357	-2.748	2.034	-0.305	29	0.762	
View 10							
POV	0.283	-1.987	2.552	0.255	29	0.801	
EOV	1.185	-0.925	3.294	1.149	29	0.260	
View 11							
POV	0.898	-1.612	3.408	0.732	29	0.470	
EOV	0.917	-1.758	3.591	0.701	29	0.489	
View 12							
POV	-0.663	-2.137	0.811	-0.933	22.26	0.361	
EOV	-0.603	-2.478	1.271	-0.658	29	0.516	

Note: * $p < 0.05$, ** $p < 0.01$.

- None of the p-values is lower than the alpha level corrected by Bonferroni method. Alpha level: 0.05; corrected alpha level: 0.0042.
- Levene's test suggests that equality of variance cannot be assumed for View 12 (POV).

In all 12 cases of POV (EOV), the difference in the mean POV (EOV) rating between the "view priority" group and the "non-view priority" group was nonsignificant at the corrected alpha level (0.0042) probably because of the small sample size. However, View 1 (EOV) and View 2 (POV) were significant at the 0.05 and 0.01 levels respectively (which were probably due to Type I error). Note that:

1. View 1 (EOV) [t(29) = 2.490, p = 0.019]. The effect size (Cohen's *d*) was 0.85, suggesting that view priority had a large effect on the EOV rating of View 1; and 18% of the variances in this EOV rating was attributable to view priority. View 1 had the highest diversity of view (score = 10) among the 12 views. For View 1, the mean EOV rating of the "view priority" group (mean EOV: 5.83, SD = 1.72) was significantly higher than that of the "non-view priority" group (mean EOV: 3.56, SD = 2.06) at the 0.05 level probably because in the evaluation of view quality, the former group generally felt that the view was somewhat more stimulating compared to the latter group which was perhaps affected by the negative aesthetical impression of the view ("view elements" score = -3).

2. View 2 (POV) [t(29) = -2.806, p = 0.009]. The effect size (Cohen's *d*) was 0.83, suggesting that view priority had a large effect on the POV rating of View 2; and 21% of the variances in this POV rating was attributable to view priority. For View 2 the mean POV rating of the "view priority" group (mean POV: 5.00, SD = 1.41) was significantly lower than that of the "non-view priority" group (mean POV: 6.70, SD = 1.49). A possible explanation is that the "view priority" group had a higher expectation of a pleasant view; the "non-view priority" group was probably influenced by the positive aesthetical scene quality ("view elements" score = 1), the moderate proportion of greenery (21%) and the relatively high openness of view (60%), hence they gave a relatively high rating of POV. According to previous studies (Matusiak and Klöckner 2016; Kaplan 2001; Lottrup et al. 2015; Ozdemir 2010), it was predicted that higher aesthetical quality of view elements, higher proportion of greenery, larger openness of view would lead to higher rating of view quality.

4.2.10 Comparison of view quality evaluations between two groups of subjects: "greenery preference" group vs. "non-greenery preference" group

The current survey (Experiment 1) shows that 54.8% of the subjects preferred to look at greenery through the window at their workplaces or homes, whilst the other 45.2 % preferred to look at other features. The researcher predicted that there was a significant difference in view quality ratings (POV or EOV on a 10-point scale) between the "greenery preference" group and the "non-greenery preference" group (see Figure 4.16). To find out whether there was any difference between the two groups, the null hypothesis and alternative hypothesis were defined as below:

H_0: There is no significant difference in the mean POV (EOV) rating between the "greenery preference" group and the "non-greenery preference" group.

H_1: There is a significant difference in the mean POV (EOV) rating between the "greenery preference" group and the "non-greenery preference" group.

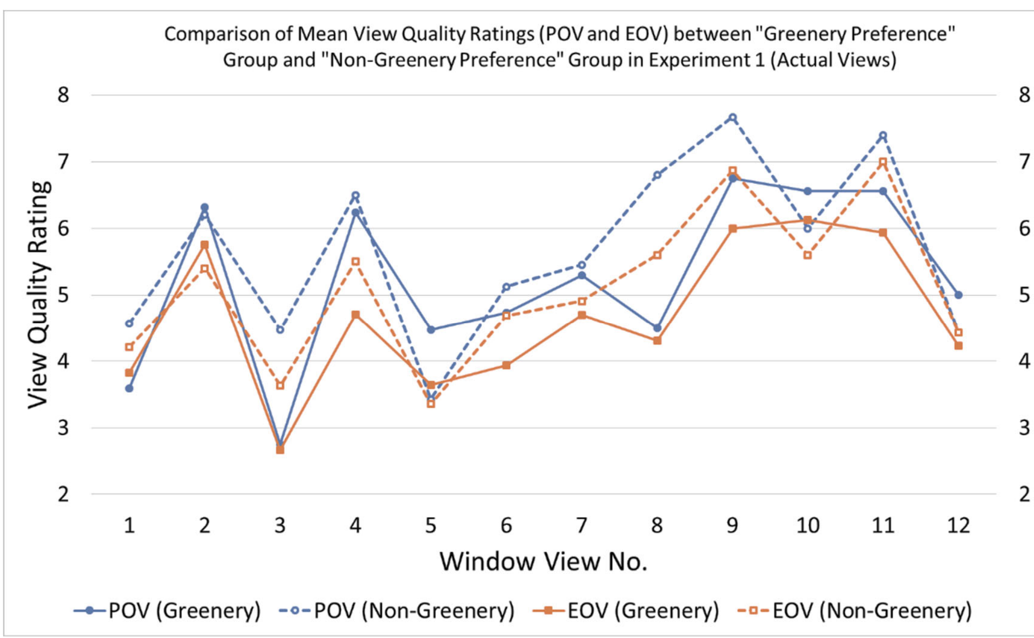


Figure 4.16: Comparison of mean view quality ratings (10-point scale) between the "greenery preference" group and the "non-greenery preference" group in Experiment 1 (actual views).

An independent samples t-test was carried out to test whether the mean POV (EOV) rating (based on 10-point scale data) was significantly different between the two groups i.e., the "greenery preference" group and the "non-greenery preference" group. To control the Type I error rate in this multiple testing, Bonferroni correction was applied to the critical level of significance. The new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042. If one or more of the 12 cases in POV (EOV) had a p-value smaller than 0.0042, then the null hypothesis for POV (EOV) was to be rejected.

The results, which are summarised in Table 4.9, show that there was a significant difference in the mean POV rating at the corrected alpha level (0.0042) for View 8 (POV) [$t(29) = -3.194$, $p = 0.0034$], in which the effect size (Cohen's *d*) was 0.81, suggesting that preference of greenery had a large effect on the POV rating of View 8; and 26% of the variances in this POV rating was attributable to such preference. In contrast to POV, there was no significant difference in the mean EOV rating between the two groups at the corrected alpha level (0.0042) for all 12 views. Therefore, the null hypothesis for POV was rejected, but the null hypothesis for EOV was retained. It can be concluded that:

1. There is a significant difference in the mean POV rating between the "greenery preference" group and the "non-greenery preference" group.

2. There is no significant difference in the mean EOV rating between the "greenery preference" group and the "non-greenery preference" group.

The outcome of analysis suggests that generally there was a consensus between the "greenery preference" group and the "non-greenery preference" group in the evaluation of view quality (actual view) based on the affective dimension of "excitingness" but not "pleasantness."

Table 4.9: Results of independent samples t-test on the differences in view quality rating (10-point scale) between the "greenery preference" group and the "non-greenery preference" group in Experiment 1 (actual view).

View No.	Mean difference	95% Confidence Interval of the Difference		t	df	p-value (2-tailed)	
		Lower	Upper				
View 1							
POV	-0.983	-2.625	0.659	-1.224	29	0.231	
EOV	-0.391	-2.017	1.236	-0.491	29	0.627	
View 2							
POV	0.113	-1.107	1.332	0.189	29	0.852	
EOV	0.350	-1.019	1.719	0.523	29	0.605	
View 3							
POV	-1.724	-3.137	-0.310	-2.495	28.59	0.019	*
EOV	-0.965	-2.506	0.576	-1.281	29	0.210	
View 4							
POV	-0.265	-1.625	1.096	-0.398	29	0.694	
EOV	-0.794	-2.225	0.637	-1.135	29	0.266	
View 5							
POV	1.042	-0.554	2.639	1.335	29	0.192	
EOV	0.290	-1.315	1.895	0.369	29	0.714	
View 6							
POV	-0.392	-2.429	1.645	-0.393	29	0.697	
EOV	-0.754	-2.905	1.397	-0.717	29	0.479	
View 7							
POV	-0.155	-2.018	1.709	-0.170	29	0.867	
EOV	-0.209	-2.128	1.710	-0.223	29	0.825	
View 8							
POV	-2.300	-3.773	-0.827	-3.194	29	**0.003**	**#
EOV	-1.288	-3.134	0.559	-1.426	29	0.165	
View 9							
POV	-0.917	-2.709	0.875	-1.046	29	0.304	
EOV	-0.867	-2.843	1.110	-0.897	29	0.377	
View 10							
POV	0.563	-1.415	2.540	0.582	29	0.565	
EOV	0.525	-1.353	2.403	0.572	29	0.572	
View 11							
POV	-0.838	-2.507	0.832	-1.026	29	0.313	
EOV	-1.063	-2.826	0.701	-1.232	29	0.228	
View 12							
POV	0.571	-1.093	2.236	0.702	29	0.488	
EOV	-0.193	-1.852	1.466	-0.238	29	0.813	

Note: * $p < 0.05$, ** $p < 0.01$. # Bold indicates p-value that is lower than the alpha level corrected by Bonferroni method (corrected alpha level: 0.0042).
- Levene's test suggests that equality of variance cannot be assumed for View 3 (POV).

There was a significant difference in the mean POV ratings between the two groups on View 3 at the 0.05 level (which may be due to Type I error). The effect size (Cohen's *d*) in this case was 0.61, suggesting that preference of greenery had a medium effect on the POV rating of View 3; and 14% of the variances in this POV rating was attributable to such preference. In this case (View 3 (POV)), Levene's test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made.

Note that View 3 and View 8 were the only two views (among the 12 views) that had no greenery content (i.e., 0% "proportion of greenery"). For View 3, the mean POV rating of the "greenery preference" group (mean POV: 2.75, SD = 1.36) was very much lower than the "non-greenery preference" group (mean POV: 4.47, SD = 2.48). For View 8, the mean POV rating of the "greenery preference" group (mean POV: 4.50, SD = 1.97) was also very low compared to the "non-greenery preference" group (mean POV: 6.80, SD = 2.04). These results suggest that the subjects' preference of greenery had a significant effect on their evaluation of view quality (POV): when there was an absence of greenery in a view, the "greenery preference" group was more inclined to evaluate more negatively on the POV, compared to the group which had no preference of greenery content. Compared to View 3, there was an increase of mean POV rating on View 8 by both groups of subjects. The increase was consistent with the prediction because View 8 had much larger openness of view (40%) and depth of view (3.0 km) compared to View 3 (12%, 0.1 km). According to previous studies (Ozdemir 2010; Matusiak and Klöckner 2016), larger openness of view and depth of view would lead to higher rating of view quality.

4.3 Results of Experiment 2 (Image Views)

There were 62 subjects (27 males and 35 females) in Experiment 2 (image views) (see Appendix E2 on tabulation of rating data). All the 62 subjects in this experiment were in the age group of 18 – 40. In terms of occupation: 61 subjects (98.4%) were students; one subject (1.6%) worked in education field. On the perceived importance of window at workplace or home, all the 62 subjects selected "important". Among these subjects, 30.6% of them regarded "view" as the primary reason for the importance of window, compared to 41.9% for daylight and 24.2% for natural ventilation (see Figure 4.17). On the preferred contents of a window view as observed from the workplace or home, "greenery" was the most popular choice (38.7%), and "human activities" the least popular choice (1.6%) (see Figure 4.18).

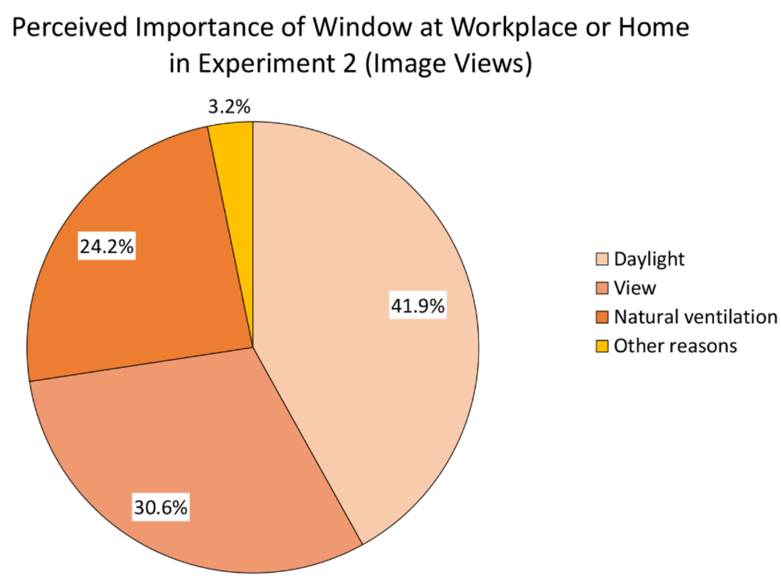


Figure 4.17: Percentage of subjects in Experiment 2 on the perceived importance of window at workplace or home.

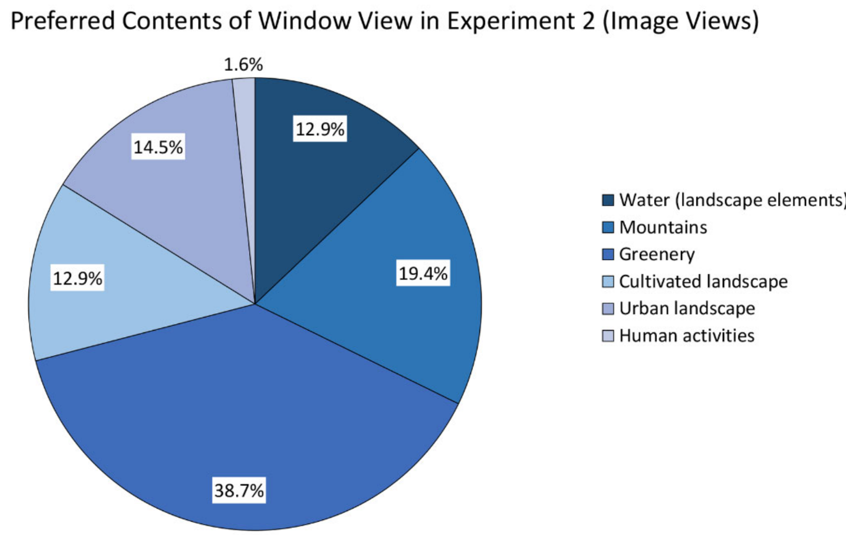


Figure 4.18: Percentage of subjects in Experiment 2 on the preferred contents of a window view as observed from the workplace or home.

4.3.1 View quality ratings: 10-point scale (Experiment 2)

Overall, the distribution of view quality ratings (POV and EOV) in Experiment 2 (image views) also covered a wide range (see Figure 4.19). For POV ratings, View 3 covered the full range of the 10-point scale; whilst for EOV, Views 2 and 11 covered the full range of the scale.

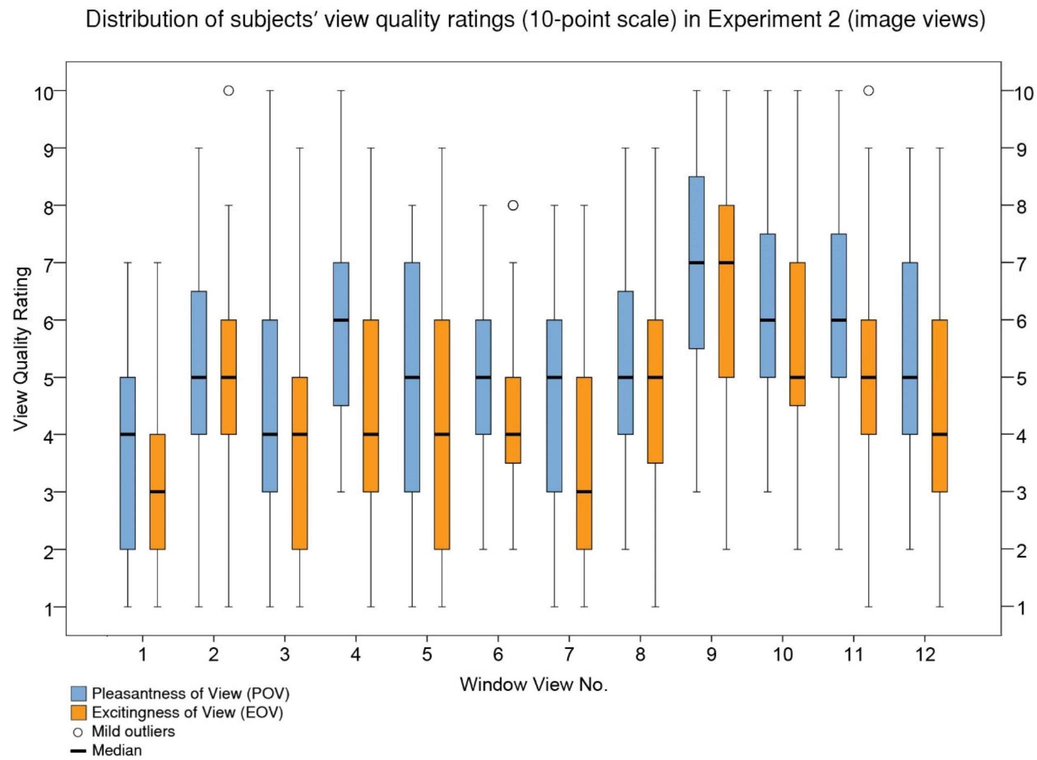


Figure 4.19: Box and whisker plots of POV and EOV ratings based on 10-point scale format in Experiment 2 (image view) indicating the interquartile range, median, highest and lowest ratings for each of the 12 window views.

Between the 12 views, View 5 (POV and EOV) had the largest IQR. View 6 (POV and EOV) demonstrated the smallest IQR. There was no outlier in POV ratings but there were four mild outliers in EOV ratings – i.e., one in View 2 (Category 10), two in View 6 (Category 8) and one in View 11 (Category 10).

Median POV was either equal to or higher than median EOV in all the views. View 9 had positive view quality in terms of POV and EOV. Views 1, 2, 3, 5, 6, 7, 8 and 12 had negative view quality in terms of both POV and EOV. Three views - i.e., Views 4, 10 and 11 had positive median POV rating but negative median EOV. The highest median view quality (POV and EOV) was in View 9 (Category 7). For POV, the lowest median view quality was in View 1 and View 3 (Category 4); for EOV, the lowest median view quality was in View 1 and View 7 (Category 3).

When the mean ratings were compared (see Figure 4.20), it was observed that View 9 had the highest mean POV (7.03) and EOV (6.29), whereas View 1 had the lowest mean POV (3.74) and EOV (3.16) among the 12 views.

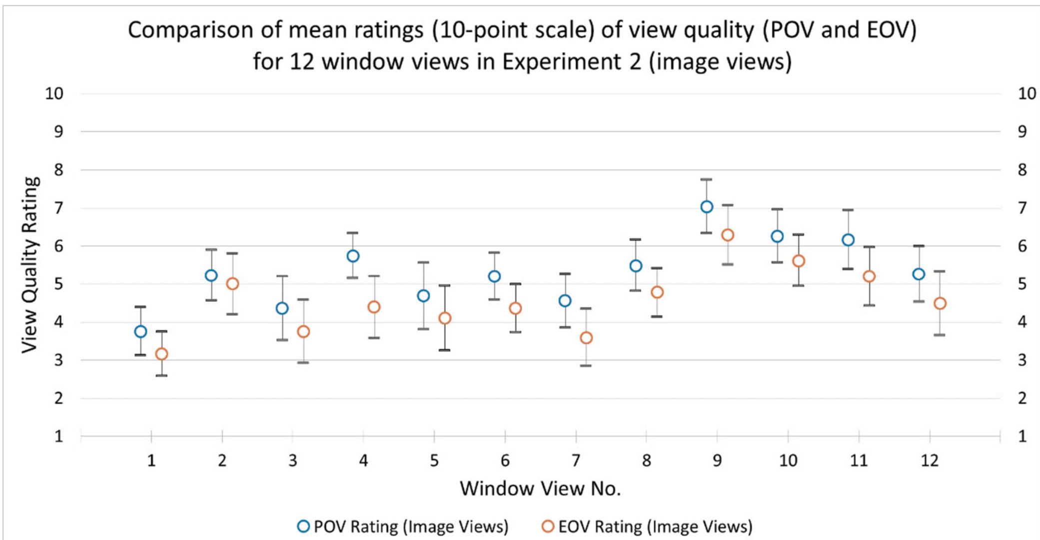


Figure 4.20: Comparison of POV and EOV mean ratings (10-point scale) and the corresponding 95% confidence intervals for each of the 12 window views in Experiment 2 (image view).

4.3.2 Normality assessment of 10-point scale ratings (Experiment 2)

Normality assessment was performed on the distribution of the POV and EOV ratings in Experiment 2 (image view) based on statistical data and graphical information supplemented with Shapiro-Wilk test. Figures 4.21 and 4.22 present histograms on the frequency of POV (EOV) rating (10-point scale) in each of the 12 window views in Experiment 2 (image views).

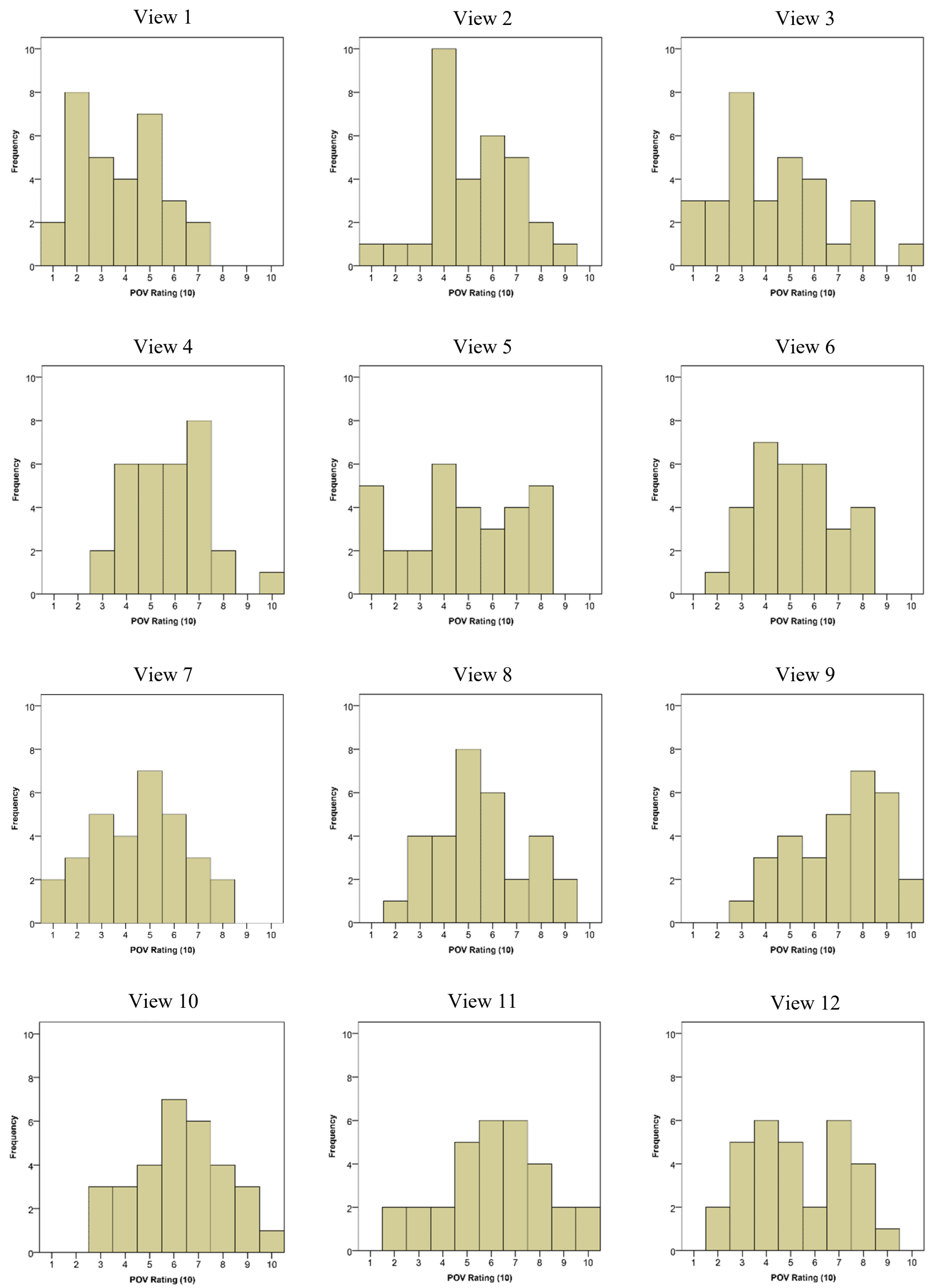


Figure 4.21: Histograms showing the frequency of POV rating (10-point scale) in each of the 12 window views in Experiment 2 (image view).

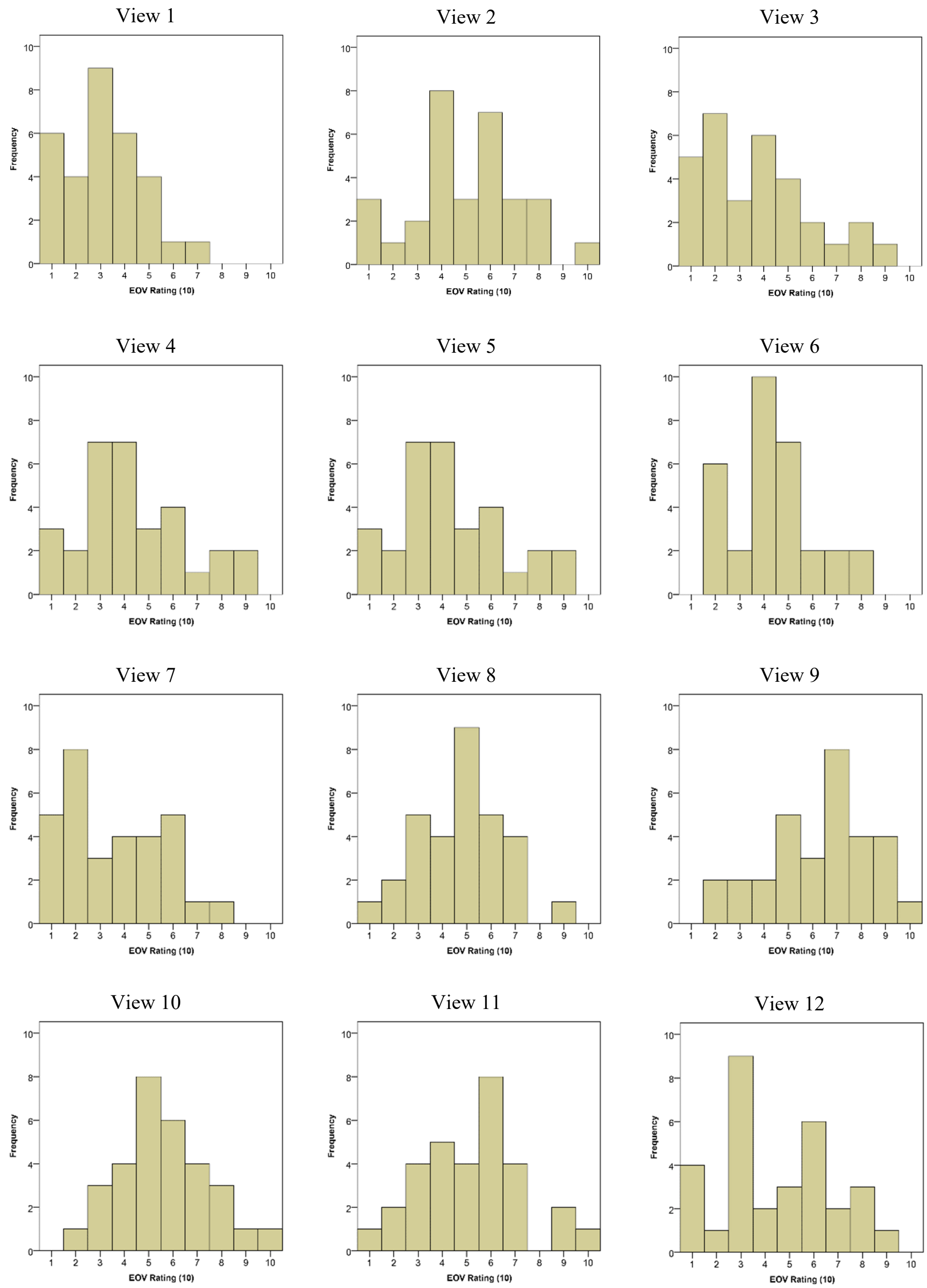


Figure 4.22: Histograms showing the frequency of EOV rating (10-point scale) in each of the 12 window views in Experiment 2 (image view).

From the visual assessment of these histograms, the ratings of views listed below seem to follow normal distribution:

POV : Views 3, 7, 8, 10 and 11.
EOV : Views 4, 8, 9, 10 and 11.

Tables 4.10 and 4.11 present the results of the measure of central tendency, measures of dispersion (in terms of skewness and kurtosis) and Shapiro-Wilk test, which are as follows:

1. Measure of central tendency: For POV and EOV, all views had median rating that lied within the 95% confidence interval of the mean.

2. Measures of dispersion: For POV and EOV, all views had normal skewness and kurtosis [z-value between -1.96 and +1.96, which was based on the 0.05 level of significance (two-tailed)].

3. Shapiro-Wilk test: The null hypothesis was that the view quality rating (POV or EOV) was normally distributed in the population. For POV, Views 1 and View 5 had p-values below 0.05, therefore we reject the null hypotheses of normal population distributions; Views 2, 3, 4, 6, 7, 8, 9, 10, 11 and 12 had p-values of 0.05 or above, therefore we retain the null hypothesis and conclude that these 10 views were normally distributed in the population. For EOV, Views 3, 6 and 7 had p-values below 0.05, therefore we reject the null hypotheses of normal population distributions; Views 1, 2, 4, 5, 8, 9, 10, 11 and 12 had p-values of 0.05 or above, therefore we retain the null hypothesis and conclude that these nine views were normally distributed in the population.

Table 4.10: Normality assessment of POV rating (10-point scale) for Experiment 2 (image view).

View	Central Tendency				Median	Measures of Dispersion						Normality Test			
	Mean rating		95% CI			Skewness			Kurtosis			Shapiro-Wilk Test			
	Stat.	SE	Lower	Upper		Stat.	SE	z-value	Stat.	SE	z-value	Stat.	df	p-value	
1	3.74	0.311	3.11	4.38	4	0.221	0.421	0.52	-1.018	0.821	-1.24	0.930	31	0.043	*
2	5.23	0.324	4.56	5.89	5	-0.069	0.421	-0.16	-0.053	0.821	-0.06	0.954	31	0.207	
3	4.35	0.411	3.52	5.19	4	0.566	0.421	1.34	-0.171	0.821	-0.21	0.945	31	0.112	
4	5.74	0.289	5.15	6.33	6	0.348	0.421	0.83	0.120	0.821	0.15	0.944	31	0.110	
5	4.68	0.431	3.80	5.56	5	-0.149	0.421	-0.35	-1.153	0.821	-1.40	0.916	31	0.019	*
6	5.19	0.302	4.58	5.81	5	0.169	0.421	0.40	-0.812	0.821	-0.99	0.943	31	0.099	
7	4.55	0.347	3.84	5.26	5	-0.079	0.421	-0.19	-0.717	0.821	-0.87	0.961	31	0.314	
8	5.48	0.334	4.80	6.17	5	0.227	0.421	0.54	-0.613	0.821	-0.75	0.952	31	0.180	
9	7.03	0.345	6.33	7.74	7	-0.409	0.421	-0.97	-0.822	0.821	-1.00	0.938	31	0.071	
10	6.26	0.338	5.57	6.95	6	-0.046	0.421	-0.11	-0.613	0.821	-0.75	0.961	31	0.312	
11	6.16	0.380	5.39	6.94	6	-0.181	0.421	-0.43	-0.343	0.821	-0.42	0.967	31	0.435	
12	5.26	0.359	4.52	5.99	5	0.128	0.421	0.30	-1.163	0.821	-1.42	0.936	31	0.065	

Note: * $p < 0.05$

Table 4.11: Normality assessment of EOV rating (10-point scale) for Experiment 2 (image view).

View	Central Tendency				Median	Measures of Dispersion						Normality Test			
	Mean rating		95% CI			Skewness			Kurtosis			Shapiro-Wilk Test			
	Stat.	SE	Lower	Upper		Stat.	SE	z-value	Stat.	SE	z-value	Stat.	df	p-value	
1	3.16	0.282	2.58	3.74	3	0.375	0.421	0.89	-0.203	0.821	-0.25	0.933	31	0.053	
2	5.00	0.393	4.20	5.80	5	-0.020	0.421	-0.05	-0.122	0.821	-0.15	0.960	31	0.301	
3	3.74	0.404	2.92	4.57	4	0.701	0.421	1.67	-0.238	0.821	-0.29	0.917	31	0.020	*
4	4.39	0.398	3.57	5.20	4	0.534	0.421	1.27	-0.276	0.821	-0.34	0.938	31	0.073	
5	4.10	0.418	3.24	4.95	4	0.146	0.421	0.35	-0.881	0.821	-1.07	0.934	31	0.055	
6	4.35	0.306	3.73	4.98	4	0.439	0.421	1.04	-0.145	0.821	-0.18	0.916	31	0.018	*
7	3.58	0.364	2.84	4.33	3	0.387	0.421	0.92	-0.977	0.821	-1.19	0.916	31	0.019	*
8	4.77	0.317	4.13	5.42	5	0.017	0.421	0.04	0.038	0.821	0.05	0.966	31	0.415	
9	6.29	0.383	5.51	7.07	7	-0.406	0.421	-0.96	-0.523	0.821	-0.64	0.951	31	0.166	
10	5.61	0.333	4.93	6.29	5	0.311	0.421	0.74	-0.056	0.821	-0.07	0.970	31	0.509	
11	5.19	0.381	4.42	5.97	5	0.222	0.421	0.53	-0.060	0.821	-0.07	0.966	31	0.420	
12	4.48	0.414	3.64	5.33	4	0.179	0.421	0.43	-0.944	0.821	-1.15	0.936	31	0.063	

Note: * $p < 0.05$

According to the results above, we conclude that, at the 0.05 level of significance, the view quality ratings (10-point scale) that fit normal distribution in Experiment 2 (image views) are as below:

POV : Views 2, 3, 4, 6, 7, 8, 9, 10, 11 and 12.
EOV : Views 1, 2, 4, 5, 8, 9, 10, 11 and 12.

If the hypothesis were tested at the 0.01 level of significance, all the view quality ratings (POV and EOV) would fit normal distribution in Experiment 2 (image views).
From the results above, we conclude that the view quality ratings (10-point scale) in Experiment 2 (image views) generally follow a normal distribution. Therefore, in the subsequent analyses of Experiment 2, parametric methods are applied on 10-point scale data.

4.3.3 View quality ratings: 4-point scale (Experiment 2)

Overall, the distribution of POV and EOV ratings in Experiment 2 (image views) covered the full range of the 4-point scale except in View 3 (POV), View 9 (POV), View 10 (POV) and View 12 (EOV) (see Figure 4.23). Between the 12 views, View 3 (POV), View 6 (EOV) and View 7 (EOV) demonstrated the largest IQR. View 4 (EOV) and View 9 (POV) had zero IQR with median Categories 2 and 3 respectively.

Numerous outliers were observed in the following:

- View 1 – one mild outlier each in POV and EOV at Category 4 [Mild outliers are values below $(Q1 - 1.5 \cdot IQR)$ or above $(Q3 + 1.5 \cdot IQR)$].
- View 3 – two mild outliers in EOV at Category 4.
- View 4 – six extreme outliers at Category 3 and one extreme outlier at Category 4 in EOV [Extreme outliers are values below $(Q1 - 3 \cdot IQR)$ or above $(Q3 + 3 \cdot IQR)$].

- View 5 – one mild outlier in EOV at Category 4.
- View 9 – six extreme outliers in POV at Category 2; and seven extreme outliers in POV at Category 4.
- View 12 – six mild outliers at Category 3 in EOV.

Median POV was either equal to or higher than median EOV in all the 12 views. View 9 and View 11 had positive view quality in terms of median POV and EOV. Views 1, 2, 3, 5 and 8 had negative view quality in terms of median POV and EOV. View 4, 6, 7, 10 and 12 had positive (and highest) median POV but negative median EOV. The highest median EOV was in View 9 and View 11 at Category 3. The lowest median POV was in Views 1, 2, 3, 5 and 8 at Category 2; the lowest median EOV was in Views 1, 2, 3, 4, 5, 6, 7, 8, 10 and 12 at Category 2.

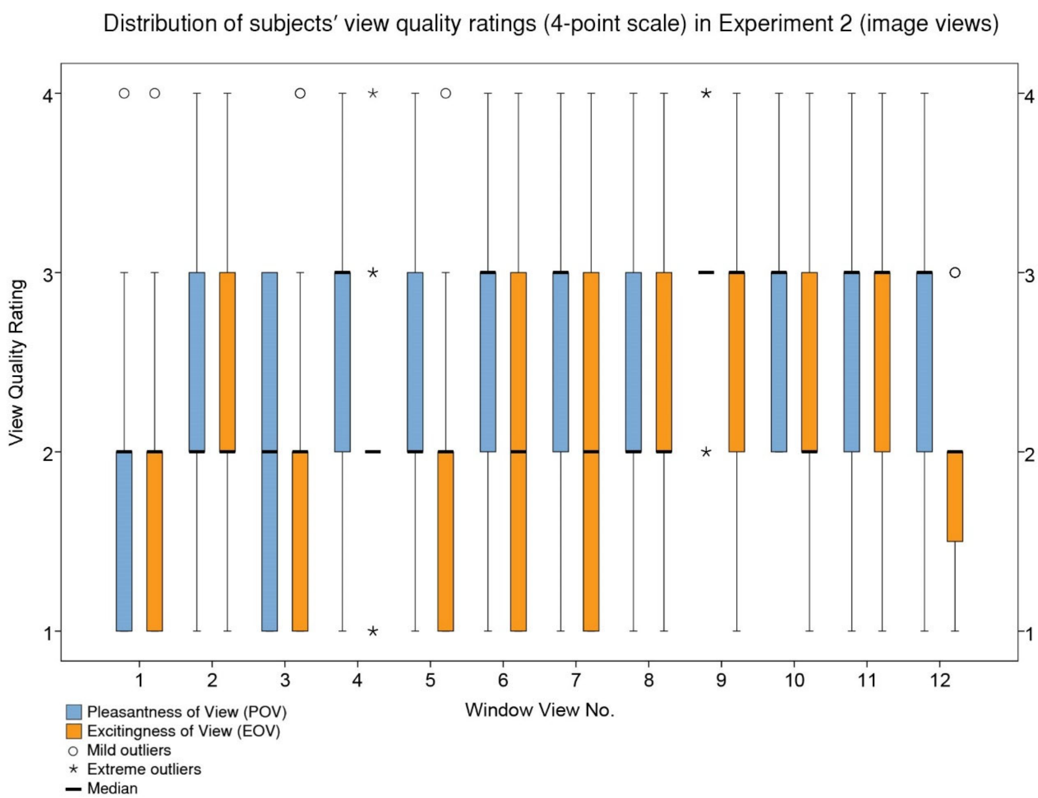


Figure 4.23: Box and whisker plots of POV and EOV ratings based on 4-point scale format in Experiment 2 (image views) indicating the interquartile range, median, highest and lowest ratings for each of the 12 window views.

When the mean ratings were compared (see Figure 4.24), it was observed that View 9 had the highest mean POV (3.03) and EOV (2.71), whereas View 1 had the lowest mean POV (1.87); View 3 and View 5 had the lowest mean EOV (1.77) among the 12 views.

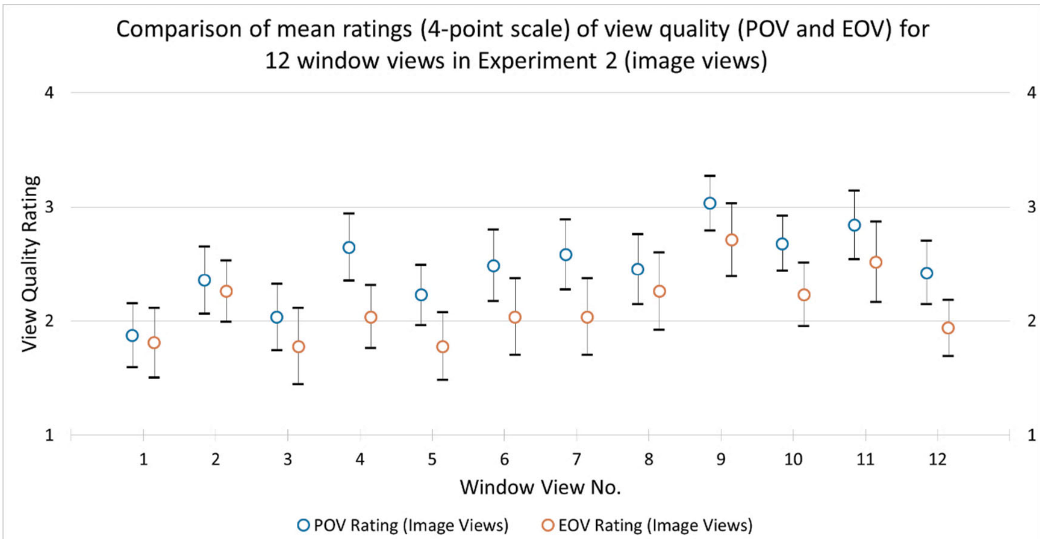


Figure 4.24: Comparison of POV and EOV mean ratings (4-point scale) and the corresponding 95% confidence intervals for each of the 12 window views in Experiment 2 (image view).

4.3.4 Normality assessment of 4-point scale ratings (Experiment 2)

Figures 4.25 and 4.26 present histograms on the frequency of POV (EOV) rating (4-point scale) in each of the 12 window views in Experiment 2 (image views).

From the visual assessment of these histograms, the ratings of views listed below seem to follow normal distribution:

POV : Views 6, 7, 8 and 11
EOV : Views 8, 9 and 11

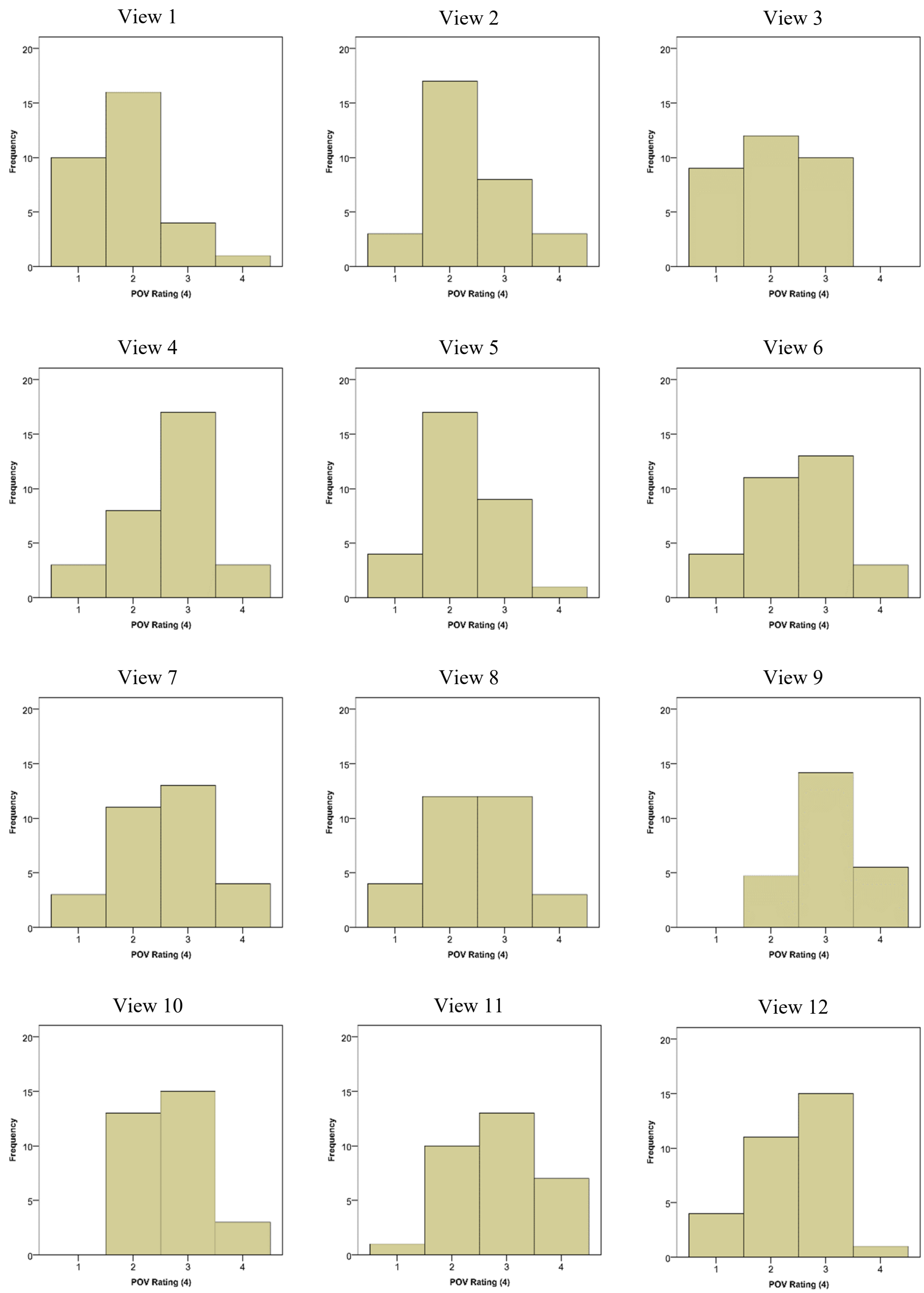


Figure 4.25: Histograms showing the frequency of POV rating (4-point scale) in each of the 12 window views in Experiment 2 (image view).

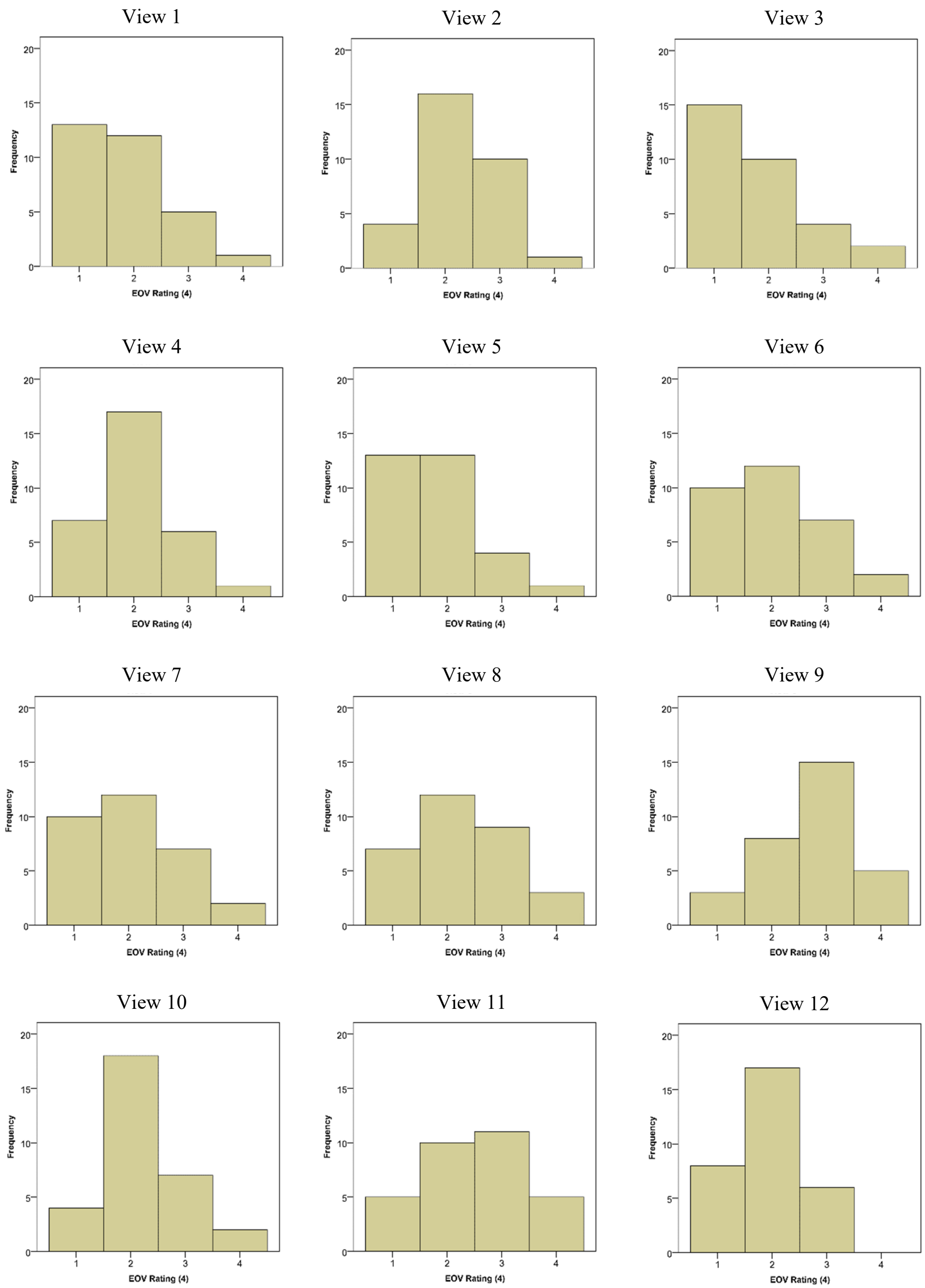


Figure 4.26: Histograms showing the frequency of EOV rating (4-point scale) in each of the 12 window views in Experiment 2 (image view).

Tables 4.12 and 4.13 present the results of the measure of central tendency, measures of dispersion (in terms of skewness and kurtosis) and Shapiro-Wilk test, which are as follows:

1. Measure of central tendency: For POV, Views 1, 3, 5, 9 and 11 had median rating that lied within the 95% confidence interval of the mean. For EOV, all views except View 11 had median rating that lied within the 95% confidence interval of the mean.

2. Measures of dispersion: For POV, all views had normal skewness and kurtosis [z-value between -1.96 and +1.96, which was based on the 0.05 level of significance (two-tailed)]. For EOV, all views except View 3 and View 5 had normal skewness; all views had normal kurtosis.

3. Shapiro-Wilk test: The null hypothesis was that the view quality rating (POV or EOV) was normally distributed in the population. For POV and EOV ratings, all 12 views had p-values below 0.01, therefore we reject the null hypothesis of normal population distributions. This shows that none of view quality ratings was normally distributed, even if the hypothesis were tested at the 0.01 level.

From the results above, we conclude that none of the view quality ratings (4-point scale) of the 12 views in Experiment 2 (image views) fits normal distribution. Therefore, in the subsequent analyses, nonparametric methods are applied on 4-point scale data.

Table 4.12: Normality assessment of POV rating (4-point scale) for Experiment 2 (image view).

View	Central Tendency				Median	Measures of Dispersion						Normality Test			
	Mean rating		95% CI			Skewness			Kurtosis			Shapiro-Wilk Test			
	Stat.	SE	Lower	Upper		Stat.	SE	z-value	Stat.	SE	z-value	Stat.	df	p-value	
1	1.87	0.137	1.59	2.15	2	0.708	0.421	1.68	0.608	0.821	0.74	0.817	31	0.000	***
2	2.35	0.143	2.06	2.65	2	0.511	0.421	1.21	0.066	0.821	0.08	0.836	31	0.000	***
3	2.03	0.143	1.74	2.32	2	-0.059	0.421	-0.14	-1.391	0.821	-1.69	0.806	31	0.000	***
4	2.65	0.143	2.35	2.94	3	-0.511	0.421	-1.21	0.066	0.821	0.08	0.836	31	0.000	***
5	2.23	0.129	1.96	2.49	2	0.213	0.421	0.51	0.100	0.821	0.12	0.835	31	0.000	***
6	2.48	0.153	2.17	2.80	3	-0.120	0.421	-0.29	-0.474	0.821	-0.58	0.874	31	0.002	**
7	2.58	0.152	2.27	2.89	3	-0.094	0.421	-0.22	-0.435	0.821	-0.53	0.876	31	0.002	**
8	2.45	0.153	2.14	2.76	2	-0.013	0.421	-0.03	-0.471	0.821	-0.57	0.876	31	0.002	**
9	3.03	0.118	2.79	3.27	3	-0.032	0.421	-0.08	-0.502	0.821	-0.61	0.794	31	0.000	***
10	2.68	0.117	2.44	2.92	3	0.436	0.421	1.04	-0.612	0.821	-0.75	0.771	31	0.000	***
11	2.84	0.147	2.54	3.14	3	-0.071	0.421	-0.17	-0.708	0.821	-0.86	0.859	31	0.001	**
12	2.42	0.137	2.14	2.70	3	-0.427	0.421	-1.01	-0.407	0.821	-0.50	0.828	31	0.000	***

Note: ** $p < 0.01$, *** $p < 0.001$

Table 4.13: Normality assessment of EOV rating (4-point scale) for Experiment 2 (image view).

View	Central Tendency				Median	Measures of Dispersion						Normality Test			
	Mean rating		95% CI			Skewness			Kurtosis			Shapiro-Wilk Test			
	Stat.	SE	Lower	Upper		Stat.	SE	z-value	Stat.	SE	z-value	Stat.	df	p-value	
1	1.81	0.150	1.50	2.11	2	0.759	0.421	1.80	-0.049	0.821	-0.06	0.815	31	0.000	***
2	2.26	0.131	1.99	2.53	2	0.104	0.421	0.25	-0.103	0.821	-0.13	0.842	31	0.000	***
3	1.77	0.165	1.44	2.11	2	1.031	0.421	2.45	0.279	0.821	0.34	0.784	31	0.000	***
4	2.03	0.135	1.76	2.31	2	0.449	0.421	1.07	0.265	0.821	0.32	0.835	31	0.000	***
5	1.77	0.145	1.48	2.07	2	0.856	0.421	2.03	0.395	0.821	0.48	0.806	31	0.000	***
6	2.03	0.164	1.70	2.37	2	0.497	0.421	1.18	-0.534	0.821	-0.65	0.855	31	0.001	**
7	2.03	0.164	1.70	2.37	2	0.497	0.421	1.18	-0.534	0.821	-0.65	0.855	31	0.001	**
8	2.26	0.167	1.92	2.60	2	0.239	0.421	0.57	-0.713	0.821	-0.87	0.878	31	0.002	**
9	2.71	0.155	2.39	3.03	3	-0.373	0.421	-0.89	-0.281	0.821	-0.34	0.865	31	0.001	**
10	2.23	0.137	1.95	2.51	2	0.551	0.421	1.31	0.469	0.821	0.57	0.828	31	0.000	***
11	2.52	0.173	2.16	2.87	3	-0.049	0.421	-0.12	-0.850	0.821	-1.04	0.885	31	0.003	**
12	1.94	0.122	1.69	2.18	2	0.079	0.421	0.19	-0.690	0.821	-0.84	0.801	31	0.000	***

Note: ** p < 0.01, *** p < 0.001

4.3.5 Perception of suitable locations for window views (Experiment 2)

In the experimental study, the subjects were asked in the survey questionnaires to select the location which they would consider each view to be suitable. The objective of this analysis to determine the level of concordance among the subjects on their perception of each view in terms of its suitability as a window view. There were four options offered to the subjects – i.e., home and workplace, workplace only, home only, neither home nor workplace. The results are presented in Figure 4.27.

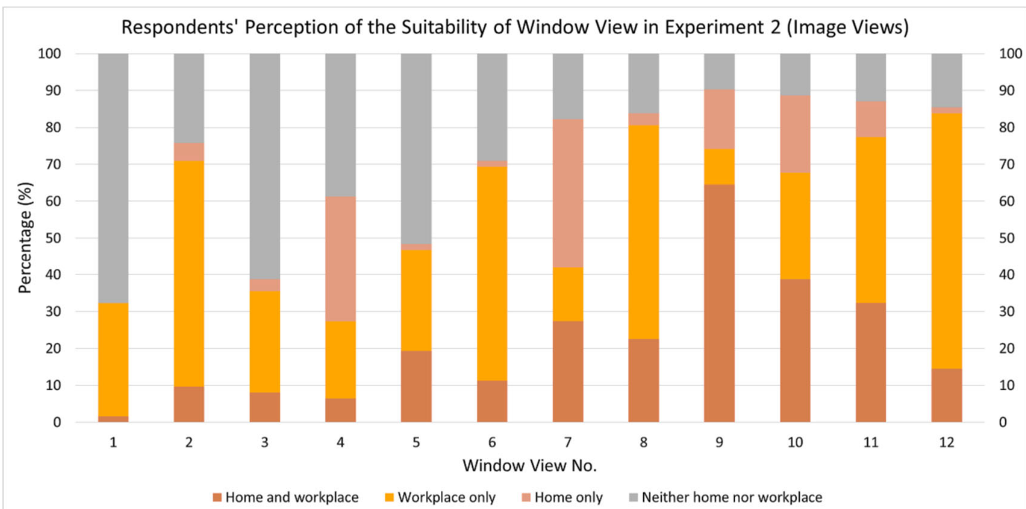


Figure 4.27: The respondents' perception of suitable locations for the window views in Experiment 2 (image views).

Among the views that were perceived to be suitable for both home and workplace: View 1 was the least popular (1.6%), and View 9 the most popular (64.5%). This is consistent with the fact that View 1 received the lowest mean POV and EOV rating (10-point scale), and View 9 received the highest mean POV and EOV rating (10-point scale) in Experiment 2. View 9 was the only view in which majority of the subjects (above 50%) selected "OK for both my home and my workplace".

For views that were perceived to be suitable for workplace only: View 9 was the least popular (9.7%), and View 12 the most popular (69.4%). For Views 2, 6, 8 and 12, majority of the subjects (above 50%) selected "OK for my workplace but not my home". An explanation for this: traffic along motorways in View 2, large open parking space in View 6, shops and office buildings that were dominant in View 8 and View 12 were associated with work and commercial activities.

For views that were perceived to be suitable for home only: View 1 was the least popular (0%), and View 7 the most popular (40.3%). Among the 12 views, View 7 received the highest proportion of subjects (40.3%) who selected "OK for my home but not my workplace". This is because the dominant tree foliage in the foreground and apartment blocks in the background were associated with home environment rather than workplace.

For views that were perceived to be neither suitable for workplace nor home: View 9 was the least popular (9.7%), and View 1 the most popular (67.7%). For Views 1, 3 and 5, majority of the subjects (above 50%) selected "neither for my home nor my workplace". An explanation for this: both View 1 and View 5 consisted of a dominant negative view element (i.e., telecommunication tower and lift motor room respectively); and View 3 was exceptionally enclosed (openness of view was only 12%).

4.3.6 Perception of dominant features in window views (Experiment 2)

The objective of this analysis to determine the level of concordance among the subjects on what they perceived to be the dominant features in each view. The most common dominant feature in each view (based on word descriptors of the subjects) is shown in Table 4.14. The results are presented in Figure 4.28.

From Figure 4.28, the proportion of respondents who ranked the most common feature as No. 1 (most dominant) was above 50% in Views 3, 4, 7, 10 and 12. This implies that there was a high degree of agreement on what the subjects perceived as dominant in these five views. An explanation for this: View 3 had extremely low degree of openness (12%) hence the window louvres appeared to be the most dominant feature in the photographic image; View 4 and View 7 had the highest proportion of greenery (i.e., 62% and 64% respectively), and trees were the most dominant feature; View 10 and View 12 were the only two views that contained dominant high-rise buildings.

Table 4.14: Most common dominant feature in the window views for Experiment 2 (image views)

View No.	Most common dominant feature perceived	View No.	Most common dominant feature perceived
1	Telecommunication tower	7	Trees
2	Motorways	8	Sky
3	Window louvres	9	Mountains
4	Trees	10	High-rise apartment buildings
5	Trees and greenery	11	High-rise office buildings
6	Parking lots	12	High-rise office buildings

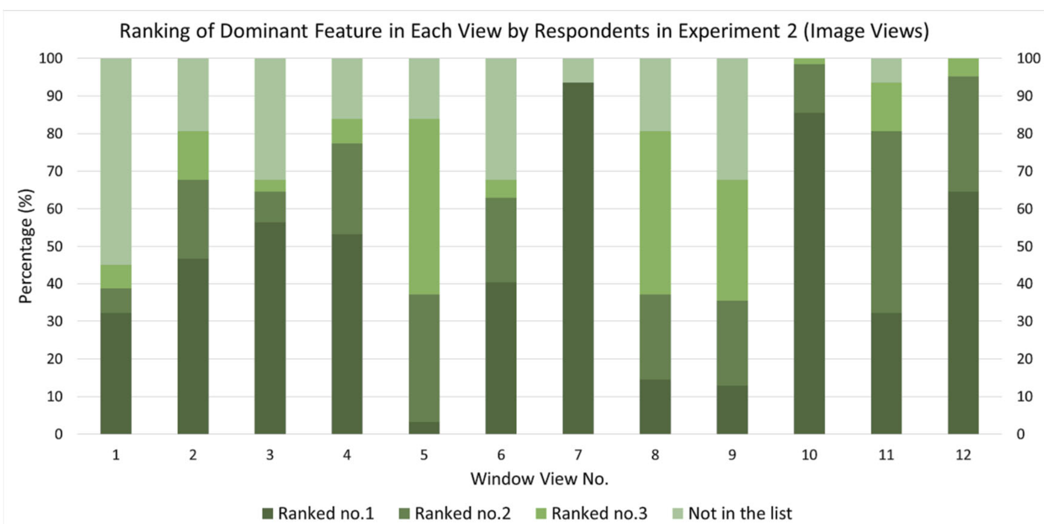


Figure 4.28: Proportion of respondents who ranked the most common dominant feature in each of the 12 window views in Experiment 2 (image views).

For View 1: although the telecommunication tower was the most commonly observed feature in the view, it was ranked the most dominant feature by 32.3% of the subjects only; majority of the subjects (54.8%) did not mention this feature in the survey ("not in the list"). A possible reason for this is that View 1 had the highest "diversity of view" (score = 10), therefore it was highly probable that other features were perceived to be more dominant.

4.3.7 Correlation and difference between POV and EOV ratings in Experiment 2 (image view)

From the results of view quality evaluation on the 12 selected scenes in Experiment 2 (image view), we compared the POV and EOV ratings given by the 31 subjects who used 10-point scale. Figure 4.29 illustrates the plots of mean POV against mean EOV ratings for the 12 views. Correlation analysis suggested a positive linear relationship that was extremely strong between the mean POV and mean EOV ratings (based on image view) across the 12 views, which was significant at the 0.001 level ($R = 0.954$, $n = 12$, $p < 0.001$).

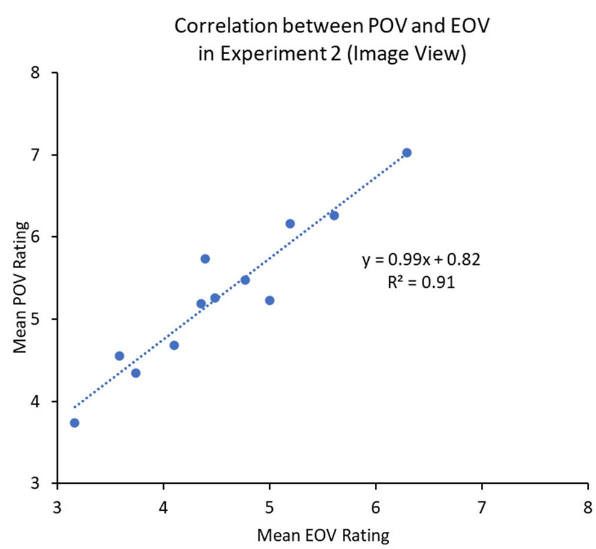


Figure 4.29: Mean POV ratings plotted against mean EOV ratings for Views 1 – 12 in Experiment 2 (image view).

To determine whether the POV ratings were significantly different from the EOV ratings for all the 12 views in Experiment 2 (image view), we established the null hypothesis and alternative hypothesis as below:

H_0: There is no significant difference between mean POV rating and mean EOV rating in the evaluation of window view quality (image view).

H_1: There is a significant difference between mean POV rating and mean EOV rating in the evaluation of window view quality (image view).

POV and EOV were two items in the evaluation of window view quality in this study. Each subject rated both POV and EOV for each of the 12 views. Based on the evaluation data collected in Experiment 2 (image view), paired samples t-test was conducted to determine whether there was any statistical evidence that the mean difference between the POV and EOV ratings given by the subjects was significantly different from zero. To control the Type I error rate in this multiple testing, Bonferroni correction was applied to the critical level of significance. Since there were 12 cases for either view quality (POV or EOV), the new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042. If one or more of the 12 cases had a p-value smaller than 0.0042, then the null hypothesis was to be rejected.

Results of the analysis are summarised in Table 4.15. The results indicate that the mean difference between the POV and EOV ratings (10-point scale) given by the subjects was significantly different from zero at the corrected alpha level (0.0042) in Views 4, 7, 10, 11 and 12. Therefore, the null hypothesis was rejected. This suggests that the subjects were able to differentiate POV from EOV in the evaluation of view quality (image view).

Table 4.15: Results of paired samples t-test that compared view quality ratings between POV and EOV in Experiment 2 (image view).

View	Mean difference (POV – EOV)	95% Confidence Interval of the Difference		t	df	p-value (2-tailed)		
		Lower	Upper					
1	0.581	0.082	1.080	2.376	30	0.024	*	
2	0.226	-0.316	0.767	0.851	30	0.401		
3	0.613	0.088	1.137	2.386	30	0.024	*	
4	1.355	0.798	1.912	4.971	30	**0.000**	***	#
5	0.581	0.129	1.033	2.624	30	0.014	*	
6	0.839	0.217	1.460	2.755	30	0.010	**	
7	0.968	0.519	1.417	4.401	30	**0.000**	***	#
8	0.710	0.198	1.221	2.832	30	0.008	**	
9	0.742	0.206	1.277	2.830	30	0.008	**	
10	0.645	0.297	0.994	3.780	30	**0.001**	**	#
11	0.968	0.539	1.396	4.611	30	**0.000**	***	#
12	0.774	0.411	1.137	4.353	30	**0.000**	***	#

Note: * $p < 0.05$, ** $p < 0.01$, ***$p < 0.001$, # Bold indicates p-value that is lower than the alpha level corrected by Bonferroni method (corrected alpha level: 0.0042).

In the case of View 2, the mean differences between the POV and EOV ratings were nonsignificant (even at the 0.05 level) probably because of the small sample size (i.e., 31), and it has been demonstrated in Chapter 3 that, with this sample size, cases with effect size (Cohen's d) smaller than 0.52 may not be significant. In this paired samples t-test, the effect size ($d = \frac{t}{\sqrt{N}}$) for View 2 was 0.15.

Interestingly, when we compare the results of paired samples t-test between Experiment 1 (actual view) and Experiment 2 (image view), it is observed that cases which have significant mean difference between the POV and EOV ratings in these two experiments are cases of different views, except View 4 which is common between the two experiments. A possible explanation is that mode of viewing (actual view vs. image view) affects the perceived difference between POV and EOV. Further studies with a larger sample of views are required to confirm this.

4.3.8 Comparison of view quality evaluations between two groups of subjects: males vs. females (Experiment 2)

Figure 4.30 presents a comparison on the mean view quality ratings (POV and EOV) between male and female subjects in the evaluation of 12 window views for Experiment 2 (image view). To determine whether there was a significant difference in the mean POV (EOV) rating between male and female subjects, we established the null hypothesis and alternative hypothesis as below:

H_0: There is no significant difference in the mean POV (EOV) rating between male and female subjects when evaluating image views.

H_1: There is a significant difference in the mean POV (EOV) rating between male and female subjects when evaluating image views.

An independent samples t-test was carried out to test whether the mean POV (EOV) rating (based on 10-point scale data) was significantly different between the two groups i.e., the male and female groups, when they evaluated window views which were in the form of digital images displayed on computer screen. To control the Type I error rate in this multiple testing, Bonferroni correction was applied to the critical level of significance. Since there were 12 cases for either view quality (POV or EOV), the new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 =

0.0042. If one or more of the 12 cases for POV (EOV) had a p-value smaller than 0.0042, then the null hypothesis for POV (EOV) was to be rejected.

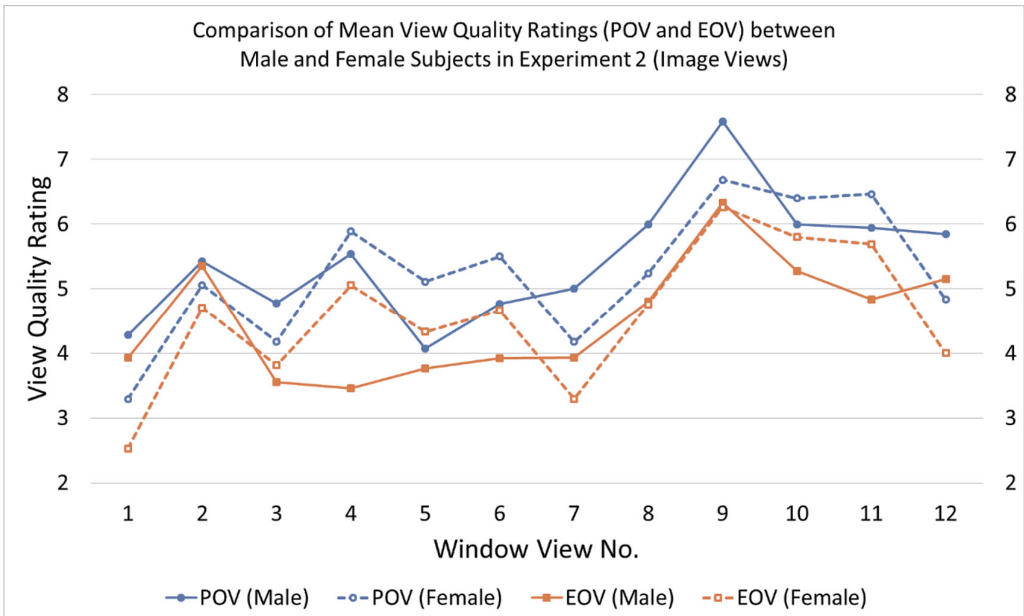


Figure 4.30: Comparison of mean view quality ratings (10-point scale) between male and female subjects in Experiment 2 (image views).

The results, which are summarised in Table 4.16, show that there was no significant difference in the mean POV (EOV) rating at the corrected level of significance (0.0042) between the male and female subjects for all 12 views when the view evaluation was based on images. Therefore, the null hypothesis was retained for POV (EOV). This suggests that generally there was a consensus between the male and female groups in the evaluation of view quality (image view). Note that for View 4 (EOV), Levene's test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made in this case.

Table 4.16: Results of independent samples t-test on the differences in view quality rating (10-point scale) between the male and female subjects in Experiment 2 (image view).

View No.	Mean difference	95% Confidence Interval of the Difference		t	df	p-value (2-tailed)	
		Lower	Upper				
View 1							
POV	0.992	-0.253	2.236	1.630	29	0.114	
EOV	1.399	0.345	2.453	2.714	29	0.011	*
View 2							
POV	0.370	-0.976	1.715	0.562	29	0.578	
EOV	0.651	-0.975	2.277	0.819	29	0.419	
View 3							
POV	0.596	-1.274	2.466	0.652	29	0.520	
EOV	-0.263	-2.112	1.587	-0.290	29	0.774	
View 4							
POV	-0.350	-1.563	0.863	-0.591	29	0.559	
EOV	-1.594	-3.048	-0.140	-2.244	28.46	0.033	*
View 5							
POV	-1.034	-2.808	0.740	-1.192	29	0.243	
EOV	-0.564	-2.314	1.186	-0.659	29	0.515	
View 6							
POV	-0.731	-1.973	0.512	-1.203	29	0.239	
EOV	-0.744	-2.002	0.515	-1.208	29	0.237	
View 7							
POV	0.824	-0.591	2.238	1.191	29	0.243	
EOV	0.634	-0.870	2.139	0.863	29	0.395	
View 8							
POV	0.762	-0.696	2.220	1.069	29	0.294	
EOV	0.038	-1.372	1.448	0.055	29	0.956	
View 9							
POV	0.899	-0.536	2.334	1.281	29	0.210	
EOV	0.070	-1.565	1.705	0.088	29	0.931	
View 10							
POV	-0.400	-1.859	1.059	-0.561	29	0.579	
EOV	-0.527	-1.963	0.908	-0.751	29	0.459	
View 11							
POV	-0.517	-2.106	1.072	-0.665	29	0.511	
EOV	-0.859	-2.431	0.713	-1.118	29	0.273	
View 12							
POV	1.013	-0.451	2.477	1.415	29	0.168	
EOV	1.154	-0.537	2.845	1.395	29	0.174	

Note: * $p < 0.05$

- None of the p-values is lower than the alpha level corrected by Bonferroni method. Alpha level: 0.05; corrected alpha level: 0.0042.
- Levene's test suggests that equality of variance cannot be assumed for View 4 (EOV).

Note that there was a significant difference in the mean EOV ratings between the two groups (male vs. female) on View 1 at the 0.05 level (likely to be a false positive) where the effect size (Cohen's *d*) was 0.68, suggesting that gender had a medium effect on the EOV rating of View 1; and 20% of the variances in this EOV rating was attributable to gender in this case. For View 1 (image view) the mean EOV rating of the male group (mean EOV: 3.93, SD = 1.77) was significantly higher than that of the female group (mean EOV: 2.53, SD = 1.07) probably because in the evaluation of view quality, the male group was generally more receptive to the negative aesthetical quality of View 1 ("view elements" score = -3) compared to the female group that was perhaps affected by the telecommunication tower in the centre of view, which was an eyesore.

There was also a significant difference in the mean EOV ratings between the two groups on View 4 at the 0.05 level (likely to be a false positive) where the effect size (Cohen's *d*) was 0.56, indicating that gender had a medium effect on the EOV rating of View 4; and 13% of the variances in this EOV rating was attributable to gender in this case. For View 4 (image view) the mean EOV rating of the male group (mean EOV: 3.46, SD = 1.51) was much lower than that of the female group (mean EOV: 5.06, SD = 2.44) probably because in the evaluation of view quality, the male group was less excited by View 4 (image view), which was dominated by natural greenery that consists of a layer of trees with dense foliage in the background blocking visual connection with the distant landscapes.

4.3.9 Comparison of view quality evaluations between two groups of subjects: "view priority" group vs. "non-view priority" group (Experiment 2)

The current survey (Experiment 2) shows 30.6% of the subjects believed that outdoor view was the primary reason for the provision of windows at workplace or home, compared to 69.4% who believed that daylight, natural ventilation or other reasons justified the existence of windows. It was therefore predicted that there was a significant difference in view quality ratings (POV or EOV rating on a 10-point scale) between the "view priority" group and the "non-view priority" group when the views were evaluated based on digital images (see Figure 4.31).

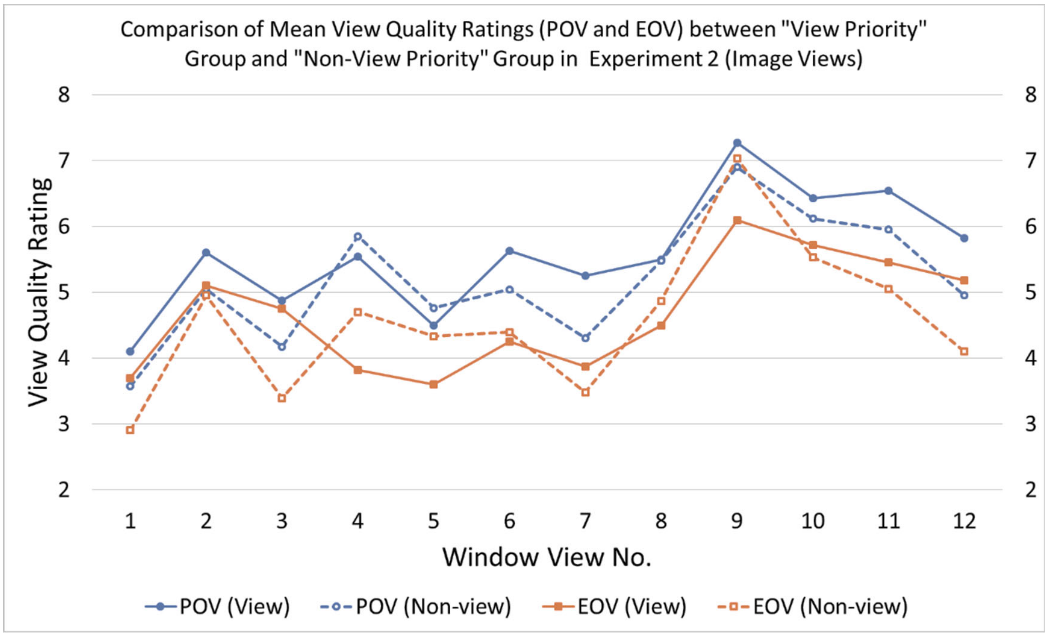


Figure 4.31: Comparison of mean view quality ratings (10-point scale) between the "view priority" group and the "non-view priority" group in Experiment 2 (image views).

In order to find out whether there was any difference between the two groups, the null hypothesis and alternative hypothesis were defined as below:

H_0: There is no significant difference in the mean POV (EOV) rating between the "view priority" group and the "non-view priority" group when evaluating image views.

H_1: There is a significant difference in the mean POV (EOV) rating between the "view priority" group and the "non-view priority" group when evaluating image views.

An independent samples t-test was carried out to test whether the mean POV (EOV) rating (based on 10-point scale data) was significantly different between the two groups i.e., “view priority” group and “non-view priority” group, when they evaluated window views which were in the form of digital images displayed on computer screen. Bonferroni correction was applied to the critical level of significance to control the Type I error rate in this multiple testing (12 cases for POV and 12 cases for EOV). The new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042. If one or more of the 12 cases in POV (EOV) had a p-value smaller than 0.0042, then the null hypothesis for POV (EOV) was to be rejected.

The results, which are summarised in Table 4.17, show that there was no significant difference in the mean POV (EOV) rating between the “view priority” group and “non-view priority” group for all 12 views. Therefore, the null hypothesis was retained for POV (EOV). This suggests that generally there was a consensus between the “view priority” group and the “non-view priority” group in the evaluation of view quality (image view). Note that in the cases of View 2 (EOV), View 3 (EOV) and View 10 (EOV), Levene’s test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made in these cases.

Table 4.17: Results of independent samples t-test on the differences in view quality rating (10-point scale) between the "view priority" group and "non-view priority" group in Experiment 2 (image view).

View No.	Mean difference	95% Confidence Interval of the Difference		t	df	p-value (2-tailed)
		Lower	Upper			
View 1						
POV	0.529	-0.841	1.898	0.790	29	0.436
EOV	0.795	-0.425	2.015	1.333	29	0.193
View 2						
POV	0.552	-0.873	1.977	0.793	29	0.434
EOV	0.148	-1.180	1.475	0.228	28.26	0.821
View 3						
POV	0.701	-1.235	2.637	0.741	29	0.465
EOV	1.359	-1.318	4.035	1.156	8.65	0.279
View 4						
POV	-0.305	-1.558	0.949	-0.497	29	0.623
EOV	-0.882	-2.580	0.816	-1.062	29	0.297
View 5						
POV	-0.262	-2.177	1.654	-0.280	29	0.782
EOV	-0.733	-2.574	1.107	-0.815	29	0.422
View 6						
POV	0.582	-0.837	2.000	0.838	29	0.409
EOV	-0.141	-1.595	1.313	-0.199	29	0.844
View 7						
POV	0.946	-0.662	2.553	1.203	29	0.239
EOV	0.397	-1.329	2.123	0.470	29	0.642
View 8						
POV	0.022	-1.566	1.610	0.028	29	0.978
EOV	-0.370	-1.870	1.131	-0.504	29	0.618
View 9						
POV	0.373	-1.122	1.868	0.510	29	0.614
EOV	-0.309	-1.970	1.352	-0.381	29	0.706
View 10						
POV	0.311	-1.095	1.717	0.452	29	0.654
EOV	0.185	-1.132	1.502	0.290	23.25	0.774
View 11						
POV	0.595	-1.040	2.231	0.744	29	0.463
EOV	0.405	-1.244	2.053	0.502	29	0.619
View 12						
POV	0.868	-0.658	2.394	1.164	29	0.254
EOV	1.082	-0.673	2.836	1.261	29	0.217

Note:
Levene's test suggests that equality of variance cannot be assumed for View 2 (EOV), View 3 (EOV) and View 10 (EOV).

4.3.10 Comparison of view quality evaluations between two groups of subjects: "greenery preference" group vs. "non-greenery preference" group (Experiment 2)

The survey in Experiment 2 shows that 38.7% of the subjects preferred to look at greenery through the window at their workplaces or homes, whilst the other 61.3 % preferred to look at other features. The researcher predicted that there was a significant difference in view quality ratings (POV or EOV on a 10-point scale) between the "greenery preference" group and the "non-greenery preference" group when view evaluation was conducted based on digital images of the scenes. Figure 4.32 shows a comparison of mean view quality ratings (10-point scale) between the "greenery preference" group and the "non-greenery preference" group in Experiment 2 (image views). To find out whether there was any difference between the two groups, the null hypothesis and alternative hypothesis were defined as below:

H_0: There is no significant difference in the mean POV (EOV) rating between the "greenery preference" group and the "non-greenery preference" group when evaluating image views.

H_1: There is a significant difference in the mean POV (EOV) rating between the "greenery preference" group and the "non-greenery preference" group when evaluating image views.

An independent samples t-test was carried out to test whether the mean POV (EOV) rating (based on 10-point scale data) was significantly different between the two groups i.e., the "greenery preference" group and the "non-greenery preference" group (image view). To control the Type I error rate in this multiple testing, Bonferroni correction was applied to the critical level of significance. The new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042. If one or more of the 12 cases in POV (EOV) had a p-value smaller than 0.0042, then the null hypothesis for POV (EOV) was to be rejected.

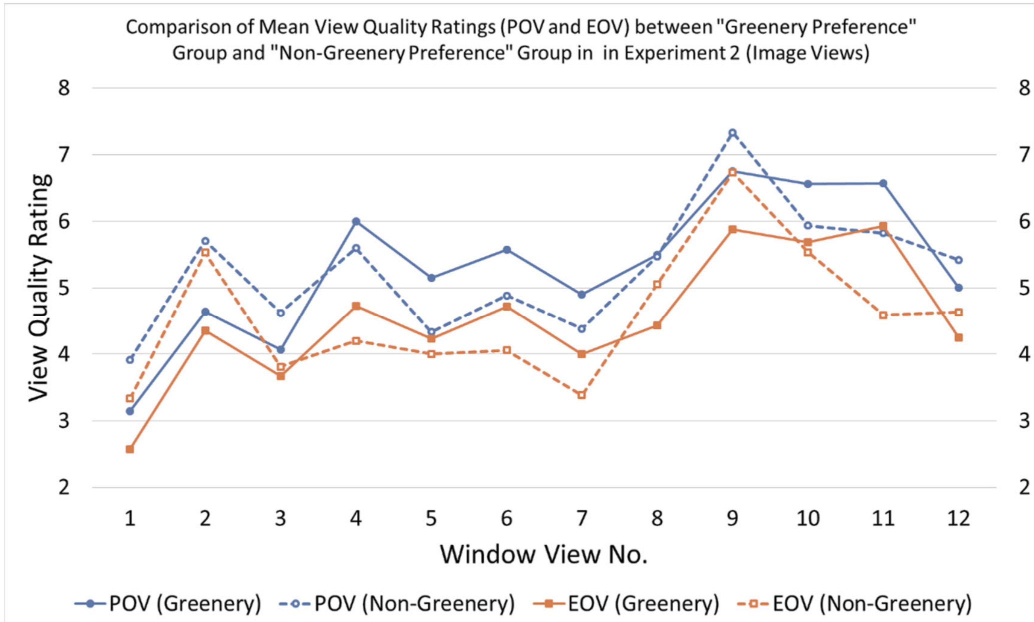


Figure 4.32: Comparison of mean view quality ratings (10-point scale) between the "greenery preference" group and the "non-greenery preference" group in Experiment 2 (image views).

The results, which are summarised in Table 4.18, show that there was no significant difference in the mean POV (EOV) rating between the "greenery preference" group and the "non-greenery preference" group for all 12 views (images). Therefore, the null hypothesis was retained for POV (EOV). This suggests that generally there was a consensus between the "greenery preference" group and the "non-greenery preference" group in the evaluation of view quality (image view). Note that in the cases of View 8 (POV), View 9 (EOV) and View 11 (POV), Levene's test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made in these cases.

Table 4.18: Results of independent samples t-test on the differences in view quality rating (10-point scale) between the "greenery preference" group and the "non-greenery preference" group in Experiment 1 (actual view).

View No.	Mean difference	95% Confidence Interval of the Difference		t	df	p-value (2-tailed)
		Lower	Upper			
View 1						
POV	-0.774	-2.293	0.745	-1.042	29	0.306
EOV	-0.762	-2.137	0.613	-1.133	29	0.266
View 2						
POV	-1.063	-2.354	0.228	-1.684	29	0.103
EOV	-1.172	-2.756	0.411	-1.514	29	0.141
View 3						
POV	-0.558	-2.256	1.139	-0.673	29	0.506
EOV	-0.146	-1.827	1.536	-0.177	29	0.860
View 4						
POV	0.400	-0.849	1.649	0.655	29	0.518
EOV	0.527	-1.192	2.246	0.627	29	0.535
View 5						
POV	0.821	-0.970	2.611	0.937	29	0.356
EOV	0.231	-1.530	1.992	0.268	29	0.791
View 6						
POV	0.689	-0.546	1.924	1.141	29	0.263
EOV	0.655	-0.599	1.910	1.068	29	0.294
View 7						
POV	0.519	-1.010	2.048	0.694	29	0.493
EOV	0.619	-0.986	2.224	0.789	29	0.437
View 8						
POV	0.029	-1.452	1.511	0.041	21.12	0.967
EOV	-0.630	-1.933	0.673	-0.989	29	0.331
View 9						
POV	-0.583	-2.004	0.837	-0.840	29	0.408
EOV	-0.858	-2.406	0.689	-1.144	24.25	0.264
View 10						
POV	0.629	-0.755	2.014	0.929	29	0.360
EOV	0.154	-1.232	1.541	0.227	29	0.822
View 11						
POV	0.748	-0.918	2.414	0.935	20.54	0.361
EOV	1.340	-0.168	2.848	1.818	29	0.079
View 12						
POV	-0.421	-1.946	1.104	-0.565	29	0.577
EOV	-0.382	-2.146	1.382	-0.442	29	0.661

Note:
Levene's test suggests that equality of variance cannot be assumed for View 8 (POV), View 9 (EOV) and View 11 (POV).

4.4 Summary

The main outcomes of this chapter can be summarised as follows:

1. The view quality ratings based on 10-point scale in Experiment 1 (actual view) and Experiment 2 (image view) generally follow a normal distribution. Therefore, parametric methods can be applied on the 10-point scale data. In contrast, the ratings based on 4-point scale in the same experiments have a serious departure from normality, hence nonparametric methods of analysis are more suitable for the 4-point scale data. In the analyses of associations between view quality rating and view attributes (see Chapter 7), Pearson's correlation (parametric analysis) and Spearman's correlation (nonparametric analysis) are used to analyse 10-point and 4-point scale data respectively.

2. Results of correlation analyses and hypotheses testing in this chapter are summarised as follows:

    - On the correlation between POV and EOV ratings, the results show a positive linear relationship that is extremely strong between the mean POV and mean EOV ratings across the 12 views in both Experiment 1 (actual view) and Experiment 2 (image view). Paired samples t-test shows that there is a significant difference between mean POV rating and mean EOV rating in the evaluation of window view quality – either in actual or image viewing mode. This finding suggests that the subjects were able to differentiate POV from EOV in the evaluation of view quality.

    - When comparing view quality evaluations between the genders, independent samples t-test shows that there is no significant difference in the mean POV (EOV) rating between the male and female subjects across all 12 views in both Experiment 1 (actual view) and Experiment 2 (image view).

- When comparing view quality evaluations between the "view priority" group and "non-view priority" group, independent samples t-test shows that there is no significant difference in the mean POV (EOV) rating between these two groups across all 12 views in both Experiment 1 (actual view) and Experiment 2 (image view).

- When comparing view quality evaluations between the "greenery preference" group and the "non-greenery preference" group, independent samples t-test shows that there is a significant difference in the mean POV rating between the "greenery preference" group and the "non-greenery preference" group in Experiment 1 (actual view). However, no significant difference is found in the mean EOV rating between these two groups in the same experiment. In Experiment 2 (image view), there is no significant difference observed in the mean POV (EOV) rating between the two groups.

3. Table 4.19 presents a summary of the view quality evaluations of the 12 selected window views and the seven proposed view attributes – i.e., proportion of greenery (PG), number of visual layers (VL), view elements (VE), balance of view (BV), diversity of view (DV), openness of view (OV) and depth of view (DP).

Table 4.19: Window view quality (POV and EOV) evaluations in Experiment 1 (actual view) and Experiment 2 (image view).

View No.	Window View	View Attributes	Evaluation of Actual View (10-point scale)	Evaluation of Image View (10-point scale)
1		PG = 6% VL = 4 VE = -3 BV = 0.87 DV = 10 OV = 48% DP = 5.0 km	POV: M = 4.03 , SD = 2.24 (Median = 4) EOV: M = 4.00 , SD = 2.18 (Median = 4) Priority of view had a large effect on this EOV rating. This was the only actual view in which the difference between mean POV and EOV ratings was nonsignificant.	POV: M = 3.74 , SD = 1.73 (Median = 4) EOV: M = 3.16 , SD = 1.57 (Median = 3) Lowest median and mean POV and EOV among the 12 views. Gender had a medium effect on this EOV rating.
2		PG = 21% VL = 4 VE = 1 BV = 0.86 DV = 10 OV = 60% DP = 8.0 km	POV: M = 6.26 , SD = 1.63 (Median = 6) EOV: M = 5.58 , SD = 1.84 (Median = 6) Priority of view had a large effect on this POV rating.	POV: M = 5.23 , SD = 1.80 (Median = 5) EOV: M = 5.00 , SD = 2.19 (Median = 5) This was the only image view in which the difference between mean POV and EOV ratings was nonsignificant.
3		PG = 0% VL = 3 VE = 1 BV = 0.99 DV = 7 OV = 12% DP = 0.1 km	POV: M = 3.81 , SD = 2.26 (Median = 3) EOV: M = 3.26 , SD = 2.07 (Median = 3) Lowest median and mean POV and EOV among 12 views.	POV: M = 4.35 , SD = 2.29 (Median = 4) EOV: M = 3.74 , SD = 2.25 (Median = 4) Lowest median POV among 12 views.

Table 4.19 (Continued)

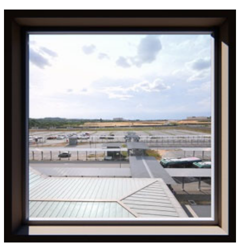
View No.	Window View	View Attributes	Evaluation of Actual View (10-point scale)	Evaluation of Image View (10-point scale)
4		PG = 62% VL = 3 VE = 2 BV = 0.92 DV = 3 OV = 58% DP = 0.2 km	POV: M = 6.35 , SD = 1.82 (Median = 7) EOV: M = 5.06 , SD = 1.95 (Median = 5) Smallest IQR among 12 views in EOV ratings indicating relatively small variability in the data. Most popular choice (32.3%) for "home only."	POV: M = 5.74 , SD = 1.61 (Median = 6) EOV: M = 4.39 , SD = 2.22 (Median = 4)
5		PG = 8% VL = 4 VE = -2 BV = 0.97 DV = 7 OV = 56% DP = 3.3 km	POV: M = 4.00 , SD = 2.19 (Median = 4) EOV: M = 3.52 , SD = 2.14 (Median = 4)	POV: M = 4.68 , SD = 2.40 (Median = 5) EOV: M = 4.10 , SD = 2.33 (Median = 4) Largest IQR among 12 views in POV and EOV ratings, indicating relatively large variability in the data.
6		PG = 2% VL = 4 VE = -1 BV = 0.94 DV = 8 OV = 62% DP = 10.7 km	POV: M = 4.94 , SD = 2.73 (Median = 6) EOV: M = 4.32 , SD = 2.90 (Median = 4) Largest IQR among 12 views in POV and EOV ratings, indicating relatively large variability in the data.	POV: M = 5.19 , SD = 1.68 (Median = 5) EOV: M = 4.35 , SD = 1.70 (Median = 4) Smallest IQR among 12 views in EOV ratings indicating relatively small variability in the data.

Table 4.19 (Continued)

View No.	Window View	View Attributes	Evaluation of Actual View (10-point scale)	Evaluation of Image View (10-point scale)
7		PG = 64% VL = 4 VE = 0 BV = 0.89 DV = 7 OV = 26% DP = 3.0 km	POV: M = 5.35 , SD = 2.39 (Median = 6) EOV: M = 4.77 , SD = 2.46 (Median = 5)	POV: M = 4.55 , SD = 1.93 (Median = 5) EOV: M = 3.58 , SD = 2.03 (Median = 3) Lowest median EOV. Most popular choice (40.3%) for "home only."
8		PG = 0% VL = 3 VE = -2 BV = 0.77 DV = 6 OV = 40% DP = 3.0 km	POV: M = 5.61 , SD = 2.29 (Median = 6) EOV: M = 4.94 , SD = 2.56 (Median = 5) Preference of greenery had a large effect on this POV rating.	POV: M = 5.48 , SD = 1.86 (Median = 5) EOV: M = 4.77 , SD = 1.77 (Median = 5)
9		PG = 11% VL = 4 VE = 3 BV = 0.93 DV = 8 OV = 65% DP = 2.0 km	POV: M = 7.19 , SD = 2.44 (Median = 8) EOV: M = 6.42 , SD = 2.68 (Median = 7) Highest median and mean POV and EOV among 12 views. Most popular choice (71.0%) for "home and workplace."	POV: M = 7.03 , SD = 1.92 (Median = 7) EOV: M = 6.29 , SD = 2.13 (Median = 7) Highest median and mean POV and EOV among 12 views. Most popular choice (64.5%) for "home and workplace."

Table 4.19 (Continued)

View No.	Window View	View Attributes	Evaluation of Actual View (10-point scale)	Evaluation of Image View (10-point scale)
10		PG = 4% VL = 3 VE = 1 BV = 0.77 DV = 6 OV = 20% DP = 3.0 km	POV: M = 6.29 , SD = 2.66 (Median = 7) EOV: M = 5.87 , SD = 2.53 (Median = 6)	POV: M = 6.26 , SD = 1.88 (Median = 6) EOV: M = 5.61 , SD = 1.86 (Median = 5)
11		PG = 5% VL = 4 VE = 2 BV = 0.70 DV = 6 OV = 47% DP = 2.4 km	POV: M = 6.97 , SD = 2.27 (Median = 8) EOV: M = 6.45 , SD = 2.42 (Median = 7) Highest median POV and EOV among 12 views.	POV: M = 6.16 , SD = 2.12 (Median = 6) EOV: M = 5.19 , SD = 2.12 (Median = 5)
12		PG = 6% VL = 4 VE = -1 BV = 0.80 DV = 8 OV = 38% DP = 2.2 km	POV: M = 4.74 , SD = 2.24 (Median = 5) EOV: M = 4.32 , SD = 2.21 (Median = 4) Most popular choice (72.6%) for “workplace only.“	POV: M = 5.26 , SD = 2.00 (Median = 5) EOV: M = 4.48 , SD = 2.31 (Median = 4) Most popular choice (69.4%) for “workplace only.“

CHAPTER 5

Comparison of Two Different Rating Scale Formats

5.1 Introduction

This chapter focuses on the comparison of two different response formats of rating scales – i.e., 4-point and 10-point scales that were used in both Experiment 1 (actual view) and Experiment 2 (image view). For the purpose of comparing the means and variances of subjects' ratings on the "pleasantness of view" (POV) and "excitingness of view" (EOV) of each of the 12 window views between these two different scale formats, the primary scales – i.e., 4-point and 10-point scales were rescaled to a common 101-point format. This chapter also compares the reliability and validity of the rating scale between these two formats, and discusses the optimum number of response categories that is suitable for evaluating window view quality.

From the analyses of variances, reliability and validity, this chapter attempts to answer the following questions:

1. Is there a significant difference in the evaluation of window view quality when using scale format of either 4-point or 10-point?

2. Between 4-point and 10-point scales, which one is better for the purpose of evaluating window view quality?

Note that the 101-point common scale is only used in this chapter for the purpose of comparing the properties of the two different scale formats – i.e., 4-point and 10-point scales.

5.2 Rescaling

In order to examine the various data characteristics of interest, the rating scores of the two primary scale formats were rescaled so that they were comparable, each with the same lower limit and upper limit. The purpose of the rescaling was to facilitate comparison between the scale formats instead of finding a specific functional transformation that would minimise any rescaled differences (Dawes 2008). In the present study, 4-point and 10-point primary scales were rescaled to a common 101-point scale with 0 as the lower limit and 100 as the upper limit.

The transformation of these two rating scales (i.e., 4-point and 10-point scales) to a set of common scale values can be considered a two-step process. The first step is to convert the interval-level measurement to ratio-level measurement. Since both rating scales start with "1", the conversion is a left shift by reducing one point from each of the primary scale points in order to start from "0". The second step is to stretch this converted scale into a common scale (100) by multiplying the converted scale point with a factor 100 / (j – 1) where j is the number of scale points in the rating scale. In the case of a 4-point primary scale, 1 → 0 and 4 → 100, which is a shift [1, 4] → [0, 3], followed by a stretching [0, 3] → [0, 100]. In the case of a 10-point primary scale, 1 → 0 and 10 → 100, which is a shift [1, 10] → [0, 9], followed by a stretching [0, 9] → [0, 100] (see Table 5.1).

This rescaling method can be applied in a single step by using the following formula (Preston and Colman 2000):

$$\text{Common scale value} = \frac{(\text{Rating} - 1)}{(\text{Number of scale points} - 1)} \times 100$$

Table 5.1: Values of the 4-point and 10-point scale formats that are rescaled to a common 101-point scale.

4-point scale		10-point scale	
Original value (Category)	Rescaled value (0 - 100 point)	Original value (Category)	Rescaled value (0 - 100 point)
1	0.00	1	0.00
		2	11.11
		3	22.22
2	33.33	4	33.33
		5	44.44
		6	55.56
3	66.67	7	66.67
		8	77.78
		9	88.89
4	100.00	10	100.00

A 101-point scale was adopted as the common scale format in this study because it was comparable to a typical performance assessment based on percentage (i.e., 0% being the lower limit, and 100% being the upper limit), thus easier to interpret the measurement.

5.3 Comparison of view quality ratings based on a common 101-point scale: Experiment 1 (actual view)

There was a total of 62 subjects in Experiment 1. For each of the 12 window views, 62 sets of survey questionnaires that comprised 31 sets 4-point format and 31 sets 10-point format were shuffled and randomly given to each subject to evaluate the view on site. Therefore, for each of the 12 window views, POV and EOV ratings were collected from two groups of subjects – i.e., Group 1 (31 persons) who used a 4-point scale format, and Group 2 (31 persons) who used a 10-point scale format. To reduce bias, the 4-point and 10-point scale questionnaires were shuffled for the evaluation: every subject was randomly given either a 4-point or 10-point scale survey questionnaire for each of the 12 views (for each view, there is a total 62 sets of questionnaires – i.e., 31 sets each with 4-point and 10-point scale).

5.3.1 Comparing mean rating scores (actual view)

In order to find out whether the mean ratings of POV (or EOV) were significantly different between the two different scale formats after rescaling, the null and alternative hypotheses were defined as the following:

H_0: There is no significant difference in the mean POV (EOV) value between the rescaled 4-point and rescaled 10-point ratings.

H_1: There is a significant difference in the mean POV (EOV) value between the rescaled 4-point and rescaled 10-point ratings.

To test the hypothesis, we compared the mean POV (EOV) ratings of the 12 window views based on the rescaled values in a 101-point format between two independent groups of subjects – i.e., 31 subjects who used the 4-point scale format and another 31 subjects who used the 10-point scale format in Experiment 1 (actual view). An independent samples t-test was performed using SPSS on each of the 12 views with the null hypothesis that there was no significant difference in the mean POV (EOV) between the rescaled 4-point and 10-point ratings. To control the Type I error rate in this multiple testing, Bonferroni correction was applied to the critical level of significance. Since there were 12 cases for either view quality (POV or EOV), the new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042.

Results of the analysis are summarised in Table 5.2 (difference in mean scores). The results indicate that the difference in mean POV (EOV) between the rescaled 4-point and 10-point ratings was nonsignificant at the corrected alpha level (0.0042). Therefore, the null hypothesis was retained. It can be concluded that there is no significant difference in the mean POV (EOV) values between the rescaled 4-point and 10-point ratings. In other words, evaluation of window view quality using either 4-point or 10-point scale is likely to yield the same results when the rating data are converted to common scale values.

Table 5.2: Comparison of mean rating scores between 4-point and 10-point formats based on a common scale (101-point) in Experiment 1 (actual view).

Item	Mean Score: 4-point rescaled 101-point (1)	Mean Score: 10-point rescaled 101-point (2)	Difference in mean scores: (1) - (2)	Independent Samples t-Test (t)	df	p-value	
View 1							
POV	25.81	33.69	-7.89	-1.111	60	0.271	
EOV	26.88	33.33	-6.45	-1.003	60	0.320	
View 2							
POV	55.91	58.42	-2.51	-0.396	49.06	0.694	
EOV	49.46	50.90	-1.43	-0.222	53.26	0.825	
View 3							
POV	30.11	31.18	-1.07	-0.149	60	0.882	
EOV	24.73	25.09	-0.36	-0.050	54.25	0.960	
View 4							
POV	62.37	59.50	2.87	0.510	60	0.612	
EOV	44.08	45.16	-1.08	-0.182	60	0.857	
View 5							
POV	36.56	33.33	3.23	0.463	60	0.645	
EOV	32.26	27.96	4.30	0.591	60	0.556	
View 6							
POV	38.71	43.73	-5.02	-0.597	60	0.552	
EOV	34.41	36.92	-2.51	-0.294	60	0.770	
View 7							
POV	46.24	48.39	-2.15	-0.296	60	0.769	
EOV	32.26	41.94	-9.68	-1.494	60	0.140	
View 8							
POV	47.31	51.25	-3.94	-0.550	60	0.584	
EOV	38.71	43.73	-5.02	-0.663	60	0.510	
View 9							
POV	74.20	68.82	5.38	0.879	60	0.383	
EOV	65.59	60.22	5.38	0.810	55.12	0.422	
View 10							
POV	48.39	58.78	-10.39	-1.279	60	0.206	
EOV	36.56	54.12	-17.56	-2.423	60	0.018	*
View 11							
POV	66.67	66.31	0.36	0.061	60	0.952	
EOV	62.37	60.57	1.79	0.270	60	0.788	
View 12							
POV	47.31	41.58	5.73	0.924	60	0.359	
EOV	39.78	36.92	2.87	0.430	60	0.668	

Note: * $p < 0.05$
- None of the p-values is lower than the alpha level corrected by Bonferroni method.
Alpha level: 0.05; corrected alpha level: 0.0042

- Levene's test suggests that equality of variances cannot be assumed for View 2 (POV and EOV), View 3 (EOV) and View 9 (EOV).

In all 12 cases of POV (EOV), the difference in the mean POV (EOV) rating between the rescaled 4-point and 10-point ratings was nonsignificant probably because of the small sample size (i.e., 31 per group), and it has been demonstrated in Chapter 3 that, with this sample size, cases with effect size (Cohen's *d*) smaller than 0.72 may not be significant in this independent samples t-test. Note that View 10 (EOV) has the largest difference in mean scores among all the cases [t(60) = -2.423, p = 0.018]; the effect size (Cohen's *d*) was 0.44, suggesting that scale format had a small effect on the EOV rating of View 10; and 8.9% of the variance in this EOV rating was attributable to the scale format.

5.3.2 Comparing variances in rating scores (actual view)

Variance is usually measured using standard deviation (variance is the square of standard deviation). If the view quality ratings are not dependent on the response formats of rating scale, then once the scores are rescaled to a 101-point common scale, the standard deviations of the rescaled 4-point and the rescaled 10-point ratings should not have any significant difference.

Standard deviations of the rescaled POV and EOV scores are tabulated in Table 5.3. Results of Levene's test (at the 0.05 level of significance) indicated that the two groups of data (rescaled 4-point and rescaled 10-point ratings) that were compared had equal population variances except in the following views:

1. For View 2 (POV), the rescaled 4-point ratings had significantly higher variance as compared to the rescaled 10-point ratings [F(1,60) = 9.478, p = 0.003].

2. For View 2 (EOV), the rescaled 4-point ratings had significantly higher variance as compared to the rescaled 10-point ratings [F(1,60) = 6.755, p = 0.012].

Table 5.3: Comparison of standard deviations (SD) of rating scores between 4-point and 10-point formats based on a common scale (101-point) in Experiment 1 (actual view).

Item	SD: 4-point rescaled 101-point (1)	SD: 10-point rescaled 101-point (2)	Difference in SD: (1) - (2)	Levene statistic for homogeneity of variance test: F (1, 60)	p-value	
View 1						
POV	30.68	24.93	5.76	1.962	0.166	
EOV	26.42	24.18	2.24	0.556	0.459	
View 2						
POV	30.29	18.14	12.15	9.478	0.003	**
EOV	29.65	20.44	9.21	6.755	0.012	*
View 3						
POV	31.45	25.08	6.37	3.638	0.061	
EOV	32.17	22.95	9.22	8.934	0.004	**
View 4						
POV	23.95	20.20	3.75	0.052	0.820	
EOV	24.93	21.65	3.28	0.405	0.527	
View 5						
POV	30.25	24.34	5.91	0.558	0.458	
EOV	32.76	23.81	8.95	2.901	0.094	
View 6						
POV	35.59	30.35	5.23	1.058	0.308	
EOV	34.94	32.25	2.69	0.003	0.958	
View 7						
POV	30.65	26.54	4.11	1.278	0.263	
EOV	23.55	27.33	-3.78	2.841	0.097	
View 8						
POV	30.76	25.45	5.31	1.503	0.225	
EOV	31.15	28.39	2.76	0.746	0.391	
View 9						
POV	20.57	27.13	-6.56	2.402	0.126	
EOV	21.92	29.78	-7.87	4.957	0.030	*
View 10						
POV	34.25	29.57	4.69	1.601	0.211	
EOV	29.00	28.07	0.93	0.055	0.816	
View 11						
POV	21.08	25.25	-4.17	3.773	0.057	
EOV	25.45	26.89	-1.44	0.584	0.448	
View 12						
POV	24.00	24.84	-0.84	0.012	0.913	
EOV	27.78	24.58	3.20	0.039	0.845	

Note: * $p < 0.05$, ** $p < 0.01$

3. For View 3 (EOV), the rescaled 4-point ratings had significantly higher variance as compared to the rescaled 10-point ratings [$F(1,60) = 8.934$, $p = 0.004$].

4. For View 9 (EOV), the rescaled 4-point ratings had significantly lower variance as compared to the rescaled 10-point ratings [$F(1,60) = 4.957$, $p = 0.030$].

Note that in the four cases listed above – i.e., View 2 (POV and EOV), View 3 (EOV) and View 9 (EOV), Levene's test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made in each of these four cases when independent samples t-test was conducted to compare the mean POV (EOV) ratings between the rescaled 4-point and 10-point formats.

Because the differences in mean rating scores between the rescaled 4-point and 10-point ratings on POV or EOV are nonsignificant at the corrected alpha level (0.0042), it can be concluded that in the evaluation of window view quality (actual view) the results are consistent between 4-point and 10-point rating scales. Contrary to our initial prediction, the results suggest that using either a 4-point or 10-point scale to evaluate window view quality (based on actual views) makes no difference in the mean rating scores.

5.4 Comparison of view quality ratings based on a common 101-point scale: Experiment 2 (image view)

There was a total of 62 subjects who participated in Experiment 2 (image view). High-resolution digital photographs of the same 12 window views used in Experiment 1 (actual view) were shown to each subject one-by-one in Experiment 2 using a computer screen. As in Experiment 1: for each of the 12 window views (displayed on computer screen), 62 sets of survey questionnaires that comprised 31 sets 4-point format and 31 sets 10-point format were randomly given to each subject to evaluate the views (images). Therefore, for each of the 12 window views, POV and EOV ratings were collected from two groups of subjects – i.e., Group 1 (31 persons) who used a 4-point response format, and Group 2 (31 persons) who used a 10-point response format. To reduce bias, the 4-point and 10-point scale questionnaires were shuffled: every subject was randomly given either a 4-point or 10-point scale survey questionnaire for each of the 12 views.

5.4.1 Comparing mean rating scores (image view)

In order to find out whether the mean ratings of POV (EOV) were significantly different between the two different scale formats after rescaling, the null and alternative hypotheses were defined as the following:

H_0: There is no significant difference in the mean POV (EOV) value between the rescaled 4-point and rescaled 10-point ratings based on image viewing.

H_1: There is a significant difference in the mean POV (EOV) value between the rescaled 4-point and rescaled 10-point ratings based on image viewing.

To test the hypothesis, we compared the mean POV (EOV) ratings of the 12 window views (images) based on the rescaled values in a 101-point format between two independent groups of subjects – i.e., 31 subjects who used the 4-point scale format and another 31 subjects who used the 10-point scale format in Experiment 2 (image view). An independent samples t-test was performed using SPSS on each of the 12 views with the null hypothesis that there was no significant difference in the mean POV (EOV) value between the rescaled 4-point and 10-point ratings based on image viewing. To control the Type I error rate in this multiple testing, Bonferroni correction was applied to the critical level of significance. Since there were 12 cases for either view quality (POV or EOV), the new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042.

Results of the analysis are summarised in Table 5.4 (difference in mean scores). The results indicate that the difference in mean POV (EOV) between the rescaled 4-point and 10-point ratings based on image viewing was nonsignificant at the corrected alpha level (0.0042). Therefore, the null hypothesis was retained. It can be concluded that, when pictorial views instead of real views are evaluated, there is no significant difference in the mean POV (EOV) value between the rescaled 4-point and 10-point ratings. In other words, evaluation of window view quality using either 4-point or 10-point scale is likely to yield the same results if the ratings are converted to common scale values – even when the evaluation is based on image viewing.

In all 12 cases of POV (EOV), the difference in the mean POV (EOV) rating between the rescaled 4-point and 10-point ratings based on image viewing was nonsignificant probably because of the small sample size (i.e., 31 per group), and it has been demonstrated in Chapter 3 that, with this sample size, cases with effect size (Cohen's *d*) smaller than 0.72 may not be significant in this independent samples t-test. Note that View 7 (POV) has the largest difference in mean scores among all cases [$t(60) = 2.082$, $p = 0.042$]; the effect size (Cohen's *d*) was 0.37, suggesting that scale format had a small effect on the POV rating of View 7 (image view); and 6.7% of the variance in this POV rating was attributable to the scale format.

Table 5.4: Comparison of mean rating scores between 4-point and 10-point formats based on a common scale (101-point) in Experiment 2 (image view).

Item	Mean Score: 4-point rescaled 101-point (1)	Mean Score: 10-point rescaled 101-point (2)	Difference in mean scores: (1) - (2)	Independent Samples t-Test (t)	df	p-value	
View 1							
POV	29.03	30.46	-1.43	-0.250	60	0.803	
EOV	26.88	24.01	2.87	0.487	50.52	0.629	
View 2							
POV	45.16	46.95	-1.79	-0.300	60	0.765	
EOV	41.93	44.44	-2.51	-0.406	60	0.686	
View 3							
POV	34.41	37.28	-2.87	-0.435	60	0.665	
EOV	25.81	30.46	-4.66	-0.655	60	0.515	
View 4							
POV	54.84	52.69	2.15	0.374	52.57	0.710	
EOV	34.41	37.63	-3.23	-0.511	60	0.611	
View 5							
POV	40.86	40.86	0.00	0.000	60	1.000	
EOV	25.81	34.41	-8.60	-1.285	60	0.204	
View 6							
POV	49.46	46.59	2.87	0.470	51.90	0.640	
EOV	34.41	37.27	-2.87	-0.445	50.22	0.658	
View 7							
POV	52.69	39.43	13.26	2.082	60	0.042	*
EOV	34.41	28.67	5.73	0.843	60	0.402	
View 8							
POV	48.39	49.82	-1.43	-0.228	54.87	0.821	
EOV	41.94	41.93	0.00	0.000	50.70	1.000	
View 9							
POV	67.74	67.03	0.72	0.130	60	0.897	
EOV	56.99	58.78	-1.79	-0.268	60	0.790	
View 10							
POV	55.91	58.42	-2.51	-0.463	60	0.645	
EOV	40.86	51.25	-10.40	-1.769	60	0.082	
View 11							
POV	61.29	57.35	3.94	0.609	60	0.545	
EOV	50.54	46.60	3.94	0.552	55.09	0.583	
View 12							
POV	47.31	47.31	0.00	0.000	60	1.000	
EOV	31.18	38.71	-7.53	-1.225	60	0.225	

Note: * $p < 0.05$
- None of the p-values is lower than the alpha level corrected by Bonferroni method.
Alpha level: 0.05; corrected alpha level: 0.0042

- Levene's test suggests that equality of variances cannot be assumed for View 1 (EOV), View 4 (POV), View 6 (POV and EOV), View 8 (POV and EOV) and View 11 (EOV).

5.4.2 Comparing variances in rating scores (image view)

Standard deviations of the rescaled POV and EOV scores (based on image viewing) are tabulated in Table 5.5. Results of Levene's test (at the 0.05 level of significance) indicated that the two groups of data (rescaled 4-point and rescaled 10-point ratings) that were compared had equal population variances except in the following views:

1. For View 1 (EOV), the rescaled 4-point ratings produced significantly higher variances as compared to the rescaled 10-point ratings [$F(1,60) = 6.810$, $p = 0.011$].

2. For View 4 (POV), the rescaled 4-point ratings produced significantly higher variances as compared to the rescaled 10-point ratings [$F(1,60) = 4.880$, $p = 0.031$].

3. For View 6 (POV), the rescaled 4-point ratings produced significantly higher variances as compared to the rescaled 10-point ratings [$F(1,60) = 7.926$, $p = 0.007$]

4. For View 6 (EOV), the rescaled 4-point ratings produced significantly higher variances as compared to the rescaled 10-point ratings [$F(1,60) = 4.271$, $p = 0.043$].

5. For View 8 (POV), the rescaled 4-point ratings produced significantly higher variances as compared to the rescaled 10-point ratings [$F(1,60) = 5.101$, $p = 0.028$].

6. For View 8 (EOV), the rescaled 4-point ratings produced significantly higher variances as compared to the rescaled 10-point ratings [$F(1,60) = 7.755$, $p = 0.007$].

7. For View 11 (EOV), the rescaled 4-point ratings produced significantly higher variances as compared to the rescaled 10-point ratings [$F(1,60) = 5.268$, $p = 0.025$].

Table 5.5: Comparison of standard deviations (SD) of rating scores between 4-point and 10-point formats based on a common scale (101-point) in Experiment 2 (image view).

Item	SD: 4-point rescaled 101-point (1)	SD: 10-point rescaled 101-point (2)	Difference in SD: (1) - (2)	Levene statistic for homogeneity of variance test: F (1, 60)	p-value	
View 1						
POV	25.45	19.24	6.21	0.386	0.537	
EOV	27.78	17.47	10.31	6.810	0.011	*
View 2						
POV	26.60	20.02	6.57	2.571	0.114	
EOV	24.30	24.34	-0.05	0.009	0.923	
View 3						
POV	26.51	25.43	1.08	0.000	1.000	
EOV	30.68	25.01	5.68	1.428	0.237	
View 4						
POV	26.60	17.91	8.69	4.880	0.031	*
EOV	25.07	24.63	0.44	0.472	0.495	
View 5						
POV	23.90	26.67	-2.77	0.967	0.329	
EOV	26.82	25.88	0.94	0.011	0.917	
View 6						
POV	28.38	18.69	9.69	7.926	0.007	**
EOV	30.41	18.93	11.48	4.271	0.043	*
View 7						
POV	28.25	21.44	6.81	3.531	0.065	
EOV	30.41	22.55	7.86	0.762	0.386	
View 8						
POV	28.34	20.66	7.67	5.101	0.028	*
EOV	30.99	19.61	11.39	7.755	0.007	**
View 9						
POV	21.92	21.37	0.55	0.703	0.405	
EOV	28.80	23.69	5.10	1.030	0.314	
View 10						
POV	21.75	20.88	0.87	0.591	0.445	
EOV	25.40	20.63	4.78	0.652	0.423	
View 11						
POV	27.35	23.50	3.85	0.866	0.356	
EOV	32.06	23.56	8.50	5.268	0.025	*
View 12						
POV	25.50	22.22	3.28	1.092	0.300	
EOV	22.67	25.64	-2.97	2.728	0.104	

Note: * $p < 0.05$, ** $p < 0.01$

Note that in the seven cases listed above – i.e., View 1 (EOV), View 4 (POV), View 6 (POV and EOV), View 8 (POV and EOV) and View 11 (EOV), Levene's test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made in each of these seven cases when independent samples t-test was conducted to compare the mean POV (EOV) ratings between the rescaled 4-point and 10-point formats (image viewing).

Because the differences in mean rating scores between the rescaled 4-point and 10-point ratings on POV or EOV are nonsignificant at the corrected alpha level (0.0042), it can be concluded that in the evaluation of window view quality (image view) the results are consistent between 4-point and 10-point rating scales. Contrary to our initial prediction, the results suggest that using either a 4-point or 10-point scale to evaluate window view quality (based on image views) makes no difference in the mean rating scores.

5.5 Reliability of rating scale

Reliability analysis of a rating scale is carried out by obtaining the proportion of systematic variation in the scale, which can be done by determining the association between the scores obtained from different administrations of the scale. Thus, if the association in reliability analysis is high, the scale yields consistent results, and it is considered reliable.

There were two types of reliability analysis in this study:

(i) Internal consistency – measured with Cronbach's alpha. It is a measure of how well the items comprising a rating scale (i.e., POV and EOV) measure the same construct (window view quality) consistently. Alpha value above 0.7 is considered acceptable consistency; above 0.8 is considered good consistency; above 0.9 is excellent consistency; whereas alpha between 0.6

and 0.7 is considered questionable consistency; between 0.5 and 0.6 is considered poor consistency; value below 0.5 is deemed unacceptable (George and Mallery 2003).

(ii) Interrater reliability – measured with Intraclass Correlation Coefficient (ICC). It is the degree of agreement among raters (subjects) indicating how much homogeneity or consensus exists in the ratings given by various raters. Values less than 0.5 are indicative of poor reliability, values between 0.5 and 0.75 indicate moderate reliability; values between 0.75 and 0.9 indicate good reliability; and values greater than 0.90 indicate excellent reliability (Koo and Li 2016).

In this chapter, Exploratory Factor Analysis (EFA) was also conducted to confirm that the two scale items (POV and EOV) were unidimensional, which was an important assumption in reliability analysis that must not be violated.

Difference between the internal consistencies of the two different scale formats (4-point vs 10-point) in each view was determined by using the method developed by Feldt and Kim (2006), in which a test statistic, W, was adopted for comparison with the critical F-value.

5.6 Reliability analysis: Experiment 1 (actual view)

In the following, we compare the internal consistency and interrater reliability between the 4-point and 10-point scales used in Experiment 1 (actual view).

5.6.1 Internal consistency (actual view)

Analysis on internal consistency of the rating scales was performed in SPSS Statistics programme. Figure 5.1 presents the results of analysis on internal consistency.

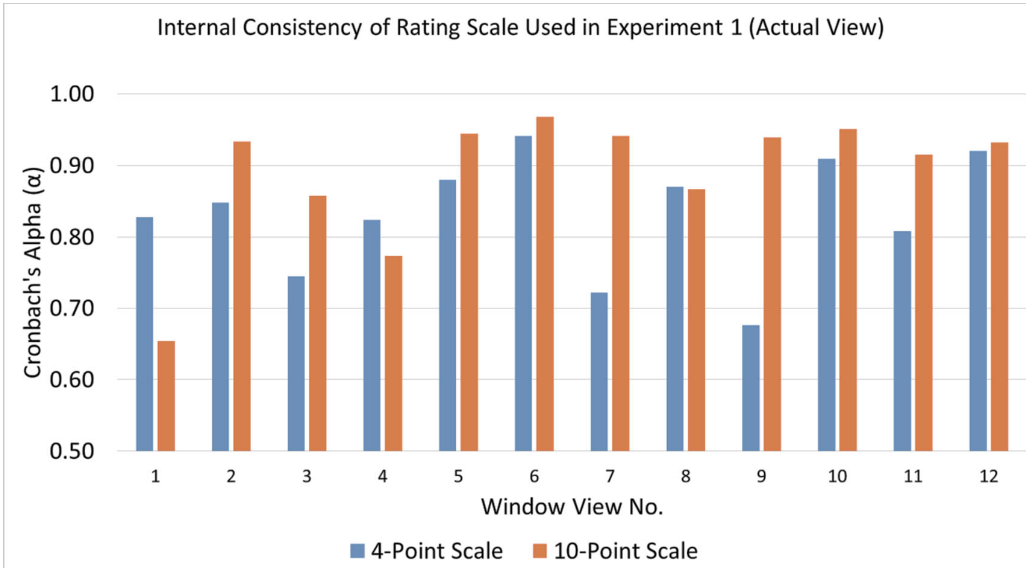


Figure 5.1: A comparison of internal consistency of the two scale items (POV and EOV) between two different scale formats (4-point scale vs. 10-point scale) in Experiment 1 (actual view).

The results showed that both 4-point and 10-point rating scales demonstrated acceptable to high levels of internal consistency (Cronbach's alpha value larger than 0.70) in all views except in View 1 (10-point scale) and View 9 (4-point scale), which had questionable levels of internal consistency. The results suggest that generally 10-point scale ratings of POV and EOV had relatively higher internal consistencies compared to that of 4-point scale, except for Views 1, 4 and 8 (see Appendix F1).

To find out whether there was any significant difference in the internal consistencies between two rating scales formats, the null and alternative hypotheses were defined as the following:

H_0: There is no significant difference in the internal consistencies between 4-point scale and 10-point scale.

H_1: There is a significant difference in the internal consistencies between 4-point scale and 10-point scale.

The null hypothesis above was tested using the method proposed by Feldt and Kim (2006), in which the test statistic, $W = \frac{1-\alpha_2}{1-\alpha_1}$ where α_1 and α_2 are the Cronbach's alpha coefficients of the two studies (4-point vs 10-point scales), and α_1 being the higher value among the two. To control the Type I error rate in this multiple testing, Bonferroni correction was applied to the critical level of significance. Since there were 12 cases for either scale format (4-point or 10-point scale), the new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042. If W is larger than F at the corrected alpha level (0.0042) in one or more of the 12 cases, then we can reject the null hypothesis and conclude that there is a significant difference in the Cronbach alpha coefficients between 4-point and 10-point scale formats. If W is not larger than F in all 12 cases, then the null hypotheses is retained.

The test results showed that there were significant differences in the internal consistencies between 4-point and 10-point scale formats at the corrected alpha level (0.0042) in View 7 (W = 4.71) and View 9 (W = 5.31), in which the test statistic W was larger than the critical value, F [$F(16,15) = 4.17$] (see calculations in Appendix G1). Therefore, the null hypothesis was rejected. It was concluded that there was a significant difference in the internal consistencies between 4-point scale and 10-point scale. From the sample views (12 views), it appeared that generally 10-point scale ratings of POV (EOV) had relatively higher internal consistencies compared to that of 4-point scale. However, a larger sample of views with wider range of view attributes is needed in further studies to confirm this.

5.6.2 Interrater reliability (actual view)

Analysis on the interrater reliability of the rating scales was performed in SPSS Statistics programme. Figure 5.2 presents the results of interrater reliability analysis.

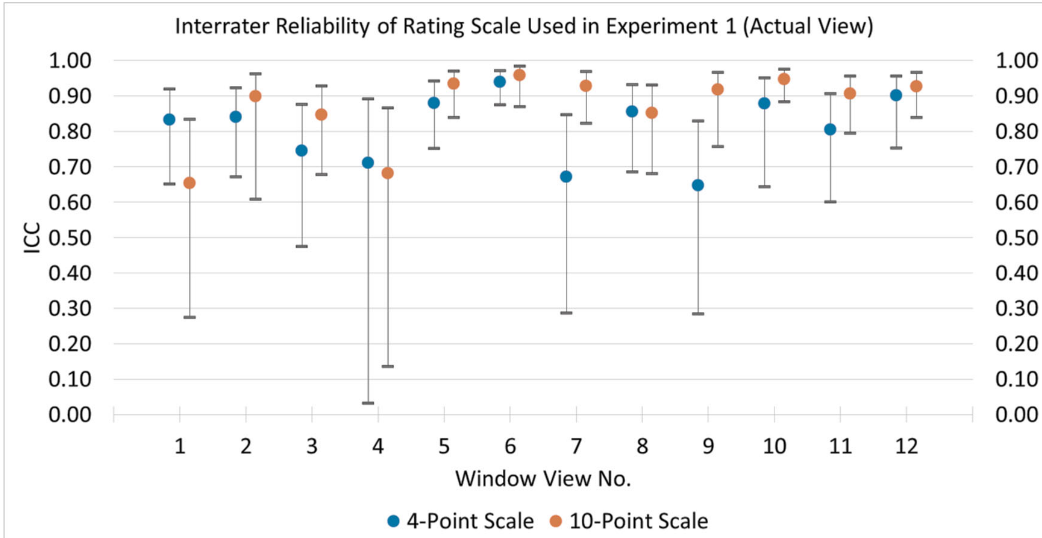


Figure 5.2: Interrater reliability of the rating scale used in Experiment 1 (actual view) - Intraclass Correlation Coefficient (ICC) with 95% confidence interval.

The results showed that overall, both 4-point and 10-point scales had good interrater reliability (ICC value larger than 0.70) in all views except View 1 (10-point scale), View 4 (10-point scale), View 7 (4-point scale), and View 9 (4-point scale). The wide confidence intervals in these four cases indicated that a larger sample size may be required to estimate the interrater reliability more accurately (see Appendix F1).

5.7 Reliability analysis: Experiment 2 (image view)

In the following we compare the internal consistency and interrater reliability between the 4-point and 10-point scales used in Experiment 2 (image view).

5.7.1 Internal consistency (image view)

Analysis on internal consistency of the rating scales was performed in SPSS Statistics. Figure 5.3 presents the results of analysis on internal consistency.

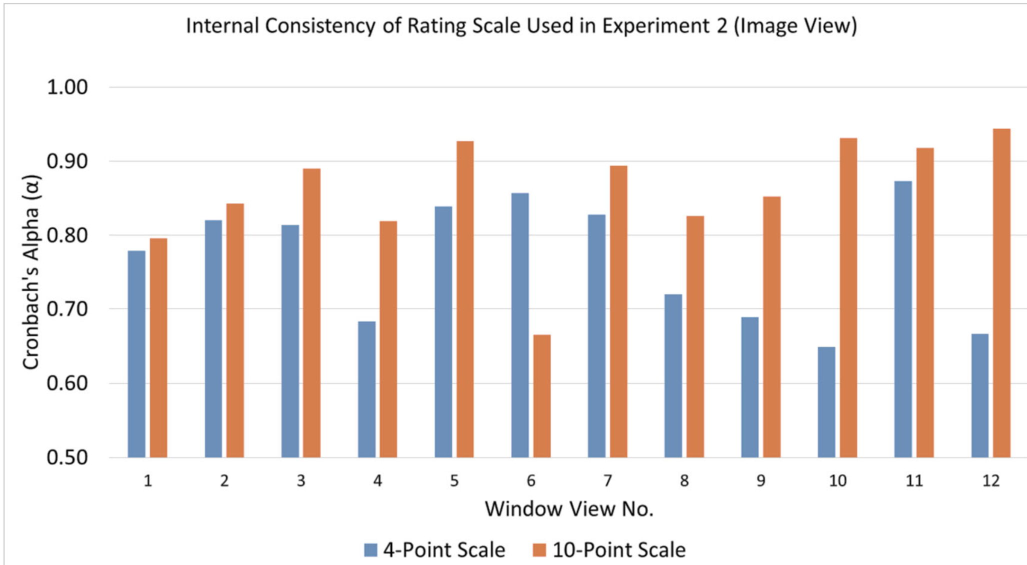


Figure 5.3: A comparison of internal consistency of the two scale items (POV and EOV) between two different scale formats (4-point scale vs. 10-point scale) in Experiment 2 (image view).

The results showed that both 4-point and 10-point rating scales had good internal consistency (Cronbach's alpha value larger than 0.70) in all views except View 4 (4-point), View 6 (10-point), View 9 (4-point), View 10 (4-point) and View 12 (4-point) which demonstrated moderate levels of internal consistency. The results suggest that generally 10-point scale ratings of POV and EOV had relatively higher internal consistencies compared to that of 4-point scale, except for View 6 (see Appendix F1).

To find out whether there was any significant difference in the internal consistencies between two rating scales formats when the view evaluation was based on images, the null and alternative hypotheses were defined as the following:

H_0: There is no significant difference in the internal consistencies between 4-point scale and 10-point scale when the view evaluation was based on images.

H_1: There is a significant difference in the internal consistencies between 4-point scale and 10-point scale when the view evaluation was based on images.

The null hypothesis above was tested using the method proposed by Feldt and Kim (2006) (see Section 5.6.1). Since there were 12 cases for either scale format (4-point or 10-point scale), the new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042. If W is larger than F at the corrected alpha level (0.0042) in one or more of the 12 cases, then we can reject the null hypothesis and conclude that there is a significant difference in the Cronbach alpha coefficients between 4-point and 10-point scale formats when the view evaluation was based on images. If W is not larger than F in all 12 cases, then the null hypotheses is retained.

The test results showed that there were significant differences in the internal consistencies between 4-point and 10-point scale formats at the corrected alpha level (0.0042) in View 10 (W = 5.09) and View 12 (W = 5.96), in which the test statistic W was larger than the critical value, F [$F(16,15) = 4.17$] (see calculations in Appendix G1). Therefore, the null hypothesis was rejected. It was concluded that there was a significant difference in the internal consistencies between 4-point scale and 10-point scale when the view evaluation was based on images. From the sample views (12 views), it appeared that generally 10-point scale ratings of POV (EOV) had relatively higher internal consistencies compared to that of 4-point scale (in image-view mode). A larger sample of views (images) with wider range of view attributes is needed in further studies to confirm this.

5.7.2 Interrater reliability (image view)

Analysis on the interrater reliability of the rating scales (used in image viewing) was performed in SPSS Statistics. Figure 5.4 presents the results of interrater reliability analysis. The results showed that both 4-point and 10-point formats of the rating scale demonstrated good interrater reliability (ICC value larger than 0.70) except in View 4 (4-point scale), View 6 (10-point scale), View 9 (4-point scale), View 10 (4-point scale) and View 12 (4-point scale) which demonstrated moderate levels of interrater reliability. The wide confidence intervals in these five cases indicated that a larger sample size may be required to estimate the interrater reliability more accurately (see Appendix F1).

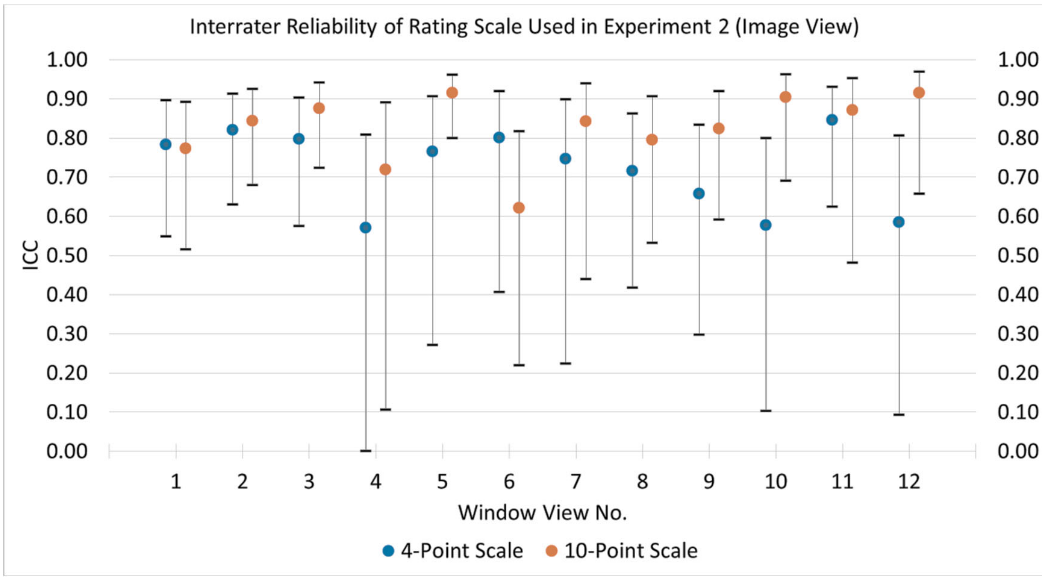


Figure 5.4: Interrater reliability of the rating scale used in Experiment 2 (image view) - Intraclass Correlation Coefficient (ICC) with 95% confidence interval.

5.8 Validity of rating scale

Validity refers to how well the rating scale measures what it intends to measure. There are two types of validity analysis in this study:

1. Dimensionality - Exploratory Factor Analysis (EFA), as a measure of the rating scale's validity, tells whether the two items (i.e., POV and EOV) in the questionnaire match with the corresponding dimensions as designed in the rating scale.

2. Construct validity - Convergent and discriminant validity are both considered subtypes of construct validity. Convergent validity is assessed by examining the correlations of scores on each scale with scores on each of the others. Scores from a scale are assumed to show convergent validity to the extent to which they correlated with scores from other scales measuring the same underlying construct (Preston and Colman 2000). High correlation between the POV and EOV rating scores indicates evidence for convergent reliability. Since there was only one underlying construct in this study (i.e., window view quality), assessment of discriminant validity was unnecessary, hence convergent validity alone sufficed to prove that there was construct validity.

5.9 Validity analysis: Experiment 1 (actual view)

In the following, we compare the dimensionality and construct validity between the 4-point and 10-point scales used in Experiment 1 (actual view).

5.9.1 Dimensionality

Exploratory Factor Analysis (EFA) was run using SPSS Statistics software to determine the dimensionality of the underlying construct (window view quality). The initial eigenvalues for the first component and its percentage of variance explained among the 12 views ranged from 1.478 (73.9%) in View 1 (10-point scale) to 1.940 (97.0%) in View 6 (10-point scale). Therefore, the results showed that the two items of the rating scale – i.e., POV and EOV were unidimensional in all 12 views (both 4-point and 10-point scales).

5.9.2 Construct validity

The results of analysis on convergent validity are presented in Figure 5.5. The correlation between the POV and EOV rating was analysed using SPSS Statistics

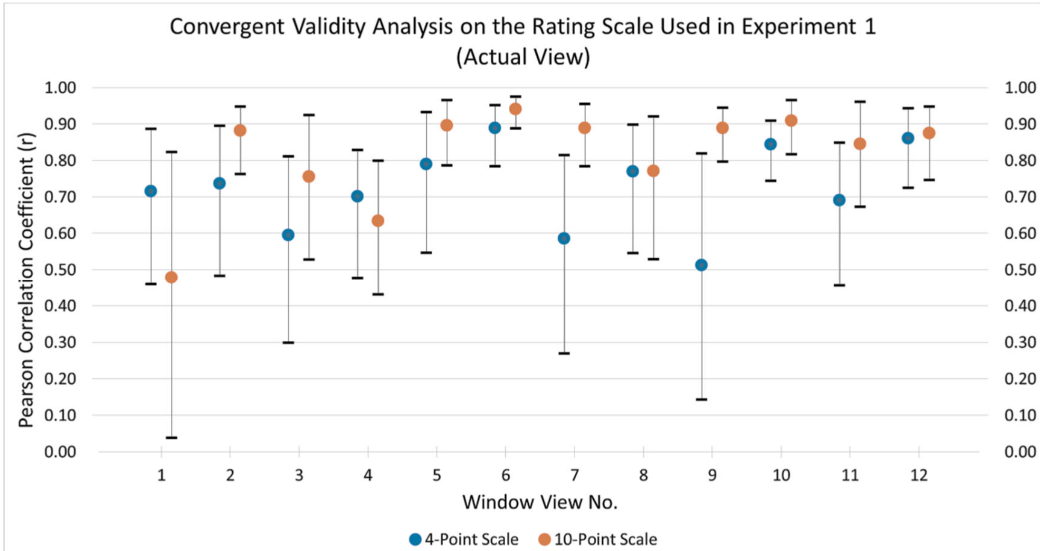


Figure 5.5: Convergent validity of the rating scale used in Experiment 1 (actual view) measured in Pearson Correlation Coefficient (r) with 95% confidence interval.

based on a significance at the 0.05 level. The correlation between the POV and EOV rating for View 1 (10-point scale) was 0.478, the lowest among all scales in Experiment 1. The correlation for other views (4-point or 10-point scale) ranged from 0.512 to 0.940, which were from moderate to strong correlation. Overall, the correlation between the POV and EOV rating scores was evidence for convergent validity. Since there was only one underlying construct in this study (window view quality), test on discriminant validity was not required. The results generally confirmed the construct validity of the rating scales used in Experiment 1 (actual view) in assessing window view quality.

5.10 Validity analysis: Experiment 2 (image view)

In the following we compare the dimensionality and construct validity between the 4-point and 10-point scales used in Experiment 2 (image view).

5.10.1 Dimensionality

Exploratory Factor Analysis (EFA) was run using SPSS Statistics to determine the dimensionality of the underlying construct (i.e., window view quality). The initial eigenvalues for the first component and its percentage of variance explained among the 12 views ranged from 1.487 (74.3%) in View 10 (4-point scale) to 1.904 (95.2%) in View 12 (10-point scale). Therefore, the results showed that the two items of the rating scale – i.e., POV and EOV were unidimensional in all 12 views (both 4-point and 10-point scales).

5.10.2 Construct validity

The results of analysis on convergent validity are presented in Figure 5.6. The correlation between the POV and EOV rating was analysed using SPSS Statistics based on a significance at the 0.05 level. The correlation between the POV and EOV rating for View 10 (4-point scale) was 0.487, the lowest among all scales in Experiment 2. The correlation for other views (4-point or 10-point scale) ranged from 0.499 to 0.904, which were from moderate to strong correlation. Overall, the correlation between the POV and EOV rating scores was evidence for convergent validity. Since there was only one underlying construct in this study (window view quality), test on discriminant validity was not required. The results generally confirmed the construct validity of the rating scales used in Experiment 2 (image view) in assessing window view quality.

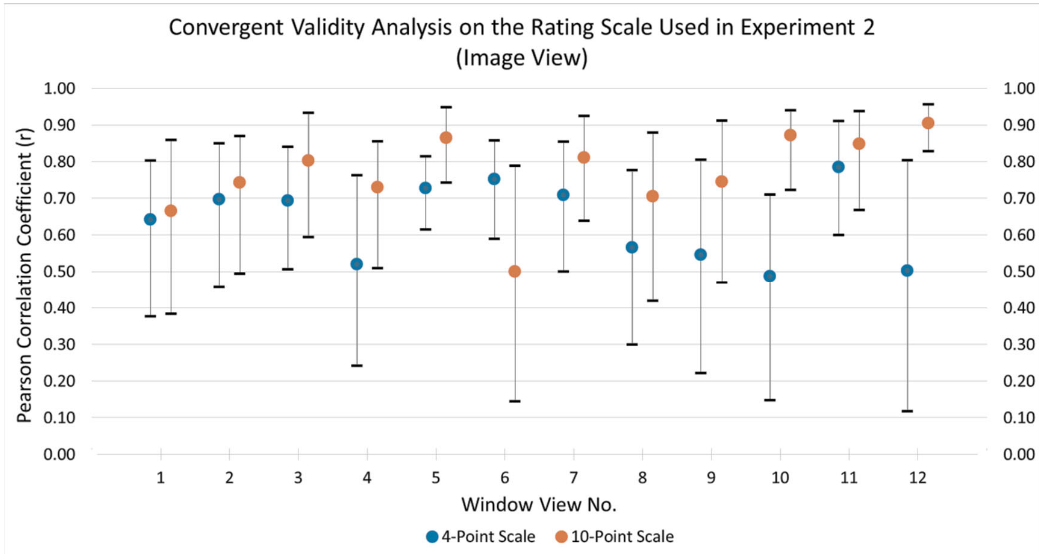


Figure 5.6: Convergent validity of the rating scale used in Experiment 2 (image view) measured in Pearson Correlation Coefficient (r) with 95% confidence interval.

5.11 Optimum number of response categories

In order to find out the optimum number of response categories or scale points on a rating scale for window view quality evaluation, an analysis was conducted on the probability of receiving a response category within the category limit. The probability was based on the proportion of cumulative frequency of response categories. Figures 5.7 and 5.8 present the probability against category limit (4-point / 10-point scale) for POV evaluations in Experiment 1 (actual view). Plateau of the 10-point scale line graph for POV is observed in View 1 (Category 7 – 9), View 2 (Category 1 – 2; 9 – 10), View 3 (Category 8 – 10), View 4 (Category 1 – 2; 9 – 10), View 5 (Category 8 – 10), View 7 (Category 8 – 9), View 9 (Category 2 – 3) and View 12 (Category 9 – 10). None of the 4-point scale line graphs for POV displays plateau.

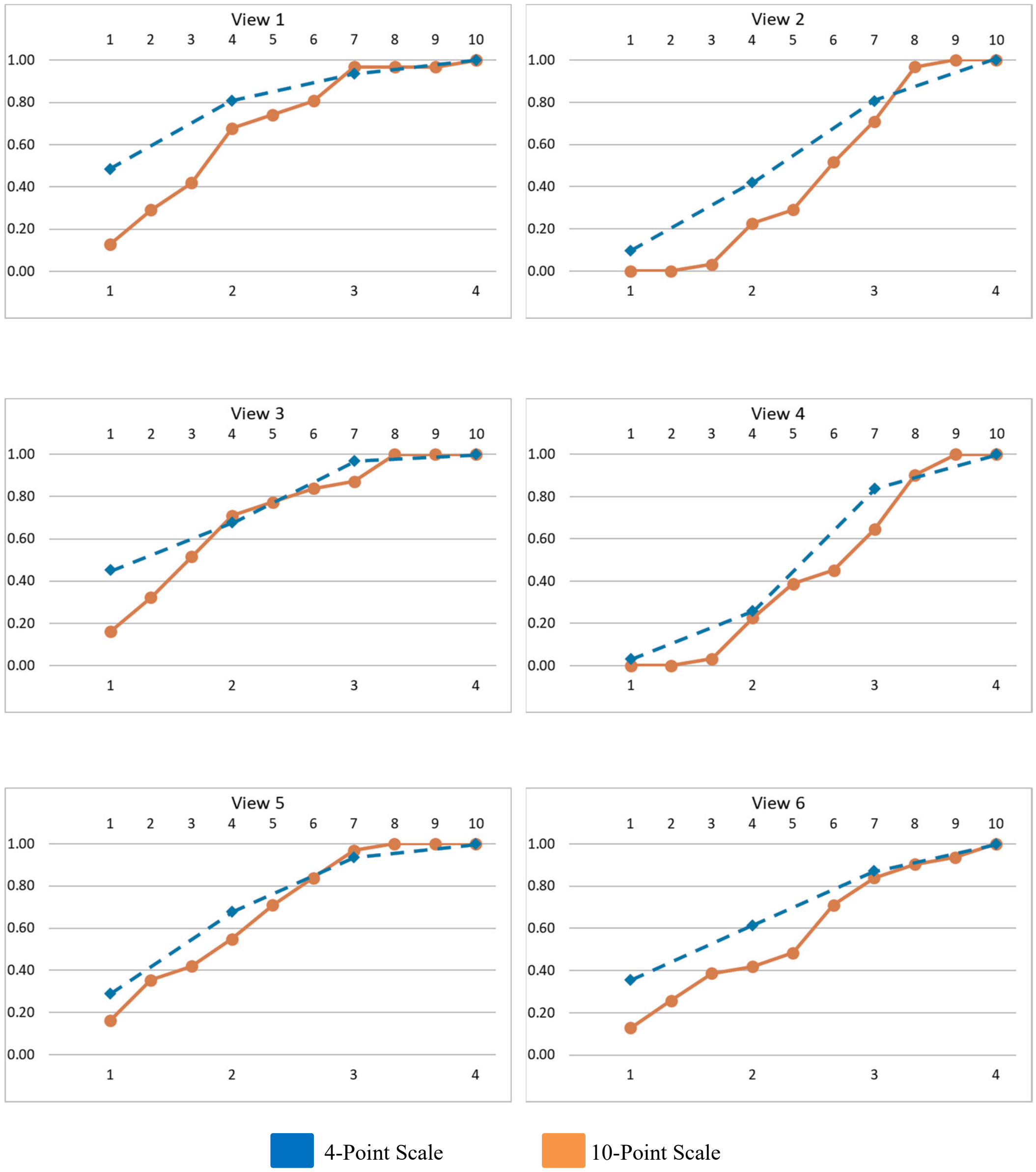


Figure 5.7: Probability against category limit (4-point / 10-point scale) for POV evaluations in Experiment 1 (actual view), View 1 – View 6.

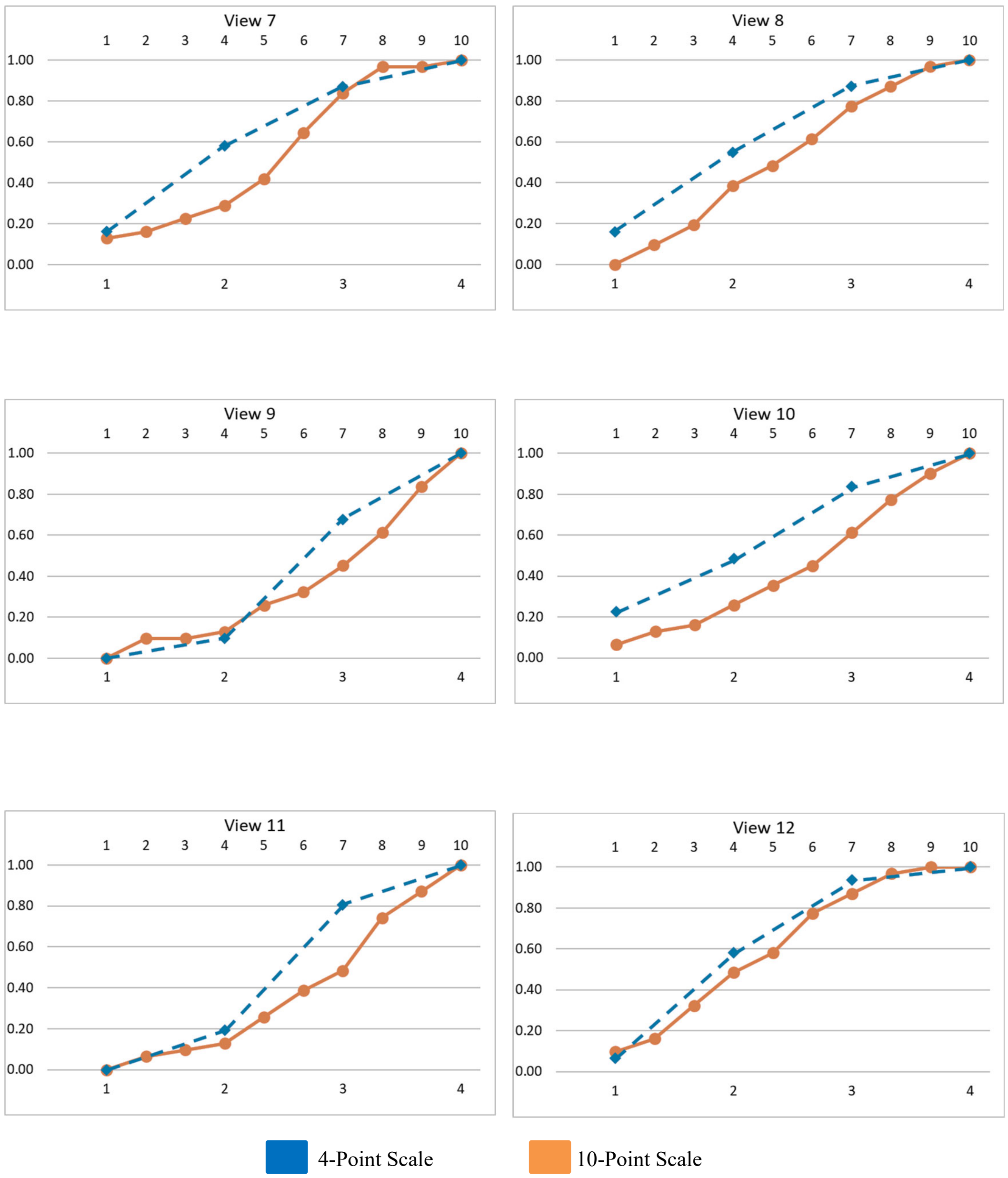


Figure 5.8: Probability against category limit (4-point / 10-point scale) for POV evaluations in Experiment 1 (actual view), View 7 – View 12.

Figures 5.9 and 5.10 present the probability against category limit (4-point / 10-point scale) for EOV evaluations in Experiment 1 (actual view). Plateau of the 10-point scale line graph for EOV is observed in View 1 (Category 8 –10), View 2 (Category 9 – 10), View 3 (Category 8 – 10), View 4 (Category 9 – 10), View 5 (Category 7 – 10), View 6 (Category 8 – 9), View 7 (Category 9 – 10), View 11 (Category 3 – 4) and View 12 (Category 8 – 10). For the 4-point scale line graphs for EOV, plateau is observed in View 1 (Category 3 – 4) and View 7 (Category 3 – 4).

The results also indicate that in majority of the views, the subjective evaluations based on 10-point scale format did not receive any response on the higher or lower end of the rating scale, resulting in plateaus on the two ends in the plots of probability (proportion of cumulative frequency) against the category limit. For 4-point scale, only two views in EOV display plateau in the graphs. This suggests that 10-point scale may be too fine (too many scale points) for the purpose of evaluating window view quality, whilst the 4-point scale can be finer to increase the discriminating power of the scale. Considering that an effective rating scale for window view quality should avoid having a neutral category at the centre to demand a forced-choice response (Fotios 2015) between a positive (pleasant or exciting) and a negative (unpleasant or boring) rating, the optimum number of response categories on a rating scale for evaluating window view quality may be either 6 or 8.

5.12 Discussions

In terms of scale reliability, both 4-point and 10-point formats showed moderate to excellent internal consistencies (Cronbach's alpha value higher than 0.70) in most of the cases – i.e., 10 out of 12 views in Experiment 1 (actual view), and 7 out of 12 views in Experiment 2 (image view). The remaining cases showed acceptable levels of internal consistencies. This implies that both scale formats were reliable, and the scales used in Experiment 1 (actual view) were somewhat more consistent internally compared to Experiment 2 (image view).

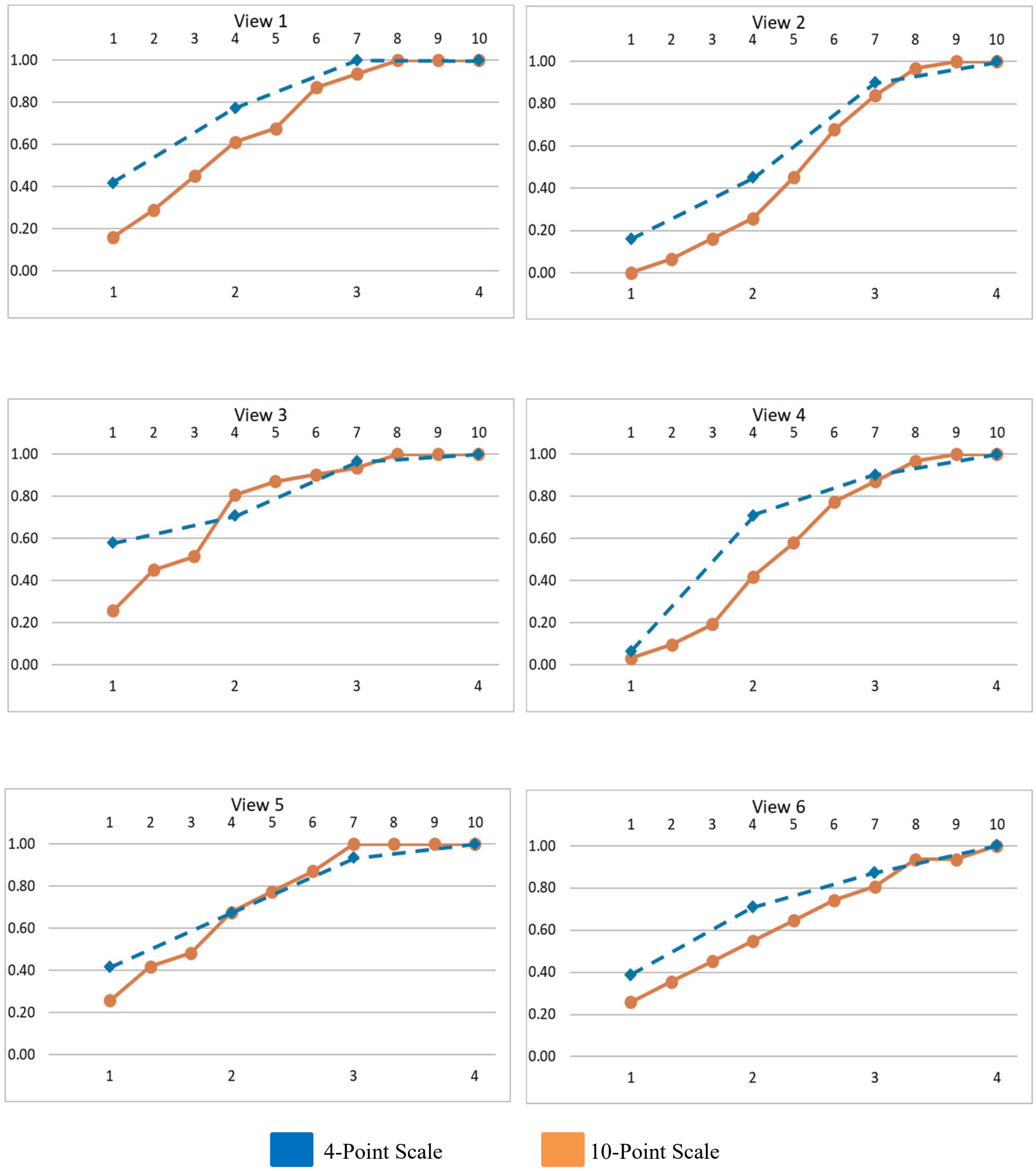


Figure 5.9: Probability against category limit (4-point / 10-point scale) for EOV evaluations in Experiment 1 (actual view), View 1 – View 6.

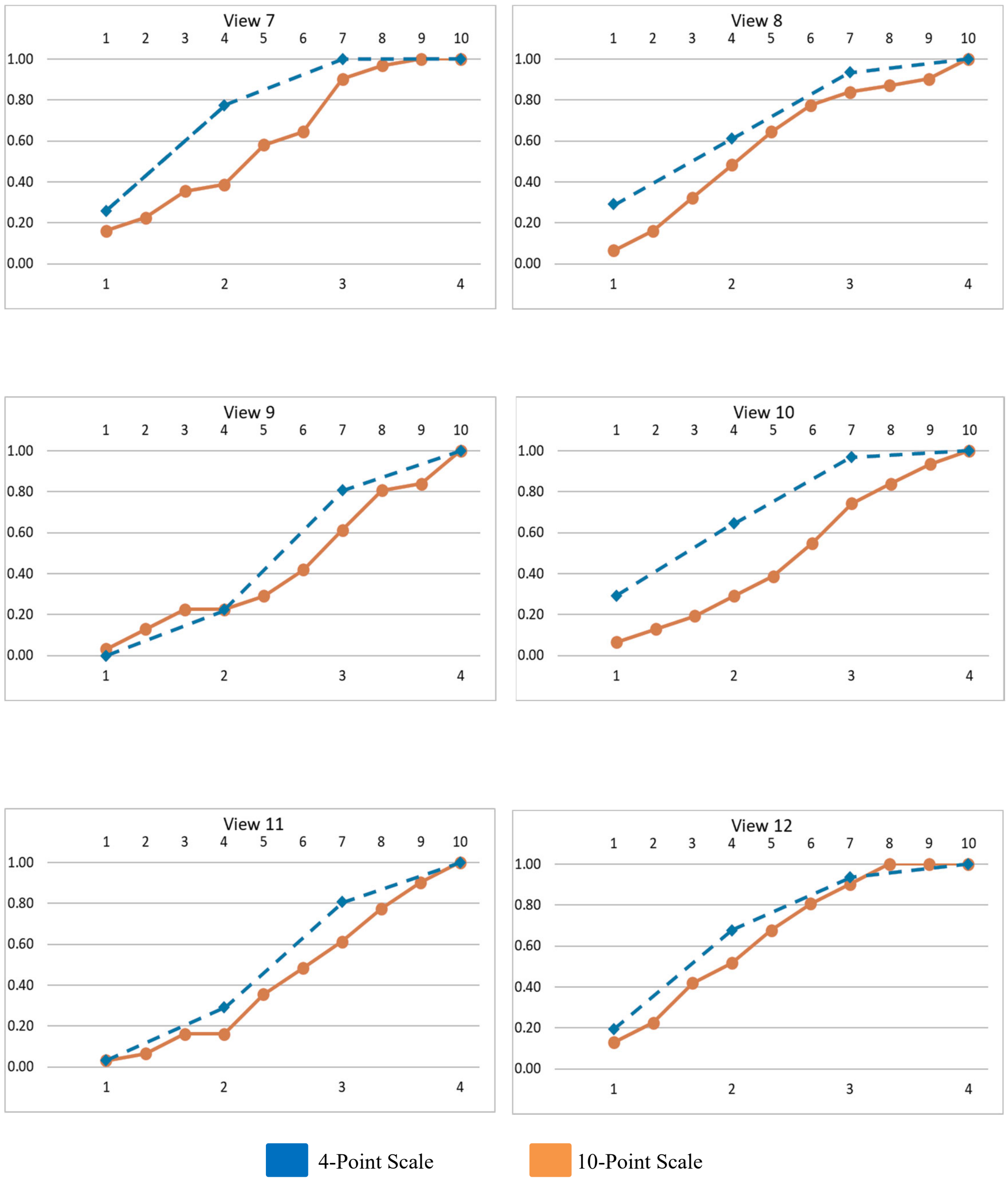


Figure 5.10: Probability against category limit (4-point / 10-point scale) for EOV evaluations in Experiment 1 (actual view), View 7 – View 12.

The test results of both experiments (real view and image view) showed that there were significant differences in the internal consistencies between 4-point and 10-point scale formats at the corrected alpha level (0.0042). From the 12 sample views – either actual or image views, it appeared that generally 10-point scale ratings of POV (EOV) had relatively higher internal consistencies compared to that of 4-point scale. Overall, both 4-point and 10-point formats of the rating scale used in both experiments have good interrater reliability (ICC value larger than 0.70) except for four cases in Experiment 1, and five cases in Experiment 2, which have moderate level of interrater reliability. Results of Exploratory Factor Analysis show that the two items of rating – i.e., POV and EOV were unidimensional in all 12 cases for both 4-point and 10-point scales. The correlation between the POV and EOV rating scores shows evidence of convergent validity. Since there was only one underlying construct in this study (window view quality), the results of convergent validity confirmed construct validity of the rating scales (POV and EOV) used in both experiments in assessing view quality.

Despite the significant differences in the internal consistencies between 4-point and 10-point scale formats, there was no significant difference found in the POV (EOV) mean scores between the two scale formats – i.e., 4-point and the 10-point scale, when the comparison was made based on rescaled 4-point and 10-point rating data. Consistency was observed in the evaluations on the same view using 4-point and 10-point rating scales – i.e., the difference in scale format (4-point vs. 10-point) did not affect the judgement of the subjects in the view quality evaluations on either POV or EOV, and in either actual or image viewing mode.

This concludes that both 4-point and 10-point rating scales serve the same purpose as the response formats of a rating scale for measuring view quality based on actual views. This is because the average quality rating (POV or EOV) of a window view is not significantly affected by the format of rating scale used in the subjective evaluation, as shown in this study.

However, if the 4-point scale data are used to formulate a linear prediction model of the view quality, it is likely that there will be biased parameter estimates and incorrect standard errors and model test statistics due to the categorical (non-continuous) nature of the dependent variable, which violates the assumption of normality and thus can result in a loss of statistical power (Rhemtulla et al. 2012; Harpe 2015). In comparison, 10-point scale data can generally be treated as continuous interval-level data and used to establish a linear prediction model (Harpe 2015).

5.13 Summary

The main outcomes of this chapter can be summarised as follows:

1. When compared on a 101-point common scale, there is no significant difference in the mean POV (EOV) scores between the rescaled 4-point and rescaled 10-point ratings – whether the evaluation is carried out in actual or image viewing mode. This suggests that 4-point and 10-point scales serve the same purpose as the response formats of a rating scale for measuring window view quality in either actual view or image view.

2. Although 4-point and 10-point scales have no significant difference in measuring view quality, the 4-point scale data should not be used to establish a linear prediction model of the view quality to avoid biased parameter estimates and incorrect standard errors. In comparison, the 10-point scale data may be treated as continuous interval-level data and used to establish a linear prediction model.

3. In terms of scale reliability, the 4-point and 10-point scales in most cases show moderate to excellent internal consistencies. Whether measured in actual view or image view, 10-point scale appears to have higher internal consistency and interrater reliability in most cases compared to the 4-point scale. Either the 4-point or 10-point scale appears to have generally higher interrater reliability

when the view evaluation is carried out based on actual view compared to image view.

4. Overall, the correlations between POV and EOV rating scores using either the 4-point or 10-point scale range from moderate to very strong, which indicates evidence for convergent validity. The results generally confirm the construct validity of the rating scales – i.e., the 4-point and 10-point scales that are used in the assessment of actual or image view quality.

5. The results suggest that 10-point scale is probably too fine (too many scale points) for the purpose of evaluating window view quality, whereas 4-point scale is perhaps too coarse (too few scale points) to achieve a sufficient discriminating power between the scale points. The optimum number of response categories on a rating scale for evaluating window view quality may be either 6 or 8. Further studies are required to confirm this finding.

CHAPTER 6

Comparison of Two Different Modes of View

6.1 Introduction

This chapter focuses on the comparison of view quality evaluations under two different modes of view – i.e., actual view and image view. The objective is to determine whether there is any difference in the perceived view quality of the same window view when the evaluation is carried out under these two different modes of view. The parametric analyses in this chapter use the 10-point scale data collected from Experiment 1 (actual view) and Experiment 2 (image view) as these data were closer to normal distribution compared to the 4-point scale data collected from the same experiments.

6.2 Pleasantness of view (POV) rating: actual view vs. image view

In the past studies (Wijntjes 2014; Hecht et al. 1999) (see Chapter 2), it was found that perception of the real space was more accurate and less ambiguous than pictorial space. Therefore, it was predicted in this study that the perceived aesthetical quality of elements in the real space would be accentuated and thus the evaluation of pleasantness (POV) in the real space (actual view) would tend to produce a more extreme rating compared to that in the pictorial space (image view).

In the present study, we compare POV ratings between actual and image modes of view. A comparison of POV rating distributions in Experiment 1 (actual view) and Experiment 2 (image view) is presented in Figure 6.1 - box and whisker plots of indicating the interquartile range, median, highest and lowest ratings for each of the 12 window views. A comparison of POV mean ratings and the corresponding 95% confidence intervals for the 12 window views between the two experiments is presented in Figure 6.2.

From Figure 6.1, POV ratings in actual-view mode had larger dispersions compared to that in image view in Views 1, 6, 7, 8, 9, 10 and 12; whilst POV ratings in image view had larger dispersions in Views 2, 3 and 4. The spreads were equal in View 5 and View 11; however, View 5 had a more positive skewness in actual view (0.081) compared to image view (-0.149), and View 11 had a more negative skewness in actual view (-0.650) compared to image view (-0.181).

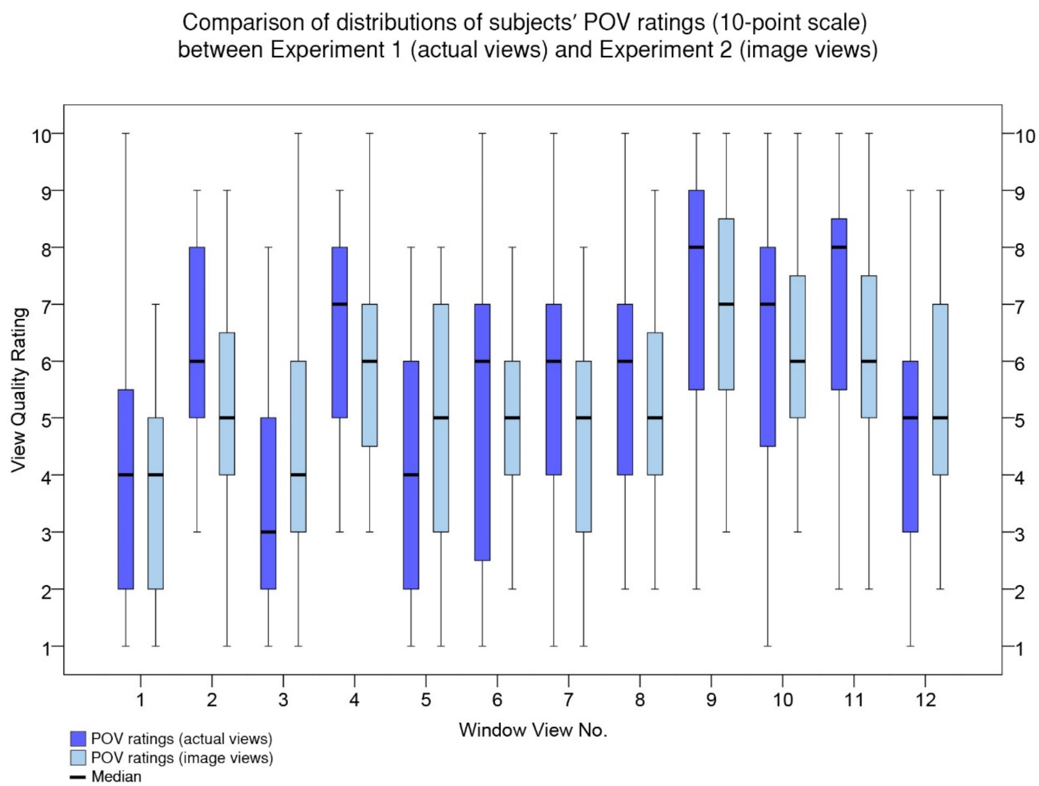


Figure 6.1: Box and whisker plots of POV ratings based on 10-point scale format in Experiment 1 (actual view) and Experiment 2 (image view) indicating the interquartile range, median, highest and lowest ratings for each of the 12 window views.

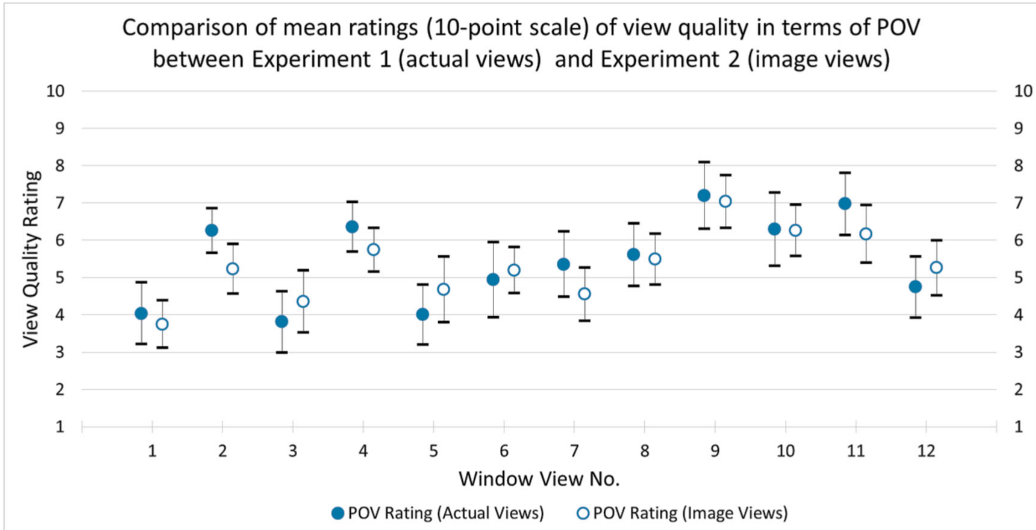


Figure 6.2: Comparison of POV mean ratings (10-point scale) and the corresponding 95% confidence intervals for each of the 12 window views in Experiment 1 (actual view) and Experiment 2 (image view).

POV ratings in actual-view mode had larger interquartile range (IQR) compared to that in image-view mode in Views 1, 2, 4, 6, 8, 9, 10 and 11. POV ratings in the two modes of view had equal IQR in Views 3, 5, 7 and 12. None of the image-view mode POV ratings had larger IQR than that of actual-view mode. This implies that generally POV ratings in actual-view mode had higher variability compared to that in image-view mode.

In terms of median of POV ratings, actual-view mode had higher medians than that of image-view mode in Views 2, 4, 6, 7, 8, 9, 10 and 11. The two modes of view had equal medians in View 1 and View 12. Actual-view mode had lower medians than that of image-view mode in View 3 and View 5. In this 10-point rating scale for POV, if ratings 1 – 5 were considered negative view quality and 6 – 10 were considered positive view quality, then the two different modes of view yielded consistent view qualities in View 1 (negative), View 3 (negative), View 4 (positive), View 5 (negative), View 9 (positive), View 10 (positive), View 11 (positive) and View 12 (negative). The two different modes of view yielded inconsistent view qualities in

Views 2, 6, 7 and 8 where the actual-view mode had positive view quality whereas image-view mode had negative view quality in each of these four views.

In terms of mean of POV ratings, actual-view mode had higher means compared to that of image-view mode in Views 1, 2, 4, 7, 8, 9, 10 and 11, but lower means in Views 3, 5, 6 and 12. Therefore, if we take into consideration both medians and means, we can conclude that generally Views 2, 4, 7, 8, 9, 10 and 11 had higher POV ratings in actual-view mode, whereas View 3 and View 5 had higher POV ratings in image-view mode.

A comparison between the mean POV ratings of actual and image views that were in either end of the 10-point scale: For View 3 and View 5, which had unsatisfactory mean POV ratings, the actual views had lower mean ratings compared to the image views of the same scenes; for Views 2, 4, 9, 10 and 11, which had satisfactory POV ratings, the actual views had higher mean ratings compared to the image views of the same scenes. The trends observed in Views 2, 3, 4, 5, 9, 10 and 11 support our prediction.

6.3 Excitingness of view (EOV) rating: actual view vs. image view

Previous studies (Wijntjes 2014; Foley 1980, 1977; Luneburg 1950) suggested that the distribution of equally perceived depths is curved in real space, and relatively flat in pictorial space. This distortion in real view can be stimulating, thus it is likely to enhance the EOV of a window view. However, for large viewing distances, the difference between real and pictorial viewing is surprisingly small (Hecht et al. 1999). Therefore, it was predicted in this study that views that were observed in real mode would have a higher EOV rating than the same views in image mode.

In the present study, we compare EOV ratings between actual and image modes of view. A comparison of EOV rating distributions in Experiment 1 (actual view) and Experiment 2 (image view) is presented in Figure 6.3 - box and whisker plots of indicating the interquartile range, median, the highest and lowest ratings for each of the 12 window views. A comparison of EOV mean ratings and the corresponding 95% confidence intervals for the 12 window views between the two experiments is presented in Figure 6.4.

From Figure 6.3, EOV ratings in actual-view mode had larger dispersions compared to that in image-view mode in Views 1, 6, 7, 8, 9 and 10; whilst EOV ratings in image-view mode had larger dispersions in Views 3, 5 and 12. The spreads were equal in View 2, 4 and 11. However, View 2 had a more negative skewness in actual-view mode (-0.257) compared to image-view (-0.020); View 4 had a less positive skewness in actual-view mode (0.019) compared to image-view (0.534); View 11 had a less positive skewness in actual-view mode (-0.435) compared to image-view (0.222).

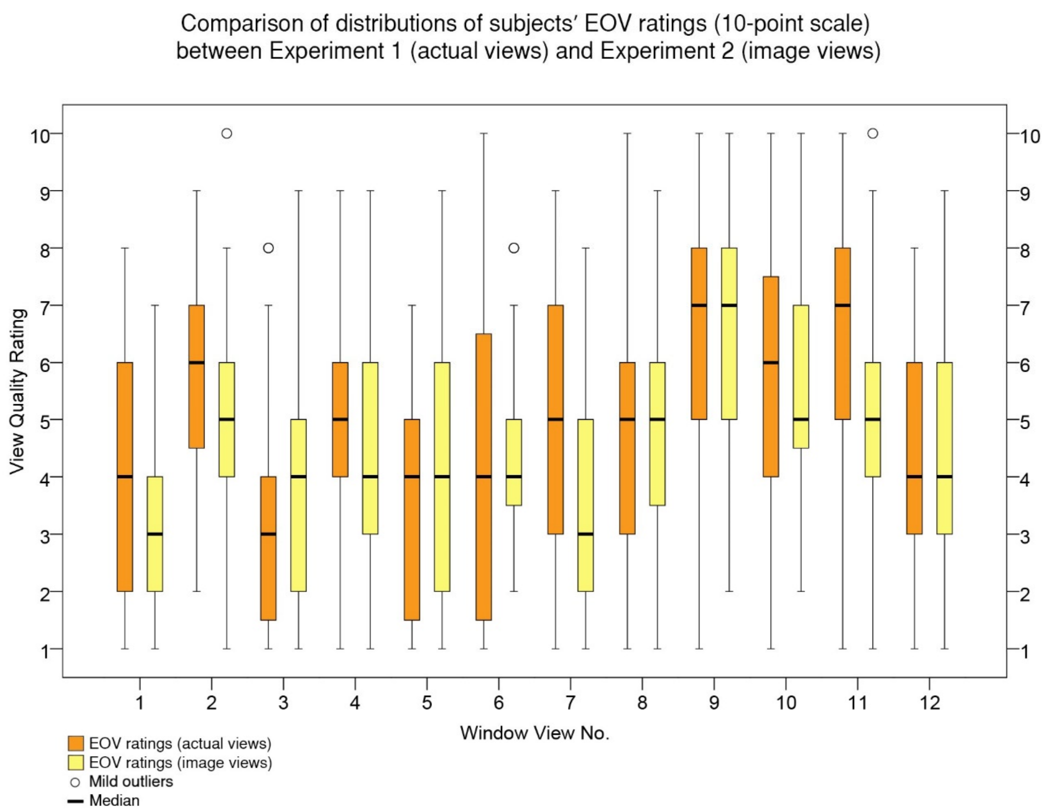


Figure 6.3: Box and whisker plots of EOV ratings based on 10-point scale format in Experiment 1 (actual view) and Experiment 2 (image view) indicating the interquartile range, median, highest and lowest ratings for each of the 12 window views.

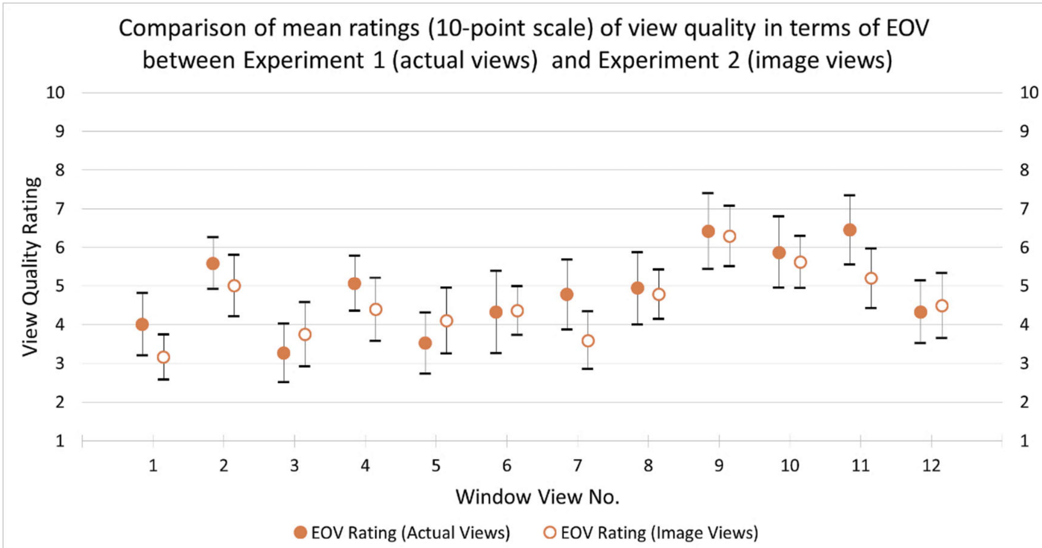


Figure 6.4: Comparison of EOV mean ratings (10-point scale) and the corresponding 95% confidence intervals for each of the 12 window views in Experiment 1 (actual view) and Experiment 2 (image view).

EOV ratings in actual-view mode had larger interquartile range (IQR) in Views 1, 2, 6, 7, 8, 10 and 11 compared to that in image-view mode. EOV ratings in the two modes of view had equal IQR in View 9 and View 12. EOV ratings in actual-view mode had smaller IQR in Views 3, 4 and 5 compared to that of image-view mode.

In terms of median of EOV ratings, actual-view mode had higher medians than that of image-view mode in Views 1, 2, 4, 7, 10 and 11. The two modes of view had equal medians in Views 5, 6, 8, 9 and 12. Actual-view mode had lower medians than that of image-view mode in View 3. In this 10-point rating scale for EOV, if ratings 1 – 5 were considered negative view quality and 6 – 10 were considered positive view quality, then the two different modes of view yielded consistent view qualities in View 1 (negative), View 3 (negative), View 4 (negative), View 5 (negative), View 6 (negative), View 7 (negative), View 8 (negative), View 9 (positive) and View 12 (negative). The two different modes of view yielded inconsistent view qualities in Views 2, 10 and 11 where the actual-view mode had positive view quality whereas image-view mode had negative view quality in each of these three views.

In terms of EOV, actual-view mode had higher mean ratings compared to that of image-view mode in Views 1, 2, 4, 7, 8, 9, 10 and 11, but lower mean ratings in Views 3, 5, 6 and 12. Therefore, if we take into consideration both medians and means, we can conclude that generally Views 1, 2, 4, 7, 10 and 11 had higher EOV ratings in actual-view mode, whereas View 3 had higher EOV ratings in image-view mode.

The trends observed in Views 1, 2, 4, 7, 10 and 11 support our prediction. View 3 does not follow the trend probably because it is the only view (among the 12 views) that is extremely enclosed (openness of view: 12%) and this sense of enclosure was felt more strongly in actual space compared to pictorial space, hence the subjects felt less excited (lower EOV) when observing View 3 in actual-view mode.

6.4 Hypotheses testing

From the data in Chapter 4 and this Chapter, the following hypotheses were tested.

6.4.1 Hypothesis: View quality ratings were significantly different under different modes of view

In order to determine whether the overall mean ratings of POV (EOV) were significantly different between the different modes of view, the null and alternative hypotheses were defined as the following:

> H_0: There is no significant difference in the mean POV (EOV) rating between the actual-view mode and image-view mode.
>
> H_1: There is a significant difference in the mean POV (EOV) rating between actual-view mode and image-view mode.

To test the hypothesis, we compared the mean POV (EOV) ratings (based on 10-point scale) of the 12 window views between two independent groups of subjects – i.e., 31 subjects who viewed the real scenes in Experiment 1, and 31 subjects who viewed images of the same scenes in Experiment 2. An independent samples t-test was performed using SPSS on each of the 12 views with the null hypothesis that there is no difference in the mean POV (EOV) rating between the actual-view and image-view mode. To control the Type I error rate in this multiple testing, Bonferroni correction was applied to the critical level of significance. Since there were 12 cases for either view quality (POV or EOV), the new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042. Results of the analysis are summarised in Table 6.1 and Figure 6.5. The results indicate that the difference in the mean POV or EOV rating between the actual-view and image-view mode was nonsignificant at the corrected alpha level (0.0042). Therefore, the null hypothesis was retained. It can be concluded that there is no significant difference in the mean POV (EOV) rating between the actual-view and image-view mode. Note that in the cases of View 1 (EOV), View 6 (POV and EOV) and View 10 (POV), Levene's test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made in each of these four cases.

In all 12 cases of POV (EOV), the difference in the mean POV (EOV) rating between the actual-view and image-view modes was nonsignificant probably because of the small sample size (i.e., 31 per group), and it has been demonstrated in Chapter 3 that, with this sample size, cases with effect size (Cohen's *d*) smaller than 0.72 may not be significant in this independent samples t-test. Note three cases which have the largest differences in mean scores:

1. View 2 (POV) [$t(60) = 2.364$, $p = 0.021$]. The effect size (Cohen's *d*) was 0.42, suggesting that mode of view had a small effect on the POV rating of View 2; and 8.5% of the variance in this POV rating was attributable to mode of view. Here the actual view appeared to be somewhat more pleasant than the image view because the vast greenery in the real space, when projected orthographically to a two-dimensional picture, only occupied a relatively low proportion of the scene (21%); and greenery elements have been proven in numerous past studies to be useful in creating positive mood for the observer (Ulrich 1984; Kaplan 2001; Lottrup et al. 2015).

Table 6.1: Comparison of mean rating scores of view quality (POV or EOV) between two different modes of view (actual view vs. image view)

Item	Mean Score: Actual View (X1)	Mean Score: Image View (X2)	Difference in mean scores: (X1) - (X2)	Independent Samples t-Test (t)	df	p-value	
View 1							
POV	4.03	3.74	0.29	0.570	60	0.571	
EOV	4.00	3.16	0.84	1.740	54.63	0.088	
View 2							
POV	6.26	5.23	1.03	2.364	60	0.021	*
EOV	5.58	5.00	0.58	1.130	60	0.263	
View 3							
POV	3.81	4.35	-0.55	-0.950	60	0.346	
EOV	3.26	3.74	-0.48	-0.882	60	0.381	
View 4							
POV	6.35	5.74	0.61	1.405	60	0.165	
EOV	5.06	4.39	0.67	1.278	60	0.206	
View 5							
POV	4.00	4.68	-0.68	-1.161	60	0.250	
EOV	3.52	4.10	-0.58	-1.022	60	0.311	
View 6							
POV	4.94	5.19	-0.25	-0.448	49.88	0.656	
EOV	4.32	4.35	-0.03	-0.053	48.48	0.958	
View 7							
POV	5.35	4.55	0.80	1.463	60	0.149	
EOV	4.77	3.58	1.19	2.084	60	0.041	*
View 8							
POV	5.61	5.48	0.13	0.244	60	0.808	
EOV	4.94	4.77	0.17	0.289	60	0.773	
View 9							
POV	7.19	7.03	0.16	0.289	60	0.774	
EOV	6.42	6.29	0.13	0.210	60	0.835	
View 10							
POV	6.29	6.26	0.03	0.055	53.97	0.956	
EOV	5.87	5.61	0.26	0.458	60	0.648	
View 11							
POV	6.97	6.16	0.81	1.446	60	0.153	
EOV	6.45	5.19	1.26	2.177	60	0.033	*
View 12							
POV	4.74	5.26	-0.52	-0.958	60	0.342	
EOV	4.32	4.48	-0.16	-0.281	60	0.780	

Note: * $p < 0.05$
- None of the p-values is lower than the alpha level corrected by Bonferroni method.
Alpha level: 0.05; corrected alpha level: 0.0042

- Levene's test suggests that equality of variances cannot be assumed for View 1 (EOV), View 6 (POV and EOV) and View 10 (POV).

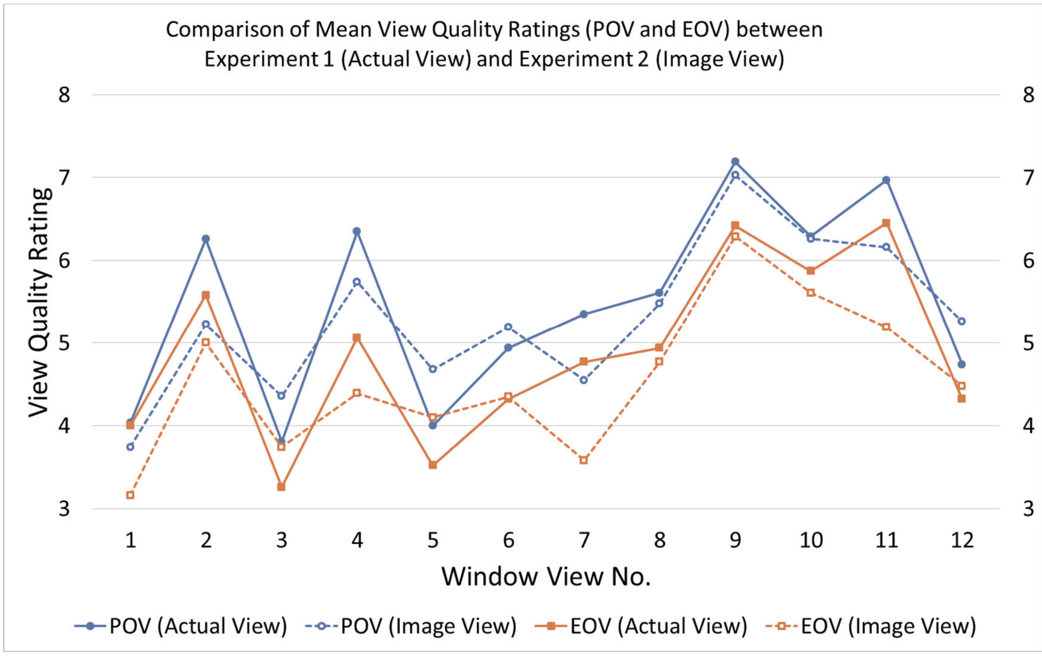


Figure 6.5: Comparison of mean ratings of POV (EOV) between two different modes of view (actual view vs. image view)

2. View 7 (EOV) [t(60) = 2.084, p = 0.041]. The effect size (Cohen's *d*) was 0.37, suggesting that mode of view had a small effect on the EOV rating of View 7; and 6.8% of the variance in this EOV rating was attributable to mode of view. In this case, the actual view appeared to be somewhat more exciting than the image view probably because the subjects could see the four visual layers (i.e., sky, apartment buildings in the background, open terrain, the predominant tree foliage in the foreground) more distinctive in real space but the same layers looked rather flat in the pictorial space.

3. View 11 (EOV) [t(60) = 2.177, p = 0.033]. The effect size (Cohen's *d*) was 0.39, suggesting that mode of view had a small effect on the EOV rating of View 11; and 7.3% of the variance in this EOV rating was attributable to mode of view. The actual view in this case appeared to be somewhat more exciting than the image view because the green landscape at the centre and the surrounding low-rise buildings seemed to be flattened into the same visual

layer in the pictorial space, hence it looked less exciting compared to the real view. As suggested by Hecht et al. (1999), the main pictorial effect that was found to be different from actual viewing was the underestimation of angles at near-centred camera positions. If compared to View 12, which shared the same orientation as View 11 (with a common high-rise building in the scene), the green landscape and surrounding buildings appeared to be multi-layered, thus the EOV on the image view of View 12 was not significantly different from its real view.

6.4.2 Hypothesis: View quality ratings of the male subjects were significantly different under different modes of view

In order to determine whether the mean ratings of POV or EOV by the male subjects were significantly different between the different modes of view, the null and alternative hypotheses were defined as the following:

H_0: There is no significant difference in the mean POV (EOV) rating by the male subjects between the actual-view mode and image-view mode.

H_1: There is a significant difference in the mean POV (EOV) rating by the male subjects between actual-view mode and image-view mode.

To test the hypothesis, we compared the mean POV (EOV) ratings (based on 10-point scale) of the 12 window views between two independent groups of subjects – i.e., male subjects who viewed the real scenes in Experiment 1, and male subjects who viewed images of the same scenes in Experiment 2. An independent samples t-test was performed using SPSS on each of the 12 views with the null hypothesis that there is no significant difference in the mean POV (EOV) rating by the male subjects between the actual-view and image-view mode.

Results of the analysis are summarised in Table 6.2 and Figure 6.6. The results indicate that the difference in the mean POV (EOV) rating by the male subjects (using a 10-point scale) between actual-view and image-view mode was nonsignificant at the

Table 6.2: Comparison of mean ratings of POV (EOV) by male subjects between two different modes of view (actual view vs. image view)

Item	Mean Score: Actual View (X1)	Mean Score: Image View (X2)	Difference in mean scores: (X1) - (X2)	Independent Samples t-Test (t)	df	p-value	
View 1							
POV	3.93	4.29	-0.35	-0.439	27	0.664	
EOV	4.00	3.93	0.07	0.090	27	0.929	
View 2							
POV	6.44	5.43	1.01	1.598	28	0.121	
EOV	5.88	5.36	0.52	0.675	28	0.505	
View 3							
POV	3.81	4.78	-0.97	-1.032	23	0.313	
EOV	3.25	3.56	-0.31	-0.411	23	0.685	
View 4							
POV	6.41	5.54	0.87	1.576	28	0.126	
EOV	5.00	3.46	1.54	2.422	28	0.022	*
View 5							
POV	4.07	4.08	-0.01	-0.011	26	0.991	
EOV	3.60	3.77	-0.17	-0.190	26	0.851	
View 6							
POV	4.93	4.77	0.16	0.187	22.59	0.854	
EOV	4.27	3.92	0.35	0.386	20.44	0.704	
View 7							
POV	5.39	5.00	0.39	0.484	30	0.632	
EOV	4.89	3.93	0.96	1.187	30	0.245	
View 8							
POV	5.69	6.00	-0.31	-0.377	24	0.709	
EOV	4.50	4.80	-0.30	-0.369	24	0.715	
View 9							
POV	7.67	7.58	0.08	0.123	25	0.903	
EOV	6.80	6.33	0.47	0.611	25	0.546	
View 10							
POV	6.80	6.00	0.80	0.915	24	0.369	
EOV	6.20	5.27	0.93	1.177	24	0.251	
View 11							
POV	7.00	5.94	1.06	1.525	35	0.136	
EOV	6.63	4.83	1.80	2.650	35	0.012	*
View 12							
POV	4.94	5.85	-0.91	-1.106	27	0.278	
EOV	4.63	5.15	-0.53	-0.632	27	0.532	

Note: * $p < 0.05$
- None of the p-values is lower than the alpha level corrected by Bonferroni method.
Alpha level: 0.05; corrected alpha level: 0.0042

- Levene's test suggests that equality of variances cannot be assumed for View 6 (POV and EOV).

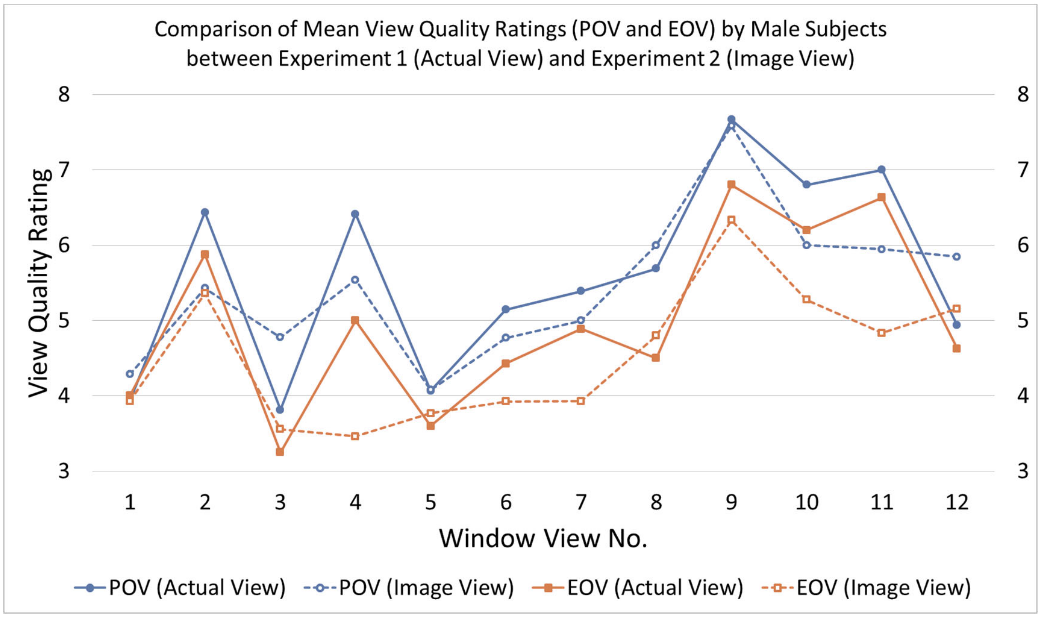


Figure 6.6: Comparison of mean ratings of POV and EOV by male subjects between two different modes of view (actual view vs. image view)

corrected alpha level (0.0042). It can be concluded that there is no significant difference in the mean POV (EOV) rating by the male subjects between the actual-view mode and image-view mode. Therefore, the null hypothesis was retained. Note that in the cases of View 6 (POV and EOV), Levene's test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made in each of these two cases.

In all 12 cases of POV (EOV), the difference in the mean POV (EOV) rating by the male subjects between the actual-view and image-view mode was nonsignificant probably because of the small sample size (i.e., 31 per group), and it has been demonstrated in Chapter 3 that, with this sample size, cases with effect size (Cohen's *d*) smaller than 0.72 may not be significant in this independent samples t-test. Note two cases which have the largest differences in mean scores:

1. View 4 (EOV) [t(28) = 2.422, p = 0.022]. The effect size (Cohen's *d*) was 0.64, suggesting that mode of view had a medium effect on the male subjects'

EOV rating of View 4; and 17.3% of the variance in this EOV rating was attributable to mode of view.

2. View 11 (EOV) [t(35) = 2.650, p = 0.012]. The effect size (Cohen's *d*) was 0.62, suggesting that mode of view had a medium effect on the male subjects' EOV rating of View 11; and 16.7% of the variance in this EOV rating was attributable to mode of view.

6.4.3 Hypothesis: View quality ratings of the female subjects were significantly different under different modes of view

In order to determine whether the mean ratings of POV or EOV by the female subjects were significantly different between the different modes of view, the null and alternative hypotheses were defined as the following:

H_0: There is no significant difference in the mean POV (EOV) rating by the female subjects between the actual-view mode and image-view mode.

H_1: There is a significant difference in the mean POV (EOV) rating by the female subjects between actual-view mode and image-view mode.

To test the hypothesis, we compared the mean POV (EOV) ratings (based on 10-point scale) of the 12 window views between two independent groups of subjects – i.e., female subjects who viewed the real scenes in Experiment 1, and female subjects who viewed images of the same scenes in Experiment 2. An independent samples t-test was performed using SPSS on each of the 12 views with the null hypothesis that there is no significant difference in the mean POV (EOV) rating by the female subjects between the actual-view and image-view mode.

Results of the analysis are summarised in Table 6.3 and Figure 6.7. The results indicate that the difference in the mean POV (EOV) rating by the female subjects

Table 6.3: Comparison of mean ratings of POV (EOV) by female subjects between two different modes of view (actual view vs. image view)

Item	Mean Score: Actual View (X1)	Mean Score: Image View (X2)	Difference in mean scores: (X1) - (X2)	Independent Samples t-Test (t)	df	p-value	
View 1							
POV	4.13	3.29	0.83	1.282	31	0.209	
EOV	4.00	2.53	1.47	2.612	22.60	0.016	*
View 2							
POV	6.07	5.06	1.01	1.626	30	0.114	
EOV	5.27	4.71	0.56	0.803	30	0.428	
View 3							
POV	3.80	4.18	-0.38	-0.487	35	0.629	
EOV	3.27	3.82	-0.55	-0.679	35	0.502	
View 4							
POV	6.29	5.89	0.40	1.291	24.44	0.209	
EOV	5.14	5.06	0.09	0.713	30	0.481	
View 5							
POV	3.94	5.11	-1.17	-1.564	32	0.128	
EOV	3.44	4.33	-0.90	-1.189	32	0.243	
View 6							
POV	4.76	5.50	-0.74	-0.970	26.85	0.341	
EOV	4.24	4.67	-0.43	-0.542	33	0.592	
View 7							
POV	5.31	4.18	1.13	1.452	28	0.158	
EOV	4.62	3.29	1.32	1.510	21.70	0.146	
View 8							
POV	5.53	5.24	0.30	0.382	22.57	0.706	
EOV	5.40	4.76	0.64	0.744	20.96	0.465	
View 9							
POV	6.75	6.68	0.07	0.075	23.56	0.941	
EOV	6.06	6.26	-0.20	-0.215	33	0.831	
View 10							
POV	5.81	6.40	-0.59	-0.735	34	0.468	
EOV	5.56	5.80	-0.24	-0.296	34	0.769	
View 11							
POV	6.92	6.46	0.46	0.474	23	0.640	
EOV	6.17	5.69	0.47	0.457	23	0.652	
View 12							
POV	4.53	4.83	-0.30	-0.419	31	0.678	
EOV	4.00	4.00	0.00	0.000	31	1.000	

Note: * $p < 0.05$
- None of the p-values is lower than the alpha level corrected by Bonferroni method.
Alpha level: 0.05; corrected alpha level: 0.0042

- Levene's test suggests that equality of variances cannot be assumed for View 1 (EOV), View 4 (POV), View 6 (POV), View 7(EOV), View 8 (POV and EOV) and View 9 (POV).

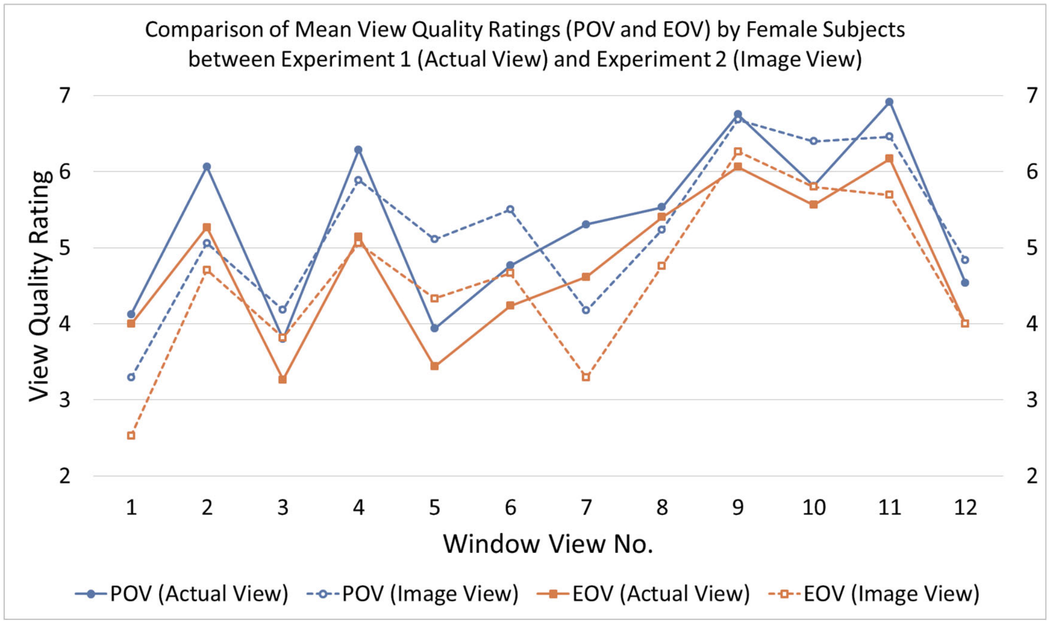


Figure 6.7: Comparison of mean ratings of POV and EOV by female subjects between two different modes of view (actual view vs. image view)

(using a 10-point scale) between actual-view and image-view mode was nonsignificant at the corrected alpha level (0.0042). It can be concluded that there is no significant difference in the mean POV (EOV) rating by the female subjects between the actual-view mode and image-view mode. Therefore, the null hypothesis was retained. Note that in the cases of View 1 (EOV), View 4 (POV), View 6 (POV), View 7(EOV), View 8 (POV and EOV) and View 9 (POV), Levene's test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made in each of these seven cases.

In all 12 cases of POV (EOV), the difference in the mean POV (EOV) rating by the female subjects between the actual-view and image-view mode was nonsignificant probably because of the small sample size. Note the case of View 1 (EOV) [$t(22.60) = 2.612$, $p = 0.016$], which has the largest difference in mean scores, the effect size (Cohen's *d*) was 0.65, suggesting that mode of view had a medium effect on the female subjects' EOV rating of View 1; and 18.6% of the variance in this EOV rating was attributable to mode of view.

6.4.4 Hypothesis: View quality ratings by the "view priority" group were significantly different under different modes of view

"View priority" group is comprised of subjects who opined (as a response to the survey) that window is important because of its view-out function. In order to find out whether the mean ratings of POV and EOV by the "view priority" group were significantly different between the different modes of view, the null and alternative hypotheses were defined as the following:

H_0: There is no significant difference in the mean POV (EOV) rating by the "view priority" group between the actual-view mode and image-view mode.

H_1: There is a significant difference in the mean POV (EOV) rating by the "view priority" group between the actual-view mode and image-view mode.

To test the hypothesis, we compared the mean POV (EOV) ratings (based on 10-point scale) of the 12 window views between two independent groups of subjects – i.e., subjects in a "view priority" group who viewed the real scenes in Experiment 1, and subjects in a different "view priority" group who viewed images of the same scenes in Experiment 2. An independent samples t-test was performed using SPSS on each of the 12 views with the null hypothesis that there is no significant difference in the mean POV (EOV) rating by the "view priority" group between the actual-view and image-view mode.

Results of the analysis are summarised in Table 6.4 and Figure 6.8. The results indicate that the difference in the mean POV (EOV) rating by the "view priority" group (using a 10-point scale) between actual-view and image-view mode was nonsignificant at the corrected alpha level (0.0042). It can be concluded that there is no significant difference in the mean POV (EOV) rating by the "view priority" group between the actual-view mode and image-view mode. Therefore, the null hypothesis was retained.

Table 6.4: Comparison of mean ratings of POV and EOV by "view priority" group between two different modes of view (actual view vs. image view)

Item	Mean Score: Actual View (X1)	Mean Score: Image View (X2)	Difference in mean scores: (X1) - (X2)	Independent Samples t-Test (t)	df	p-value	
View 1							
POV	4.50	4.10	0.40	0.435	14	0.670	
EOV	5.83	3.70	2.13	2.543	14	0.023	*
View 2							
POV	5.00	5.60	-0.60	-0.918	16	0.372	
EOV	4.50	5.10	-0.60	-0.976	16	0.344	
View 3							
POV	4.29	4.88	-0.59	-0.432	13	0.673	
EOV	3.57	4.75	-1.18	-0.850	13	0.410	
View 4							
POV	5.88	5.55	0.33	0.477	17	0.640	
EOV	4.75	3.82	0.93	0.941	17	0.360	
View 5							
POV	3.80	4.50	-0.70	-0.538	13	0.600	
EOV	3.60	3.60	0.00	0.000	13	1.000	
View 6							
POV	2.80	5.63	-2.83	-2.967	11	0.013	*
EOV	2.40	4.25	-1.85	-1.730	11	0.112	
View 7							
POV	5.00	5.25	-0.25	-0.170	10	0.868	
EOV	3.75	3.88	-0.13	-0.092	10	0.929	
View 8							
POV	5.71	5.50	0.21	0.190	13	0.852	
EOV	5.14	4.50	0.64	0.532	13	0.604	
View 9							
POV	6.57	7.27	-0.70	-0.704	16	0.491	
EOV	6.14	6.09	0.05	0.042	16	0.967	
View 10							
POV	6.50	6.43	0.07	0.074	9.55	0.942	
EOV	6.75	5.71	1.04	1.195	8.74	0.264	
View 11							
POV	7.75	6.55	1.20	1.249	13	0.234	
EOV	7.25	5.45	1.80	1.681	13	0.117	
View 12							
POV	4.25	5.82	-1.57	-1.985	17	0.064	
EOV	3.88	5.18	-1.31	-1.343	17	0.197	

Note: * $p < 0.05$
- None of the p-values is lower than the alpha level corrected by Bonferroni method.
Alpha level: 0.05; corrected alpha level: 0.0042

- Levene's test suggests that equality of variances cannot be assumed for View 10 (POV and EOV).

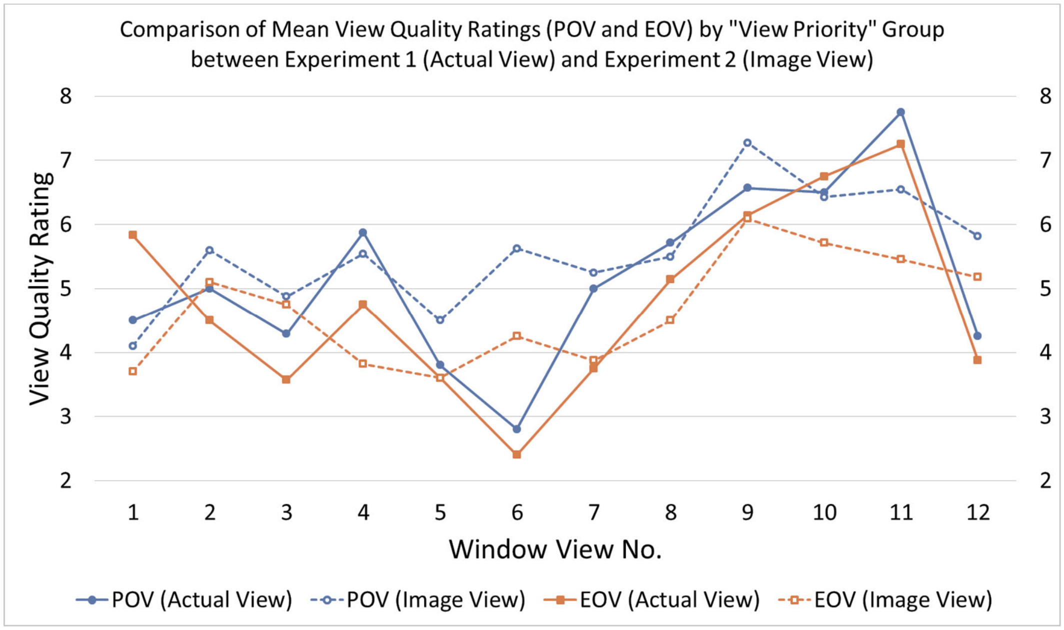


Figure 6.8: Comparison of mean ratings of POV and EOV by "view priority" group between two different modes of view (actual view vs. image view)

Note that in the cases of View 10 (POV and EOV), Levene's test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made in each of these two cases.

In all 12 cases of POV (EOV), the difference in the mean POV (EOV) rating by the "view priority" group between the actual-view and image-view mode was nonsignificant probably because of the small sample size. Note two cases which have the largest differences in mean scores:

1. View 1 (EOV) [t(14) = 2.543, p = 0.023]. The effect size (Cohen's *d*) was 0.92, suggesting that mode of view had a large effect on the "view priority" group's EOV rating of View 1; and 31.6% of the variance in this EOV rating was attributable to mode of view.

2. View 6 (POV) [t(11) = -2.967, p = 0.013]. The effect size (Cohen's *d*) was 1.16, suggesting that mode of view had a very large effect on the "view

priority" group's POV rating of View 6; and 44.5% of the variance in this EOV rating was attributable to mode of view.

6.4.5 Hypothesis: View quality ratings by the "greenery preference" group were significantly different under different modes of view

"Greenery preference" group is comprised of subjects who opined (as a response to the survey) that their most preferred element to be seen through a window is greenery. In order to determine whether the mean ratings of POV and EOV by the "greenery preference" group were significantly different between the different modes of view, the null and alternative hypotheses were defined as the following:

H_0: There is no significant difference in the mean POV (EOV) rating by the "greenery preference" group between the actual-view mode and image-view mode.

H_1: There is a significant difference in the mean POV (EOV) rating by the "greenery preference" group between actual-view mode and image-view mode.

To test the hypothesis, we compared the mean POV (EOV) ratings (based on 10-point scale) of the 12 window views between two independent groups of subjects – i.e., subjects in a "greenery preference" group who viewed the real scenes in Experiment 1, and subjects in a different "greenery preference" group who viewed images of the same scenes in Experiment 2. An independent samples t-test was performed using SPSS on each of the 12 views with the null hypothesis that there is no significant difference in the mean POV (EOV) rating by the "greenery preference" group between the actual-view and image-view mode.

Results of the analysis are summarised in Table 6.5 and Figure 6.9. The results indicate that the difference in the mean POV (EOV) rating by the "greenery preference" group (using a 10-point scale) between actual-view and image-view mode was nonsignificant at the corrected alpha level (0.0042). It can be concluded that there is no significant difference in the mean POV (EOV) rating by the "greenery preference" group between the actual-view mode and image-view mode. Therefore, the null hypothesis was retained. Note that in the cases of View 3 (POV) and View 6 (POV and EOV), Levene's test indicated that the assumption of equal variances across the two groups was violated, hence a correction to the degrees of freedom was made in each of these three cases.

In all 12 cases of POV (EOV), the difference in the mean POV (EOV) rating by the "greenery preference" group between the actual-view and image-view mode was nonsignificant probably because of the small sample size. Note two cases which have the largest differences in mean scores:

1. View 2 (POV) [$t(28) = 3.100$, $p = 0.004$]. The effect size (Cohen's *d*) was 0.80, suggesting that mode of view had a large effect on the "greenery preference" group's POV rating of View 2; and 25.6% of the variance in this POV rating was attributable to mode of view.

2. View 2 (EOV) [$t(28) = 2.075$, $p = 0.047$]. The effect size (Cohen's *d*) was 0.53, suggesting that mode of view had a medium effect on the "greenery preference" group's EOV rating of View 2; and 13.3% of the variance in this EOV rating was attributable to mode of view.

Table 6.5: Comparison of mean ratings of POV and EOV by "greenery preference" group between two different modes of view (actual view vs. image view)

Item	Mean Score: Actual View (X1)	Mean Score: Image View (X2)	Difference in mean scores: (X1) - (X2)	Independent Samples t-Test (t)	df	p-value	
View 1							
POV	3.59	3.14	0.45	0.552	22	0.586	
EOV	3.82	2.57	1.25	1.393	22	0.178	
View 2							
POV	6.31	4.64	1.67	3.100	28	0.004	**
EOV	5.75	4.36	1.39	2.075	28	0.047	*
View 3							
POV	2.75	4.07	-1.32	-1.843	23.17	0.078	
EOV	2.67	3.67	-1.00	-1.199	25	0.242	
View 4							
POV	6.24	6.00	0.24	0.332	26	0.742	
EOV	4.71	4.73	-0.02	-0.024	26	0.981	
View 5							
POV	4.47	5.15	-0.68	-0.796	28	0.433	
EOV	3.65	4.23	-0.58	-0.680	28	0.502	
View 6							
POV	4.73	5.57	-0.84	-1.064	21.37	0.299	
EOV	3.93	4.71	-0.78	-0.891	22.22	0.382	
View 7							
POV	5.30	4.90	0.40	0.448	28	0.658	
EOV	4.70	4.00	0.70	0.770	28	0.448	
View 8							
POV	4.50	5.50	-1.00	-1.281	28	0.211	
EOV	4.31	4.43	-0.12	-0.151	28	0.881	
View 9							
POV	6.75	6.75	0.00	0.000	30	1.000	
EOV	6.00	5.88	0.13	0.130	30	0.897	
View 10							
POV	6.56	6.56	0.00	0.000	30	1.000	
EOV	6.13	5.69	0.44	0.587	30	0.561	
View 11							
POV	6.56	6.57	-0.01	-0.009	28	0.993	
EOV	5.94	5.93	0.01	0.009	28	0.993	
View 12							
POV	5.00	5.00	0.00	0.000	27	1.000	
EOV	4.24	4.25	-0.01	-0.017	27	0.987	

Note: * $p < 0.05$, ** $p < 0.01$
- None of the p-values is lower than the alpha level corrected by Bonferroni method.
Alpha level: 0.05; corrected alpha level: 0.0042. View 2 (POV): $p = 0.0044 > 0.0042$

- Levene's test suggests that equality of variances cannot be assumed for View 3 (POV) and View 6 (POV and EOV).

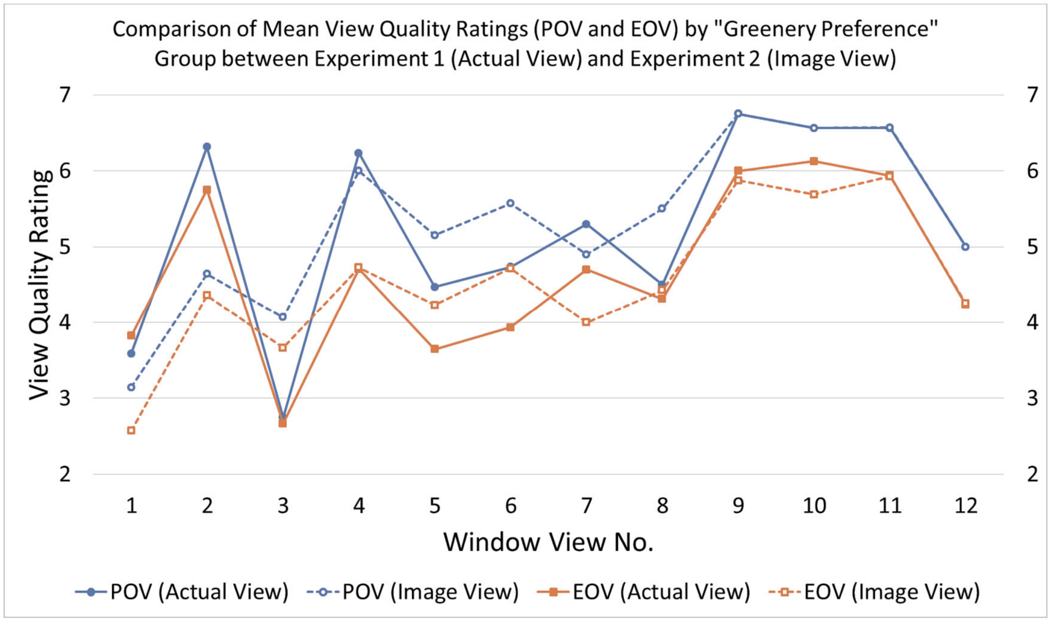


Figure 6.9: Comparison of mean ratings of POV and EOV by "greenery preference" group between two different modes of view (actual view vs. image view)

6.5 Discussions

Overall, either POV or EOV ratings in actual-view mode had larger variability compared to that in image-view mode for most of the 12 views. This was expected as the observers were inevitably affected by other visual stimuli in the real space where the viewing was performed, thus affected the observers' judgements on the POV or EOV. As suggested by Wijntjes (2014) that in the case of looking at images, the observer is in a real space whereas the objects are in a pictorial space, hence the inherent difference between actual view and image view.

Contrary to our initial prediction, the differences in the mean POV (EOV) rating between the actual and image modes of viewing were nonsignificant in all 12 views. Even if we compared these differences based on certain groups only e.g., male or female groups, “view priority” group or “greenery preference” group, the results were similar – i.e., there was no significant difference in the mean POV (EOV) rating between the actual and image modes of viewing. The outcome of analysis was probably affected by the small sample size (i.e., 31 per group). It has been demonstrated in Chapter 3 that cases with effect size (Cohen’s *d*) smaller than 0.72 may not be significant in an independent t-test which has alpha level of 0.05, statistical power of 0.8 and a total sample size of 62 (two groups of 31 subjects).

From the results of hypotheses testing, we can retain the Alberti’s window hypothesis (Wijntjes 2014) that there is no significant difference in the perceived view quality between image view and actual window view of the same scene, despite the difference in depth perception between actual view and image view mentioned in Wijntjes (2014). It was also established that there was generally no significant difference in the mean POV (EOV) rating by the either male or female subjects between the actual-view mode and image-view mode. It is interesting to note that, compared to the male, female subjects are more consistent in the view quality evaluation between actual and image views. Overall, there is no significant difference in the mean POV (EOV) rating by the “view priority” group or the “greenery preference” group between the actual-view mode and image-view mode.

The results of the current experimental study therefore support the findings of Gibson (1971) and Cutting (2003), which suggested that there is no difference between perceiving pictorial space and perceiving environmental space because images contain the same optical information for an observer as reality does (Gibson 1971). In this study, the depth of view ranged from 0.1 to 10.7 kilometres, which was considered to be a relatively large distance compared to the human scale. Hecht et al. (1999) argued that the difference between real and pictorial viewing was “surprisingly small” for large viewing distances, and that the difference was mainly due to the “underestimation of angles at the near centred camera positions”, which was only significant from close range.

The results of the present study can also be explained based on the “boundary extension” theory proposed by Intraub (2014), which suggested that when viewing a picture of a scene, the observer can normally make a fairly good prediction of what is beyond the physical boundaries of the view – i.e. despite being shown only the picture of a window view, the observer perceives it in a larger context, which includes the imagined environment of the surrounding to a certain extent. This natural perceptual ability is probably the reason for the nonsignificant difference between actual view and image view.

6.6 Summary

The main outcomes of this chapter can be summarised as follows:

1. There is no significant difference in the mean POV or EOV rating between the actual view and the image view. However, either POV or EOV ratings in actual-view mode generally have larger variability compared to that in image-view mode.

2. Contrary to our initial prediction, the differences in the mean POV (EOV) rating between the actual and image modes of viewing were nonsignificant in all 12 views. Even if we compared these differences based on certain groups only e.g., male or female groups, "view priority" group or "greenery preference" group, the results were similar – i.e., there was no significant difference in the mean POV (EOV) rating between the actual and image modes of viewing.

3. The results support the findings of Gibson (1971) and Cutting (2003), which suggested that there is no difference between perceiving pictorial space and perceiving environmental space because images contain the same optical information for an observer as reality does (Gibson 1971). Hecht et al. (1999) pointed out that the difference between real and pictorial viewing was "surprisingly small" for large viewing distances. The results of the present study can also be explained using the "boundary extension" theory proposed by Intraub (2014), which suggested that when viewing a picture of a scene, the

observer can normally make a good prediction of what is beyond the physical boundaries of the view.

4. Difference in depth perception between actual view and image view does not significantly affect the perceived qualities of window views (measured in terms of POV or EOV). Therefore, the Alberti's window hypothesis may be still applicable to the evaluation of window view quality.

CHAPTER 7

Testing Predictions of Window View Quality

7.1 Introduction

Previous studies (see Chapter 2) suggest that the quality of the view from a window can be predicted using several attributes of that view – i.e., proportion of greenery, number of view layers, view elements, balance of view, diversity of view, openness of view and depth of view. Experiment 1 (actual view) was conducted to measure the quality of view from 12 windows, which were chosen to exhibit an array of the seven view attributes (see Table 7.1). In this Chapter, these results are used to test predictions made using the seven view attributes.

In Chapter 5 it was demonstrated that the results of view quality evaluations using 10-point and 4-point scales led to similar conclusion (after rescaling to a common 101-point scale) – with the assumption that both rating scales produced interval-level data. However, none of the 4-point scale data obtained from the 12 window views in the experiment was normally distributed (see Chapter 4). Therefore, the subsequent analyses were conducted separately for the 10-point and 4-point response scales: interval-level of measurement for 10-point scale data; ordinal-level for 4-point scale data. Pearson's correlation (parametric analysis) and Spearman's correlation (nonparametric analysis) were used to analyse 10-point and 4-point scale data respectively.

It has been demonstrated in Chapter 6 that there is no significant difference in mean rating on pleasantness of view (POV) or excitingness of view (EOV) between actual views and image views. Therefore, the analyses in this Chapter use data of view quality evaluation based on real scenes only.

Table 7.1: Median and mean rating scores of POV and EOV in Experiment 1 (actual view) and the seven view attributes.

View No.	Median POV Score: 4-point scale	Median EOV Score: 4-point scale	Mean POV Score: 10-point scale	Mean EOV Score: 10-point scale	Proportion of Greenery (10% per unit)	Number of Visual Layers	View Elements (Net Score)	Balance of view (0 - 1)	Diversity of View (Score)	Openness of View (10% per unit)	Depth of View (km)
1	2	2	4.03	4.00	0.6	4	-3	0.87	10	4.8	5.0
2	3	3	6.26	5.58	2.1	4	1	0.86	10	6.0	8.0
3	2	1	3.81	3.26	0.0	3	1	0.99	7	1.2	0.1
4	3	2	6.35	5.06	6.2	3	2	0.92	3	5.8	0.2
5	2	2	4.00	3.52	0.8	4	-2	0.97	7	5.6	3.3
6	2	2	4.94	4.32	0.2	4	-1	0.94	8	6.2	10.7
7	2	2	5.35	4.77	6.4	4	0	0.89	7	2.6	3.0
8	2	2	5.61	4.94	0.0	3	-2	0.77	6	4.0	3.0
9	3	3	7.19	6.42	1.1	4	3	0.93	8	6.5	2.0
10	3	2	6.29	5.87	0.4	3	1	0.77	6	2.0	3.0
11	3	3	6.97	6.45	0.5	4	2	0.70	6	4.7	2.4
12	2	2	4.74	4.32	0.6	4	-1	0.80	8	3.8	2.2

7.2 Analysis of predictions

A series of regressions were conducted to test the degree to which window view attributes predicted the window view quality evaluations. This was performed separately for each of the seven view attributes.

The regressions were repeated separately for evaluations gained using the 10-point scale and the 4-point scale. Results of POV and EOV evaluations using the 10-point scale were suggested to be normally distributed. These regressions were therefore analysed using Pearson's correlation. The hypotheses being tested for Pearson's correlation analysis are the following:

H_0: There is no significant linear association between the mean POV (EOV) rating (10-point scale) and the view attribute.

H_1: There is a significant linear association between the mean POV (EOV) rating (10-point scale) and the view attribute.

Pearson's correlation analysis was performed by using SPSS Statistics programme to test the null hypothesis that there is no significant linear association between the mean POV (or EOV) rating (10-point scale) and each of the seven view attributes. Pearson's correlation coefficient (R_p), which is the effect size of the correlation, measures the strength of the linear relationship: Correlation coefficients (absolute values) between 0.10 and 0.29 represent a small effect; coefficients between 0.30 and 0.49 represent a medium effect; and coefficients of 0.50 and above represent a large effect (Cohen 1988, 1992b). An effect size (R) is an objective and standardised measure of the importance of the experimental effect. R-square (R^2) indicates the percentage of the total variance explained by this effect: if $|R| = 0.10$ (small effect), this case explains 1% of the total variance; if $|R| = 0.30$ (medium effect), the effect accounts for 9% of the total variance; if $|R| = 0.50$ (large effect), the effect accounts for 25% of the total variance (Field and Hole 2003).

Based on a rule of thumb (Krehbiel 2004; Newbold et al. 2003), in order to be statistically significant in the hypothesis testing, $|R_p| \geq 2/\sqrt{n}$, where n is the size of sample (views). When all the 12 window views are included in the correlation analysis (n = 12), the linear association is significant only if $|R_p| \geq 0.577$.

Scatter plots between mean POV (or EOV) rating and view attribute were produced. The lines of best fit and the corresponding simple linear regressions (and R^2 value) express the association between the two variables. Essentially the Pearson's correlation coefficient (R_p) is the standardised slope (β) of the simple linear regression.

Results of POV and EOV evaluations using the 4-point scale were not suggested to be normally distributed (Chapter 4); these regressions were therefore analysed using Spearman's correlation as appropriate for ordinal level data.

The hypotheses being tested for Spearman's correlation analysis are the following:

H_0: There is no significant monotonic relationship between the median POV (EOV) rating (4-point scale) and the view attribute.

H_1: There is a significant monotonic relationship between the median POV (EOV) rating (4-point scale) and the view attribute.

Spearman's correlation analysis was performed by using SPSS Statistics programme to test the null hypothesis that there is no significant monotonic relationship between the median POV (or EOV) rating and each of the seven view attributes.

Spearman's correlation coefficient (R_s) is the special case of the Pearson correlation coefficient for ranked data (Myers et. al. 2010). Spearman's correlation limits an outlier to the value of its rank, thus it is less sensitive than Pearson's correlation to strong outliers. Cohen's (1988, 1992b) standard may be used to evaluate Spearman's correlation coefficient to determine the strength of the relationship or the effect size.

Similar to Pearson's correlation (as explained above): when all the 12 window views are included in the correlation analysis (n = 12), the monotonic relationship between the median POV (EOV) rating (4-point scale) and the view attribute is significant only if $|R_s| \geq 0.577$.

7.3 Proportion of greenery

The proportion of greenery in the 12 views ranged from 0% to 64% (Table 7.1). According to previous studies (Kaplan 2001; Lottrup et al. 2015), higher proportions of greenery or natural content in the view would lead to significantly higher view satisfaction. A further study concluded that exposure to views of nature with an abundance of greenery brought restorative effects to surgical patients (Ulrich 1984). Therefore, it was predicted that higher proportion of greenery in this study would lead to higher ratings of POV and EOV.

7.3.1 Proportion of greenery: 10-point scale data

Figure 7.1(A) and (B) plot mean POV and EOV ratings of 10-point scale against the greenery proportion. The association between either of the mean ratings and greenery proportion is not statistically significant (POV: $R_p = 0.235$, n = 12, p = 0.463. EOV: $R_p = 0.105$, n = 12, p = 0.746). Consider View 4 and View 7, which have greenery proportions of 62% and 64% respectively: if greenery proportion were a robust and significant predictor, the evaluations of these two views would be the highest of the 12 windows, but they are not. In summary, the null hypothesis is retained: these data do not support the predicted trend that an increase in greenery proportion is associated with an increase in view quality.

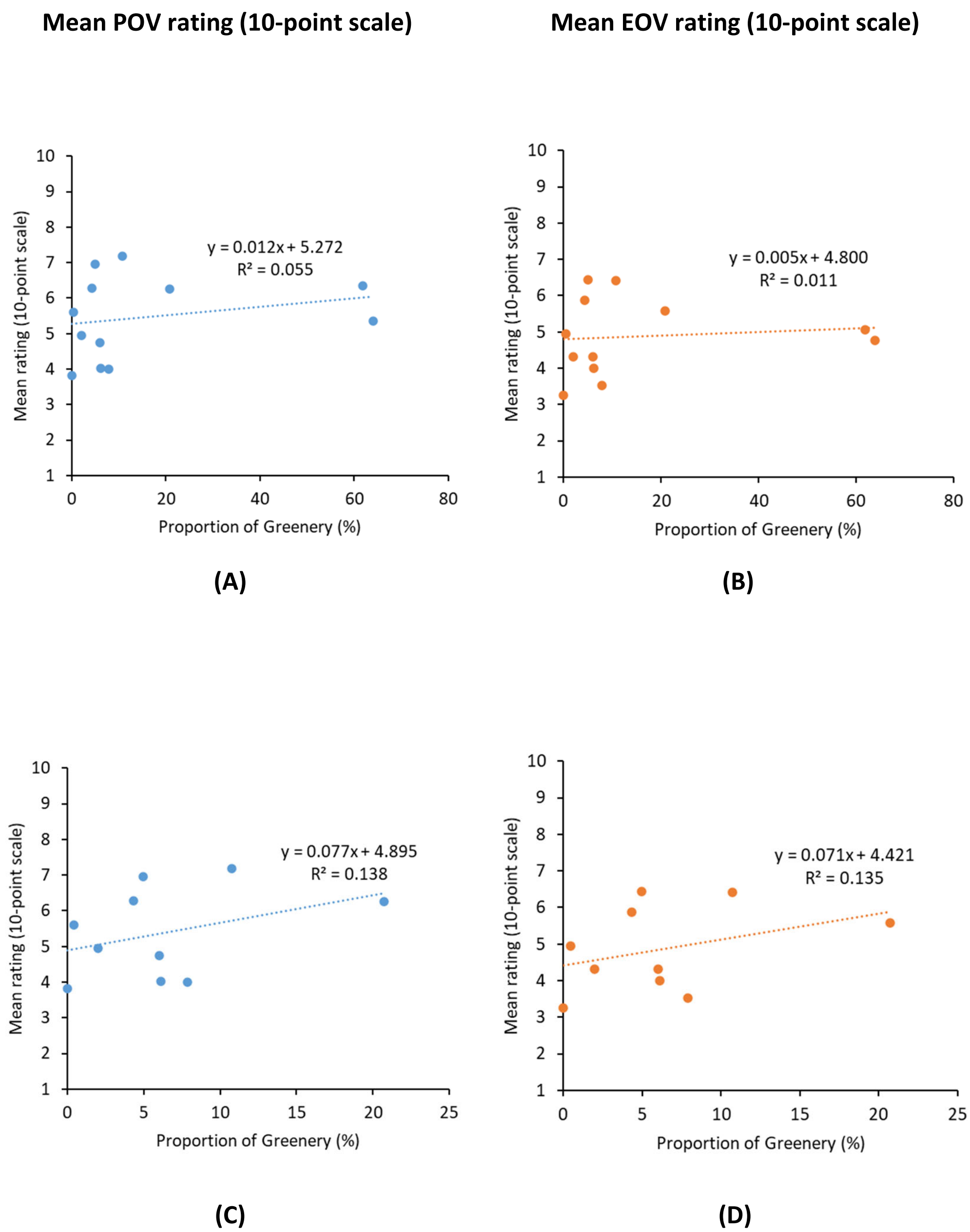


Figure 7.1: Mean ratings of POV and EOV (10-point scale) plotted against proportion of greenery. (A) POV: all 12 views included in analysis. (B) EOV: all 12 views included in analysis. (C) POV: View 4 and View 7 omitted from analysis. (D) EOV: View 4 and View 7 omitted from analysis.

Note however in Figure 7.1(A) and (B) that two points (Views 4 and 7) appear to anchor the best fit line. If these two views are omitted from the analysis (Figure 7.1 (C) and (D)) the association increases, although it is still not statistically significant (POV: $R_p = 0.368$, $n = 10$, $p = 0.295$. EOV: $R_p = 0.363$, $n = 10$, $p = 0.303$), and the best fit line now displays the predicted trend for an increase in greenery proportion to lead to a better evaluation of view quality. There are several explanations for this:

1. That greenery proportion is not a valid predictor of view quality.
2. That greenery proportion alone is insufficient and interacts with one or more of the other variables.
3. That the effect of greenery proportion on view quality is not linear but, upon reaching a threshold, further increase in greenery proportion leads to a reduction in view quality. In other words, we want some greenery, but too much is not a good thing.

7.3.2 Proportion of greenery: 4-point scale data

Figures 7.2 (A) and (B) plot median POV and EOV ratings against the greenery proportion. The plots are random, indicating that the relationship between POV (or EOV) and greenery proportion is not suggested to be significant (POV: $R_s = 0.319$, $n = 12$, $p = 0.312$. EOV: $R_s = 0.399$, $n = 12$, $p = 0.199$). Again, these data do not support the prediction that an increase in greenery proportion leads to an increase in view quality: from the plots and Spearman's rank correlation analysis, the null hypothesis is retained.

View 4 and View 7 have extremely high greenery proportions relative to the other ten views. As with the 10-point scale data, this analysis was repeated with these two views omitted (Figure 7.2 (C) and (D)). Here, the POV and EOV data lead to different conclusions: For EOV, the remaining ten views suggest a significant association between EOV and greenery proportion at the 0.05 level (EOV: $R_s = 0.666$, $n = 10$, $p = 0.035$). However, for POV, the relationship between POV and greenery proportion still does not exhibit significant association ($R_s = 0.429$, $n = 10$, $p = 0.216$).

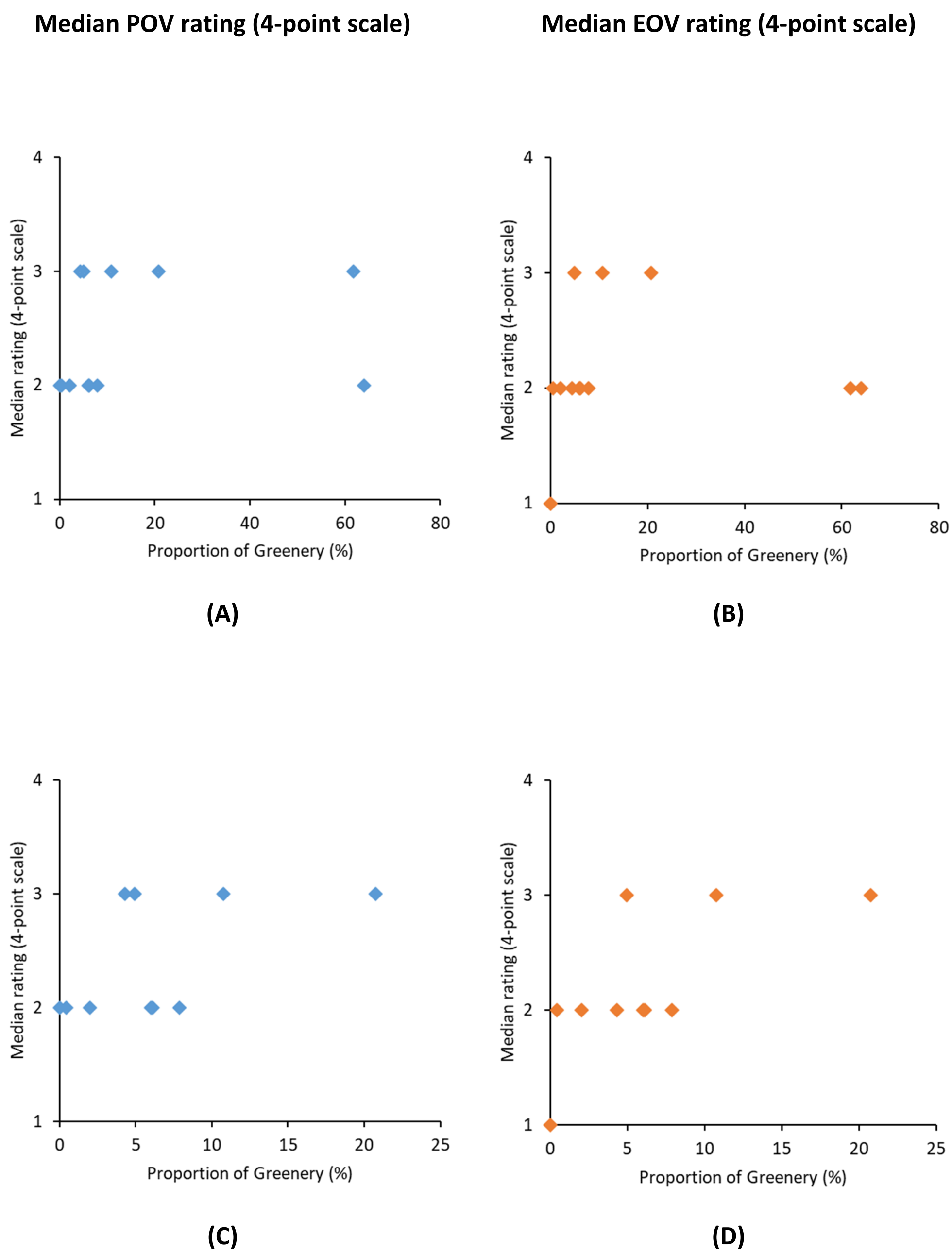


Figure 7.2: Median ratings of POV and EOV (4-point scale) plotted against proportion of greenery. (A) POV: all 12 views included in analysis. (B) EOV: all 12 views included in analysis. (C) POV: View 4 and View 7 omitted from analysis. (D) EOV: View 4 and View 7 omitted from analysis (Spearman's rank correlation is significant at the 0.05 level in (D)).

A possible reason for this difference in results between POV and EOV is that an increase in the greenery proportion (to a certain limit) creates a better "mood" of view – i.e., a more stimulating or motivating view (measured in terms of EOV), but not a more pleasant view (measured in terms of POV).

7.3.3 Proportion of greenery: summary

Evaluations of the 12 window views do not support the proposal that a higher proportion of greenery in the view leads to a higher evaluation of view quality. For both 10-point and 4-point evaluations, and for both EOV and POV, the association between evaluation and greenery proportion was not statistically significant. This result concurs with that of Matusiak and Klöckner (2016) who did not find a significant effect of greenery proportion on view quality, but it is not consistent with the studies of Kaplan (2001) and Lottrup et al. (2015) who reported a significant effect.

One explanation for the differences in these conclusions is the degree to which the experimental method prompted a focus on greenery. In the two studies which did not find a significant effect of greenery proportion (Matusiak and Klöckner 2016, and the current work), greenery proportion was an independent variable categorised by the experimenter and observers evaluated view quality without a specific prompt to focus on greenery proportion. In the two studies (Kaplan 2001; Lottrup 2015) where greenery proportion was suggested to be significant, this was a specific focus of the test instructions and evaluation questions.

In Kaplan (2001), the test participants were informed through a cover letter that the postal survey was about "*trying to understand how trees and bushes and lawns and flowers relate to how people feel*". In Lottrup et al. (2015) five of the 10 possible response categories offered to the subjects in the survey questionnaire comprised items of greenery ("trees", "mowed lawn", "flowers", "park-like environment" and "wild self-seeded natural environment"). Thus, in both studies the test participants were expected to rate the view quality with reference to the greenery content in each of the scenes, which was the focus of the surveys. Therefore, the difference in conclusions may be attributed to the difference in the test procedure for evaluation of view quality.

In the present study, two views have distinctively higher greenery proportions (View 4: 62%, and View 7: 64%) than the remaining ten views (0% to 21%). When Views 4 and 7 were omitted from the analysis the degree of association increased in all cases, and for one case (EOV evaluations with the 4-point scale) the association reached statistical significance at the 0.05 level ($p = 0.035$). It is possible that an increase in greenery proportion improves view quality when the proportion is low, here being in the range of zero to about 20% of the view by area, but when a certain proportion of greenery is reached, further increase in greenery proportion has negligible effect. In the current data, the threshold for that transition lies somewhere between about 20% and 60%.

In the current analysis, the correlation between "proportion of greenery" and the view quality (either POV or EOV) does not support the previous studies (Kaplan 2001; Lottrup et al. 2015), which suggested that higher proportion of greenery would lead to higher view quality. One of the possible explanations for this is that the "proportion of greenery" attribute in this study represents the combined area of greenery content that is observed in a two-dimensional pictorial space in relation to the entire view (image); the aesthetical quality of the greenery elements is not considered in the assessment of the "proportion of greenery" but in the "view elements" attribute. Therefore, it is predicted that if the greeneries in several selected views have equal (or very close) qualities but diverse proportions, then the greenery proportion of these views will probably demonstrate a much stronger correlation with the view quality. However, the 12 views in this study did not cover sufficiently large variety of proportions of greeneries that have similar quality. In contrast, View 4 and View 7 were both dominated by greenery with very close proportions, but the qualities of greenery between them were significantly different: View 4 was dominated by greenery that consisted of a layer of shrubs and trees with dense foliage in the background whilst the greenery in View 7 was made by a tree located very closely to the window thus obstructing part of the view. Therefore, to test "proportion of greenery" as a predictor of view quality, we need more views that have greeneries of the same quality but varied in terms of proportions, so that we can control for the possible confounding effect of the quality of greenery.

7.4 Number of visual layers

The number of visual layers in the 12 window views of this study is either 3 or 4 (see Table 7.1). According to previous studies (Hellinga and Hordijk 2014; Matusiak and Klöckner 2016), it was predicted that a larger number of visual layers in the view would lead to higher (more positive) evaluations of view quality (measured in terms of POV and/or EOV).

7.4.1 Number of visual layers: 10-point scale data

Figure 7.3 (A) and (B) plot mean POV and EOV ratings against the number of visual layers. These data do not support that trend: from the plots and Pearson's correlation analysis, the null hypothesis is retained – i.e., the linear association between either of the mean ratings and the number of visual layers is nonsignificant (POV: $R_p = -0.034$, $n = 12$, $p = 0.917$. EOV: $R_p = 0.065$, $n = 12$, $p = 0.840$). Therefore, these results do not support the previous studies.

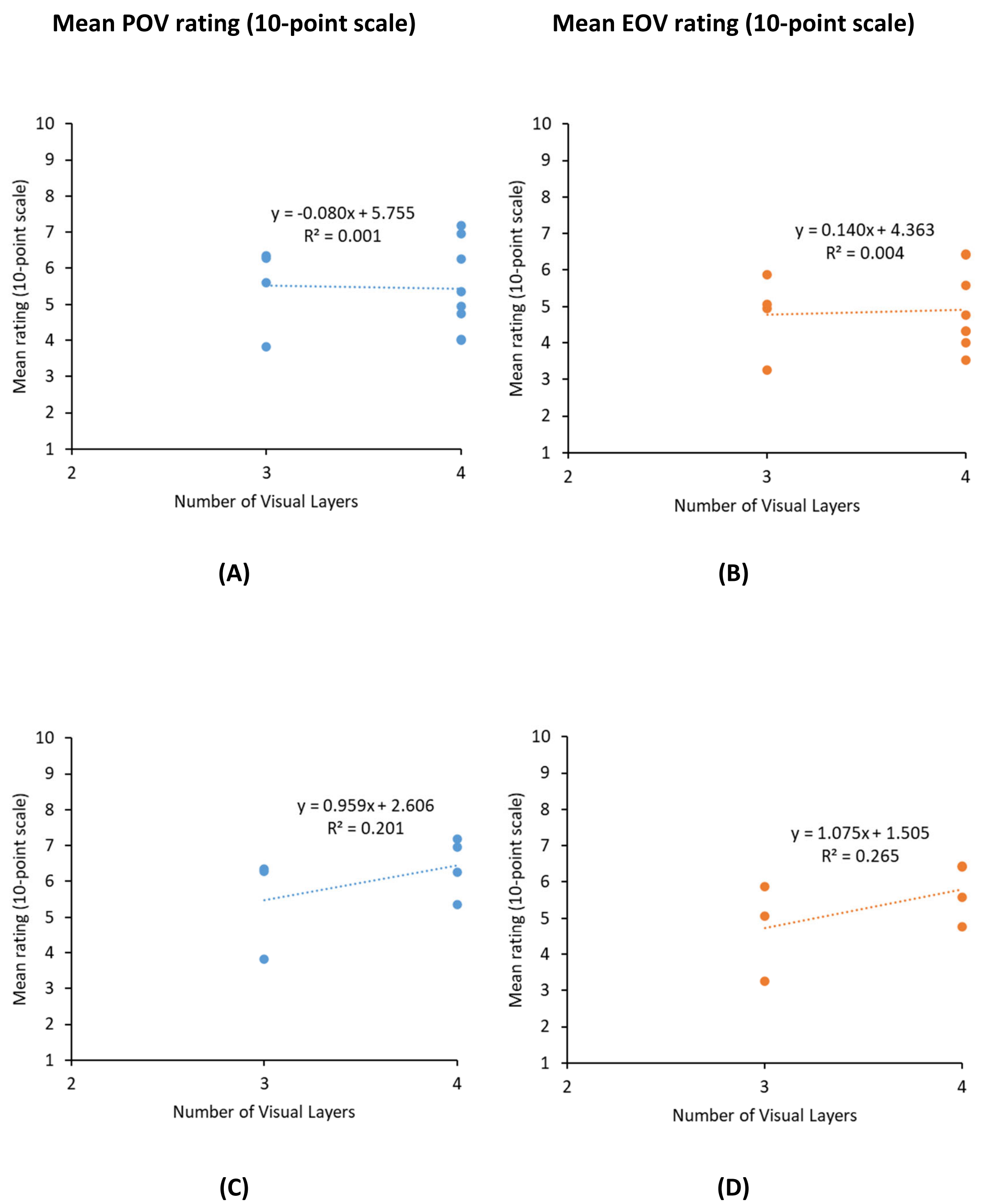


Figure 7.3: Mean ratings of POV and EOV (10-point scale) plotted against the number of visual layers. (A) POV: all 12 views included in analysis. (B) EOV: all 12 views included in analysis. (C) POV: Views 1, 5, 6, 8 and 12 omitted from analysis. (D) EOV: Views 1, 5, 6, 8 and 12 omitted from analysis

Views 1, 5, 6, 8 and 12 have negative "view elements" scores (see Table 7.1). Interestingly, when these five views were omitted from the analysis (see Figure 7.3 (C) and (D)), the linear association between either of the mean ratings and the number of visual layers became much stronger; and in this case EOV rating had large effect size ($R > 0.50$) (POV: $R_p = 0.448$, $n = 7$, $p = 0.313$. EOV: $R_p = 0.515$, $n = 7$, $p = 0.237$). However, this linear association was still nonsignificant at the 0.05 level.

7.4.2 Number of visual layers: 4-point scale data

Figures 7.4 (A) and (B) plot median POV and EOV ratings of 4-point scale respectively against the number of visual layers. From the plots and Spearman's rank correlation analysis, the null hypothesis is retained – i.e., there is no significant monotonic relationship between median POV or EOV rating and the number of visual layers at the 0.05 level (POV: $R_s = -0.120$, $n = 12$, $p = 0.711$. EOV: $R_s = 0.523$, $n = 12$, $p = 0.081$). EOV of 4-point scale had large effect size ($R > 0.50$) – i.e., a much stronger association with the number of visual layers (compared to POV) but this association was nonsignificant at the 0.05 level (only significant at the 0.1 level). Therefore, the results do not confidently support the previous studies.

If Views 1, 5, 6, 8 and 12 (which have negative view elements score) are removed from the analysis (see Figure 7.4 (C) and (D)), there is still no significant relationship for median POV rating (POV: $R_s = 0.091$, $n = 7$, $p = 0.846$) but the monotonic association between the median EOV rating and the number of visual layers becomes strong and significant at the 0.05 level (EOV: $R_s = 0.780$, $n = 7$, $p = 0.039$). This suggests that an increase in the number of visual layers from 3 to 4 will positively affect the "mood" of view (i.e., more stimulating, measured in terms of EOV) rather than the beauty of the view (measured in terms of POV) – on condition that the aesthetical scene quality is not negative (i.e., net score of "view elements" is zero or above).

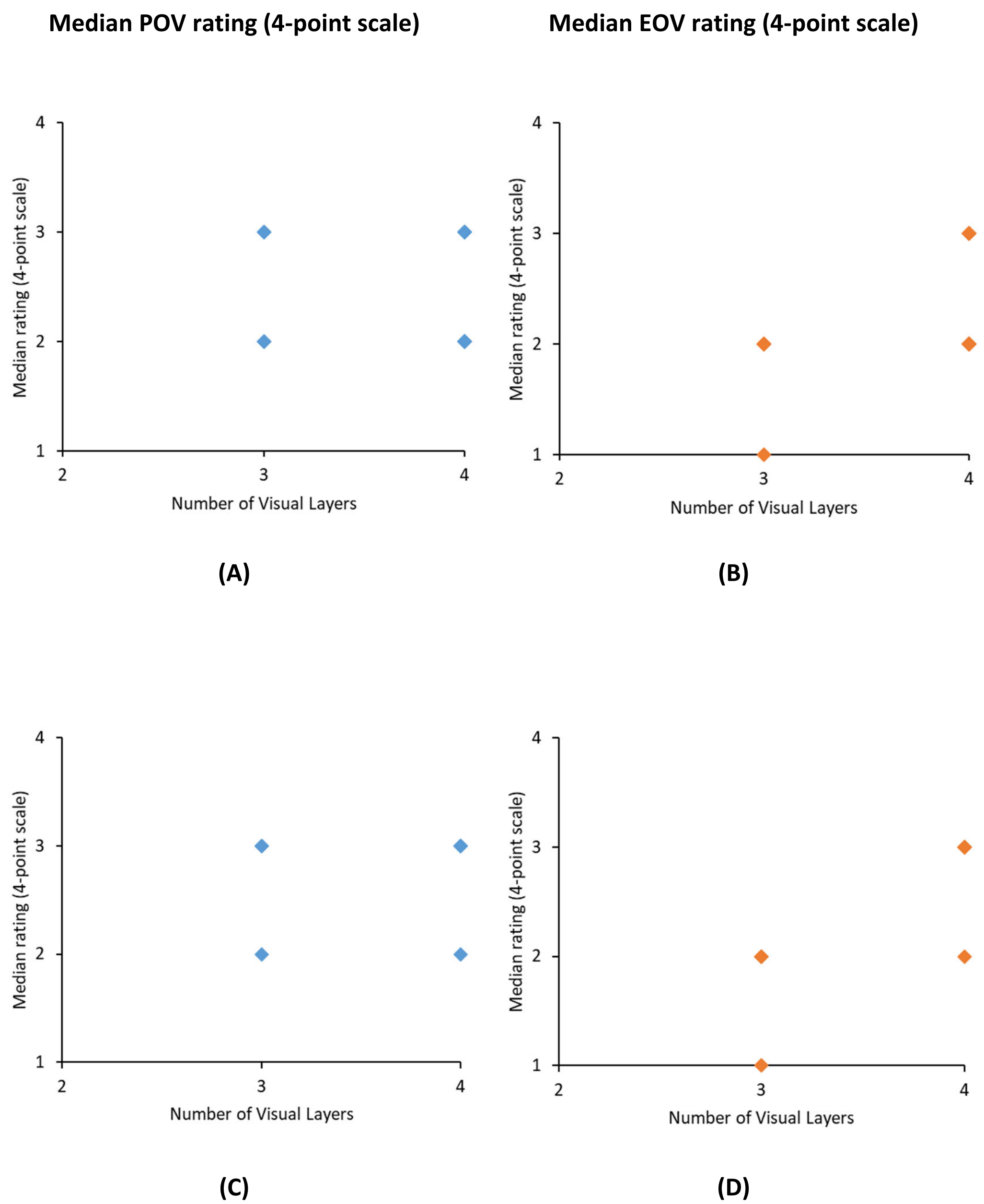


Figure 7.4: Median ratings of POV and EOV (4-point scale) plotted against the number of visual layers. (A) POV: all 12 views included in analysis. (B) EOV: all 12 views included in analysis. (C) POV: Views 1, 5, 6, 8 and 12 omitted from analysis. (D) EOV: Views 1, 5, 6, 8 and 12 omitted from analysis (Spearman's rank correlation is significant at the 0.05 level).

7.4.3 Number of visual layers: summary

Contrary to the previous studies, there was no evidence to suggest that the number of visual layers in the 12 window views of this study was associated with the view quality measured in terms of POV or EOV (either 10-point or 4-point scale). However, the number of visual layers was found to have strong and significant monotonic relationship with EOV of 4-point scale when the five views with negative view elements scores (i.e., Views 1, 5, 6, 8 and 12) were omitted from the analysis. A plausible explanation for this difference is as follows:

1. The view quality measured in Matusiak and Klöckner (2016) was based on a single-item 4-point rating scale ("1"- not satisfactory; "2" – satisfactory; "3" – good; "4" – excellent). It is considered to have captured both POV and EOV; in the current study these were measured as separate rating-scale items. Therefore, it is possible that the earlier prediction (that a larger number of visual layers in the view would lead to higher evaluations of view quality) was only valid if the view quality was measured in terms of EOV rating of 4-point scale on condition that the overall aesthetic impression of the view elements was not negative.

2. Because the window views in the current study only included three or four visual layers, more views with two visual layers are needed to ascertain its relationship with window view quality (measured in terms of POV and EOV).

7.5 View Elements

"View elements" median scores in the 12 views of this study ranged from -3 to 3 (Table 7.1). According to previous studies (Matusiak and Klöckner 2016) on "aesthetical scene quality" (ordinal variable: from "1" – very poor to "4" – very good), it was predicted that higher (more positive) "view elements" (net score) in the view would lead to higher evaluations of view quality.

7.5.1 View Elements: 10-point scale data

Figure 7.5 (A) and (B) plot mean POV and EOV ratings (10-point scale) against the "view elements" (median net score) on the assumption of a linear relationship. These data support that trend: from the plots and Pearson's correlation analysis, the null hypothesis is rejected – i.e., the association between the mean POV (EOV) rating and "view elements" is statistically significant at the 0.01 (0.05) level (POV: $R_p = 0.747$, $n = 12$, $p = 0.005$. EOV: $R_p = 0.667$, $n = 12$, $p = 0.018$). There appears to be a positive linear relationship between either mean POV or EOV rating (10-point scale) and view elements. Therefore, these results concur with the previous studies.

The evaluations of two views – i.e., View 3 and View 8, lie away from the best fit line. Removal of these two views from the analysis increases the R_p values and the associations are now significant at the 0.001 level (POV: $R_p = 0.979$, $n = 10$, $p < 0.001$. EOV: $R_p = 0.901$, $n = 10$, $p < 0.001$) (see Figure 7.5 (C) and (D)). These two views coincidently are the only ones (among the 12 views) with 0% greenery proportion. This implies that "view elements" has an extremely large effect size ($R > 0.9$) on view quality when greenery is present in each of the scene evaluated. For scenes without any greenery, "view elements" is likely to be confounded by other view attributes, hence its relationship with view quality does not follow the trend.

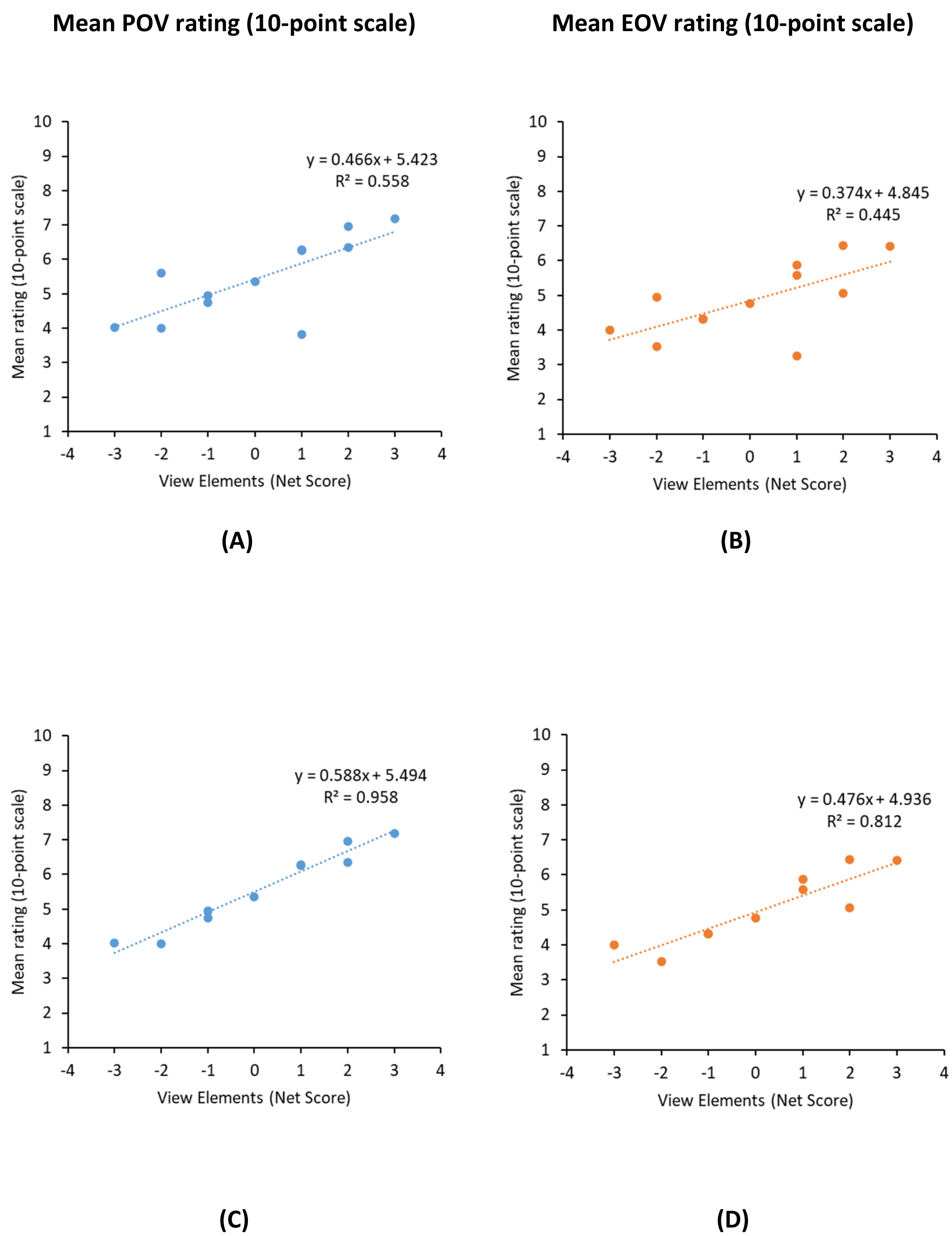


Figure 7.5: Mean ratings of POV and EOV (10-point scale) plotted against view elements. (A) POV: all 12 views included in analysis. (B) EOV: all 12 views included in analysis. (C) POV: Views 3 and 8 omitted from analysis. (D) EOV: Views 3 and 8 omitted from analysis (Pearson's correlation is significant at the 0.01 and 0.05 levels in (A) and (B) respectively, and at the 0.001 level in (C) and (D)).

7.5.2 View Elements: 4-point scale data

Figures 7.6 (A) and (B) plot median POV and EOV ratings of 4-point scale respectively against the "view elements" (median net score). The data of POV rating (4-point scale) support that trend: from the plot and Spearman's rank correlation analysis, the null hypothesis is rejected – i.e., there is a significant monotonic relationship between median POV rating and view elements at the 0.01 level (POV: $R_s = 0.818$, $n = 12$, $p = 0.001$). A strong positive rank correlation exists between median POV rating (4-point scale) and "view elements" – i.e., when view elements score gets higher (more positive), the median POV rating (4-point scale) increases. However, the data of EOV rating (4-point scale) do not support that trend: from the plot and Spearman's rank correlation analysis, we do not reject the null hypothesis – i.e., there is no significant monotonic relationship between EOV (4-point scale) and view elements (EOV: $R_s = 0.457$, $n = 12$, $p = 0.135$). Therefore, the results of POV (4-point scale), but not EOV (4-point scale), concur with the previous studies.

When View 3 and View 8, which have no greenery content, are removed from the analysis, the monotonic relationship between median POV (EOV) rating and "view elements" is significant at the 0.01 (0.05) level (POV: $R_s = 0.878$, $n = 10$, $p = 0.001$. EOV: $R_s = 0.652$, $n = 10$, $p = 0.041$) (see Figures 7.6 (C) and (D)).

7.5.3 View Elements: summary

Evaluations of the 12 window views support the proposal that a higher (more positive) view elements score in the view leads to a higher evaluation of view quality. For the 10-point scale data evaluations, and for both POV and EOV, the association between the view evaluation and view elements was statistically significant. These linear associations become stronger and more significant when two views without greenery content (View 3 and View 8) are removed from the analysis.

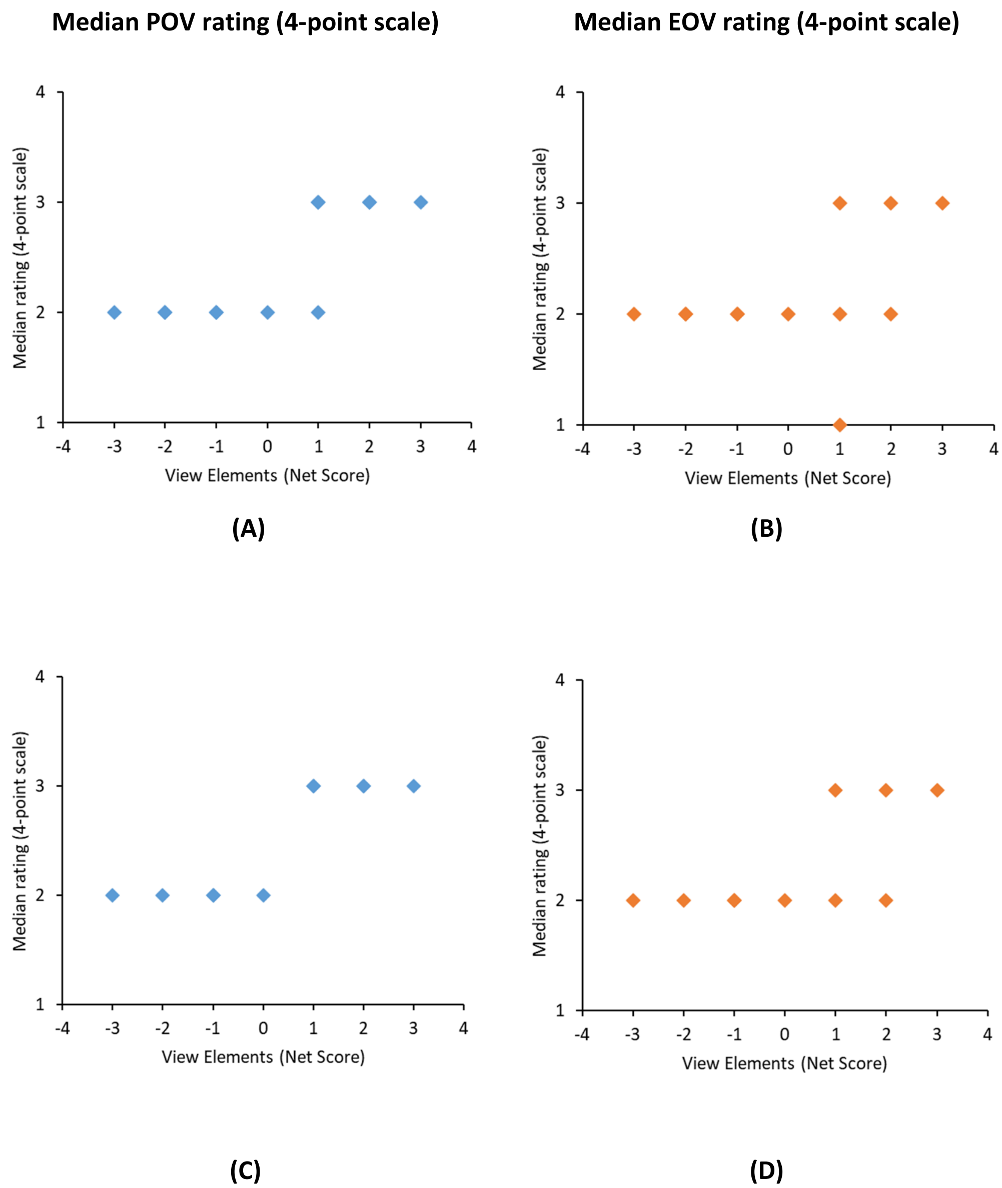


Figure 7.6: Median ratings of POV and EOV (4-point scale) plotted against view elements. (A) POV: all 12 views included in analysis. (B) EOV: all 12 views included in analysis. (C) POV: Views 3 and 8 omitted from analysis. (D) EOV: Views 3 and 8 omitted from analysis (Spearman's rank correlation is significant at the 0.01 level in (A) and (C), and at the 0.05 level in (D)).

For the 4-point scale POV, the monotonic relationship between the evaluation and "view elements" was statistically significant, and this relationship also becomes significant in EOV when the two views without greenery content (View 3 and View 8) are removed from the analysis.

The results for POV (both 10-point and 4-point scales) and EOV of 10-point scale are consistent with the previous study of Matusiak and Klöckner (2016), which indicated that "aesthetical scene quality" had a significant effect on view quality. The result suggests that "view elements" is potentially a robust predictor of POV. Proportion of greenery appears to be a confounding variable to the prediction based on "view elements". Because when View 3 and View 8, which have no greenery content, are removed from the analysis, the prediction of either POV or EOV based on "view elements" (linear or monotonic relationship) improves, and particularly the monotonic relationship between "view elements" and EOV becomes significant.

7.6 Balance of View

"Balance of view" for the 12 views of this study ranged from 0.70 to 0.99 (Table 7.1). According to a previous study by Matusiak and Klöckner (2016) on "composition of the scene" (ordinal variable: from "1" – very poor to "4" – very good), it was predicted that higher balance of view would lead to higher (more positive) evaluations of view quality.

7.6.1 Balance of View: 10-point scale data

Figures 7.7 (A) and (B) plot mean POV and EOV ratings (10-point scale) against the balance of view on the assumption of a linear relationship. From the plots and Pearson's correlation analysis, the null hypothesis is retained for POV but rejected for EOV evaluation – i.e., the linear association between the mean POV rating and "balance of view" is nonsignificant; between mean EOV rating and "balance of view", it is

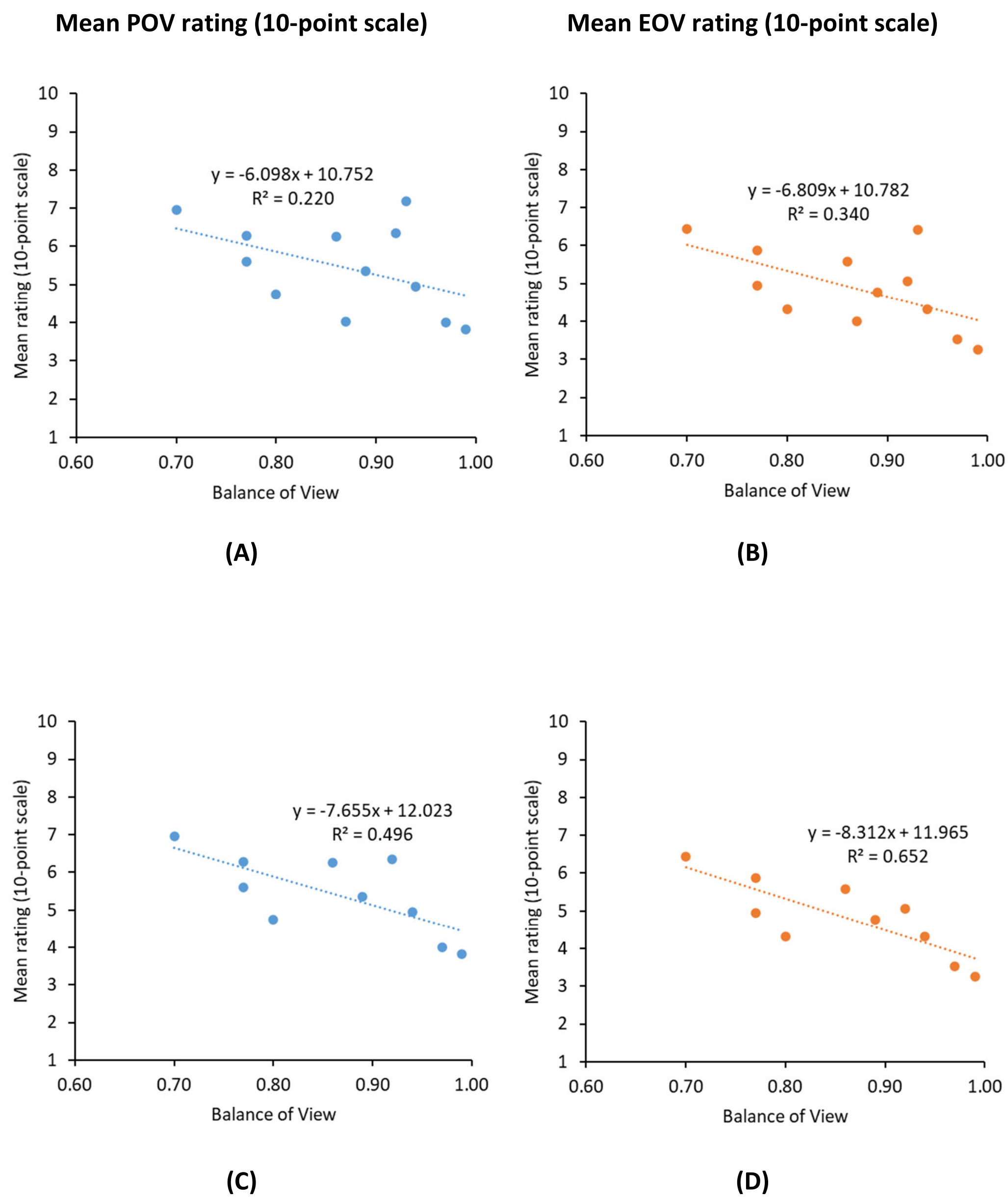


Figure 7.7: Mean ratings of POV and EOV (10-point scale) plotted against "balance of view." (A) POV: All 12 views included in analysis. (B) EOV: All 12 views included in analysis. (C) POV: Views 1 and 9 omitted from analysis. (D) EOV: Views 1 and 9 omitted from analysis. (Pearson's correlation is significant at the 0.05 level in (B) and (C), 0.01 level in (D)).

statistically significant at the 0.05 level with a large effect size (POV: R_p = -0.470, n = 12, p = 0.124. EOV: R_p = -0.583, n = 12, p = 0.047). There appears to be a negative linear relationship between EOV rating (10-point scale) and “balance of view.” Therefore, these results do not concur with the previous studies, which predicted that higher balance of view would lead to higher (more positive) evaluations of view quality. Analysis of the 12 views does not show any significant linear relationship between pleasantness of a view and the degree of balance of the view. However, it suggests a negative linear association between excitingness of a view and balance of the view – i.e., it is predicted that a view will appear to be less exciting when the view has a higher degree of balance; and a view will appear to be more exciting when the view has a lower degree of balance.

Among the 12 views in this study, Views 1 and 9 have the lowest (most negative) and highest (most positive) “view elements” score respectively (see Table 7.1). Interestingly, when these two views are omitted from the analysis (see Figure 7.3 (C) and (D)), the linear association between either of the view quality ratings and the “balance of view” becomes significant at the 0.05 and 0.01 levels for POV and EOV respectively and has a large effect size (POV: R_p = -0.704, n = 10, p = 0.023. EOV: R_p = -0.808, n = 10, p = 0.005). This suggest that the perceived pleasantness of a view also has a negative linear correlation with balance of the view – only if the aesthetical scene quality (“view elements”) is not extremely low (negative) or high (positive).

7.6.2 Balance of View: 4-point scale data

Figures 7.8 (A) and (B) plot median POV and EOV ratings (4-point scale) respectively against balance of view. From the plots and Spearman’s rank correlation analysis, the null hypothesis is retained – i.e., there is no significant monotonic relationship between median POV or EOV rating (4-point scale) and “balance of view” (POV: R_s = -0.343, n = 12, p = 0.275. EOV: R_s = -0.417, n = 12, p = 0.178). When the two views that have extreme aesthetical scene qualities (View 1 and View 9) are removed from the analysis, there is still no statistically significant monotonic relationship between median POV or

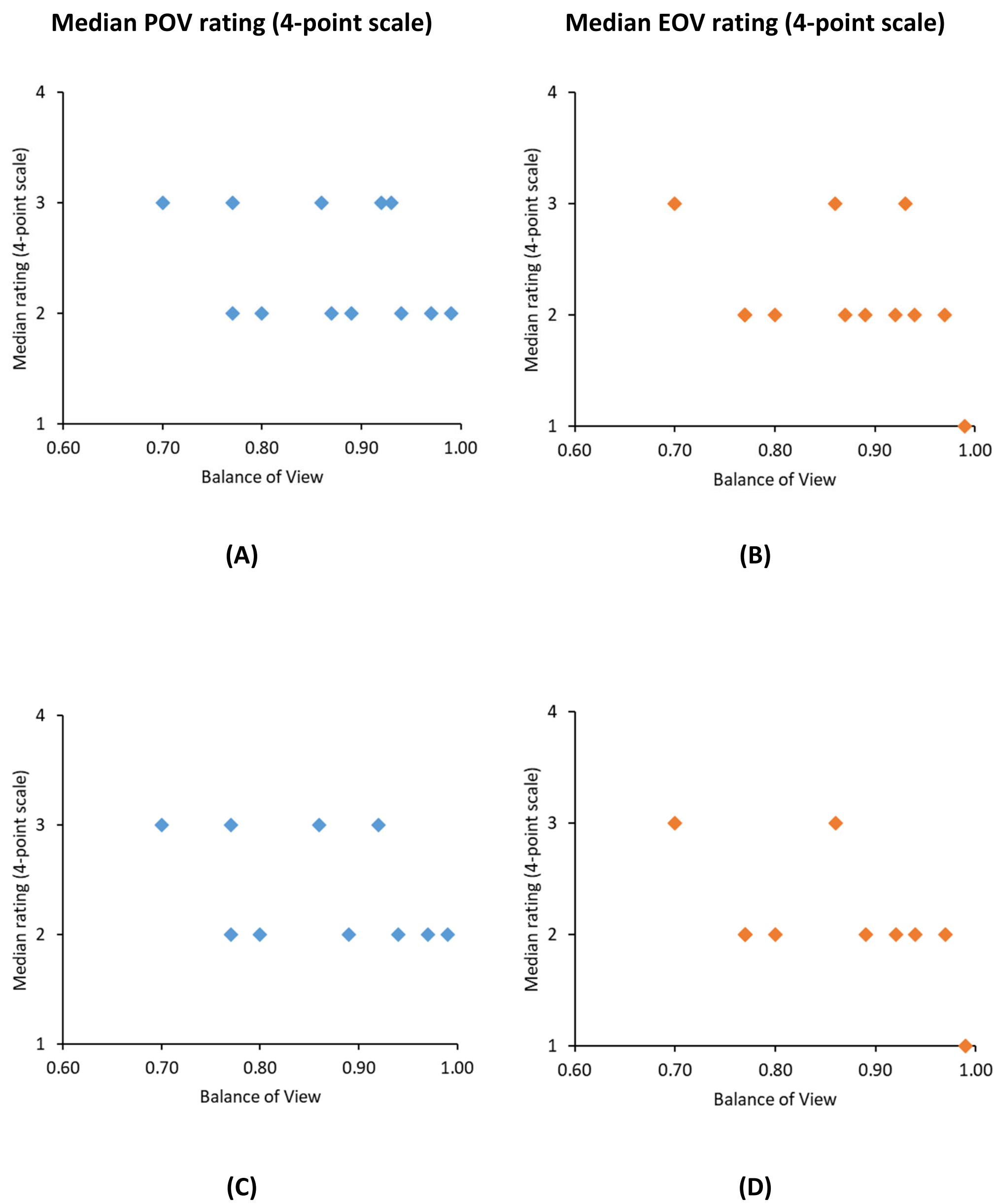


Figure 7.8: Median ratings of POV and EOV (4-point scale) plotted against balance of view. (A) POV: All 12 views included in analysis. (B) EOV: All 12 views included in analysis. (C) POV: Views 1 and 9 omitted from analysis. (D) EOV: Views 1 and 9 omitted from analysis.

EOV rating (4-point scale) and "balance of view" (POV: $R_s = -0.463$, $n = 10$, $p = 0.177$. EOV: $R_s = -0.609$, $n = 10$, $p = 0.062$) (see Figure 7.8 (C) and (D)). Therefore, the null hypotheses (i.e., there is no significant monotonic relationship between "balance of view" and the median POV or EOV rating using 4-point scale) is retained.

7.6.3 Balance of View: summary

Evaluations of the 12 window views do not support the outcome of past studies by Matusiak and Klöckner (2016) that a higher (more positive) balance of view leads to a higher evaluation of view quality. The outcome of this analysis suggests the contrary – i.e., a negative linear association between excitingness of a view and balance of the view, which means that a view is predicted to be less exciting when the view has a higher degree of balance; and a view is predicted to be more exciting when the view has a lower degree of balance. In addition, the perceived pleasantness of a view may have a negative linear relationship with balance of the view when the aesthetical scene quality ("view elements") is not extremely low (negative) or high (positive).

The possible explanations for this difference in result are as follows:

1. That "balance of view" in this study is a quantitative parameter (with a ratio-level measurement), whereas the equivalent parameter, "composition of scene" in Matusiak and Klöckner (2016) was a qualitative parameter (with an ordinal-level measurement). The difference in the methods of measuring "balance of view" in the two studies probably causes the difference in results.

2. That "balance of view" may be confounded by other predictors of view quality such as "openness of view" (significant correlation between these two attributes was observed, as shown in Table 7.3). Bias in prediction may occur when the confounding variables correlate with "balance of view", resulting in multicollinearity in the prediction model. Matusiak and Klöckner (2016) pointed out that there was a strong correlation between "composition of scene"

and “aesthetical scene quality”, and with the perceived view quality. The qualitative parameters – “composition of scene” and “aesthetical scene quality” in Matusiak and Klöckner (2016) are equivalent to the quantitative parameters “balance of view” and “view elements” respectively in this study.

7.7 Diversity of View

Diversity of view in the 12 views of this study ranged from 3 to 10 (Table 7.1). According to previous studies (Hellinga and Horjik 2014), higher diversity of view (“low diversity” – 0 point; “medium diversity” – 1 point; “high diversity” – 2 points) contributed to higher view quality. Therefore, in this study it was predicted that higher diversity of view would lead to higher (more positive) evaluations of POV and EOV.

7.7.1 Diversity of View: 10-point scale data

Figures 7.9 (A) and (B) plot mean POV and EOV ratings (10-point scale) against “diversity of view” on the assumption of a linear relationship. These data do not support that trend: from the plots and Pearson’s correlation analysis, the null hypothesis is retained – i.e., the association between either of the mean rating and diversity of view is not statistically significant under linear assumption (POV: R_p = -0.304, n = 12, p = 0.336. EOV: R_p = -0.157, n = 12, p = 0.627). Therefore, these results do not concur with the previous studies.

Views 2, 6 and 9 had the highest openness (60% or above) among the 12 views. When these three views are omitted from the analysis, there is a statistically significant linear association between POV (10-point scale) and diversity of view at the 0.05 level with large effect size ($|R| > 0.5$) (POV: R_p = -0.675, n = 9, p = 0.046), but not significant on the EOV (10-point scale) evaluation (EOV: R_p = -0.455, n = 9, p = 0.218) (see Figure 7.9 (C) and (D)). Negative correlation coefficient for the POV evaluation here suggests that as the diversity of view increases, the view quality (measured in terms of POV) decreases. This result is inconsistent with the result of past studies (Hellinga and Horjik 2014), which proposed the opposite effect.

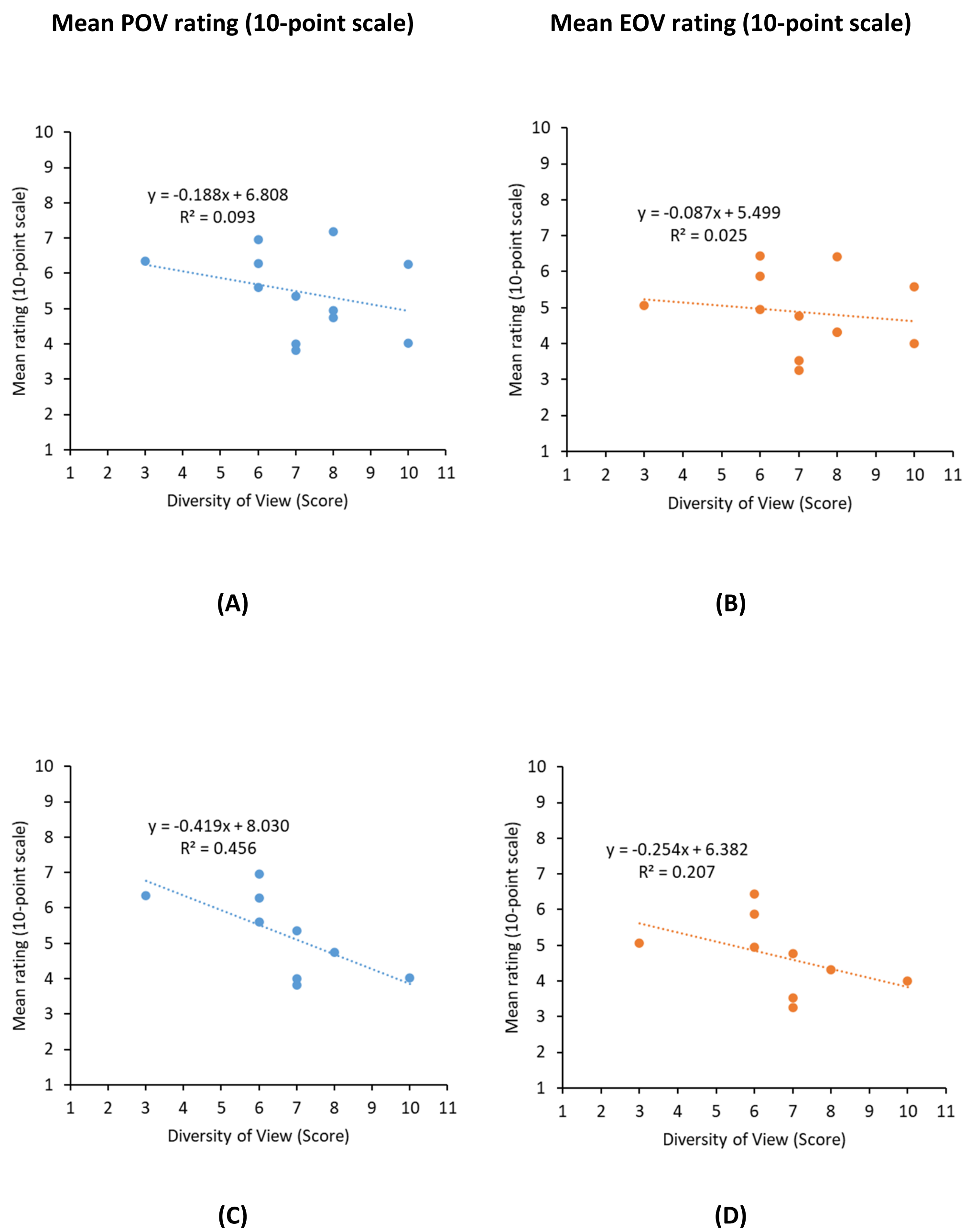


Figure 7.9: Mean ratings of POV and EOV (10-point scale) plotted against diversity of view. (A) POV: All 12 views included in analysis. (B) EOV: All 12 views included in analysis. (C) POV: Views 2, 6 and 9 omitted from analysis. (D) EOV: Views 2, 6 and 9 omitted from analysis (Pearson's correlation is significant at the 0.05 level in (C)).

7.7.2 Diversity of View: 4-point scale data

Figures 7.10 (A) and (B) plot median POV and EOV ratings of 4-point scale respectively against diversity of view. These data do not support that trend: from the plots and Spearman's rank correlation analysis, the null hypothesis is retained – i.e., there is no significant monotonic relationship between median POV or EOV rating (4-point scale) and diversity of view (POV: $R_s = -0.251$, $n = 12$, $p = 0.432$. EOV: $R_s = 0.209$, $n = 12$, $p = 0.515$). Therefore, these results do not concur with the previous studies.

When the three views (Views 2, 6 and 9) with openness of 60% or above are removed from the analysis, there is a statistically significant monotonic relationship between POV (4-point scale) and diversity of view at the 0.05 level with a large effect size ($|R| > 0.5$) (POV: $R_s = -0.756$, $n = 9$, $p = 0.018$), but not significant on the EOV (4-point scale) evaluation (EOV: $R_s = -0.283$, $n = 9$, $p = 0.460$) (see Figure 7.10 (C) and (D)). Again, negative correlation coefficient for the POV (4-point scale) evaluation here suggests that as the diversity of view increases in rank, the view quality (measured in terms of POV) decreases in rank. This result is inconsistent with the result of the past studies, which proposed the opposite effect.

7.7.3 Diversity of View: summary

Both 4-point and 10-point scale data, for POV and EOV, are consistent in terms of the outcome of analysis – i.e., evaluations of the 12 window views do not support the outcome of past studies by Hellinga and Horjik (2014) that a higher (more positive) diversity of view leads to a higher evaluation of view quality. This suggests that view quality is not associated with the number of groups of elements (i.e., "diversity of view"), but the aesthetical scene quality of each group of elements (i.e., "view elements") in this study (as shown in section 7.5).

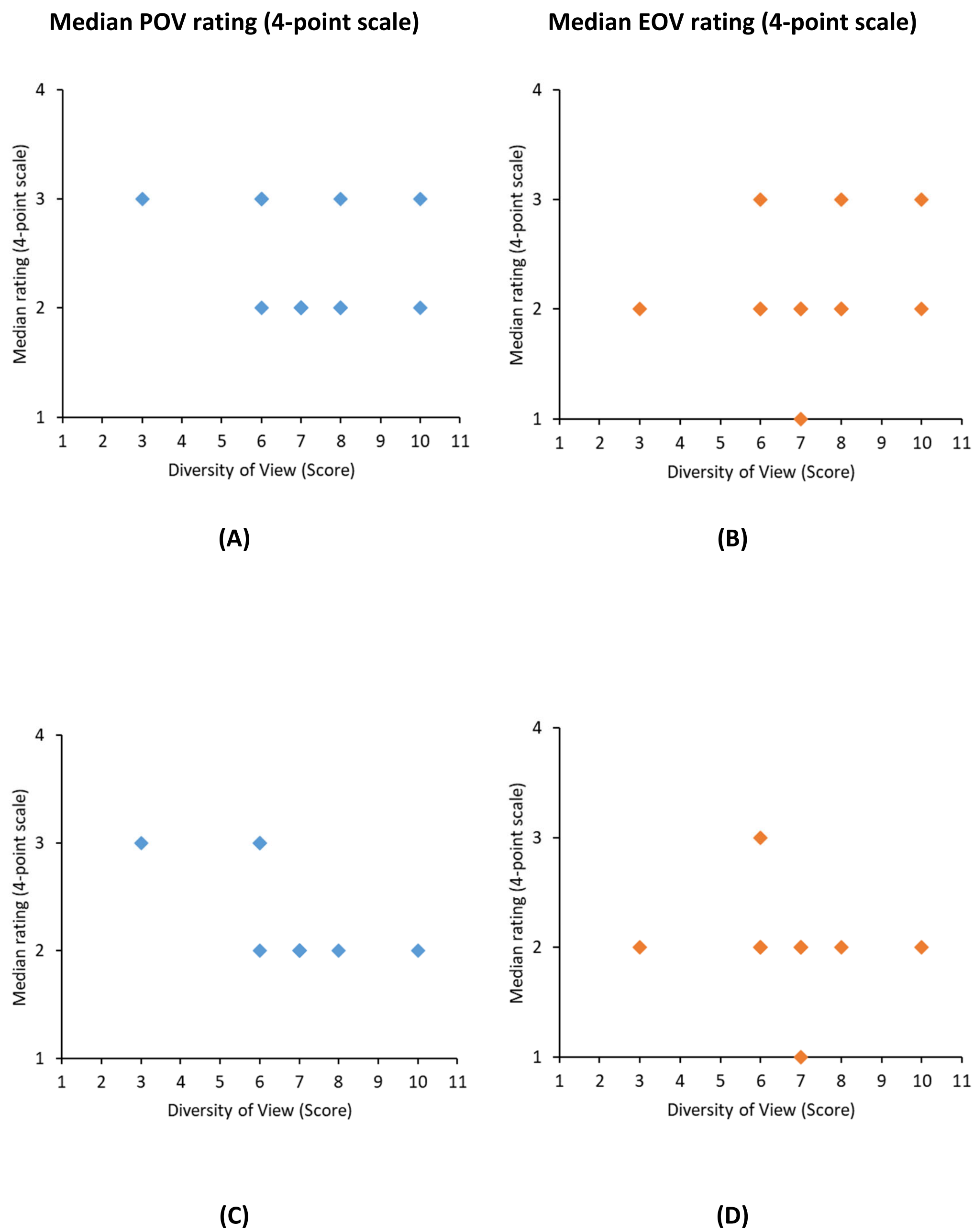


Figure 7.10: Median ratings of POV and EOV (4-point scale) plotted against diversity of view. (A) POV: All 12 views included in analysis. (B) EOV: All 12 views included in analysis. (C) POV: Views 2, 6 and 9 omitted from analysis. (D) EOV: Views 2, 6 and 9 omitted from analysis (Spearman's rank correlation is significant at the 0.05 level in (C)).

However, it is interesting to note in this study that when the openness of a view is relatively low (under 60%), view quality (in terms of POV) is negatively correlated with diversity of view (significant at the 0.05 level) – i.e., when diversity of view increases, it is predicted that view quality will decrease.

In Hellinga and Hordijk (2014), "diversity of view" was one of the view attributes that contributed to an aggregate score of view quality (from "0" – low quality to "12" – high quality), which was calculated based on 23 photographs. The scores were found to have a positive correlation with the mean view quality ratings of the same photographs from a questionnaire study. However, there was no analysis of correlation between diversity of view and view quality rating in that study. This probably explains the differences in results between that past study and the current study.

7.8 Openness of View

"Openness of view" in the 12 views of this study ranged from 12% to 65% (Table 7.1). In a previous study, Ozdemir (2010) observed that openness of window view and room satisfaction were positively correlated in both winter and summer. As "room satisfaction" was considered to be the effect of good view quality, it was reasonably predicted that higher openness of view would lead to higher (more positive) evaluations of POV and EOV in this study.

7.8.1 Openness of View: 10-point scale data

Figure 7.11 (A) and (B) plot mean POV and EOV ratings (10-point scale) against openness of view on the assumption of a linear relationship. These data do not support that trend: from the plots and Pearson's correlation analysis, the null hypothesis is retained – i.e., the association between either of the mean rating and openness of view is not statistically significant under linear assumption (POV: $R_p = 0.320$, $n = 12$, $p = 0.311$. EOV: $R_p = 0.267$, $n = 12$, $p = 0.402$). Therefore, these results do not support the prediction.

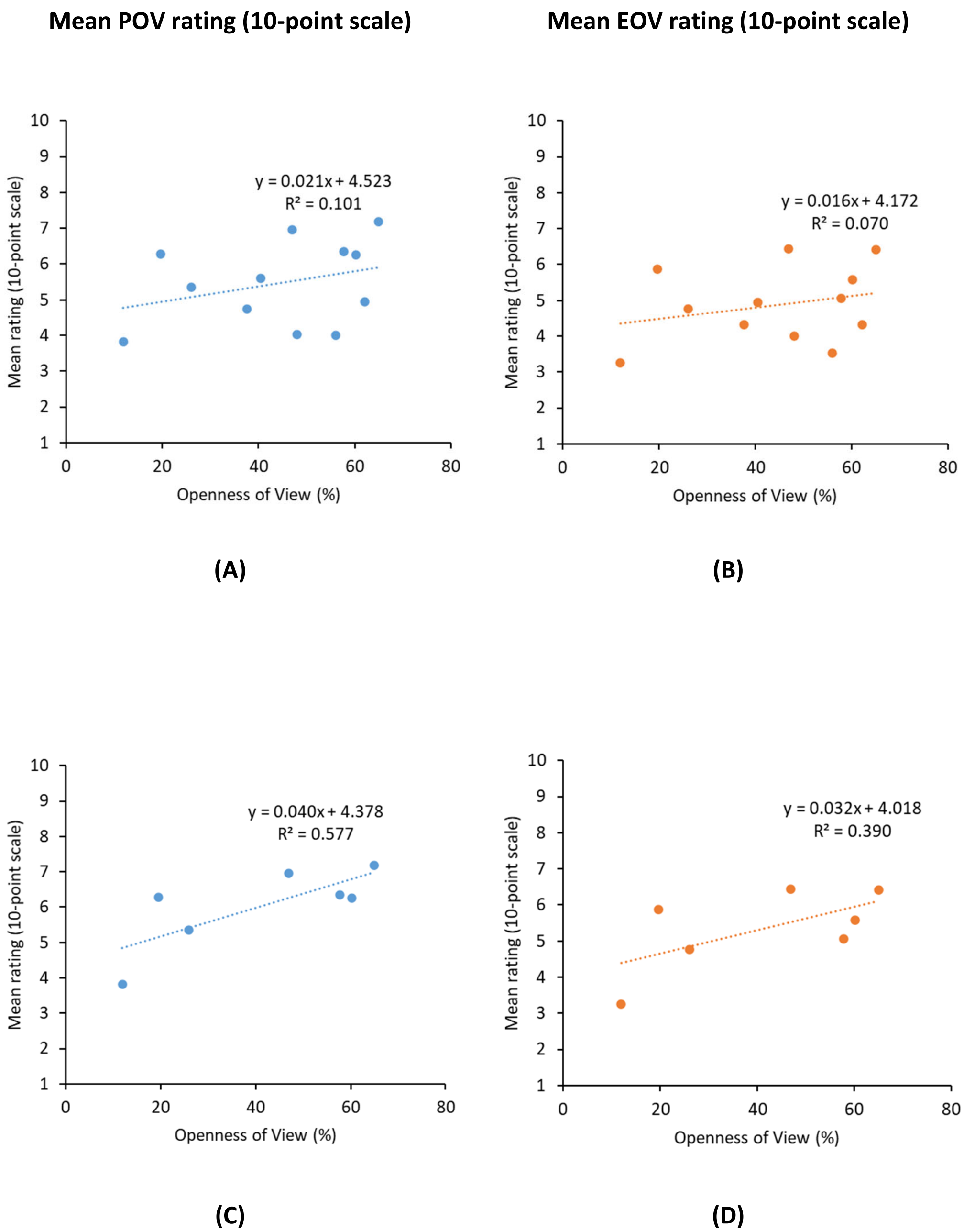


Figure 7.11: Mean ratings of POV and EOV (10-point scale) plotted against openness of view. (A) POV: All 12 views included in analysis. (B) EOV: All 12 views included in analysis. (C) POV: Views 1, 5, 6, 8 and 12 omitted from analysis. (D) EOV: Views 1, 5, 6, 8 and 12 omitted from analysis (Pearson's correlation is significant at the 0.05 level in (C)).

Among the 12 views in this study, Views 1, 5, 6, 8 and 12 have negative "view elements" scores. Interestingly, when these five views are omitted from the analysis, there is a statistically significant linear association between POV (10-point scale) and openness of view at the 0.05 level with large effect size ($|R| > 0.5$) (POV: $R_p = 0.763$, $n = 7$, $p = 0.046$), but not significant for the EOV (10-point scale) evaluation (EOV: $R_p = 0.627$, $n = 7$, $p = 0.132$) (see Figure 7.11 (C) and (D). Positive correlation coefficient for the POV evaluation here suggests that as the openness of view increases, the predicted view quality (measured in terms of POV) increases – on condition that the net score of "view elements" is not negative (i.e., zero or positive score for the aesthetical quality of the view). This result supports the prediction.

7.8.2 Openness of View: 4-point scale data

Figures 7.12 (A) and (B) plot median POV and EOV ratings of 4-point scale respectively against "openness of view." From the plots and Spearman's rank correlation analysis on POV rating, the null hypothesis is retained – i.e., there is no significant monotonic relationship between median POV rating (4-point scale) and openness of view (POV: $R_s = 0.318$, $n = 12$, $p = 0.313$). However, the null hypothesis is rejected for EOV rating as there is a significant monotonic relationship between median EOV rating (4-point scale) and openness of view at the 0.05 level with large effect size ($|R| > 0.5$) (EOV: $R_s = 0.601$, $n = 12$, $p = 0.039$). Therefore, the results of EOV rating (4-point scale) data support the predictions, but POV rating (4-point scale) data do not support the predictions.

When Views 1, 5, 6, 8 and 12 (which have negative "view elements" scores) were removed from the analysis, still there is no significant monotonic relationship between median POV rating (4-point scale) and openness of view (POV: $R_s = 0.632$, $n = 7$, $p = 0.127$). Again, there is a significant monotonic relationship between median EOV rating (4-point scale) and openness of view at the 0.05 level with large effect size ($|R| > 0.5$) (EOV: $R_s = 0.810$, $n = 7$, $p = 0.027$) (see Figures 7.12 (C) and (D)).

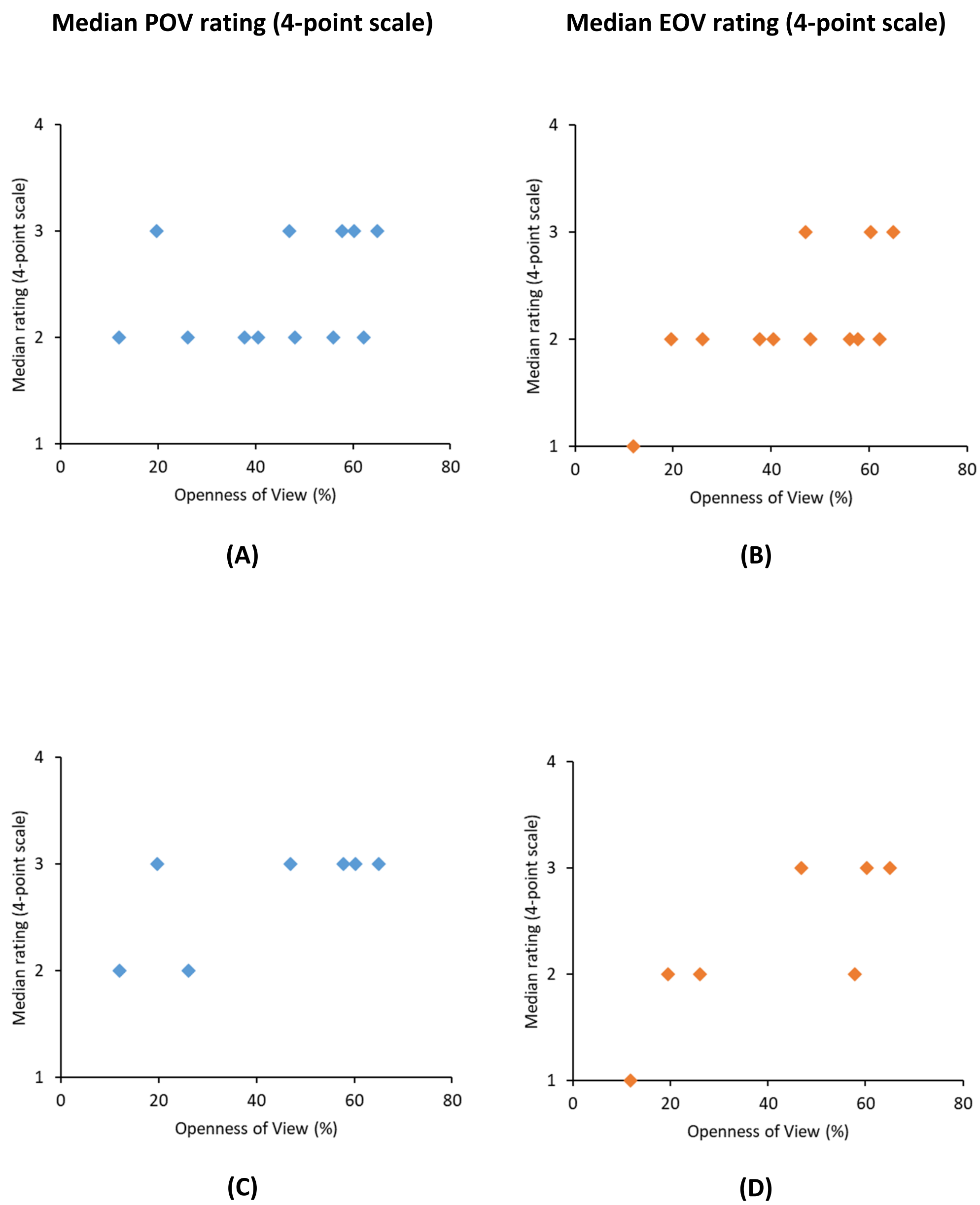


Figure 7.12: Median ratings of POV and EOV (4-point scale) plotted against openness of view. (A) POV: All 12 views included in analysis. (B) EOV: All 12 views included in analysis. (C) POV: Views 1, 5, 6, 8 and 12 omitted from analysis. (D) EOV: Views 1, 5, 6, 8 and 12 omitted from analysis (Spearman's rank correlation is significant at the 0.05 level in (B) and (D)).

The observed monotonic relationship between EOV rating (4-point scale) and openness of view suggests that openness of view would positively affect the "mood" of view – i.e., how stimulating the view is (as measured in terms of EOV) rather than the aesthetics of the view (measured in terms of POV).

7.8.3 Openness of View: summary

Correlation analyses on the openness of view and perceived view quality in this study show that:

1. When 10-point rating scale was used, the linear association between openness of view and POV or EOV was not significant. However, when the five views that have negative "view elements" scores were removed from the analysis, there was a significant and positive linear relationship between openness of view and POV only.

2. When 4-point rating scale was used, there was a positive monotonic relationship between openness of view and EOV (but not POV). Similar result was obtained when the five views that have negative "view elements" scores were omitted from the analysis.

In summary, "openness of view" is positively associated with POV under linear assumption only if the views have either neutral or positive aesthetic impression (i.e., "view elements" score is zero or above). On the other hand, "openness of view" is positively associated with EOV in rank order regardless of the aesthetic impression of view (i.e., negative, neutral or positive "view elements" score). The results can be interpreted in this way: when a view is more open, it is perceived to be more exciting or stimulating (indicator: EOV), but not more pleasant (indicator: POV) – unless the view is not negative in its overall aesthetic impression ("view elements" score zero or above).

In a previous study by Ozdemir (2010), the views varied in terms of aesthetics. Therefore, the result of this study concurs with that of Ozdemir (2010) only if the "room satisfaction" in that study were equivalent to EOV of this study (i.e., a measure of how exciting or stimulating the space is).

7.9 Depth of View

Depths of the 12 views in this study ranged from 0.1 km to 10.7 km (see Table 7.1). According to previous studies (Matusiak and Klöckner 2016) on "maximum view distance (view depth)", it was predicted that higher depth of view would lead to higher (more positive) evaluations of view quality (POV and EOV).

7.9.1 Depth of View: 10-point scale data

Figure 7.13 (A) and (B) plot mean POV and EOV ratings against the depth of view on the assumption of a linear relationship. These data do not support that trend: from the plots and Pearson's correlation analysis, the null hypothesis is retained – i.e., the association between either of the mean ratings and depth of view is nonsignificant under linear assumption (POV: $R_p = -0.078$, $n = 12$, $p = 0.809$. EOV: $R_p = -0.022$, $n = 12$, $p = 0.945$). Therefore, these results do not concur with the previous studies.

The associations are found to be much stronger (POV: $R_p = -0.664$, $n = 8$, $p = 0.072$. EOV: $R_p = -0.579$, $n = 8$, $p = 0.132$) if the two extremely close views (View 3 and View 4) and the two extremely distant views (View 2 and View 6) are omitted from the analysis (see Figure 7.13 (C) and (D)). In this case, both POV and EOV ratings (10-point scale) demonstrate a negative linear correlation with depth of view. This implies that when the depth of view is within a typical range between 2 km and 5 km, either of the mean ratings is predicted to decrease as the depth of view increases. However, these associations are nonsignificant at the 0.05 level, but significant at the 0.10 level for POV (10-point scale). Therefore, the results of POV rating (10-point scale) concur with the previous studies at the 0.10 level, but the results of EOV rating (10-point scale) do not.

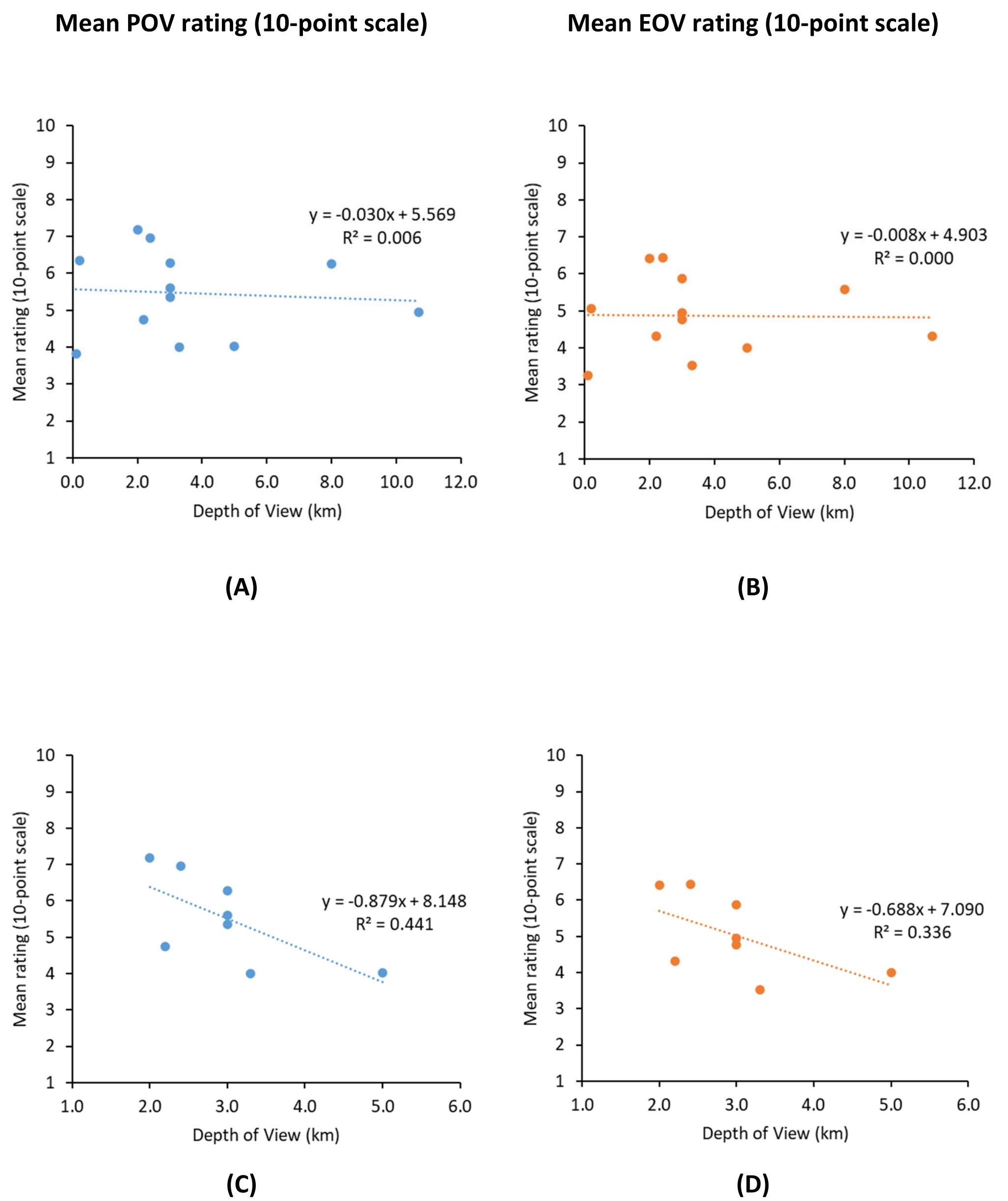


Figure 7.13: Mean ratings of POV and EOV (10-point scale) plotted against depth of view. (A) POV: All 12 views included in analysis. (B) EOV: All 12 views included in analysis. (C) POV: Views 2, 3, 4 and 6 omitted from analysis. (D) EOV: Views 2, 3, 4 and 6 omitted from analysis.

7.9.2 Depth of View: 4-point scale data

Figures 7.14 (A) and (B) plot median POV and EOV ratings of 4-point scale respectively against depth of view. These data do not support that trend: from the plots and Spearman's rank correlation analysis, the null hypothesis is retained – i.e., there is no significant monotonic relationship between median POV or EOV rating (4-point scale) and depth of view (POV: $R_s = -0.222$, $n = 12$, $p = 0.488$. EOV: $R_s = 0.186$, $n = 12$, $p = 0.562$). Therefore, these results do not concur with the previous studies.

If the four views (Views 2, 3, 4 and 6) with extreme depths (too close or too distant) are removed from the analysis, the associations are found to be stronger (POV: $R_s = -0.520$, $n = 8$, $p = 0.187$. EOV: $R_s = -0.645$, $n = 8$, $p = 0.084$). In this case, both POV and EOV ratings (4-point scale) demonstrate a negative monotonic association with depth of view. This implies that when the depth of view is within a typical range between 2 km and 5 km, either of the ratings would decrease as the depth of view increases. However, these associations are not significant at the 0.05 level, but significant at the 0.10 level for EOV (4-point scale). Therefore, the results of EOV rating (4-point scale) concur with the previous studies at the 0.10 level, but the results of POV rating (4-point scale) do not concur with the previous studies.

7.9.3 Depth of View: summary

Correlation analyses on the depth of view and perceived view quality in this study show that:

1. When 10-point rating scale was used, the linear association between depth of view and POV or EOV was not significant. However, when the four views with extreme depths (too close or too distant) were removed from the analysis, there was a seemingly negative linear relationship between depth of view and POV ($p < 0.1$) but not significant at the 0.05 level.

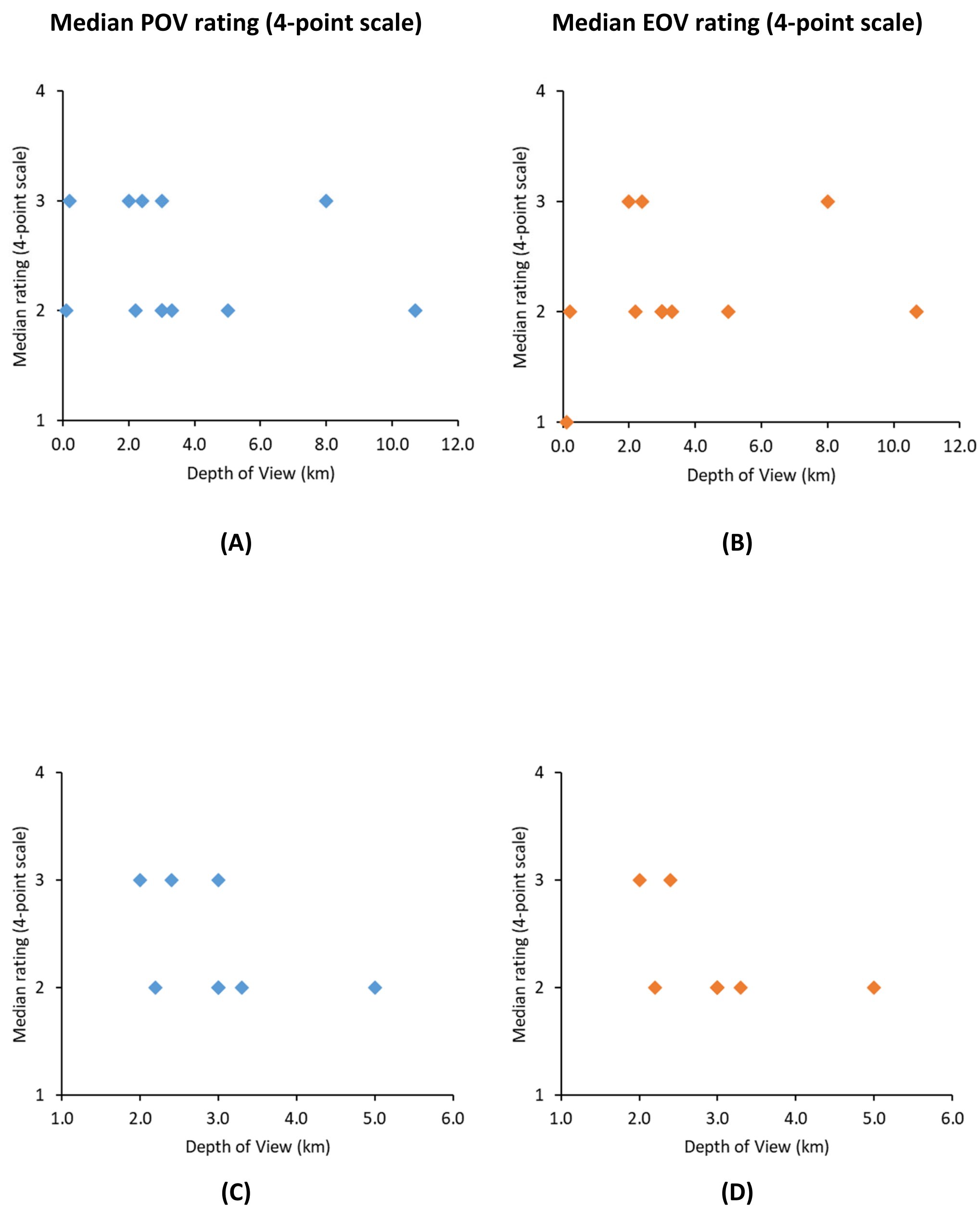


Figure 7.14: Median ratings of POV and EOV (4-point scale) plotted against depth of view. (A) POV: All 12 views included in analysis. (B) EOV: All 12 views included in analysis. (C) POV: Views 2, 3, 4 and 6 omitted from analysis. (D) EOV: Views 2, 3, 4 and 6 omitted from analysis.

2. When 4-point rating scale was used, the monotonic relationship between depth of view and POV or EOV was nonsignificant. However, when the four views with extreme depths (too close or too distant) were removed from the analysis, there was a seemingly negative linear relationship between depth of view and EOV ($p < 0.1$) but not significant at the 0.05 level.

One possible explanation for the differences between these results and prediction based on previous study: in Matusiak and Klöckner's (2016) study, which was conducted within a university campus, the views with good or excellent ratings were mostly views that have large depths and contained beautiful distant landscapes; the views with unsatisfactory ratings were mostly views that were blocked by the opposite building (i.e., small depths of view). In comparison with this study, views that have large depths e.g., View 1 and View 6 happened to have negative "view elements" scores (i.e., poor aesthetic impressions). Therefore, a larger variety of scenes with different view depths are required in future studies to further explore the relationship between "depth of view" and the predicted view quality (POV or EOV).

7.10 Summary of prediction analysis

Tables 7.2 summarises the associations between predicted POV or EOV rating and the seven view attributes based on Experiment 1 (actual view). Overall, the following trends were observed in the analyses of the seven view attributes:

1. "Proportion of greenery" that was not extremely high had a significant and positive monotonic relationship with view quality in terms of EOV. Greenery proportion had a large effect size on EOV under this condition.

2. "Number of visual layers" had a significant and positive monotonic relationship with EOV provided that the aesthetical quality of view was not negative. Under this condition, number of visual layers had large effect size on EOV.

Table 7.2: Summary of prediction analysis – associations between window view quality (in terms of POV or EOV ratings) and seven view attributes based on Experiment 1 (actual view).

	View Attributes (Predictor variables)	POV / EOV (4/ 10 pt scale)	Type of association	Correlation Coefficient (R)	Sig.	Condition
1.	Proportion of Greenery	EOV (4)	Monotonic	0.666	$p < 0.05$	View 4 and View 7 (extremely high greenery proportion) omitted from analysis (n = 10)
2.	Number of Visual Layers	EOV (4)	Monotonic	0.780	$p < 0.05$	Views 1, 5, 6, 8, 12 (views with negative "view elements" score) omitted from analysis (n = 7)
3.	View Elements	POV (10)	Linear	0.747	$p < 0.01$	All 12 views included in analysis (n = 12)
		EOV (10)	Linear	0.667	$p < 0.05$	
		POV (10)	Linear	0.979	$p < 0.001$	View 3 and View 8 (no greenery content) omitted from analysis (n = 10)
		EOV (10)	Linear	0.901	$p < 0.001$	
		POV (4)	Monotonic	0.818	$p < 0.01$	All 12 views included in analysis (n = 12)
		POV (4)	Monotonic	0.878	$p < 0.01$	View 3 and View 8 (no greenery content) omitted from analysis (n = 10)
		EOV (4)	Monotonic	0.652	$p < 0.05$	
4.	Balance of view	EOV (10)	Linear	-0.583	$p < 0.05$	All 12 views included in analysis (n = 12)
		POV (10)	Linear	-0.704	$p < 0.05$	View 1 and View 9 (lowest and highest "view elements" scores) omitted from analysis (n = 10)
		EOV (10)	Linear	-0.808	$p < 0.01$	
5.	Diversity of View	POV (10)	Linear	-0.675	$p < 0.05$	Views 2, 6 and 9 (openness of 60% or above) omitted from analysis (n = 9)
		POV (4)	Monotonic	-0.756	$p < 0.05$	
6.	Openness of View	POV (10)	Linear	0.763	$p < 0.05$	Views 1, 5, 6, 8, 12 (views with negative view elements score) omitted from analysis (n = 7)
		EOV (4)	Monotonic	0.810	$p < 0.05$	
		EOV (4)	Monotonic	0.601	$p < 0.05$	All 12 views included in analysis (n = 12)
7.	Depth of View	---	---	---	---	---

3. “View elements” (aesthetical impression of the scene) had a significant and positive linear association with view quality (either POV or EOV) based on 10-point scale data and had a large effect size on either view quality. When two views without greenery were omitted from the analysis, “view elements” was found to have an extremely large effect size on either POV or EOV. When 4-point scale data were analysed, “view elements” had a significant monotonic relationship with POV too but not EOV, except if all the views contained greenery.

4. “Balance of view” had a significant and negative linear relationship with EOV and had a large effect size on EOV evaluation. When two views with the lowest and highest “view elements” scores were removed from the analysis, “balance of view” appeared to have a significant and negative linear association with either POV or EOV evaluation with a larger effect size.

5. “Diversity of view” had a significant and negative linear association with view quality in terms of POV and had a large effect size on POV – on condition that the views were not extremely open.

6. “Openness of view” had a significant and positive monotonic relationship with view quality (EOV) and had a large effect size on EOV. If five views with negative aesthetical impression scores were omitted from the analysis, “openness of view” had a very large effect size on EOV. Under the same condition, “openness of view” was found to have a significant and positive linear association with view quality (POV) and had a large effect size on POV.

7. “Depth of view” had neither linear nor monotonic relationship with either of the view quality in the analyses. Probably this view attribute was confounded by other factors, which need to be explored in future studies.

7.11 Development of prediction models

After the study of associations between view quality ratings (POV and EOV) and individual view attributes, regression models were developed for predicting window view quality based on the combination of these seven view attributes (proportion of greenery, number of visual layers, view elements, balance of view, diversity of view, openness of view and depth of view).

7.11.1 Multiple linear regression model: 10-point scale data

One of the prediction models explored in the present study was based on a multiple linear regression (MLR) equation as follows:

$$y_n = \beta_0 + \beta_1\, x_{n1} + \beta_2\, x_{n2} + \beta_3\, x_{n3} + \cdots\cdots + \beta_k\, x_{nk} + \varepsilon_n$$

where y_n is the predicted view quality rating (dependent variable) of a particular window n ; x_{nk} are the predictor variables (view attributes); β_k are coefficients of the predictor variables; β_0 is the intercept; ε_n is the error term; *n* represents the n^{th} window view in the experiment; *k* is the number of predictor variables (independent variables).

In this study, there were 12 different window views (*n* = 1, 2, 3, …12) and seven view attributes (*k* = 7). In each of the 12 window views, there were 31 response ratings given by the test participants on POV (or EOV) evaluations (10-point scale format). With the assumption that the evaluation of each view was independent (i.e., not influenced by the evaluation of the other views), a total of 372 cases were included in the regression analyses of POV (or EOV).

Using the subjects' rating data (POV and EOV rating) collected in Experiment 1 (actual view) and the view attributes (see Table 7.1), a standard regression analysis was conducted in SPSS Statistics software to estimate the coefficients of the view attributes. Proportion of greenery (PG), number of visual layers (VL), view elements (VE), balance of view (BV), diversity of view (DV), openness of view (OV) and depth of view (DP) were used in the standard regression analysis to predict window view quality

(POV or EOV). The results of the standard regression analysis are as follows. Pearson's correlations coefficients of the predictor variables are shown in Table 7.3. All correlations were significant at the 0.05 level except those between proportion of greenery and number of visual layers, between proportion of greenery and openness of view, between number of visual layers and balance of view, between view elements and balance of view, between view elements and openness of view, and between balance of view and depth of view. Test results from exploratory studies are normally not expected to include multiplicity correction (Ranstam 2016). Since this correlation analysis was an exploratory rather than a confirmatory study, the alpha level (0.05) was maintained and not adjusted using Bonferroni correction method to avoid inflating the risk of Type II error (false negative).

Table 7.3: Correlations of the predictor variables in the standard regression analysis of view quality (POV or EOV) evaluations.

	Variable	PG	VL	VE	BV	DV	OV	DP
1	Proportion of Greenery (PG)	---	n.s.	0.285	0.202	-0.396	n.s.	-0.217
2	Number of Visual Layers (VL)		---	-0.164	n.s.	0.648	0.500	0.484
3	View Elements (VE)			---	n.s.	-0.361	n.s.	-0.344
4	Balance of view (BV)				---	0.109	0.160	n.s.
5	Diversity of View (DV)					---	0.168	0.588
6	Openness of View (OV)						---	0.449
7	Depth of View (DP)							---

Note:
All correlations were statistically significant ($p < 0.05$) except those indicated "n.s." (nonsignificant).

Note that there were positive correlations with large effect sizes ($R_p \geq 0.5$) between number of visual layers and diversity of view; between number of visual layers and openness of view; between diversity of view and depth of view. These correlations between predictor variables indicated possible multicollinearity, which undermined the statistical significance of a predictor in the regression model (Allen, 1997). Table 7.4 displays the standardised coefficients of the POV prediction model, which was

Table 7.4: The results of the standard regression analysis for POV evaluation.

		Standardized Coefficients			Correlations			Collinearity Statistics	
No.	POV Model	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
	(Constant)		8.221	0.000					
1	Proportion of Greenery (PG)	0.055	1.000	0.318	0.106	0.052	0.047	0.754	1.326
2	View Elements (VE) ***	0.311	5.812	0.000	0.334	0.291	0.275	0.783	1.278
3	Balance of view (BV)***	-0.236	-4.715	0.000	-0.210	-0.240	-0.223	0.895	1.118
4	Diversity of View (DV)	-0.029	-0.445	0.656	-0.136	-0.023	-0.021	0.544	1.837
5	Openness of View (OV)**	0.148	2.653	0.008	0.143	0.138	0.126	0.722	1.385
6	Depth of View (DP)	0.045	0.670	0.504	-0.036	0.035	0.032	0.489	2.045

Note: ** $p < 0.01$, *** $p < 0.001$

statistically significant [$F(6, 365) = 13.586$, $p < 0.001$], and accounted for 18.3% of the variance of POV ($R^2 = 0.183$, Adjusted $R^2 = 0.169$). The dependent variable (POV) was predicted by three factors – i.e., view elements, balance of view and openness of view, which have standardised coefficients of 0.311, -0.236 and 0.148 respectively. Number of visual layers (VL) was not used in this linear regression because it only has two levels (either 3 or 4 layers) across all 12 views, and it did not exhibit any significant linear relationship with either view quality in the prediction analysis (Table 7.2). Squaring the part correlations listed in the table informs us of the percentage of variance each predictor uniquely explains: view elements, balance of view and openness of view each accounts for 7.6%, 5.0% and 1.6% of the variance of POV respectively.

Table 7.5 displays the standardised coefficients of the EOV prediction model, which was statistically significant, $F(6, 365) = 10.186$, $p < 0.001$, and accounted for 14.3% of the variance of EOV score ($R^2 = 0.143$, Adjusted $R^2 = 0.129$). The dependent variable (EOV) was predicted by the same three factors as in the POV model – i.e., view elements, balance of view and openness of view, which have standardised coefficients of 0.271, -0.257 and 0.114 respectively. Squaring the part correlations listed in the table informs us of the percentage of variance each predictor uniquely explains: view elements, balance of view and openness of view each accounts for 5.7%, 5.9% and 0.9% of the variance of EOV respectively.

Note that in the standard regression analyses of POV and EOV, "view elements", "balance of view" and "openness of view" were the common predictors in both linear models. However, from the analyses of associations between window view quality and the individual view attributes shown in Table 7.2, "diversity of view" was also found to have a significant linear association with view quality (POV) on condition that three views with openness of 60% or above were omitted from the analysis. Proportion of greenery and depth of view were not significant in the linear predictions of either view quality (POV or EOV) in this study. These view attributes were not significant predictors in the standard regression model probably due to one or both of the following reasons:

Table 7.5: The results of the standard regression analysis for EOV evaluation.

No.	EOV Model	Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
	(Constant)		7.711	0.000					
1	Proportion of Greenery (PG)	0.033	0.587	0.557	0.043	0.031	0.028	0.754	1.326
2	View Elements (VE) ***	0.271	4.948	0.000	0.268	0.251	0.240	0.783	1.278
3	Balance of view (BV)***	-0.257	-5.022	0.000	-0.234	-0.254	-0.243	0.895	1.118
4	Diversity of View (DV)	0.039	0.591	0.555	-0.063	0.031	0.029	0.544	1.837
5	Openness of View (OV)*	0.114	1.991	0.047	0.107	0.104	0.096	0.722	1.385
6	Depth of View (DP)	0.030	0.437	0.663	-0.009	0.023	0.021	0.489	2.045

Note: * $p < 0.05$, *** $p < 0.001$

1. Multicollinearity – from the summary in Table 7.3, we know that there were moderate correlations between number of visual layers and diversity of view (0.648), and between diversity of view and depth of view (0.588). The variance inflation factor (VIF) for diversity of view and depth of view were relatively high (in both POV and EOV models) compared to the other four predictors.

2. Confounding variables – probably there were some underlying variables that confounded the association between individual predictors and the dependent variable. Note the substantial differences between the zero-order correlation and partial correlation in proportion of greenery and diversity of view in both POV and EOV models, and depth of view in the EOV model.

In order to have a variable selection procedure to establish a more robust prediction model, a stepwise multiple regression analysis was performed in this study.

7.11.2 Stepwise multiple regression: 10-point scale data

Stepwise regression analysis was adopted as a variable selection procedure. It is a combination of the forward and backward selection techniques: after each step in which a predictor variable is added, all predictors in the model are checked to see if their significance has been reduced below the specified tolerance level; if a nonsignificant variable is found, it is removed from the model. The goal of this variable selection procedure is to achieve a balance between simplicity (as few regressors as possible) and fit (as many regressors as needed) (NCSS 2020).

Six view attributes – i.e., proportion of greenery (PG), view elements (VE), balance of view (BV), diversity of view (DV), openness of view (OV) and depth of view (DP) were used in a stepwise multiple regression analysis to predict window view quality (POV or EOV). The results of stepwise regression analyses of POV and EOV are presented in Table 7.6 and Table 7.7 respectively.

Table 7.6: Stepwise regression results for POV evaluation.

POV Model	Predictor variables	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	Correlations Zero-order	Partial	Part
1	(Constant)	5.424	0.123		44.040	0.000			
	View Elements (VE)	0.466	0.068	0.334	6.815	0.000	0.334	0.334	0.334
2	(Constant)	10.506	1.214		8.651	0.000			
	View Elements (VE)	0.458	0.067	0.329	6.858	0.000	0.334	0.336	0.329
	Balance of View (BV)	-5.858	1.393	-0.202	-4.206	0.000	-0.210	-0.214	-0.202
3	(Constant)	10.081	1.203		8.378	0.000			
	View Elements (VE)	0.447	0.066	0.321	6.774	0.000	0.334	0.333	0.320
	Balance of View (BV)	-6.631	1.391	-0.228	-4.767	0.000	-0.210	-0.241	-0.225
	Openness of View (OV)	0.247	0.072	0.165	3.440	0.001	0.143	0.176	0.163

Table 7.7: Stepwise regression results for EOV evaluation.

EOV Model	Predictor variables	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Correlations Zero-order	Correlations Partial	Correlations Part
1	(Constant)	4.845	0.126		38.343	0.000			
	View Elements (VE)	0.375	0.070	0.268	5.343	0.000	0.268	0.268	0.268
2	(Constant)	10.586	1.240		8.539	0.000			
	View Elements (VE)	0.366	0.068	0.262	5.370	0.000	0.268	0.269	0.262
	Balance of View (BV)	-6.617	1.422	-0.227	-4.654	0.000	-0.234	-0.235	-0.227
3	(Constant)	10.237	1.235		8.287	0.000			
	View Elements (VE)	0.357	0.068	0.255	5.271	0.000	0.268	0.265	0.255
	Balance of View (BV)	-7.253	1.428	-0.249	-5.078	0.000	-0.234	-0.256	-0.245
	Openness of View (OV)	0.203	0.074	0.135	2.753	0.006	0.107	0.142	0.133

In the POV prediction model, the stepwise regression Model 3 (R^2 = 0.179, Adjusted R^2 = 0.172) is as below (Q_{POV} is the predicted view quality, value between 1 – 10, measured in the "pleasantness" dimension of affective quality):

$$Q_{POV} = 0.45VE - 6.63BV + 0.25OV + 10.08$$

In the EOV prediction model, the stepwise regression Model 3 (R^2 = 0.141, Adjusted R^2 = 0.134) is as below (Q_{EOV} is the predicted view quality, value between 1 – 10, measured in the "excitingness" dimension of affective quality):

$$Q_{EOV} = 0.36VE - 7.25BV + 0.20OV + 10.24$$

Compared to the standard linear models of POV (R^2 = 0.183, Adjusted R^2 = 0.169) and EOV (R^2 = 0.143, Adjusted R^2 = 0.129), the stepwise regression models have equally good prediction power but appear to be much simpler as there are only three predictors in each of the prediction models.

7.11.3 Ordinal logistic regression (OLR): 4-point scale data

In Chapter 4 (results), it has been demonstrated that the 4-point scale data collected in Experiment 1 (actual view) and Experiment 2 (image view) did not follow normal distribution. With just four response points in the rating scale, parametric method was not adopted; because when we treat categorical variables as continuous variables, it will result in biased parameter estimates, as well as incorrect standard errors and model test statistics (Rhemtulla 2012). Therefore, the 4-point scale ratings of POV (or EOV) were treated as ordinal-level data in the current regression analyses. Ordinal logistic regression (OLR) model was used to analyse these 4-point scale ratings (POV and EOV).

The objective of this OLR is to complement the linear model by providing a more comprehensive investigation on the associations between the view attributes and the response ratings, covering monotonic relationships (as shown in the previous section of this Chapter) that may not be detected when using linear regression analyses.

In OLR, the dependent variable is a logit function, which is the natural logarithm of odds ("log-odds") of an increase in the response category for every one-unit increase in a predictor variable. The ordinal logistic model for a single independent variable is:

$$\ln(\theta_j) = \alpha_j - \beta X$$

where j ranges from 1 to 3 (for 4-point rating scale), and the odds that the rating score is not higher than j , $\theta_j = \frac{prob(score \leq j)}{1-prob(score \leq j)}$; the odds ratio associated with a one-unit increase in a predictor variable is equal to Exp (β) (Norušis 2011). When a predictor variable in the OLR increases, the underlying response variable may shift towards either end of the spectrum of ordinal response categories. Below are three possible outcomes of odds ratio:

1. Odds ratio larger than 1 indicates that there is an increasing probability of a subject rating a higher category of response on a window view quality as the value of a certain predictor increases by one unit, holding the remaining predictors constant.

2. Odds ratio smaller than 1 indicates that there is a decreasing probability of a subject rating a higher category of response on a window view quality as the value of a certain predictor increases by one unit, holding the remaining predictors constant.

3. Odds ratio that is equal to 1 means that there is no predicted change in the likelihood of a subject rating a higher category of response on a window view quality as the value of a certain predictor increases by one unit, holding the remaining predictors constant.

In OLR, assumption of proportional odds states that the relationships between the independent variables are the same across all possible comparisons involving the logit (dependent variable) (Osborne 2015). Test of parallel lines is normally conducted: if the result of the test (i.e., assumption proportional odds) indicates nonsignificant, then it means that the assumption is satisfied.

In this study, there was a total of 12 different window views (n = 12) and seven view attributes (k = 7). In each of the 12 window views, there were 31 response ratings given by the test participants on POV (or EOV) evaluations (4-point scale format). With the assumption that the evaluation of each view was independent (i.e., not influenced by the evaluation of the other views), a total of 372 cases were included in the ordinal regression analyses of POV (or EOV), which was performed in SPSS Statistics software. There were seven predictors in this OLR: "proportion of greenery", "view elements", "balance of view", "openness of view" and "depth of view" were analysed as continuous variables, whilst "number of visual layers" and "diversity of view" were analysed as categorical variables.

Results of the ordinal logistic regression on POV and EOV evaluations are presented in Table 7.8 and Table 7.9 respectively. The "B" column contains the ordered log-odds (logit) regression coefficients: for a one unit increase in the predictor, the response variable level is expected to change by its respective regression coefficient in the ordered log-odds scale while the other variables in the model are held constant. The "Exp (B)" column consists of odds ratios that indicate the multiplicative change in the odds of being in a higher category of view quality rating for every one-unit increase on the predictor, holding the remaining independent variables constant.

In this POV prediction model based on OLR:

1. "View elements" was a significant predictor of view quality (POV) at the 0.001 level. For every one-point increase in "view elements", there was a predicted increase of 0.305 in the log-odds (approximately 36% increase in the odds) of a subject giving a higher POV rating for an actual window view (B = 0.305, $p < 0.001$, Exp(B) = 1.357).

Table 7.8: Ordinal logistic regression results for POV evaluation.

	POV Model (4-point scale)	B	Std. Error	Wald	df	Sig.	95% Confidence Interval		Exp (B)
							Lower Bound	Upper Bound	
Threshold	[Rating = 1]	-5.342	3.813	1.963	1	0.161	-12.815	2.131	0.005
	[Rating = 2]	-3.699	3.801	0.947	1	0.330	-11.148	3.751	0.025
	[Rating = 3]	-1.571	3.808	0.170	1	0.680	-9.035	5.893	0.208
Location	Proportion of Greenery (PG)	0.171	0.090	3.616	1	0.057	-0.005	0.348	1.187
	View Elements (VE) ***	0.305	0.071	18.368	1	0.000	0.166	0.445	1.357
	Balance of view (BV)	-7.428	5.180	2.057	1	0.152	-17.580	2.724	0.001
	Openness of View (OV) **	0.511	0.165	9.598	1	0.002	0.188	0.835	1.668
	Depth of View (DP)	-0.074	0.057	1.695	1	0.193	-0.186	0.038	0.928
	VL = 3	1.049	0.740	2.009	1	0.156	-0.402	2.500	2.856
	VL = 4	0.000	-	-	-	-	-	-	1.000
	DV = 3	-1.680	1.008	2.776	1	0.096	-3.655	0.296	0.186
	DV = 6	-0.276	0.850	0.105	1	0.746	-1.941	1.389	0.759
	DV = 7	0.566	0.745	0.577	1	0.448	-0.894	2.025	1.761
	DV = 8	0.553	0.340	2.647	1	0.104	-0.113	1.219	1.738
	DV = 10	0.000	-	-	-	-	-	-	1.000

Link function: Logit.

Note: ** $p < 0.01$, *** $p < 0.001$

Table 7.9: Ordinal logistic regression results for EOV evaluation.

	EOV Model (4-point scale)	B	Std. Error	Wald	df	Sig.	95% Confidence Interval		Exp (B)
							Lower Bound	Upper Bound	
Threshold	[Rating = 1]	-3.957	3.797	1.086	1	0.297	-11.398	3.485	0.019
	[Rating = 2]	-2.276	3.789	0.361	1	0.548	-9.702	5.151	0.103
	[Rating = 3]	-0.044	3.799	0.000	1	0.991	-7.490	7.402	0.957
Location	Proportion of Greenery (PG)	0.077	0.090	0.723	1	0.395	-0.100	0.254	1.080
	View Elements (VE) ***	0.263	0.071	13.689	1	0.000	0.124	0.402	1.301
	Balance of view (BV)	-5.177	5.154	1.009	1	0.315	-15.279	4.924	0.006
	Openness of View (OV) **	0.434	0.164	6.959	1	0.008	0.111	0.756	1.543
	Depth of View (DP)	-0.091	0.057	2.541	1	0.111	-0.202	0.021	0.913
	VL = 3	0.320	0.737	0.188	1	0.664	-1.124	1.764	1.377
	VL = 4	0.000	-	-	-	-	-	-	1.000
	DV = 3	-1.662	1.007	2.722	1	0.099	-3.637	0.312	0.190
	DV = 6	-0.162	0.850	0.036	1	0.849	-1.827	1.503	0.851
	DV = 7	0.038	0.741	0.003	1	0.959	-1.413	1.490	1.039
	DV = 8	0.108	0.338	0.102	1	0.749	-0.554	0.771	1.114
	DV = 10	0.000	-	-	-	-	-	-	1.000

Link function: Logit.

Note: ** $p < 0.01$, *** $p < 0.001$

2. "Openness of view" was another significant predictor of view quality (POV) at the 0.01 level. For every one-unit (10%) increase in "openness of view", there was a predicted increase of 0.511 in the log-odds (approximately 67% increase in the odds) of a subject giving a higher POV rating for an actual window view ($B = 0.511$, $p = 0.002$, $Exp(B) = 1.668$).

3. "View elements" and "openness of view" were two common predictors between OLR (4-point scale) and stepwise multiple regression (10-point scale) for the prediction of view quality (POV). However, "balance of view" was a significant predictor of view quality (POV) in the MLR model but not the OLR model.

4. "Proportion of greenery", "number of visual layers", "diversity of view" and "depth of view" were not significant predictors of view quality (POV) at the 0.05 level in either MLR or OLR model.

5. Test of parallel lines indicating nonsignificance at the 0.05 level suggested that the assumption of proportional odds was satisfied (-2 log likelihood = 109.446, Chi-square = 31.204, $df = 20$, $p = 0.053$).

In the EOV prediction model based on OLR (4-point scale): "view elements" and "openness of view" were significant predictors of view quality at the 0.001 and 0.01 levels respectively. However, test of parallel lines indicated significance at the 0.001 level, which suggested that the assumption of proportional odds was violated (-2 log likelihood = 99.790, Chi-square = 48.768, $df = 20$, $p < 0.001$). It is possible that the link function selected is incorrect for the data or that the relationships between the independent variables and logits are not the same for all logits. Therefore, the prediction of EOV evaluation based on OLR is not a valid model.

7.12 Validation of prediction models

The proposed prediction models (POV and EOV) based on stepwise multiple regression were validated using two methods as follows:

7.12.1 Internal validation

Internal validation was carried out based on the following steps:

1. Determine the correlations between predicted ratings and the actual mean ratings of the 12 window views in Experiment 1 (actual view).

2. Test the difference in the means of POV (EOV) between predicted ratings and subjects' ratings.

First, the predicted POV (EOV) rating of each of the 12 window views was obtained by inserting the values of "view elements", "balance of view" and "openness of view" of that view into the proposed prediction model. The subjects' POV (EOV) rating of each of the 12 window views was an average rating based on the subjective evaluations of the views by 31 subjects in Experiment 1 (actual view) (Figures 7.15 and 7.16). For the POV (EOV) model, correlation analysis shows that there was a strong positive association between the predicted POV (EOV) and the mean POV (EOV) rating across the 12 views, significant at the 0.001 level (POV: $R_p = 0.945$, $n = 12$, $p < 0.001$; EOV: $R_p = 0.936$, $n = 12$, $p < 0.001$).

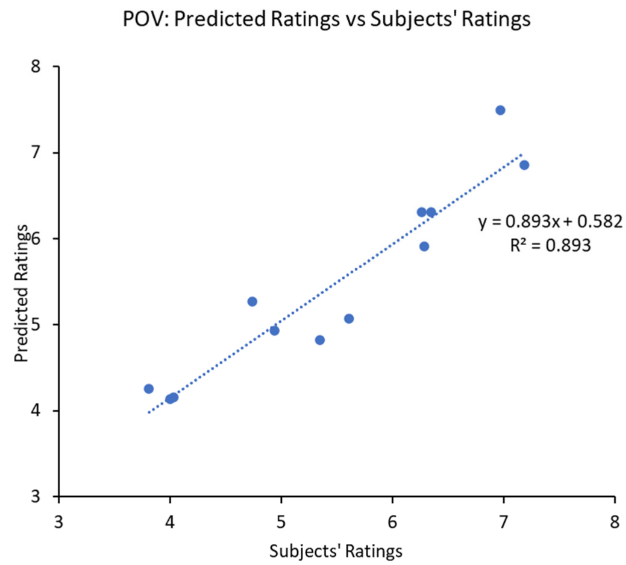


Figure 7.15: Predicted POV ratings plotted against subjects’ POV ratings of actual window Views 1 – 12 (Experiment 1).

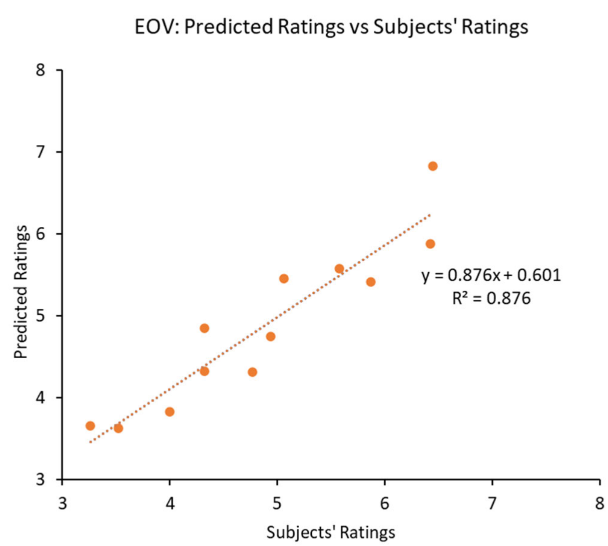


Figure 7.16: Predicted EOV ratings plotted against subjects’ EOV ratings of actual window Views 1 – 12 (Experiment 1).

The second step was to test whether the mean POV (EOV) rating of each of the 12 views was significantly different from its predicted value. One sample t-test was performed on each of the views using SPSS Statistics software with the null hypothesis that there is no significant difference between the predicted POV (EOV) value and the mean POV (EOV) rating. Results indicated that there was no significant difference between the predicted POV (EOV) values and the subjects' POV (EOV) ratings at the 0.05 level across all 12 views. The mean difference (magnitude) in POV ranged from 0.005 in View 6 [$t(30) = 0.011$, $p = 0.991$] to 0.543 in View 8 [$t(30) = 1.320$, $p = 0.197$], whilst the mean difference (magnitude) in EOV ranged from 0.003 in View 6 [$t(30) = 0.005$, $p = 0.996$] to 0.527 in View 12 [$t(30) = -1.328$, $p = 0.194$]. Therefore, the null hypothesis was retained.

7.12.2 External validation

To use out-of-sample data to validate the proposed prediction model, a third window view experiment was conducted. It has been shown in Chapter 6 that there is no significant difference in the evaluation of window view quality between actual view and image view. Therefore, Experiment 3 was designed to be an online questionnaire survey using Google Form to get view quality evaluations on a completely different sets of window views (total 16 views: View 1a – View 16a) from 40 volunteers who were not involved in the previous Experiment 1 or 2. The participants who took part in Experiment 3 were comprised of 18 males and 22 females in the age group of 18 – 40.

By using the same photomontage method as in Experiment 2, the images of 16 outdoor scenes were superimposed with digital drawing of window frame and part of the wall to create realistic effects (see Appendix D4). The questionnaire (including high-resolution digital images of the 16 views) was sent to the 40 volunteers via emails or social media. The 40 subjects in Experiment 3 were required to view and evaluate the POV and EOV of each of the 16 images of window views, one by one in sequence, using their own computer screen at home or workplace. The electronic questionnaire for Experiment 3 used only 10-point numeric scale with bipolar verbal anchors. The distances between any two adjacent points were equal, which was consistent with the scale used in the manual questionnaire for Experiments 1 and 2.

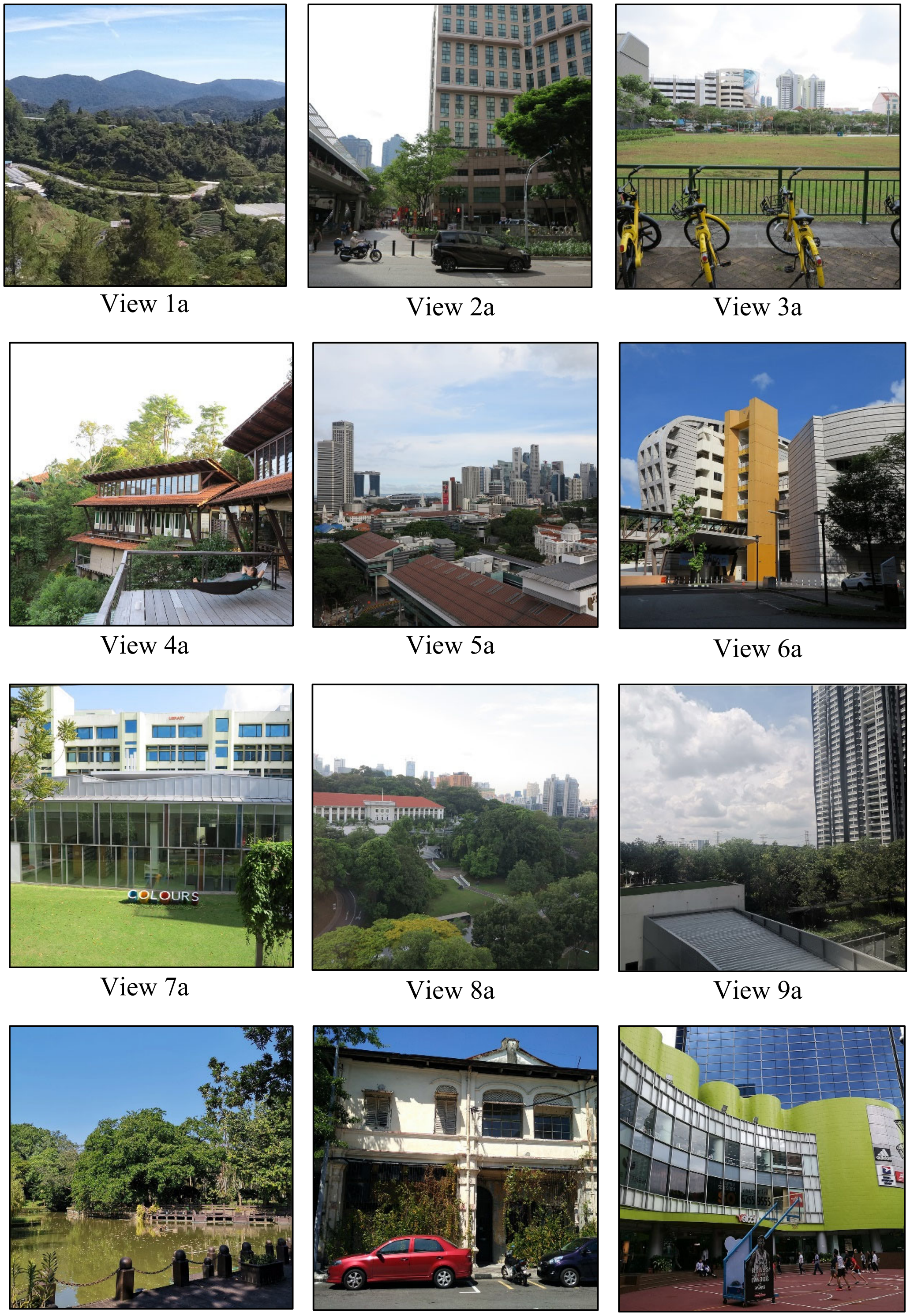
The same methods, which have been discussed in Chapter 3, were used to assess the three view attributes – i.e., "view elements", "balance of view" and "openness of view" for each of these 16 views. To minimise the bias due to subjective judgement, 10 persons - i.e., two architects, one architecture lecturer and seven architecture graduates, were invited to join the researcher in an independent assessment of "view elements" and "balance of view" on these 16 views. The median score of "view elements" and mean score of "balance of view" were derived from the scores given by these 11 assessors, whilst the value of "openness of view" for each of the 16 views was determined by the researcher alone using an objective assessment method described in Chapter 3 (see Appendix D5 for results of assessment). Figure 7.17 shows the scenes of View 1a to View 16a for the purpose of "view elements" assessment. Figure 7.18 shows pixelated images of the same 16 views for the assessment of "balance of view." Figure 7.19 shows pixelated images of the views for the assessment of "openness of view."

The results of assessment on the three view attributes suggested the following:

1. On "view elements" (aesthetical quality of the scene), three out of 16 scenes (i.e., Views 2a, 9a and 11a) have negative scores; one view (View 12a) was neutral; the remaining 12 views have positive scores ranged from 1 to 6 points. View 1a and View 8a have the highest (most positive) score (6 points), whilst View 9a has the lowest (most negative) score (-3 points).

2. "Balance of view" of the 16 scenes ranged from 0.72 (View 9a) to 0.97 (View 7a and View 12a). Nine out of the 16 scenes have "balance of view" ratings between 0.8 and 0.9.

3. "Openness of view" of the 16 scenes ranged from 10% (View 15a) to 72% (View 1a and View 5a). In addition, there are two scenes with very low degree of openness – i.e., View 14a (17%) and View 11a (19%); two scenes with very high degree of openness – i.e., View 3a (62%) and View 8a (68%).



View 1a | View 2a | View 3a

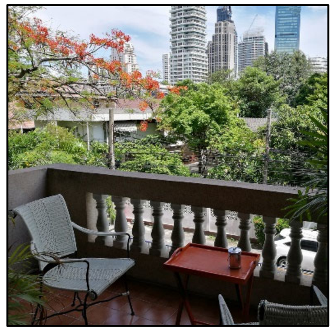
View 4a | View 5a | View 6a

View 7a | View 8a | View 9a

View 10a | View 11a | View 12a

Figure 7.17: Photographs of the 16 views for Experiment 3 (continue to next page).

View 13a



View 14a

View 15a

View 16a

Figure 7.17: Photographs of the 16 views for Experiment 3 (continued from previous page).

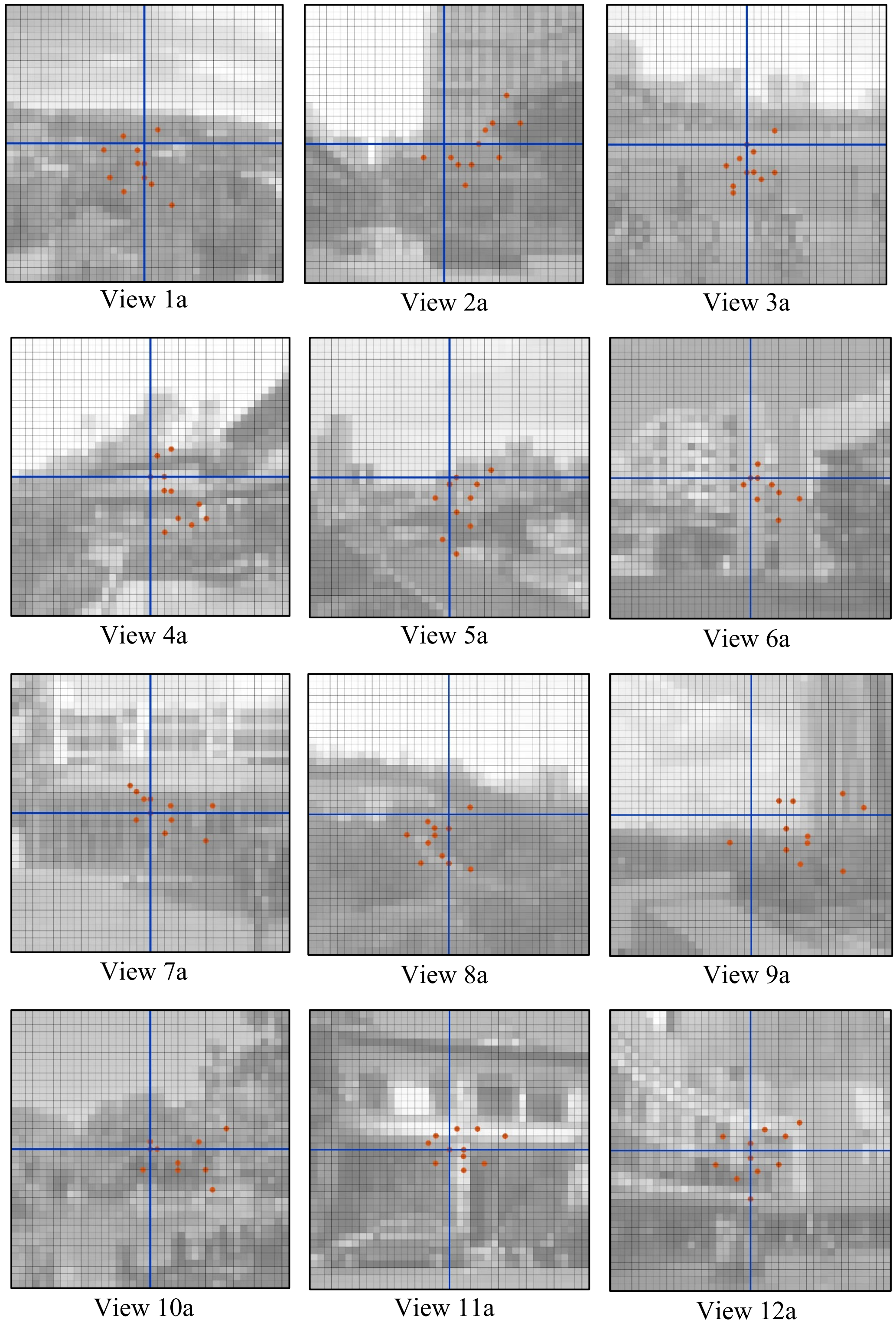
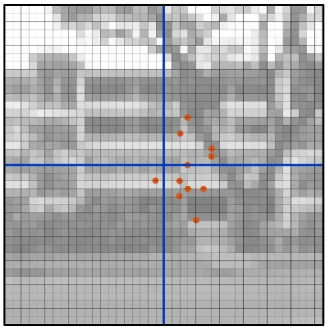
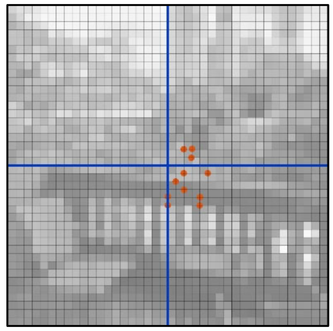
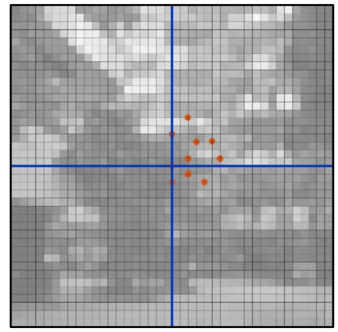


Figure 7.18: Pixelated images of the 16 views for the analyses of “balance of view” in Experiment 3 (continue to next page).


View 13a


View 14a


View 15a

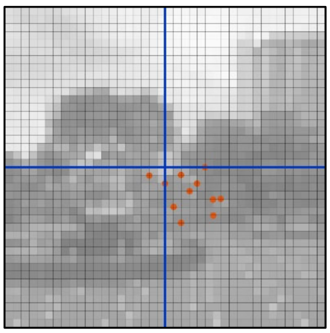

View 16a

Figure 7.18: Pixelated images of the 16 views for the analyses of "balance of view" in Experiment 3 (continued from previous page).

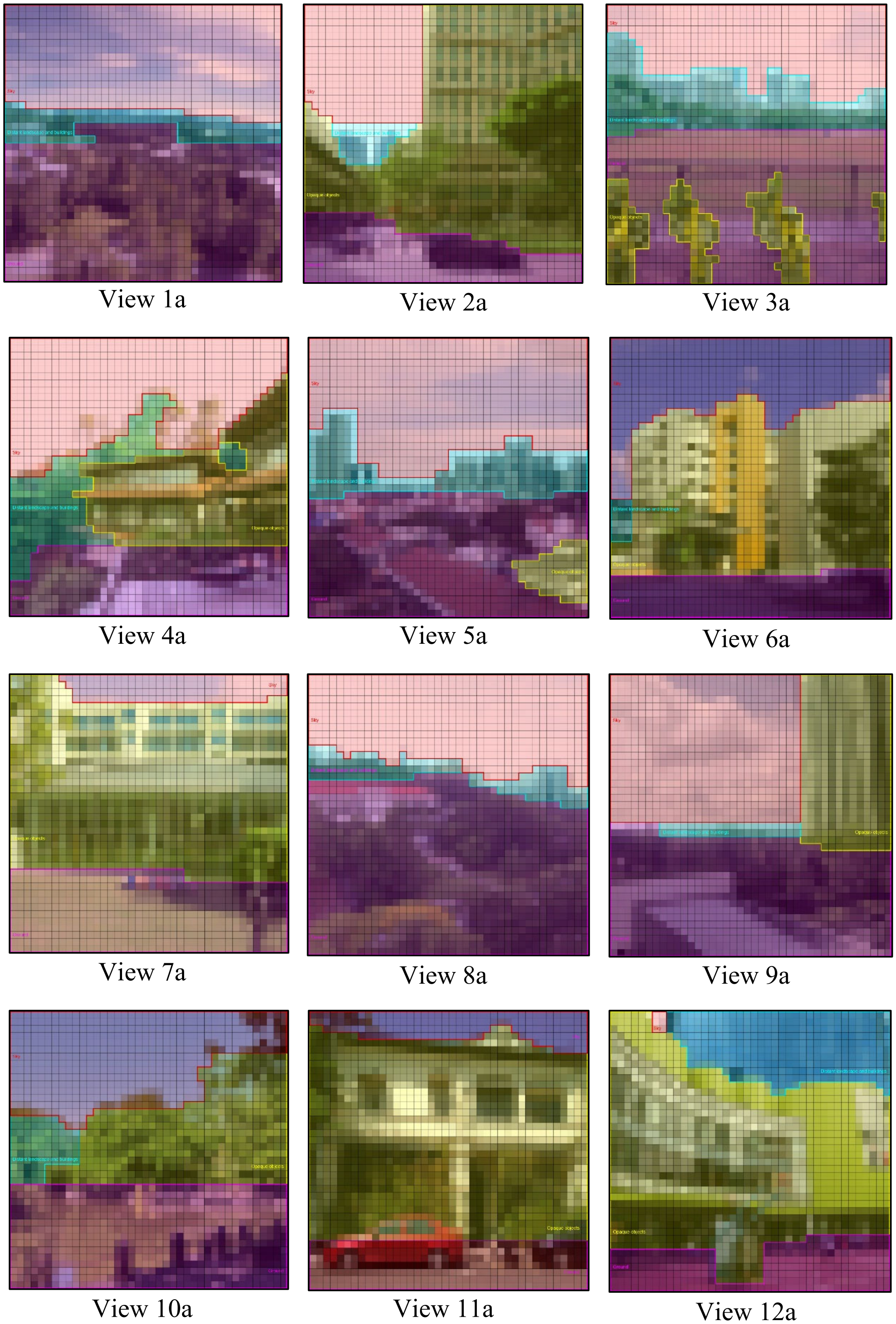
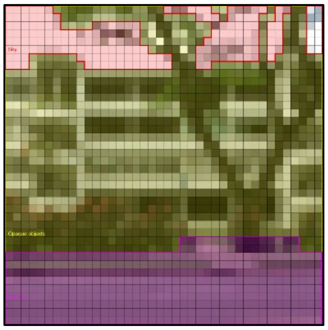
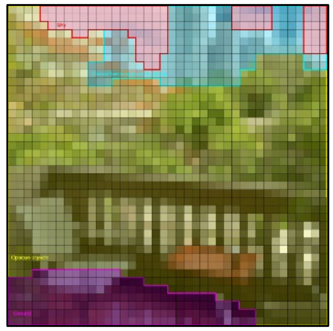


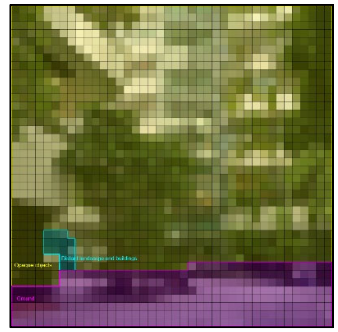
Figure 7.19: Pixelated images of the 16 views for the analyses of "openness of view" in Experiment 3 (continue to next page).



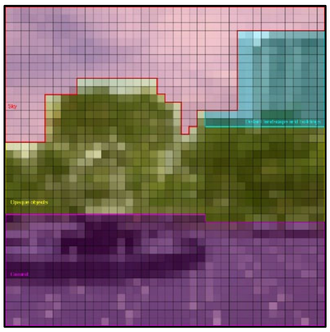
View 13a



View 14a



View 15a



View 16a

Figure 7.19: Pixelated images of the 16 views for the analyses of "openness of view" in Experiment 3 (continued from previous page).

4. Among the 16 scenes, View 1a has the highest (most positive) "view elements" score and also the highest "openness of view." View 9a has the lowest (most negative) "view elements" score and also the lowest "balance of view."

In Experiment 3 (image view), the view quality (POV or EOV) of each of the 16 scenes was measured based on the mean of ratings given by the 40 subjects. The results of Experiment 3 are presented in box and whisker plots as shown in Figure 7.20 (see Appendix E3 for tabulation of the subjects' ratings).

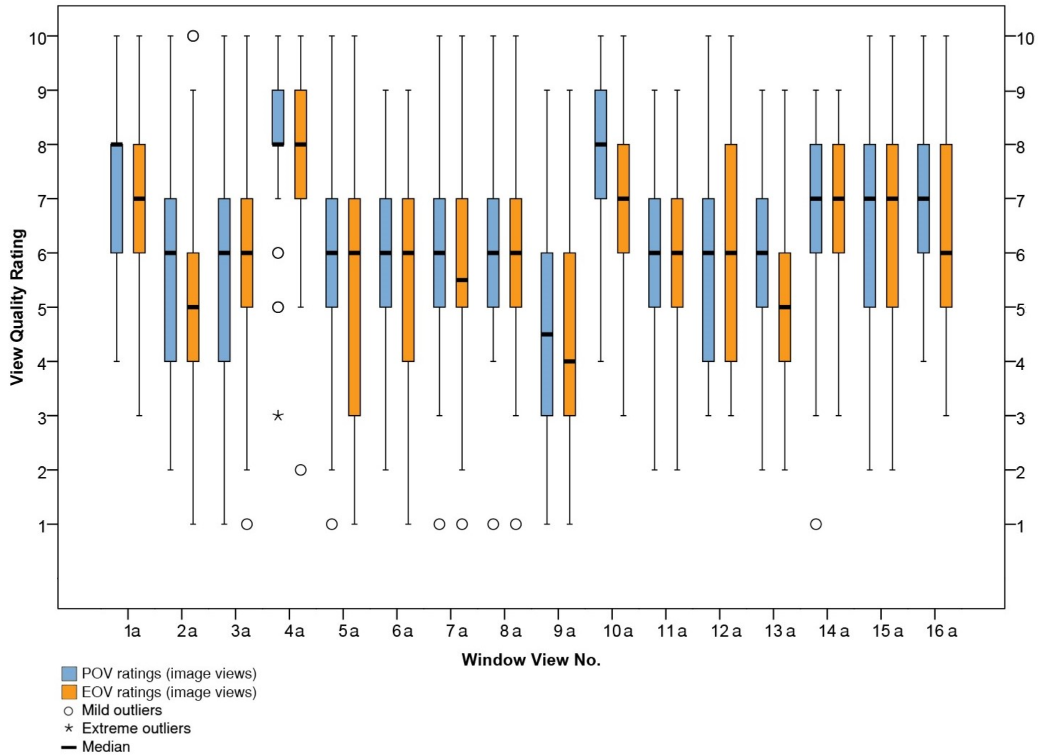


Figure 7.20: Box and whisker plots of POV and EOV ratings (10-point scale) in Experiment 3 (image view) indicating the interquartile range, median, highest and lowest ratings for each of the 16 window views.

Overall, the distribution of POV and EOV ratings in Experiment 3 (image view) covered a wide range. Among the 16 views, Views 5a and 12a (EOV) demonstrated the largest inter-quartile range (IQR), whilst View 4a (POV) had the smallest IQR. From the box plots, median POV was either equal to or higher than median EOV in all the views in Experiment 3 – the same trend was also observed in Experiment 1 (actual view) and Experiment 2 (image view) using 10-point scale. All the views in Experiment 3 had positive view qualities in both POV and EOV with median rating of 6 or above, except in Views 2a (EOV), 7a (EOV), 9a (POV and EOV) and 13a (EOV). The highest median view quality (POV and EOV) was in View 4a; the lowest median view quality (POV and EOV) was in View 9a. When mean ratings of the views were compared, it was observed that View 4a had the highest mean POV (8.08) and EOV (7.40), whereas View 9a had the lowest mean POV (4.60) and EOV (4.20) among the 16 views.

The predicted POV (EOV) rating of each of the 16 window views was obtained by inserting the assessed values of “view elements”, “balance of view” and “openness of view” of that view into the proposed prediction model (see Section 7.11.2). A summary of mean and predicted view qualities and the assessed values of three view attributes (predictors) of the proposed POV and EOV linear models is presented in Table 7.10.

Correlation analysis showed that there was a positive linear association between the predicted rating and the mean subjects’ rating of POV for the 16 views in Experiment 3 (image view), which was significant at the 0.01 level with a large effect size (POV: $R_p = 0.634$, $n = 16$, $p = 0.008$). However, the association between the predicted rating and the mean subjects’ rating of EOV was nonsignificant at the 0.05 level (EOV: $R_p = 0.486$, $n = 16$, $p = 0.056$). Figures 7.21 and Figure 7.22 illustrated the plots of predicted POV (EOV) ratings against the subjects’ evaluation (mean rating) of the 16 views (View 1a – View 16a) in Experiment 3. The results of this correlation analysis suggested that the proposed EOV model was not a valid prediction model.

Table 7.10: Mean and predicted rating scores of POV and EOV (10-point scale) in Experiment 3 (image view) and the assessed values of three view attributes (predictors) of the proposed POV and EOV linear models.

View No.	Mean POV Score: 10-pt scale	Predicted POV Score: 10-pt scale	Mean EOV Score: 10-pt scale	Predicted EOV Score: 10-pt scale	View Elements (Net Score)	Balance of view (0 - 1)	Openness of View (10% per unit)
1a	7.28	8.76	6.50	7.52	6	0.87	7.2
2a	5.43	4.69	5.15	4.29	-1	0.85	2.8
3a	5.55	5.95	5.50	5.17	1	0.92	6.2
4a	8.08	8.10	7.40	7.03	5	0.85	5.8
5a	6.08	6.60	5.55	5.81	1	0.86	7.2
6a	5.85	5.71	5.43	4.95	2	0.93	3.6
7a	5.83	5.52	5.50	4.71	3	0.97	2.2
8a	6.30	8.74	6.15	7.52	6	0.86	6.8
9a	4.60	5.41	4.20	5.13	-3	0.72	5.8
10a	7.68	7.02	7.23	6.14	3	0.86	5.3
11a	5.93	3.79	5.65	3.37	-1	0.95	1.9
12a	5.65	4.19	5.98	3.64	0	0.97	2.2
13a	5.50	5.73	5.03	5.05	2	0.88	2.4
14a	6.73	5.50	6.58	4.85	2	0.89	1.7
15a	6.73	5.63	6.35	4.90	3	0.91	1.0
16a	6.90	7.22	6.45	6.26	4	0.88	4.8

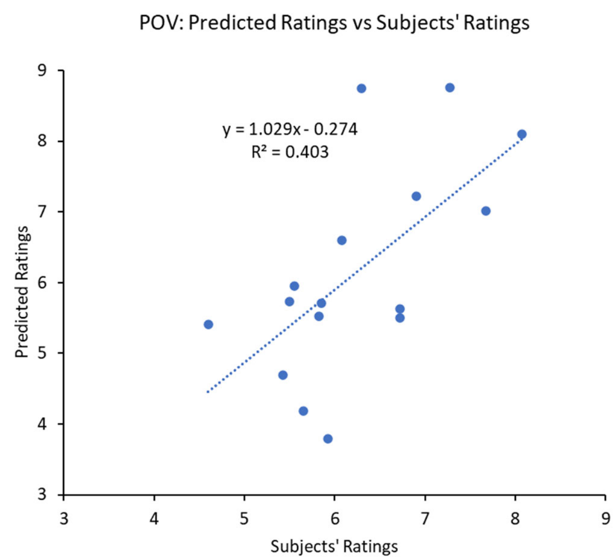


Figure 7.21: Predicted POV ratings plotted against subjects' POV ratings of image views (Experiment 3) for Window View 1a – View 16a.

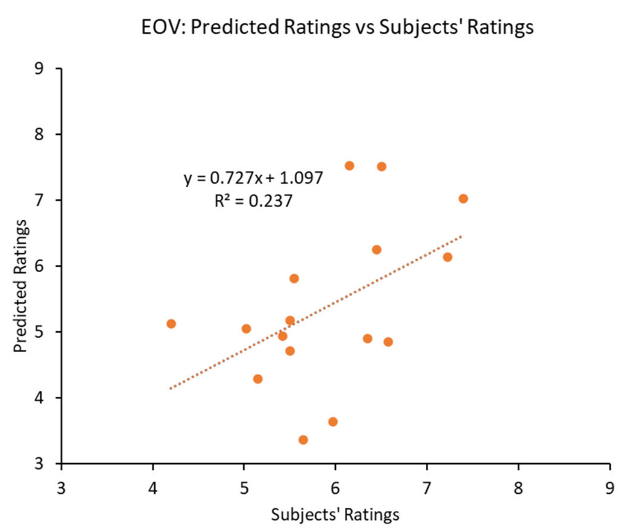


Figure 7.22: Predicted EOV ratings plotted against subjects' EOV ratings of image views (Experiment 3) for Window View 1a – View 16a.

The next step was to test whether the mean POV rating of each of the 16 views was significantly different from its predicted value, which was derived from the proposed POV model. One sample t-test was performed in SPSS on each of the 16 views with the null hypothesis that there is no significant difference between the mean POV rating and the predicted POV value. To control the Type I error rate in this multiple testing, Bonferroni correction was applied to the critical level of significance. The new critical level of significance (alpha level) after Bonferroni correction was 0.05/16 = 0.0031. Results of the one sample t-test are presented in Table 7.11. The results show that there was significant difference between the mean POV rating and the predicted POV value in Views 1a, 8a, 11a, 12a, 14a and 15a at the corrected alpha level (0.0031). Therefore, the null hypothesis was rejected. Overall, the proposed prediction model was able to predict POV ratings of 10 out of the 16 views (or 62.5% of the cases) in Experiment 3 but it was not considered to be a robust prediction model. The predicted POV was significantly different from the mean POV rating in View 1a and View 8a probably because the predictors were confounded by other factors such as a large greenery proportion in these two views (55 – 60%), whilst in Views 11a, 12a, 14a and 15a the predictors were probably confounded by other factors such as the proportion of sky layer that was extremely small in these four views (0 – 9.8%).

Note that “view elements” and “openness of view” are also significant predictors of view quality (POV) in the ordinal logistic regression model (4-point scale data) of this study. “Balance of view”, however, is a significant predictor in the linear model only. In contrast to the proposed POV model, the EOV prediction model did not fit the data, hence it is not a valid prediction model. One possible explanation is that all the views in Experiments 1, 2 and 3 are urban or sub-urban landscape views that are comprised of elements of nature, buildings and streetscape, traffic, and other built environments, hence the emotional response of the subjects towards these features was predictable in the “pleasantness” dimension but not the “excitingness” dimension based on the affective quality circumplex model developed by Russell et al. (1981). Probably the evaluation of a different category of outdoor views such as those that focus on human activities will be predictable in the “excitingness” dimension (EOV model) – however, this speculation needs to be investigated in further research.

Table 7.11: Results of one sample t-test on the difference between the mean POV rating and the predicted POV value for Experiment 3 (image view).

View No.	Mean Difference	95% Confidence Interval of the Difference		t	df	p-value		
		Lower	Upper					
1a	-1.485	-1.954	-1.016	-6.400	39	0.0000	***	#
2a	0.735	0.143	1.327	2.510	39	0.0163	*	
3a	-0.400	-0.984	0.184	-1.386	39	0.1736		
4a	-0.025	-0.513	0.463	-0.104	39	0.9180		
5a	-0.525	-1.102	0.052	-1.842	39	0.0731		
6a	0.140	-0.409	0.689	0.515	39	0.6092		
7a	0.305	-0.186	0.796	1.257	39	0.2161		
8a	-2.440	-3.002	-1.878	-8.783	39	0.0000	***	#
9a	-0.810	-1.508	-0.112	-2.348	39	0.0240	*	
10a	0.655	0.218	1.092	3.033	39	0.0043	**	
11a	2.135	1.586	2.684	7.871	39	0.0000	***	#
12a	1.460	0.869	2.051	4.998	39	0.0000	***	#
13a	-0.230	-0.762	0.302	-0.874	39	0.3874		
14a	1.225	0.673	1.777	4.493	39	0.0001	***	#
15a	1.095	0.529	1.661	3.916	39	0.0004	***	#
16a	-0.320	-0.810	0.170	-1.321	39	0.1943		

Note: * $p < 0.05$, ** $p < 0.01$, ***$p < 0.001$, # p-value (2-tailed) that is lower than the alpha level corrected by Bonferroni method (corrected alpha level: 0.0031).

7.13 Summary

Seven view attributes have been identified from the literature review (Chapter 2) – i.e., proportion of greenery, number of visual layers, view elements (aesthetic impression of elements), balance of view, diversity of view, openness of view and depth of view. In this chapter, two hypotheses below were tested on each of the seven view attributes using the data collected from Experiment 1 (actual view):

> Hypothesis 1: there is a significant linear association between the mean POV (EOV) rating (10-point scale) and the view attribute.
>
> Hypothesis 2: there is a significant monotonic relationship between the median POV (EOV) rating (4-point scale) and the view attribute.

The following trends were observed in the analyses of the seven view attributes:

1. "Proportion of greenery" that was not extremely high had a significant and positive monotonic relationship with view quality in terms of EOV. Greenery proportion had a large effect size on EOV under this condition.

2. "Number of visual layers" had a significant and positive monotonic relationship with EOV provided that the aesthetical quality of view was not negative. Under this condition, number of visual layers had large effect size on EOV.

3. "View elements" (aesthetical impression of the scene) had a significant and positive linear association with view quality (either POV or EOV) based on 10-point scale data and had a large effect size on either view quality. When 4-point scale data were analysed, "view elements" had a significant monotonic relationship with POV too but not EOV.

4. “Balance of view” had a significant and negative linear relationship with EOV and had a large effect size on EOV evaluation. When “view elements” score of a view is not extremely positive or negative, “balance of view” appeared to have a significant and negative linear association with either POV or EOV evaluation with a larger effect size.

5. “Diversity of view” had a significant and negative linear association with view quality in terms of POV and had a large effect size on POV – on condition that the views were not extremely open.

6. “Openness of view” had a significant and positive monotonic relationship with view quality (EOV) and had a large effect size on EOV. When a view had non-negative “view elements” score, its “openness of view” value had a very large effect size on EOV. Under the same condition, “openness of view” was found to have a significant and positive linear association with view quality (POV) and had a large effect size on POV.

7. “Depth of view” had neither linear nor monotonic relationship with either of the view quality (POV or EOV) in the analyses. Probably this view attribute was confounded by other factors, which need to be explored in future studies.

On correlations between view attributes in Experiment 1 (actual view): there were moderate correlations between number of visual layers and diversity of view (0.648), number of visual layers and openness of view (0.500), diversity of view and depth of view (0.588). The variance inflation factor (VIF) in diversity of view and depth of view were relatively high (in both POV and EOV models) compared to the other four predictors. Multicollinearity may be present in the standard linear regressions.

A view quality prediction model for POV was derived using a stepwise multiple regression as below:

$$Q_{POV} = 0.45VE - 6.63BV + 0.25OV + 10.08$$

where Q_{POV} is the predicted view quality (POV), value between 1 – 10, measured in the “pleasantness” dimension of affective quality.

A view quality prediction model for EOV was derived using a stepwise multiple regression as below:

$$Q_{EOV} = 0.36VE - 7.25BV + 0.20OV + 10.24$$

where Q_{EOV} is the predicted view quality (EOV), value between 1 – 10, measured in the “excitingness” dimension of affective quality.

“View elements” (VE) and “openness of view” (OV) were the only two view attributes (predictors) that were statistically significant in both the stepwise linear model (10-point scale data) and the ordinal logistic regression model (4-point scale data). “Balance of view” was a significant predictor in the stepwise linear model but not in the ordinal logistic regression model.

The stepwise linear model of prediction (POV) was validated with data collected from Experiment 3 in which 40 subjects from a different group viewed and evaluated 16 views that were different from the 12 views in the previous two experiments. The results of this correlation analysis suggested that the proposed EOV model was not a valid prediction model. The results of hypothesis testing showed that there was a significant difference between the mean POV rating and the predicted POV value in six out of 16 views in Experiment 3, hence the null hypothesis was rejected at the corrected alpha level (0.0031). Overall, the proposed prediction model (POV) was not considered to be a robust model even though it was able to predict POV ratings of 10 out of the 16 views (or 62.5% of the cases) in Experiment 3. Therefore, a larger sample of window views that cover a wider range of value in each of the predictors is needed in further studies to refine the prediction models.

CHAPTER 8

Conclusion

8.1 Introduction

The first chapter has introduced the present research. Chapter 2 has discussed the outcomes of literature review, the research questions and the hypotheses tested in this study. Chapter 3 has discussed the method and experiment design, including the method of assessing the proposed view attributes. The results of Experiment 1 (actual view) and Experiment 2 (image view) have been discussed in Chapter 4. The comparison of two different response formats of rating scales – i.e., 4-point and 10-point scales that were used in both Experiment 1 (actual view) and Experiment 2 (image view), has been discussed in Chapter 5. Chapter 6 has discussed the comparison of view quality evaluations under two different modes of view – i.e., actual view and image view. Chapter 7 has discussed the testing of view quality predictions using the proposed view attributes and has also discussed the development of prediction models using stepwise multiple regression (for 10-point scale data) and ordinal logistic regression (for 4-point scale data).

The following sections present the achievement of the objectives of the research, its theoretical and practical implications as well as its limitations and recommendations for future research.

8.2 Achievement of objectives

The objectives of this research, which have been developed in Chapter 1, are re-stated as the following:

Objective 1: To identify the potential attributes of window view quality.

Objective 2: To investigate the associations between the proposed view attributes and window view quality.

Objective 3: To compare the reliability and validity of two different rating scale formats, i.e., 4-point and 10-point, for the subjective evaluation of window view quality.

Objective 4: To compare the perceived quality of window view between two different modes of viewing, i.e., actual view and image view.

Objective 5: To develop a prediction model for the objective assessment of window view quality.

8.2.1 Objective 1

The first objective was *to identify the potential attributes of window view quality*. To achieve this objective, a literature review (Chapter 2) on the attributes of window view and the methods of assessing the attributes has been conducted. "Proportion of greenery" was found to have positive association with view quality in the previous studies of Kaplan (2001), Ozdemir (2010), Hellinga and Hordijk (2014), Lottrup et al. (2015) and Olszewska-Guizzo et al. (2018). It was established that the "number of visual layers" was contributory to a higher "view quality score" in Hellinga and Hordijk (2014) whilst it had a significant and strong impact on view quality in Matusiak and Klöckner (2016). On "view elements" (aesthetic impression of elements), it was shown that it had a positive effect on the aggregate "view quality score" in Hellinga and Hordijk (2014), whilst the equivalent attribute in Matusiak and Klöckner (2016) – i.e., "aesthetical scene quality", had a positive monotonic relationship with view quality, and was the predictor with the strongest impact on view quality. "Balance of view" (composition of view) and the "aesthetical quality of the scene" were strongly associated with each other and with the perceived view quality in Matusiak and Klöckner (2016). In Hellinga and Hordijk (2014), it was established that "diversity of view" positively contributed to the aggregate "view quality score." On "openness of view", Ozdemir (2010) demonstrated that it was positively associated with room satisfaction, whilst Raanaas et al. (2011) suggested that panoramic view was most satisfying compared to a partially blocked or fully blocked view. Ludlow (1976) suggested that "depth of view" was positively associated with view quality on the condition that there was a range of spatial sequences instead of one class of distance, whilst Matusiak and Klöckner (2016) suggested that view depth had a strong positive impact on the perceived view quality.

As a summary, it can be concluded from the outcomes of literature review that the potential view attributes of window view are proportion of greenery, number of visual layers, view elements (aesthetic impression of elements), balance of view, diversity of view, openness of view and depth of view. In this study, these seven view attributes are redefined as ratio-level measures. "Proportion of greenery" is the percentage of cells in the pixelated image of view that contains greenery or natural landscape elements. "Number of visual layers" is the number of layers observable in a scene, which include sky, distant landscape and buildings, ground and opaque objects (or layers) that cover any part of the first three basic layers. "View elements" is the total net score (positive/ zero/ negative) on the aesthetic impression of all observable groups of elements in the view. "Balance of view" is the level of proximity of the "point of balance" (centre of mass) to the centre of view. "Diversity of view" is the number of groups (types) of view elements in the scene (based on verbal descriptors). "Openness of view" is the percentage of cells in the pixelated image of the sky that is covered by other opaque layers in a scene. "Depth of view" is the distance between the observer and the most distant visible element of the landscape. The methods of measuring these seven view attributes have been discussed in Chapter 3 and summarised in Table 3.3.

8.2.2 Objective 2

The second objective was *to investigate the associations between the proposed view attributes and window view quality*. To achieve this objective, Experiment 1 (actual view) was conducted to measure the quality of view from 12 windows in terms of "pleasantness of view" (POV) and "excitingness of view" (EOV). For each of the view attributes, it was hypothesised in the current study that there was a significant linear (or monotonic) association between the mean POV (EOV) rating based on a 10-point (or 4-point) scale and the view attribute. The hypothesis was tested by using Pearson's and Spearman's correlation analyses for the 10-point and 4-point scale data respectively.

On "proportion of greenery", the results suggested that the null hypothesis was to be retained because the data did not support the predicted trend that an increase in the greenery proportion was associated with an increase in view quality. However, greenery proportion that was not extremely high (below 20%) was found to have a significant and positive monotonic relationship with view quality in terms of EOV, and in this condition, greenery proportion had a large effect size on EOV.

Contrary to the previous studies (Hellinga and Hordijk 2014; Matusiak and Klöckner 2016), the results of this study did not indicate that the "number of visual layers" in the 12 window views was significantly associated with the view quality measured in terms of POV or EOV (either 10-point or 4-point scale), hence the null hypothesis was retained. However, "number of visual layers" in this study had a significant positive monotonic relationship with the EOV evaluation when the aesthetic impression of view elements was not negative.

The analysis results showed that "view elements" (aesthetic impression of elements) had a significantly positive linear association with view quality (either POV or EOV) and had a large effect size on either view quality, therefore the null hypothesis was rejected. The result was consistent with the previous study of Matusiak and Klöckner (2016), which suggested that "aesthetical scene quality" had a significantly strong association with view quality. "Proportion of greenery" appeared to be a confounding variable to the prediction based on "view elements" because when two views without greenery content in this study were removed from the analysis, the prediction power of "view elements" became stronger.

In contrast with the previous study by Matusiak and Klöckner (2016), the analysis results on "balance of view" suggest the contrary: a negative linear association between EOV and "balance of view", which means that a view is predicted to be less exciting when the view has a higher degree of balance; and a view is predicted to be more exciting when the view has a lower degree of balance. In addition, the perceived pleasantness of a view may have a negative linear relationship with balance of the view when the aesthetical scene quality ("view elements") is not extremely low (negative) or high (positive). The difference in the methods of measuring "balance of view" in the two studies (ordinal-level vs. ratio-level measurements) probably causes the difference in results. In addition, "balance of view" may be confounded by other predictors of view quality such as "openness of view" (significant correlation between these two attributes was observed, as shown in Table 7.3, Chapter 7).

The outcome of analysis suggested that there was no significant association between "diversity of view" and view quality, hence the null hypothesis was retained. The result was inconsistent with that in Hellinga and Horjik (2014), which suggested that a higher diversity of view was a contributory factor to a higher "view quality score." In the current study, it appeared that view quality was positively affected by the aesthetic impression of the view (i.e., "view elements") rather than the number of groups of view elements (i.e., "diversity of view"). However, this study showed that when the views were not extremely open (i.e., below 60%), "diversity of view" had a significant but negative linear association with view quality in terms of POV and had a large effect size on POV.

The results also suggested that there was a significant monotonic relationship between "openness of view" and view quality in terms of EOV, hence the null hypothesis was rejected. The results of the EOV rating (4-point scale) data supported the predictions, but the POV rating (4-point scale) data did not support the predictions. However, "openness of view" was found to be positively associated with POV under a linear assumption when the views have either neutral or positive aesthetic impression (i.e., "view elements" score is zero or above). The results can be interpreted in this way: when a view is more open, it is perceived to be more exciting or stimulating, but not more pleasant unless the view is not negative in its overall aesthetic impression.

The analysis results showed that there was neither a linear nor monotonic relationship between "depth of view" and view quality, hence the null hypothesis was retained. The results did not support the findings in Matusiak and Klöckner's (2016). The possible explanations for the differences between these results are that "depth of view" was probably confounded by other factors in this study, and that in Matusiak and Klöckner's (2016) study, which was conducted within a university campus, the views with good or excellent ratings were mostly views that have large depths and contained beautiful distant landscapes; the views with unsatisfactory ratings were mostly views that were blocked by the opposite building (i.e., with small depths of view), whereas in this study (Experiment 1), views that have large depths happened to have negative "view elements" scores.

As a summary, it can be concluded that among the seven proposed view attributes, "view elements" (aesthetic impression of elements) is the most robust predictor of view quality in this study as it can predict the evaluation of either POV or EOV (10-point scale) under a linear assumption with significance at the 0.01 level and 0.05 level respectively. "Depth of view" appears to be the poorest predictor of view quality in this study as neither linear nor monotonic relationship can be established between the attribute and the view quality (POV or EOV) in this study. A summary of associations between window view quality (in terms of POV or EOV) and the seven view attributes has been presented in Table 7.2. To detect the possible confounding between the seven proposed view attributes as predictors of view quality, multiple linear regression and ordinal logistic regression analyses have been conducted on the 10-point and 4-point scale data respectively.

8.2.3 Objective 3

The third objective was *to compare the reliability and validity of two different rating scale formats, i.e., 4-point and 10-point, for the subjective evaluation of window view quality*. From the analyses of scale reliability, both 4-point and 10-point formats showed moderate to excellent internal consistencies (Cronbach's alpha value higher than 0.70) in 10 out of 12 views in Experiment 1 (actual view), and 7 out of 12 views in Experiment 2 (image view); the remaining cases showed acceptable levels of internal consistencies. This implies that both scale formats were reliable, and the scales used in Experiment 1 (actual view) were somewhat more consistent internally compared to Experiment 2 (image view). The analysis results showed that there were significant differences in the internal consistencies between 4-point and 10-point scale formats. From the 12 sample views – either actual or image views, it appeared that generally 10-point scale ratings of POV (EOV) had relatively higher internal consistencies compared to that of 4-point scale. Overall, either 4-point or 10-point scale used in both experiments had good interrater reliability (ICC value larger than 0.70) except for four cases in Experiment 1, and five cases in Experiment 2, which had moderate level of interrater reliability. Results of Exploratory Factor Analysis showed that the two items of rating – i.e., POV and EOV were unidimensional in all 12 cases for both 4-point and 10-point scales. Overall, the correlation between the POV and EOV rating scores was evidence for convergent validity. Since there was only one underlying construct in this study (i.e., window view quality), the results of convergent validity confirmed construct validity of the rating scales (POV and EOV) used in both experiments in assessing view quality.

In order to compare the means and variances of POV or EOV of the 12 window views between 4-point and 10-point scales, the two scale formats were rescaled into a common 101-point scale (0 – 100). An independent samples t-test was performed using SPSS on each of the 12 views with the null hypothesis that there was no significant difference in the mean POV (EOV) between the rescaled 4-point and 10-point ratings. Results showed that there was no significant difference in the mean POV (EOV) values between the rescaled 4-point and 10-point ratings. This implies that the difference in scale format (4-point vs. 10-point) did not affect the judgement of the subjects in the view quality evaluation on either POV or EOV, and in either actual or image viewing mode. Therefore, the results suggest that 4-point and 10-point rating scales serve the same purpose as the response formats of a rating scale for measuring window view quality. However, data from the 4-point scale may not be suitable for developing a linear prediction model of the view quality because the categorical nature of 4-point scale data in the dependent variable is likely to violate the assumption of normality and thus can result in biased parameter estimates and incorrect standard errors (Rhemtulla et al. 2012; Harpe 2015). In comparison, 10-point scale data can generally be treated as continuous interval-level data and used to establish a linear prediction model (Harpe 2015).

The results also indicate that for majority of the views, the subjective evaluations based on 10-point scale format did not receive any response on the higher or lower end of the rating scale, resulting in plateau on one or both ends in the plots of probability (cumulative frequency) against rating category. It shows that 10-point scale may be too fine (too many scale points) for the purpose of evaluating window view quality, whilst the 4-point scale can be finer to increase the discriminating power of the scale. Since a neutral category at the centre should be avoided to demand a forced-choice response (Fotios 2015) between a positive (pleasant or exciting view) and a negative (unpleasant or boring view) rating, the optimum number of response categories on a rating scale for evaluating window view quality may be either 6 or 8. Further research is recommended to measure the reliability and validity of 6-point and 8-point scales that are designed for the evaluation of window view quality.

8.2.4 Objective 4

The fourth objective was *to compare the perceived quality of window view between two different modes of viewing, i.e., actual view and image view*. Because of the potential use of digital photographs in future research of window view quality, the question of whether perceiving the picture of a scene is as veridical as perceiving the real scene has been investigated in this study. From the outcomes of literature review, it was hypothesised that there was a significant difference in the view quality evaluation between the actual-view mode and the image-view mode. The results of analyses showed that there was no significant difference in the mean POV or EOV ratings between the actual view and the image view, hence the null hypothesis was retained. However, either POV or EOV ratings in actual view had relatively larger variances compared to that in image view.

It was established from this study that the difference in depth perception between actual view and image view did not significantly affect the perceived qualities of window views (in terms of POV or EOV). Therefore, it was concluded that the Alberti's window hypothesis was retained for the evaluation window view quality despite Wijntjes's (2014) findings that perception of real space is more accurate and less ambiguous than pictorial space, and that the distribution of equally perceived depths is curved in real space but relatively flat in pictorial space. The results of the current experimental study therefore support the findings of Gibson (1971) and Cutting (2003), which suggested that there was no difference between perceiving pictorial space and perceiving environmental space. According to Hecht et al. (1999), there was still a difference between actual and image viewing but it was nonsignificant for large viewing distances, as the marginal difference was caused by the underestimation of angles at the near centred camera positions.

The results of the present study also suggest that when viewing a picture of a scene, the observer can normally make a good prediction of what is beyond the physical boundaries of the view. This natural perceptual ability of perceiving an environmental context larger than what is displayed in a picture was mentioned in the "boundary extension" theory proposed by Intraub (2014), which may be one of the reasons for the nonsignificant difference between actual view and image view in the evaluation of window view quality.

8.2.5 Objective 5

The fifth objective was *to develop a prediction model for the objective assessment of window view quality*. When the proposed view attributes (as defined in Chapter 3) were assigned as independent variables in a multiple linear regression (MLR) to predict view quality (POV or EOV) based on 10-point scale, it was found that there were moderate correlations between "number of visual layers" and "diversity of view" (0.648), between "number of visual layers" and "openness of view" (0.500), between "diversity of view" and "depth of view" (0.588); the variance inflation factor (VIF) for "diversity of view" and "depth of view" were relatively high compared to the other four predictors. This suggests that multicollinearity may be present in the MLR.

The proposed view attributes were included as independent variables in a stepwise multiple regression analysis to derive a prediction model for window view quality (in terms of POV or EOV) based on the 10-point scale data collected from Experiment 1 (actual view). The outcomes of analysis showed that the stepwise procedure (performed using SPSS) eliminated three out of six predictors from either POV or EOV model. In the proposed POV model based on stepwise multiple regression, “view elements” (VE), “balance of view” (BV) and “openness of view” (OV) were significant predictors of view quality (POV): controlling for the effects of BV and OV, POV and VE are positively correlated (R_p = 0.333); controlling for the effects of VE and OV, POV and BV are negatively correlated (R_p = -0.241); controlling for the effects of VE and BV, POV and OV are positively correlated (R_p = 0.176).

The proposed prediction model for POV was validated by using data of window view evaluation from a third experiment, which involved 16 views that were different from the first two experiments. One sample t-test was performed on each of the 16 views with the null hypothesis that there is no significant difference between the mean POV rating and the predicted POV value. Results indicated that there was no significant difference between the predicted POV ratings and subjects’ ratings in 10 out of the 16 views (62.5%). However, more scenes with view attributes covering a larger range of values need to be analysed in future studies to derive a more robust prediction model of view quality.

Ordinal logistic regression (OLR) was performed on 4-point scale data (POV or EOV) collected from Experiment 1 (actual view). Results of the POV prediction model based on OLR showed that “view elements” and “openness of view” were significant and predictors of view quality (POV): for every one-unit increase in “view elements”, there was a predicted 36% increase in the odds of a subject giving a higher POV rating for an actual window view; for every one-unit (10%) increase in “openness of view”, there was a predicted 67% increase in the odds of a subject giving higher POV rating.

As a summary, it can be concluded from the analysis that the proposed prediction model for POV based on stepwise multiple regression (10-point scale data) was not a robust prediction model since it only managed to predict the POV values of 10 out of 16 cases (62.5% of the cases) in Experiment 3. However, it has been established in this study that “view elements” and “openness of view” were two significant predictors of POV in either linear or non-linear model. In contrast to the POV model, the proposed prediction model for EOV has failed the external validation, hence it was not a valid prediction model. The EOV prediction model was not a valid model in this study probably because all the views in the experiments of this research were either urban or sub-urban landscape views that were comprised of elements of nature, buildings and streetscape, traffic, and other built environments, hence the emotional response of the subjects towards these features was somewhat predictable in the "pleasantness" dimension but not the "excitingness" dimension based on the affective quality circumplex model developed by Russell et al. (1981). Perhaps the evaluation of a different category of outdoor views that focus on human activities will be predictable in the "excitingness" dimension of affective quality. However, this is only speculation, thus further investigation is required to confirm this.

8.3 Implications of research

Since the psychological benefits of a good window view are well established from existing literature, the present research has sought to investigate the method of measuring view quality and propose view attributes that are potentially robust predictors of view quality. With the methodological contribution to the research of window view quality, the theoretical and practical implications of this study will impact future research.

8.3.1 Theoretical implications

There are two theoretical implications in this study. Firstly, the experiment design has been developed and improved from the previous studies to achieve a larger variety of views (from urban to sub-urban), which can be observed on site and within a controlled environment – i.e., the subjects performed the viewing of each scene in the same environment, as the researcher led the subjects to travel by train from one site to another for viewing all the selected scenes one by one. In Experiment 1 (actual view), the variables were the view attributes that defined the unique contents of each view, whereas the constants were the shape and size of window, which was a square window of 1,200 mm by 1,200 mm in size (defined by a viewing box); weather condition, which was mostly sunny; sun orientation, which was virtually invariant within the period of viewing each scene. The same experimental set up has not been explored in the previous studies. Scaled models with projected images of views were used by Ne'eman and Hopkinson (1970), Keighly (1973a, b), Ludlow (1976), Butler and Steuerwald (1991); scaled model with a window-like aperture was used by Roessler (1980); test rooms were used by Tuaycharoen and Tregenza (2007), and Ozdemir (2010); simulated window in a test room was used by Kim et al. (2012). The current experiment design has the potential to be further developed to obtain more views and a larger variety of views for evaluation in future research.

Secondly, the method of subjective evaluation of view quality has been developed and improved from the previous studies to incorporate two different indicators of view quality – "pleasantness" of view (POV) and "excitingness" of view (EOV), which are based on the circumplex model of affective quality developed by Russell et al. (1981). From literature review, the most common criterion of the subjective evaluation of view quality was the level of "view satisfaction", which did not provide information concerning the affective quality that was attributed to the view observed. For the purpose of view quality assessment, POV and EOV are two indicators of view quality that have been tested in this study. The results of validation indicate that POV rating data from 62.5% of the cases in Experiment 3 fitted the linear prediction model of POV. However, the EOV rating data did not fit either linear or non-linear model.

It is interesting to note that all the 12 views in Experiment 1 and 16 views in Experiment 3 were urban or sub-urban landscape views that were comprised of elements of nature, buildings and streetscape, traffic, and other built environments; the emotional response of the subjects towards these features was predictable in the "pleasantness" dimension rather than the "excitingness" dimension. Further research is required to explore the types of views in which the quality can be predicted in the "excitingness" dimension. Another potential affective dimension in the circumplex model to be explored for view quality evaluation is the "relaxing – distressing" dimension. As suggested by Ludlow (1976), a lexicon for view quality based on affective descriptors needs to be developed so that it can be used to construct survey questionnaires for the purpose of evaluating window view quality.

8.3.2 Practical implications

The findings in this research suggest that view attributes can be manipulated by the architect in the process of designing a window to achieve the desired view quality. When the architect specifies the size, shape, position and orientation of a window, he can determine the view quality of the proposed window by applying his assessment of view attributes to the prediction model. In this process, the architect can explore various window configurations until the predicted view quality is optimised – i.e., achieving the highest possible quality of view and at the same time fulfilling other parameters of window design such as privacy, daylight contribution, glare control, thermal function and acoustic function (Ludlow 1976).

It has been demonstrated in Chapter 7 that "view elements" and "openness of view" are significant predictors of view quality (POV). If the architect wishes to design a window of a newly proposed building, he can apply the prediction model according to the following steps. First, he should obtain digital photographs of views in all directions and at all relevant heights from the site of the proposed building, and then superimpose on these pictures a perspective of the proposed window using a three-dimensional digital modelling technique. On the view that is seen through the proposed window design, the architect assesses the values of "view elements", "balance of view" and "openness of view" using the methods described in Chapter 3. These values are then inserted into the equation of prediction model to obtain the expected value of view quality. The architect records this and then repeats the same procedure on different configurations of window designs that are appropriate. Finally, the architect must decide which option has the most optimised view quality so that it is selected as the preferred window design proposal. The same methods can also be applied when designing for the replacement or modification of existing windows in a building renovation project.

From the outcome of this research, it is anticipated that a prediction model of view quality is only valid for certain types of views within a certain geographical region. For instance, the prediction model of POV that was presented in Chapter 7 is perhaps only applicable to the urban and sub-urban areas that are close to MRT railway lines in Kuala Lumpur (the area in which this experimental study was carried out). Therefore, if the architect intends to design windows in a region or area that has distinctively different types of view (e.g., sea view), he will have to commission a research team to develop a new prediction model of view quality by using the proposed methods in this research. This implies that it is unlikely that we can develop a "universal" model that is able to predict view quality of all types of window view within any region of the world. This proposition nevertheless deserves further research.

8.4 Limitations of Study and Future Research

This research has several limitations, which are mainly related to the experiment design. The limitations of study and the recommendations for further research are summarised as follows:

1. Window view quality in the Experiment 1 (actual view) was evaluated based on the minimum window ratio in the range of 0.49 – 0.51 (Ne'eman and Hopkinson 1970) but did not include "window gazing" (when the observer stands or sits by the window and looks out). Therefore, view quality in "window gazing" or from a distance (in which window ratio is much smaller than 0.49) requires further research.

2. The sites on which the subjects performed viewing in Experiment 1 were all elevated from the ground level (between 9 and 13 metres approximately). Therefore, the 12 selected views in this study were considered samples of window views from Level 4 or 5 of a building. Future studies should include views from ground-floor or low-level windows.

3. In this research, the viewing of the outdoor scenes was performed only during daytime between 10.00 am and 1.00 pm, and with mostly sunny weather. Future research can investigate the difference in perceived view quality between different times of a day (e.g., daytime vs. nighttime), as well as

between different weather conditions (e.g., sunny vs. rainy weather) and between different seasons of a year (e.g., summer vs. winter).

4. Most of the subjects in this study (93.5% in Experiment 1 and 100% in Experiment 2) were comprised of adults in the age group of 18 – 40, thus limiting the generalisability of the research. Therefore, future studies should include a more balanced mix of different age groups.

5. The size of "virtual window" defined by the viewing box in Experiment 1 (actual view) was square shaped measuring 1,200 mm by 1,200 mm. Future research should explore the use of different window shapes and sizes for the assessment of view quality to test the effects on the perceived view quality.

6. This research assumed that the window glass was clear with an unobstructed view out. Future studies can include obscure glass, roller blinds, venetian blinds or curtains to test its effect on the perceived view quality.

7. The proposed methods that were used to assess "view elements" and "balance of view" required some subjective judgement as part of the assessment. To minimise bias due to the subjective judgement, the researcher invited 10 persons who were trained in architecture and urban design (two architects, one architecture lecturer and seven architecture graduates) to join him in an independent assessment of the two attributes for all the views (images) in the study. For "view elements", the median score was considered the final score in the assessment. For the "balance of view" assessment, the mean values (x, y) of all the point locations given by the assessors determine the distance of "point of balance" from the centre of view. On the assessment of view attributes, future research may explore assessment methods that do not need any subjective evaluation.

8. In this study, the word "view" was used interchangeably with "scene". According to Park and Chun (2014), a "view" refers to a particular viewpoint that the observer adopts at a particular moment in one fixation, whereas a "scene" refers to the broader extension of space that encompasses multiple viewpoints. This distinction of concepts deserves further research.

9. Due to time and cost constraints, the number of window views used in the study were relatively small. The 12 window views for Experiment 1 (actual view) were typical urban and sub-urban scenes in the same region (Kuala Lumpur). Although these 12 views were different in terms of view attributes, they were not representative of all types of window views. This is because the range of values in each of the seven view attributes is not sufficiently wide, for instance: “view elements” scores ranged from -3 to 3 only; “balance of view” ranged from 0.70 to 0.99 only; the “number of visual layers” was either 3 or 4; none of the scenes had a “depth of view” between 5 km and 10 km; eight of the 12 scenes had a “proportion of greenery” of not more than 8%. Therefore, the prediction model that was derived from the regression of these data has poor generalisability. Menton (2020) pointed out that the generalisability of a statistical prediction model limits its practical utility – i.e., such a model is useful only insofar as it allows us to meaningfully predict new data, not just the data used to develop the model. In this study, the model generalisability was evaluated based on prediction accuracy in the external validation of 16 views (Experiment 3). The proposed prediction model was able to predict POV ratings of only 10 out of the 16 views (or 62.5% of the cases) in Experiment 3, hence not a robust prediction model. To improve the generalisability of the prediction model for view quality, a much larger sample of window views with diverse attributes are needed for future studies: perhaps a total of 90 – 120 views would be a fair estimate (15 – 20 views for each of the six predictors in the MLR model). Since it has been shown in the present study (Chapter 6) that there is no significant difference in the mean view quality ratings between actual view and image view, that future experimental study can be conducted based on image viewing (it will be costly and time consuming if the researcher is to bring all the subjects to evaluate these 90 – 120 views on site).

10. The total sample size in each of the Experiments 1 and 2 was 62 (two groups of 31 subjects). This relatively small sample size has limited statistical power in the testing of hypotheses (Section 3.3.6, Chapter 3): when we used paired samples t-test to test the hypothesis that there is a significant difference

between mean POV rating and mean EOV rating in the evaluation of window view quality (Chapter 4), effect sizes smaller than 0.52 were likely to be nonsignificant; when we used independent samples t-test to test the hypotheses that there is a significant difference in the mean POV (EOV) ratings between the rescaled 4-point and 10-point ratings (see Chapter 5), or that there is a significant difference in the mean POV (EOV) ratings of window view quality between the actual and image mode of viewing (see Chapter 6), effect sizes smaller than 0.72 were likely to be nonsignificant. From the outcomes of power analyses, if the total sample size is increased from the present 62 to 120 (two groups of 60 subjects), the power can be substantially improved: for the above paired samples t-test, effect sizes of 0.26 or larger will likely to be significant; for the above independent samples t-test, effect sizes of 0.52 or larger will likely to be significant. Therefore, in future studies on the evaluation of window view quality, this proposed sample size (120) can be considered.

8.5 End point

This study has added to the existing knowledge regarding the method of measuring window view quality – i.e., how to obtain data from the subjective evaluation of view quality and the objective assessment of view attributes to develop prediction models of view quality through regression analyses. In the experimental design, a photomontage method that incorporates three-dimensional digital drawing of window frame is used in this study to create realistic images of window views for the purpose of view evaluation. This study also adopts a pixelation method to estimate the area and proportion of each visual layer and object of interest contained in an image of window view. In the questionnaire design, this study uses a linear numeric scale with bipolar verbal anchors, which are based on two proposed indicators of window view quality ("pleasantness" and "excitingness") that are derived from the circumplex model of affective quality developed by Russell et al. (1981). This research includes comparative studies of view quality using two different scale formats (10-point vs. 4-

point) in two different modes of viewing (actual vs. image). Seven view attributes have been identified from literature review and subsequently redefined in this study with either ratio-level or interval-level scales of measurement. The association between view quality and each of the view attributes has been explored in this study using regression methods. It is envisaged that the method of measuring window view quality presented in this research will serve as a guidance tool for the architect in the process of designing windows.

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Appendix A1:

Definition of Key Terms and Concepts

Alternative hypothesis – contrary to the null hypothesis, alternative hypothesis (denoted by H_1) makes a statement that suggests or advises a potential result or an outcome that a researcher may expect.

Bonferroni correction (or "Bonferroni type adjustment") – a method of adjusting probability (p) values because of the increased risk of a Type I error (false positive) when making multiple statistical tests.

Central limit theorem – states that as a sample size increases (especially for sample sizes over 30), the sampling distribution of the mean approaches a normal distribution. In other words, as a sample size increases, the sample mean and standard deviation will be closer in value to the population mean and standard deviation.

Central tendency (or "measures of central tendency") – is a central or typical value for a probability distribution. The measures indicate where most values in a distribution fall and are also referred to as the central location of a distribution. The three most common measures of central tendency are the mean, median and mode – each calculates the location of the central point using a different method.

Common scale – refers to a scale format with certain number of points that serve as the basis for the rescaling of rating scales that have different but lower number of response points. It is usually used for comparing two or more rating scales with different number of response points.

Construct validity – refers to the degree to which a test measures what it claims, or purports, to be measuring.

Convergent validity – refers to the degree to which two indicators of the same construct that theoretically should be related, are in fact related. It is a subtype of construct validity.

Cronbach's alpha – a coefficient of reliability (or consistency). It is a measure of internal consistency, i.e. how closely related a set of items are as a group. It is considered to be a measure of scale reliability.

Discriminant validity (or "divergent validity") – refers to the degree to which two indicators of different constructs that are not supposed to be related, are actually unrelated. It is a subtype of construct validity.

Eigenvalue - an eigenvalue of an n x n matrix, A is a scalar λ such that the equation Av=λv has a nontrivial solution. If Av=λv for v≠0, we say that λ is the eigenvalue for v, and that v is an eigenvector for *λ*.

Exploratory factor analysis (EFA) – a data reduction technique within factor analysis that is normally used to explain the relationship of a large number of observed variables by a smaller number of factors.

F-statistic – ratio of the explained variance to the unexplained variance.

F-test – a statistical test typically used in regression analysis to test the hypothesis that all model parameters are zero. It is also used in statistical analysis when comparing statistical models that have been fitted using the same underlying factors and data set to determine the model with the best fit.

Hypothesis testing – a statistical method that is used in making statistical decisions using experimental data. It is basically an assumption that we make about the population parameter.

Internal consistency – a measure of how well all the items comprising a rating scale measure the same construct consistently.

Interrater reliability – the degree of agreement among raters. It is a score of how much homogeneity or consensus exists in the ratings given by various raters.

Intraclass correlation coefficient (ICC) – a reliability index in test-retest, intrarater, and interrater reliability analyses.

Kruskal-Wallis test – a nonparametric (distribution free) test, which is used when the assumptions of one-way ANOVA are not met; it assesses for significant differences on a continuous dependent variable by a categorical independent variable (with two or more groups).

Levels of measurement (or "scales of measurement") – the way a set of data is measured. Data can be classified into four levels of measurement. They are (from the lowest to the highest level): "nominal" scale level, "ordinal" scale level, "interval" scale level, and "ratio" scale level.

Levene's test – an assessment for homogeneity of variance. It uses an F-test to test the null hypothesis that the variance is equal across groups: a p-value less than 0.05

indicates a violation of the assumption. If a violation occurs, conducting a non-parametric analysis is more appropriate.

Logistic regression model – a model that describes the relationship between predictor variables and a categorical response variable by estimating a probability of falling into certain level of the categorical response given a set of predictors.

Mann-Whitney U test – the nonparametric equivalent to the independent *t*-test and the appropriate analysis to compare differences that come from the same population when the dependent variable is ordinal

Multiple linear regression (MLR) model – a linear model that describes how a response variable relates to two or more predictor variables or transformations of those predictor variables.

Null hypothesis – a statistical hypothesis (denoted by H_0) which states that there is no significant difference between the two population means, i.e., $H_0: \mu_1 = \mu_2$.

Ordinal logistic regression model – a type of logistic regression model that is used when the categorical response variable consists of three or more categories with a natural ordering to the levels, but the ranking of the levels do not necessarily mean the intervals between them are equal.

Part correlation (or "semi-partial correlation") – the correlation between an independent variable and a dependent variable after controlling for the influence of other variables on the independent variable only.

Partial correlation – the correlation between an independent variable and a dependent variable after controlling for the influence of other variables on both the independent variable and the dependent variable.

Principal component analysis - a statistical method for reducing data with many dimensions (variables) by projecting the data with fewer dimensions using linear combinations of the variables, known as principal components, so that the new projected variables (principal components) are uncorrelated with each other and are ordered so that the first few components retain most of the variation present in the original variables.

Rating scale(s) – an instrument for data collection, which typically requires the respondent to select her answer from a range of statements or numbers.

Reliability – refers to the extent to which a scale produces consistent results if the measurements are repeated a number of times. The analysis on reliability is called reliability analysis.

Rescaling – a method of changing the length of a rating scale by multiplying each of the response points with a constant.

Scale format (or "response format of a rating scale") – the number of scale points or response categories in a rating scale. If the response rating is measured as scale data (interval or ratio level of measurement), the distances between any two adjacent scale points are conceptually constant, i.e., $Q_n - Q_{n-1} = Q_{n+1} - Q_n$. If the response rating is measured as ordinal data, the distances between any two adjacent scale points are considered arbitrary but with a rank order, i.e., $Q_k > Q_{k-1} > Q_{k-2} > \cdots > Q_1$.

Scale points (or "response categories") – the options given to a respondent in each rating scale item of a survey questionnaire.

Stepwise multiple regression – a regression method that combines forward selection and backward elimination. The basic direction of the steps is forward (adding variables), but if a variable becomes nonsignificant, it is removed from the equation (a backward elimination).

***t*-test** – a type of inferential statistic used to determine if there is a significant difference between the means of two groups, which may be related in certain features.

Type I error – the mistaken rejection of the null hypothesis - i.e., a "false positive".

Type II error – the mistaken acceptance of the null hypothesis - i.e., a "false negative."

Validity (or "test validity") - the degree to which evidence and theory support the interpretations of test scores entailed by proposed uses of tests.

Zero-order correlation – the correlation between two variables (i.e., an independent variable and a dependent variable) without controlling for the influence of any other variables.

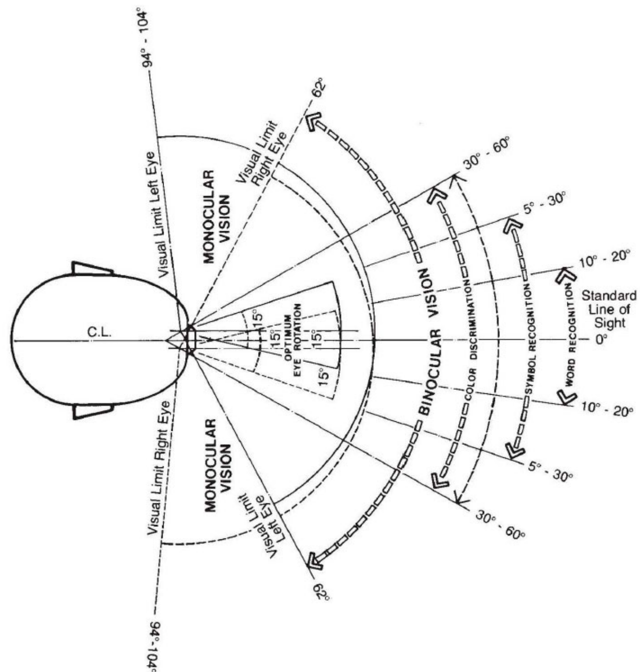
Appendix B1:
Locations of Sites

The 12 selected scenes for Experiment 1 (actual view) were viewed from the following sites – i.e. MRT train stations in Kuala Lumpur:

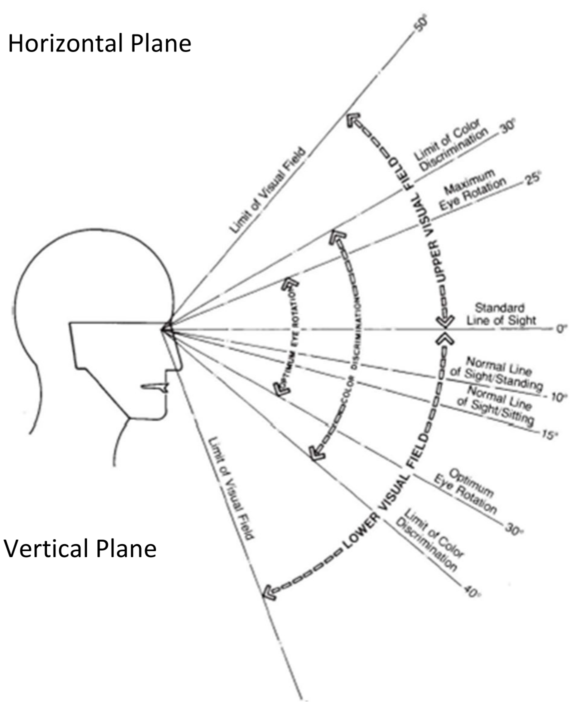
View 1 – View 4	- SBK-01 Sungai Buloh station
View 5 and View 6	- SBK-05 Kwasa Sentral station
View 7	- SBK-06 Kota Damansara station
View 8	- SBK-07 Surian station
View 9	- SBK-09 Bandar Utama station
View 10	- SBK-10 Taman Tun Dr Ismail station
View 11 and View 12	- SBK-14 Semantan station

Appendix B2:

Human Visual Field



Visual Field in Horizontal Plane



Visual Field in Vertical Plane

Source: Panero, J.; Zelnik, M. (1979) Human Dimension & Interior Space: A Source Book of Design Reference Standards. Whitney Library of Design (pp 621 – 623).

Appendix C1:

Images of 12 window views for Experiment 2.

Note:

These images were produced by superimposing digital illustrations of window frames and walls on the photographs of the 12 views in Experiment 1 (actual view).

View 1

View 2

View 3

View 4


View 5


View 6

View 7


SOVOTEL
HSBC AMANAH
Urbanez Concept
VERITY MUSIC
APPLE INTERIORS
KLINIK SURIAN
SOVOTEL
HSBC AMANAH

View 8

View 9

View 10

View 11

View 12

Appendix D1: Survey questionnaire

The common "window view survey" questionnaire for:

- **Experiment 1 (actual view)**
- **Experiment 2 (image view)**

in two versions – i.e. 10-point scale and 4-point scale.

WINDOW VIEW SURVEY

Participant ID: **Date of survey:**

Age	:	18-40	41-60	61-80	81+
Gender	:	Male	Female		
Occupation	:	Art and design			
		Engineering			
		Administration			
		Public service			
		Student			
		Other (please specify) ……………………………………………			

How important is it for you to have a window at your workplace or home?

• Important
• Not important
• No preference

If it is important, why?
• Daylight
• View
• Natural ventilation
• Other reasons?......................................

What do you prefer to look at through the window at your workplace or home?

• Water (landscape elements)
• Mountains
• Greenery
• Cultivated landscape
• Urban landscape
• Human activities

Window No:

Participant ID:

Window ID: **Date:** **Time:**

Please spend 1 minute to study the view from the window in front of you

1. How pleasant is the window view? (please circle the appropriate response)

1	2	3	4	5	6	7	8	9	10

Least pleasant Most pleasant

2. How exciting is the window view? (please circle the appropriate response)

1	2	3	4	5	6	7	8	9	10

Most boring Most exciting

3. In what location would you consider this view to be suitable?

- Neither for my home nor my workplace
- OK for my home but not my workplace
- OK for my workplace but not my home
- OK for both my home and my workplace

4. What are the dominant features or elements in the window view? Name THREE (3) dominant features that you see in sequence – starting from the most dominant to the least dominant.

    1.

    2.

    3.

Window No:

Participant ID:

Window ID: **Date:** **Time:**

Please spend 1 minute to study the view from the window in front of you

1. How pleasant is the window view? (please circle the appropriate response)

1	2	3	4

Least pleasant Most pleasant

2. How exciting is the window view? (please circle the appropriate response)

1	2	3	4

Most boring Most exciting

3. In what location would you consider this view to be suitable?

   - Neither for my home nor my workplace
   - OK for my home but not my workplace
   - OK for my workplace but not my home
   - OK for both my home and my workplace

4. What are the dominant features or elements in the window view? Name THREE (3) dominant features that you see in sequence – starting from the most dominant to the least dominant.

   1.

   2.

   3.

Appendix D2:

Assessment of "View Elements" (VE) and "Balance of View" (BV) of View 1 – View 12 (Experiment 1)

Experiment 1 - Assessment of "View Elements"

View No. 1

	View Elements										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**Diversity of View (No. of Groups)**
	Sky*	Distant landscape	Distant buildings	Billboard	Telco tower	MRT station	Elevated highway*	Utility buildings	Soffit	Ground*	10
Evaluator ID		(1 - 4)	(-2 to 2)	(-2 to 2)	(-2 to 2)	(-2 to 2)		(-2 to 2)	(-2 to 2)		**Total Points**
1	0	2	0	-1	-2	1	0	-2	-1	0	-3
2	0	1	0	0	-1	1	0	-1	-2	0	-2
3	0	1	-2	-2	-2	1	0	-2	-2	0	-8
4	0	3	0	-1	-2	0	0	-2	-2	0	-4
5	0	1	1	0	0	2	0	0	0	0	4
6	0	1	0	-2	-2	0	0	-2	-2	0	-7
7	0	1	1	-1	-1	1	0	-2	-2	0	-3
8	0	2	2	-2	-1	2	0	-1	-1	0	1
9	0	1	0	0	-1	1	0	0	-2	0	-1
10	0	1	1	0	-2	0	0	-1	-2	0	-3
11	0	1	0	-1	0	2	0	-1	0	0	1
										Median Score	**-3**

* Neutral elements (natural or man-made)

View No. 2

	View Elements										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**Diversity of View (No. of Groups)**
	Sky*	Distant landscape	Distant buildings	Trees	Water pipes	Highway*	Soffit	Railway line*	Cars/ Traffic*	Ground*	10
Evaluator ID		(1 - 4)	(-2 to 2)	(1 - 4)	(-2 to 2)		(-2 to 2)				**Total Points**
1	0	2	0	1	-1	0	-1	0	0	0	1
2	0	2	0	2	-1	0	-2	0	0	0	1
3	0	3	1	3	-2	0	-1	0	0	0	4
4	0	1	-1	3	-1	0	-2	0	0	0	0
5	0	1	-2	2	-2	0	-2	0	0	0	-3
6	0	1	0	1	-2	0	-2	0	0	0	-2
7	0	0	2	2	-1	0	-2	0	0	0	1
8	0	2	1	1	-2	0	0	0	0	0	2
9	0	1	0	0	-2	0	-1	0	0	0	-2
10	0	1	2	1	-1	0	0	0	0	0	3
11	0	2	1	3	-1	0	-2	0	0	0	3
										Median Score	**1**

* Neutral elements (natural or man-made)

View No. 3

	View Elements										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**Diversity of View (No. of Groups)**
	Sky*	Elevated railway line*	Soffit	Louvred screens	Wall cladding	Cars*	Ground*	---	---	---	7
Evaluator ID			(-2 to 2)	(-2 to 2)	(-2 to 2)						**Total Points**
1	0	0	-1	1	1	0	0				1
2	0	0	0	2	-1	0	0				1
3	0	0	-1	0	0	0	0				-1
4	0	0	-1	1	1	0	0				1
5	0	0	0	1	1	0	0				2
6	0	0	-2	2	2	0	0				2
7	0	0	-2	-2	0	0	0				-4
8	0	0	-1	-1	0	0	0				-2
9	0	0	0	-1	0	0	0				-1
10	0	0	0	0	1	0	0				1
11	0	0	-1	1	0	0	0				0
										Median Score	**1**

* Neutral elements (natural or man-made)

View No. 4

	View Elements										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**Diversity of View (No. of Groups)**
	Sky*	Trees	Bushes and grass	---	---	---	---	---	---	---	3
Evaluator ID		(1 - 4)	(1 - 4)								**Total Points**
1	0	1	1								2
2	0	2	2								4
3	0	1	1								2
4	0	1	1								2
5	0	1	1								2
6	0	2	1								3
7	0	1	1								2
8	0	2	3								5
9	0	1	1								2
10	0	2	1								3
11	0	1	2								3
										Median Score	**2**

* Neutral elements (natural or man-made)

View No. 5

	View Elements										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**Diversity of View (No. of Groups)**
	Sky*	Distant landscape	Distant buildings	Trees	Structure (above roof)	Roof	Ground*	---	---	---	7
Evaluator ID		(1 - 4)	(-2 to 2)	(1 - 4)	(-2 to 2)	(-2 to 2)					**Total Points**
1	0	1	0	1	-2	-1	0				-1
2	0	2	-1	1	-2	-2	0				-2
3	0	1	0	1	-2	-1	0				-1
4	0	2	-2	1	-2	-1	0				-2
5	0	1	0	1	-2	-2	0				-2
6	0	2	1	1	-2	-2	0				0
7	0	3	0	1	-2	-2	0				0
8	0	1	0	3	-1	-2	0				1
9	0	1	-1	2	-2	-2	0				-2
10	0	0	-2	1	-2	-2	0				-5
11	0	1	-1	1	-2	-2	0				-3
										Median Score	**-2**

* Neutral elements (natural or man-made)

View No. 6

	View Elements										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**Diversity of View (No. of Groups)**
	Sky*	Distant landscape	Distant buildings	Sheltered walkways	Roof	Cars*	Buses*	Ground*	---	---	8
Evaluator ID		(1 - 4)	(-2 to 2)	(-2 to 2)	(-2 to 2)						**Total Points**
1	0	1	0	0	-2	0	0	0			-1
2	0	1	-1	-2	0	0	0	0			-2
3	0	3	0	0	-2	0	0	0			1
4	0	1	-1	0	0	0	0	0			0
5	0	1	-2	-1	-2	0	0	0			-4
6	0	1	-2	0	0	0	0	0			-1
7	0	1	0	-2	-2	0	0	0			-3
8	0	1	-2	0	-2	0	0	0			-3
9	0	2	-1	0	0	0	0	0			1
10	0	1	-2	-2	-2	0	0	0			-5
11	0	2	0	0	-2	0	0	0			0
										Median Score	**-1**

* Neutral elements (natural or man-made)

View No. 7

	View Elements										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**Diversity of View (No. of Groups)**
	Sky*	Distant landscape	Distant buildings	Apartment buildings	Trees	Cars*	Ground*	---	---	---	7
Evaluator ID		(1 - 4)	(-2 to 2)	(-2 to 2)	(1 - 4)						**Total Points**
1	0	2	0	-1	1	0	0				2
2	0	1	-2	-2	2	0	0				-1
3	0	1	-2	-2	1	0	0				-2
4	0	1	-2	0	1	0	0				0
5	0	1	0	-1	1	0	0				1
6	0	1	-2	0	2	0	0				1
7	0	1	-2	-1	1	0	0				-1
8	0	2	0	0	1	0	0				3
9	0	1	-1	0	1	0	0				1
10	0	1	-1	-2	1	0	0				-1
11	0	1	-1	-1	1	0	0				0
										Median Score	**0**

* Neutral elements (natural or man-made)

View No. 8

	View Elements										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**Diversity of View (No. of Groups)**
	Sky*	Distant landscape	Distant buildings	High-rise buildings	Shop Offices	Roof	---	---	---	---	6
Evaluator ID		(1 - 4)	(-2 to 2)	(-2 to 2)	(-2 to 2)	(-2 to 2)					**Total Points**
1	0	1	-2	0	0	-1					-2
2	0	1	-1	-2	-1	-2					-5
3	0	1	-1	-2	-2	-2					-6
4	0	1	-1	-2	0	-1					-3
5	0	1	0	0	0	-1					0
6	0	2	1	2	1	-2					4
7	0	1	0	0	2	-2					1
8	0	1	-1	-2	-1	-2					-5
9	0	1	0	0	2	-2					1
10	0	1	-1	0	0	-2					-2
11	0	1	-2	-1	0	-2					-4
										Median Score	**-2**

* Neutral elements (natural or man-made)

View No. 9

	View Elements										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**Diversity of View (No. of Groups)**
	Sky*	Distant landscape	Distant buildings	Houses	Trees	Roof	Cars*	Ground/ road*	---	---	8
Evaluator ID		(1 - 4)	(-2 to 2)	(-2 to 2)	(1 - 4)	(-2 to 2)					**Total Points**
1	0	2	0	-1	2	-1	0	0			2
2	0	3	-1	2	2	-2	0	0			4
3	0	4	-2	-2	3	-2	0	0			1
4	0	3	-2	1	1	0	0	0			3
5	0	2	-1	0	3	-1	0	0			3
6	0	4	1	2	2	-2	0	0			7
7	0	1	0	0	3	-2	0	0			2
8	0	1	-1	1	2	0	0	0			3
9	0	3	-1	1	4	-2	0	0			5
10	0	1	0	0	1	-2	0	0			0
11	0	2	1	-2	1	0	0	0			2
										Median Score	**3**

* Neutral elements (natural or man-made)

View No. 10

	View Elements										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**Diversity of View (No. of Groups)**
	Sky*	Distant landscape	Distant buildings	High-rise buildings	Trees	Roof	---	---	---	---	6
Evaluator ID		(1 - 4)	(-2 to 2)	(-2 to 2)	(1 - 4)	(-2 to 2)					**Total Points**
1	0	1	0	1	2	-1					3
2	0	1	-1	0	2	-2					0
3	0	2	0	1	1	-1					3
4	0	1	-1	0	2	-2					0
5	0	1	0	1	1	-1					2
6	0	3	0	2	3	-2					6
7	0	2	-1	1	1	-1					2
8	0	1	-2	2	1	-2					0
9	0	1	0	0	2	-2					1
10	0	1	-1	2	1	-2					1
11	0	1	-1	0	2	-1					1
										Median Score	**1**

* Neutral elements (natural or man-made)

View No. 11

	View Elements										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**Diversity of View (No. of Groups)**
	Sky*	Distant landscape	Distant buildings	High-rise buildings	Trees	Roof	---	---	---	---	6
Evaluator ID		(1 - 4)	(-2 to 2)	(-2 to 2)	(1 - 4)	(-2 to 2)					**Total Points**
1	0	2	0	1	1	-2					2
2	0	2	0	1	1	-2					2
3	0	1	-1	2	2	-2					2
4	0	3	-1	0	2	-1					3
5	0	2	0	0	1	-1					2
6	0	4	1	2	4	-2					9
7	0	2	0	1	1	-2					2
8	0	1	-1	2	1	0					3
9	0	1	0	0	2	-1					2
10	0	2	0	2	1	-1					4
11	0	1	-2	-2	1	0					-2
										Median Score	**2**

* Neutral elements (natural or man-made)

View No. 12

	View Elements										
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Group 8**	**Group 9**	**Group 10**	**Diversity of View (No. of Groups)**
	Sky*	Distant landscape	Distant buildings	High-rise buildings	Trees	Structure above roof	Roof	Ground/ road*	---	---	8
Evaluator ID		(1 - 4)	(-2 to 2)	(-2 to 2)	(1 - 4)	(-2 to 2)	(-2 to 2)				**Total Points**
1	0	1	0	0	1	-2	-2	0			-2
2	0	1	0	-1	1	-2	-1	0			-2
3	0	2	-1	-1	2	-2	-2	0			-2
4	0	1	1	-1	1	-2	-2	0			-2
5	0	2	0	-1	1	-2	-1	0			-1
6	0	4	2	2	3	-2	0	0			9
7	0	1	0	0	1	-1	-2	0			-1
8	0	1	-2	-1	1	-1	-1	0			-3
9	0	2	0	0	2	-1	-2	0			1
10	0	1	1	0	1	-2	-2	0			-1
11	0	1	0	-2	3	-2	0	0			0
										Median Score	**-1**

* Neutral elements (natural or man-made)

Experiment 1 - Assessment of "Balance of View"

View No. 1

	Displacement along x-axis (No. of cells)	Displacement along y-axis (No. of cells)
Assessor ID		
1	-6	-3
2	-4	2
3	5	1
4	-9	4
5	-3	7
6	2	8
7	4	5
8	1	3
9	5	2
10	-3	7
11	-4	4
Mean	**-1.09**	**3.64**
	Distance from centre of view (d)	**3.80**
	Balance of View	**0.87**

View No. 2

	Displacement along x-axis (No. of cells)	Displacement along y-axis (No. of cells)
Assessor ID		
1	0	1
2	7	3
3	5	-3
4	2	-4
5	0	-7
6	3	-8
7	2	-5
8	0	-3
9	1	-6
10	-2	-7
11	-2	0
Mean	**1.45**	**-3.55**
	Distance from centre of view (d)	**3.83**
	Balance of View	**0.86**

View No. 3

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	-2	0
2	0	4
3	2	3
4	5	0
5	2	-2
6	0	-4
7	-2	3
8	1	-2
9	-3	-2
10	-4	2
11	1	-5
Mean	**0.00**	**-0.27**
	Distance from centre of view (d)	**0.27**
	Balance of View	**0.99**

View No. 4

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	-1	0
2	0	3
3	1	5
4	3	1
5	1	-2
6	1	-6
7	0	2
8	1	4
9	-2	4
10	-1	8
11	0	6
Mean	**0.27**	**2.27**
	Distance from centre of view (d)	**2.29**
	Balance of View	**0.92**

View No. 5

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	1	1
2	-2	3
3	-1	-4
4	-2	-5
5	-3	-3
6	-6	-2
7	2	4
8	4	-2
9	6	7
10	-1	-5
11	2	-4
Mean	**0.00**	**-0.91**
	Distance from centre of view (d)	**0.91**
	Balance of View	**0.97**

View No. 6

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	2	4
2	0	0
3	3	-1
4	0	-2
5	-1	-4
6	2	-5
7	0	0
8	1	2
9	0	-2
10	0	-6
11	-3	-3
Mean	**0.36**	**-1.55**
	Distance from centre of view (d)	**1.59**
	Balance of View	**0.94**

View No. 7

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	-2	-2
2	0	-5
3	-3	-4
4	-4	-2
5	-6	-1
6	-6	-6
7	0	0
8	0	4
9	-4	0
10	-3	-2
11	-2	2
Mean	**-2.73**	**-1.45**
	Distance from centre of view (d)	**3.09**
	Balance of View	**0.89**

View No. 8

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	7	3
2	10	6
3	13	-5
4	9	-7
5	7	-4
6	5	-6
7	5	1
8	3	-2
9	3	-6
10	6	-3
11	2	3
Mean	**6.36**	**-1.82**
	Distance from centre of view (d)	**6.62**
	Balance of View	**0.77**

View No. 9

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	0	1
2	1	-4
3	-2	2
4	-3	-3
5	-1	-2
6	-1	4
7	2	2
8	0	-2
9	-1	-4
10	2	-6
11	-3	-9
Mean	**-0.55**	**-1.91**
	Distance from centre of view (d)	**1.99**
	Balance of View	**0.93**

View No. 10

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	3	1
2	6	3
3	12	5
4	9	-2
5	5	-1
6	2	-4
7	7	-1
8	9	2
9	5	-3
10	5	-8
11	7	-5
Mean	**6.36**	**-1.18**
	Distance from centre of view (d)	**6.47**
	Balance of View	**0.77**

View No. 11

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	6	4
2	9	7
3	9	2
4	10	-1
5	9	-4
6	7	-3
7	12	3
8	7	-1
9	6	2
10	7	-6
11	11	-4
Mean	**8.45**	**-0.09**
	Distance from centre of view (d)	**8.46**
	Balance of View	**0.70**

View No. 12

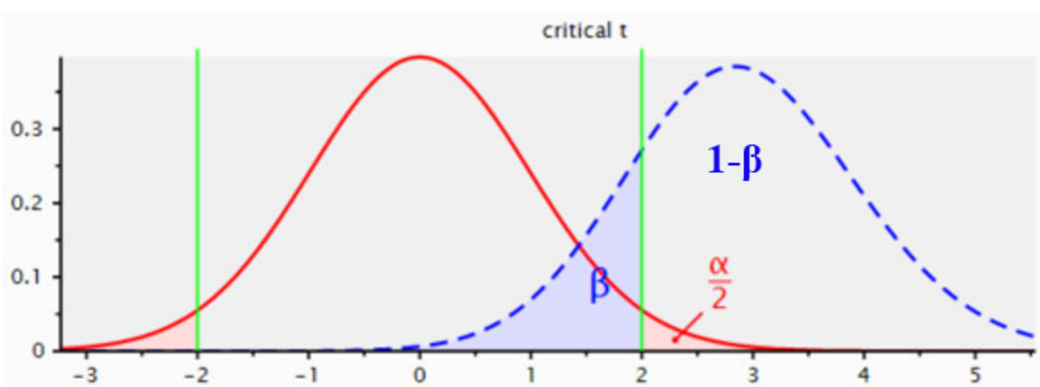
	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	7	-7
2	7	-3
3	4	-6
4	2	-2
5	3	3
6	5	1
7	3	-3
8	7	1
9	4	-6
10	5	-3
11	7	-4
Mean	**4.91**	**-2.64**
	Distance from centre of view (d)	**5.57**
	Balance of View	**0.80**

Appendix D3:

Type I and Type II Errors

Relationships between truth or falseness of null hypothesis and outcomes of the hypothesis testing are summarised in the following table:

Outcomes of statistical hypothesis testing		Null hypothesis (H_0) is:	
		True	False
Decision about null hypothesis (H_0)	Rejected	**Type I error** (False positive) Probability = α	Correct decision (True positive) Probability = $1 - \beta$
	Not rejected	Correct decision (True negative) Probability = $1 - \alpha$	**Type II error** (False negative) Probability = β



Probability of making Type I and Type II errors in a two-tailed t-test.

Appendix D4: Survey questionnaire

The "window view quality" online survey questionnaire (Google Form) for Experiment 3 (image view).

A Survey of Window View Quality

Hi,

I would like to invite you to take part in this survey of window view quality, which is part of my PhD research. The results of this study will help architects to better understand human perception of window view, so that better decisions on window placement and design can be made for future buildings.

You will evaluate the quality of 16 different window views based on the digital photographs shown to you in sequence. For each of the scenes, you will rate the view quality using a 10point numeric scale according to two affective components of attitude towards the view –
i.e. "pleasantness" of view and "excitement" of view. All you need to do is select your rating of each view by clicking at the corresponding circle. You should be able to complete the survey in approximately 10 minutes.

Please note that this survey must be completed independently – i.e. your judgement shall not be influenced by any other person. There is no right or wrong response rating in this survey – it is all about your personal perception of the window views.

For this survey, you are expected to use a laptop or desktop computer rather than a mobile phone because the visual tasks in this survey require a screen size of at least 14-inch. Once you have completed the survey, please remember to click the "Submit" tab in the final section. You will receive a Grabfood e-voucher of RM10.00 (or any other e-voucher of equivalent value) as a token of appreciation. This survey will close once we have received 50 completed forms.

If you need any clarification, please contact the researcher (Chang Choong Yew) via mobile no. 6012-215 9925.

To start the survey, click the "Next" tab in this section.

Terms & Conditions

Please note that this research has been granted ethics approval by The University of Sheffield, UK. You have the right to request the researcher to demonstrate evidence of approval before taking part in this survey.
If you agree to take part in this survey, you have understood that -

1. Your participation in this survey is voluntary and that you can choose to withdraw from this survey any time (by exiting the survey without clicking the "Submit" tab in the final section); you do not need to give any reason for your withdrawal.

2. Your personal details such as name, phone number and email address etc. will not be revealed to people outside this research project.
3. Your responses will be kept strictly confidential; you will not be identified or identifiable in the reports that result from this survey.

What you need to do

Spend some time to study each of the following 16 window views, and then evaluate the view quality by clicking the corresponding circle below the rating that you choose. Each view comes with two questions only. The questions are the same for all 16 views.

View 1 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant											Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring											Most exciting

View 2 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

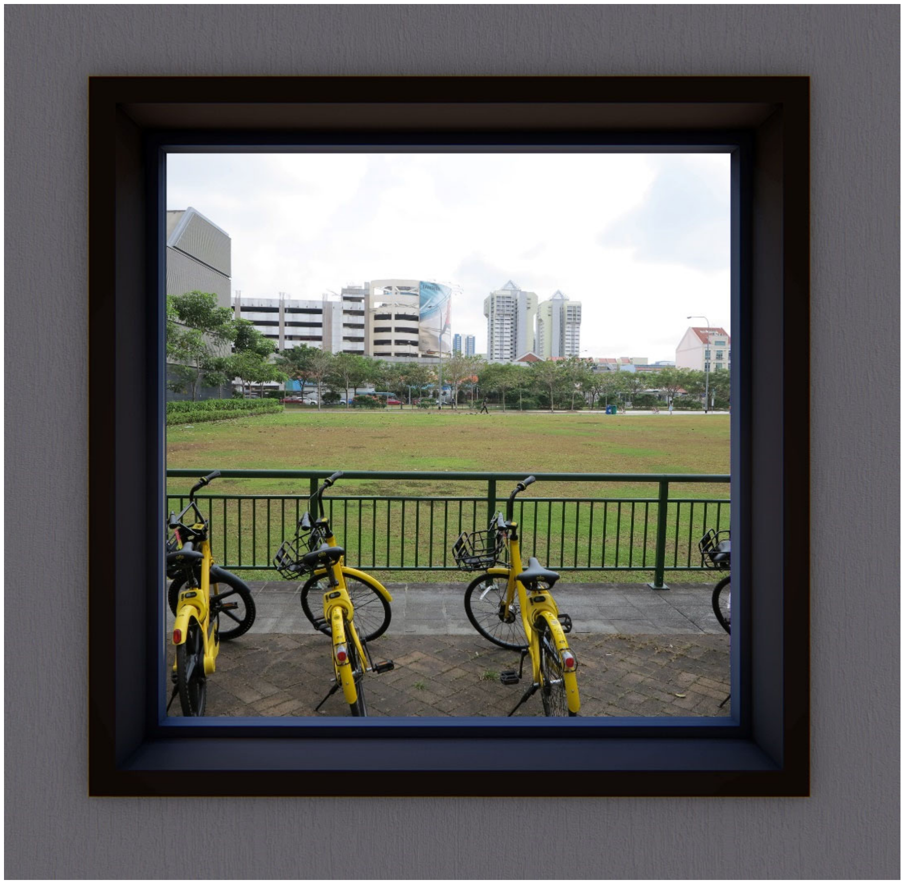
	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 3 / 16



How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 4 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 5 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 6 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 7 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 8 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 9 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 10 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Most exciting

View 11 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 12 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 13 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 14 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 15 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most exciting

View 16 / 16

How pleasant is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Least pleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Most pleasant

How exciting is the window view? (please select the appropriate response) *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Most boring	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Most exciting

Please click the "Submit" tab to end the survey. Thank you for your participation.

As a token of appreciation, you will receive a Grabfood e-voucher of RM10.00 (or any other e-voucher of equivalent value). Please leave your mobile number or email address in the space below, so that the e-voucher can be sent to you within the next three days.

Mobile Number/ Email Address *

Appendix D5:
Assessment of “View Elements” (VE), “Balance of View” (BV) and “Openness of View” (OV) of View 1a – View 16a (Experiment 3)

Experiment 3 - Assessment of "View Elements"

View No. 1a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Distant landscape	Distant buildings	Trees & greenery	Ground*	---	---	5
Evaluator ID		(1 - 4)	(-2 to 2)	(1 - 4)				**Total Points**
1	0	2	2	2	0			6
2	0	4	2	4	0			10
3	0	2	1	2	0			5
4	0	2	0	3	0			5
5	0	3	-1	3	0			5
6	0	3	0	3	0			6
7	0	2	2	2	0			6
8	0	3	0	2	0			5
9	0	3	1	3	0			7
10	0	4	1	2	0			7
11	0	1	0	1	0			2
							Median Score	**6**

* Neutral elements (natural or man-made)

View No. 2a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Distant buildings	High-rise building	Trees	Elevated walkway*	Traffic*	Ground (road)*	7
Evaluator ID		(-2 to 2)	(-2 to 2)	(1 - 4)				**Total Points**
1	0	-1	-1	1	0	0	0	-1
2	0	-1	-2	1	0	0	0	-2
3	0	-2	-1	1	0	0	0	-2
4	0	0	0	2	0	0	0	2
5	0	-2	-2	1	0	0	0	-3
6	0	-1	1	2	0	0	0	2
7	0	-2	0	3	0	0	0	1
8	0	-2	-2	1	0	0	0	-3
9	0	-1	-1	1	0	0	0	-1
10	0	-1	0	1	0	0	0	0
11	0	0	1	1	0	0	0	2
							Median Score	**-1**

* Neutral elements (natural or man-made)

View No. 3a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Distant buildings	Buildings nearby	Trees	Open green field	Railing	Bicycles*	7
Evaluator ID		(-2 to 2)	(-2 to 2)	(1 - 4)	(1 - 4)	(-2 to 2)		**Total Points**
1	0	0	0	1	1	-1	0	1
2	0	-2	2	3	3	-2	0	4
3	0	-1	0	2	2	-1	0	2
4	0	-1	1	1	2	-2	0	1
5	0	0	-1	1	1	-2	0	-1
6	0	-2	0	2	3	-2	0	1
7	0	-1	2	3	2	-2	0	4
8	0	0	0	1	1	-1	0	1
9	0	-2	1	2	2	0	0	3
10	0	0	-1	2	1	-2	0	0
11	0	0	-1	1	2	-2	0	0
							Median Score	**1**

* Neutral elements (natural or man-made)

View No. 4a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Trees	Bushes and grass	Buildings	Timber deck	---	---	5
Evaluator ID		(1 - 4)	(1 - 4)	(-2 to 2)	(-2 to 2)			**Total Points**
1	0	3	2	2	1			8
2	0	2	1	2	2			7
3	0	3	1	0	0			4
4	0	3	3	-2	-1			3
5	0	2	2	2	1			7
6	0	2	1	2	2			7
7	0	1	1	0	0			2
8	0	2	1	0	0			3
9	0	2	1	-1	-2			0
10	0	3	3	2	1			9
11	0	2	1	1	1			5
							Median Score	**5**

* Neutral elements (natural or man-made)

View No. 5a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Distant buildings	Roofs	Trees	Ground*	---	---	5
Evaluator ID		(-2 to 2)	(-2 to 2)	(1 - 4)				**Total Points**
1	0	1	-1	1	0			1
2	0	-1	-2	2	0			-1
3	0	0	-2	2	0			0
4	0	0	0	1	0			1
5	0	2	-1	1	0			2
6	0	1	-2	2	0			1
7	0	2	0	3	0			5
8	0	1	0	2	0			3
9	0	0	-1	1	0			0
10	0	0	-2	1	0			-1
11	0	1	-2	2	0			1
							Median Score	**1**

* Neutral elements (natural or man-made)

View No. 6a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Buildings	Trees & greenery	Ground*	---	---	---	4
Evaluator ID		(-2 to 2)	(1 - 4)					**Total Points**
1	0	1	1	0				2
2	0	2	1	0				3
3	0	0	2	0				2
4	0	2	1	0				3
5	0	0	2	0				2
6	0	1	2	0				3
7	0	1	1	0				2
8	0	0	1	0				1
9	0	-1	2	0				1
10	0	2	1	0				3
11	0	2	1	0				3
							Median Score	**2**

* Neutral elements (natural or man-made)

View No. 7a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Building (rear)	Buidling (front) & sculpture	Open green field	Trees	---	---	5
Evaluator ID		(-2 to 2)	(-2 to 2)	(1 - 4)	(1 - 4)			**Total Points**
1	0	0	1	1	1			3
2	0	0	2	3	1			6
3	0	0	1	3	2			6
4	0	-2	0	2	1			1
5	0	-1	1	1	1			2
6	0	-2	2	3	1			4
7	0	0	2	1	2			5
8	0	-2	2	1	1			2
9	0	-1	1	3	1			4
10	0	0	0	2	1			3
11	0	-2	1	2	1			2
							Median Score	**3**

* Neutral elements (natural or man-made)

View No. 8a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Distant buildings	Distant landscape	Main building	Trees	Lawn	---	6
Evaluator ID		(-2 to 2)	(-2 to 2)	(-2 to 2)	(1 - 4)	(1 - 4)		**Total Points**
1	0	1	2	1	2	1		7
2	0	0	1	2	1	2		6
3	0	1	1	2	3	2		9
4	0	0	1	2	2	1		6
5	0	1	1	1	1	1		5
6	0	2	2	2	3	3		12
7	0	1	-1	0	1	2		3
8	0	0	0	0	2	3		5
9	0	1	-2	1	2	3		5
10	0	0	0	-1	1	1		1
11	0	0	1	1	2	2		6
							Median Score	**6**

* Neutral elements (natural or man-made)

View No. 9a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Distant buildings	Electricity pylons (distant)	High-rise building	Trees	Roof top	Ground*	7
Evaluator ID		(-2 to 2)	(-2 to 2)	(-2 to 2)	(1 - 4)	(-2 to 2)		**Total Points**
1	0	0	-2	-1	1	-2	0	-4
2	0	-2	-2	1	1	-1	0	-3
3	0	-1	-1	2	2	-1	0	1
4	0	0	0	2	1	-1	0	2
5	0	-1	-1	-1	1	-1	0	-3
6	0	-1	-2	0	1	-2	0	-4
7	0	-2	-1	-1	2	-2	0	-4
8	0	-2	-2	1	1	-1	0	-3
9	0	0	-2	-1	1	-1	0	-3
10	0	-1	-1	0	2	-2	0	-2
11	0	0	-1	1	1	-2	0	-1
							Median Score	**-3**

* Neutral elements (natural or man-made)

View No. 10a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Trees	Waters	Timber deck	---	---	---	4
Evaluator ID		(1 - 4)	(1 - 4)	(-2 to 2)				**Total Points**
1	0	1	2	0				3
2	0	2	1	0				3
3	0	1	1	1				3
4	0	3	2	0				5
5	0	1	2	1				4
6	0	3	2	0				5
7	0	1	1	1				3
8	0	1	1	0				2
9	0	2	2	2				6
10	0	1	1	1				3
11	0	3	1	0				4
							Median Score	**3**

* Neutral elements (natural or man-made)

View No. 11a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Old building	Trees & creepers	Cars*	Ground (road)*	---	---	5
Evaluator ID		(-2 to 2)	(1 - 4)					**Total Points**
1	0	-2	1	0	0			-1
2	0	-2	1	0	0			-1
3	0	-2	1	0	0			-1
4	0	-1	2	0	0			1
5	0	-1	1	0	0			0
6	0	-2	1	0	0			-1
7	0	-1	1	0	0			0
8	0	0	2	0	0			2
9	0	-2	1	0	0			-1
10	0	-1	1	0	0			0
11	0	-2	1	0	0			-1
							Median Score	**-1**

* Neutral elements (natural or man-made)

View No. 12a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	High-rise (rear)	Main building	Ground (basketball court)*	Basketball post	---	---	5
Evaluator ID		(-2 to 2)	(-2 to 2)		(-2 to 2)			**Total Points**
1	0	0	2	0	-1			1
2	0	0	0	0	0			0
3	0	-1	0	0	-1			-2
4	0	0	1	0	0			1
5	0	0	0	0	-1			-1
6	0	-1	2	0	-2			-1
7	0	0	2	0	-1			1
8	0	0	1	0	-1			0
9	0	-1	1	0	-1			-1
10	0	0	2	0	-1			1
11	0	0	2	0	0			2
							Median Score	**0**

* Neutral elements (natural or man-made)

View No. 13a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Apartment building	Trees & plants	Ground (road)*	---	---	---	4
Evaluator ID		(-2 to 2)	(1 - 4)					**Total Points**
1	0	1	1	0				2
2	0	0	2	0				2
3	0	2	1	0				3
4	0	0	1	0				1
5	0	1	2	0				3
6	0	2	3	0				5
7	0	0	2	0				2
8	0	1	1	0				2
9	0	0	1	0				1
10	0	0	2	0				2
11	0	2	1	0				3
							Median Score	**2**

* Neutral elements (natural or man-made)

View No. 14a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Sky*	Distant buildings	Roofs & awnings	Trees & flowers	Balustrade	Coffee table & chairs	Ground (road)*	7
Evaluator ID		(-2 to 2)	(-2 to 2)	(1 - 4)	(-2 to 2)	(-2 to 2)		**Total Points**
1	0	0	0	3	0	0	0	3
2	0	1	-1	2	0	2	0	4
3	0	1	-2	2	-1	1	0	1
4	0	2	0	3	-1	1	0	5
5	0	0	0	1	0	0	0	1
6	0	0	-2	4	-1	0	0	1
7	0	1	-2	1	2	2	0	4
8	0	0	0	2	-1	1	0	2
9	0	0	-1	2	0	1	0	2
10	0	1	0	1	0	0	0	2
11	0	0	-1	3	2	0	0	4
							Median Score	**2**

* Neutral elements (natural or man-made)

View No. 15a

	View Elements							
	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**	**Diversity of View (No. of Groups)**
	Main building	Planters	Trees	Ground*	---	---	---	4
Evaluator ID	(-2 to 2)	(1 - 4)	(1 - 4)	(1 - 4)				**Total Points**
1	1	1	1	0				3
2	2	2	2	0				6
3	1	1	1	0				3
4	-1	1	1	0				1
5	0	2	1	0				3
6	1	1	2	0				4
7	1	2	2	0				5
8	2	1	1	0				4
9	2	1	1	0				4
10	-1	2	1	0				2
11	0	1	1	0				2
							Median Score	**3**

* Neutral elements (natural or man-made)

View No. 16a

	View Elements							
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Diversity of View (No. of Groups)
	Sky*	Distant buildings	Trees & plants	Fountain & sculpture	Piazza	---	---	5
Evaluator ID		(-2 to 2)	(1 - 4)	(-2 to 2)	(-2 to 2)			**Total Points**
1	0	-1	2	2	-1			2
2	0	0	1	2	1			4
3	0	-2	2	0	2			2
4	0	0	1	2	2			5
5	0	0	1	0	1			2
6	0	-2	3	2	-1			2
7	0	0	1	2	2			5
8	0	0	1	2	1			4
9	0	-1	2	-1	1			1
10	0	-2	3	2	2			5
11	0	0	2	2	2			6
							Median Score	**4**

* Neutral elements (natural or man-made)

Experiment 3 - Assessment of "Balance of View"

View No. 1a

	Displacement along x-axis (No. of cells)	**Displacement along y-axis** (No. of cells)
Assessor ID		
1	-3	1
2	-6	-1
3	-1	-3
4	0	-5
5	-3	-7
6	4	-9
7	0	-3
8	1	-6
9	2	2
10	-5	-5
11	-1	-1
Mean	**-1.09**	**-3.36**
	Distance from centre of view (d)	**3.54**
	Balance of View	**0.87**

View No. 2a

	Displacement along x-axis (No. of cells)	**Displacement along y-axis** (No. of cells)
Assessor ID		
1	11	3
2	8	-2
3	9	7
4	2	-3
5	6	2
6	-3	-2
7	7	3
8	0	5
9	1	-2
10	4	-3
11	3	-6
Mean	**4.36**	**0.18**
	Distance from centre of view (d)	**4.37**
	Balance of View	**0.85**

View No. 3a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	-3	-3
2	1	-1
3	-1	-2
4	2	-5
5	-2	-7
6	-2	-6
7	0	4
8	0	0
9	1	-4
10	4	2
11	4	-4
Mean	**0.36**	**-2.36**
	Distance from centre of view (d)	**2.39**
	Balance of View	**0.92**

View No. 4a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	8	-6
2	2	-8
3	4	-6
4	3	-2
5	7	-4
6	0	2
7	1	3
8	0	0
9	4	3
10	2	-2
11	6	-7
Mean	**3.36**	**-2.45**
	Distance from centre of view (d)	**4.16**
	Balance of View	**0.85**

View No. 5a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	1	-11
2	-1	-9
3	0	-1
4	3	-7
5	1	-5
6	6	1
7	3	-3
8	0	-1
9	1	0
10	4	-1
11	-2	-3
Mean	**1.45**	**-3.64**
	Distance from centre of view (d)	**3.92**
	Balance of View	**0.86**

View No. 6a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	-1	-1
2	7	-3
3	4	-6
4	4	-2
5	1	-3
6	0	0
7	0	1
8	1	2
9	3	1
10	0	0
11	0	0
Mean	**1.73**	**-1.00**
	Distance from centre of view (d)	**2.00**
	Balance of View	**0.93**

View No. 7a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	8	-4
2	-3	4
3	-2	-1
4	3	-1
5	-1	2
6	0	2
7	-2	-3
8	0	0
9	1	9
10	2	-3
11	1	3
Mean	**0.64**	**0.73**
	Distance from centre of view (d)	**0.97**
	Balance of View	**0.97**

View No. 8a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	3	-8
2	-3	-1
3	-2	-3
4	-4	-7
5	-1	-6
6	1	3
7	0	-7
8	-2	-2
9	0	-2
10	-6	-3
11	-3	-4
Mean	**-1.55**	**-3.64**
	Distance from centre of view (d)	**3.95**
	Balance of View	**0.86**

View No. 9a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	6	2
2	13	-8
3	16	1
4	13	3
5	8	-3
6	5	-5
7	8	-4
8	7	-7
9	5	-2
10	4	2
11	-3	-4
Mean	**7.45**	**-2.27**
	Distance from centre of view (d)	**7.79**
	Balance of View	**0.72**

View No. 10a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	11	3
2	4	-3
3	8	-3
4	9	-6
5	7	1
6	0	1
7	0	0
8	4	-2
9	1	0
10	0	0
11	-1	-3
Mean	**3.91**	**-1.09**
	Distance from centre of view (d)	**4.06**
	Balance of View	**0.86**

View No. 11a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	1	3
2	0	0
3	2	-3
4	-3	1
5	-2	-2
6	0	2
7	-2	2
8	4	3
9	2	-1
10	8	2
11	5	-2
Mean	**1.36**	**0.45**
	Distance from centre of view (d)	**1.44**
	Balance of View	**0.95**

View No. 12a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	0	-7
2	1	-3
3	-4	2
4	-2	-4
5	-5	-2
6	7	4
7	2	3
8	0	1
9	5	2
10	0	-1
11	4	-2
Mean	**0.73**	**-0.64**
	Distance from centre of view (d)	**0.97**
	Balance of View	**0.97**

View No. 13a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	3	6
2	6	2
3	2	-2
4	5	-3
5	2	4
6	3	-3
7	-1	-2
8	3	0
9	6	1
10	4	-7
11	2	-4
Mean	**3.18**	**-0.73**
	Distance from centre of view (d)	**3.26**
	Balance of View	**0.88**

View No. 14a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	5	-1
2	2	-1
3	2	-3
4	3	2
5	4	-5
6	3	1
7	2	2
8	0	-5
9	4	-4
10	0	-4
11	1	-2
Mean	**2.36**	**-1.82**
	Distance from centre of view (d)	**2.98**
	Balance of View	**0.89**

View No. 15a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	2	1
2	4	-2
3	0	-2
4	0	0
5	2	-1
6	2	6
7	0	4
8	2	-1
9	3	3
10	5	3
11	6	1
Mean	**2.36**	**1.09**
	Distance from centre of view (d)	**2.60**
	Balance of View	**0.91**

View No. 16a

	Displacement along x-axis	Displacement along y-axis
	(No. of cells)	(No. of cells)
Assessor ID		
1	2	-7
2	6	-6
3	3	-3
4	7	-4
5	4	-2
6	0	5
7	6	4
8	2	-1
9	0	-2
10	-2	-1
11	1	-5
Mean	**2.64**	**-2.00**
	Distance from centre of view (d)	**3.31**
	Balance of View	**0.88**

Experiment 3 - Assessment of "Openness of View"

	Visual Layer 1	Visual Layer 2	Visual Layer 3	Visual Layer 4	All Layers	Openness of View
	Sky	Distant landscape and buildings	Opaque objects	Ground	Total No. of Cells in Image = 1,600	(10% per unit)
Relative Weight of Visual Barrier	**0**	**0.25**	**1.00**	**0.50**		
View No.	**No. of Cells in the Pixelated Image**	**No. of Cells in the Pixelated Image**	**No. of Cells in the Pixelated Image**	**No. of Cells in the Pixelated Image**		
1a	618	140	0	842	1,600	7.2
2a	272	50	998	280	1,600	2.8
3a	409	316	196	679	1,600	6.2
4a	563	223	430	384	1,600	5.8
5a	640	240	67	653	1,600	7.2
6a	445	18	887	250	1,600	3.6
7a	124	0	1036	440	1,600	2.2
8a	510	135	0	955	1,600	6.8
9a	567	44	322	667	1,600	5.8
10a	480	80	440	600	1,600	5.3
11a	156	0	1164	280	1,600	1.9
12a	6	300	1059	235	1,600	2.2
13a	186	0	1024	390	1,600	2.4
14a	90	170	1218	122	1,600	1.7
15a	0	15	1299	286	1,600	1.0
16a	390	140	525	545	1,600	4.8

Appendix E1:

Data tabulation for Experiment 1 (actual view)

Notes

"ID"	: Participant's ID
"Age"	: Age group – "1" (18-40); "2" (41-60); "3" (61-80); "4" (81 or above)
"Gender"	: Gender – "1" (Male); "2" (Female)
"Occup"	: Occupation – "1" (Art and design); "2" (Engineering); "3" (Administration); "4" (Public service); "5" (Student); "6" (Other)
"Window"	: Perceived importance of window at workplace or home – "1" (Important); "2" (Not important); "3" (No preference)
"Reason"	: Main reason for the perceived importance – "1" (Daylight); "2" (View); "3" (Natural ventilation); "4" (Other reasons)
"Prefer"	: The most preferred item to look at through the window at workplace or home – "1" (Water (landscape elements)); "2" (Mountains); "3" (Greenery); "4" (Cultivated landscape); "5" (Urban landscape); "6" (Human activities)

"P4"	: "Pleasantness of view" (POV) rating on a 4-point scale
"P10"	: "Pleasantness of view" (POV) rating on a 10-point scale
"E4"	: "Excitingness of view" (EOV) rating on a 4-point scale
"E10"	: "Excitingness of view" (EOV) rating on a 10-point scale
"Location"	: Perceived suitability of location for that particular view – "1" (Neither for my home nor my workplace); "2" (OK for my home but not my workplace); "3" (OK for my workplace but not my home); "4" (OK for both my home and my workplace)
"Feature"	: Participant's ranking on the presumably most dominant feature as perceived by the majority in the sample group for that particular view.

ID	Age	Gender	Occup	Window	Reason	Prefer
A01	1	2	1	1	3	4
A02	1	2	1	1	1	2
A03	1	2	1	1	3	1
A04	2	1	1	2	4	5
A05	1	2	6	1	2	2
A06	1	1	1	1	3	3
A07	1	2	5	1	3	3
A08	1	1	5	1	3	1
A09	1	1	5	1	3	3
A10	1	2	5	1	4	3
A11	1	1	1	1	1	3
A12	1	2	1	1	3	4
A13	1	2	1	1	2	4
A14	1	2	1	1	3	3
A15	1	2	6	1	1	5
A16	1	2	6	1	1	1
A17	2	1	2	1	4	2
A18	2	1	6	1	2	5
A19	1	1	5	1	3	3
A20	1	2	5	1	1	3
A21	1	2	5	1	3	2
A22	1	1	5	1	4	3
A23	1	2	5	1	3	5
A24	1	2	5	1	3	1
A25	1	1	5	1	3	3
A26	1	1	5	1	4	4
A27	1	2	5	1	2	3
A28	1	2	5	1	3	3
A29	1	1	5	1	3	3
A30	1	1	5	1	3	5
A31	1	1	5	1	1	1

ID	Age	Gender	Occup	Window	Reason	Prefer
A32	1	2	5	1	3	1
A33	1	1	2	1	2	1
A34	1	1	1	1	1	3
A35	1	1	1	1	1	3
A36	1	1	1	1	1	3
A37	1	1	1	1	3	2
A38	1	2	1	1	1	3
A39	1	2	1	1	1	3
A40	1	2	1	1	3	3
A41	1	2	6	1	2	3
A42	1	2	1	1	1	3
A43	1	1	6	1	2	3
A44	1	1	6	1	1	4
A45	1	1	5	1	3	3
A46	1	1	5	1	3	3
A47	1	2	5	1	3	3
A48	1	2	5	1	1	5
A49	1	1	5	1	3	3
A50	1	2	5	1	2	3
A51	1	1	5	1	1	3
A52	1	2	6	1	1	3
A53	1	2	5	1	2	3
A54	1	2	5	1	2	3
A55	1	1	5	1	1	3
A56	1	1	5	1	1	5
A57	1	1	5	1	1	2
A58	1	2	5	1	2	3
A59	1	1	1	1	2	5
A60	1	1	6	1	2	2
A61	1	2	1	1	1	6
A62	2	1	1	1	1	3

ID	View 1					
	P4	P10	E4	E10	Location	Feature
A01	1		1		1	1
A02	1		1		1	2
A03	1		1		1	1
A04		1		1	1	1
A05		4		7	3	3
A06		1		1	1	4
A07	1		1		1	1
A08	1		2		3	4
A09	1		1		1	4
A10	2		2		3	1
A11		4		6	1	1
A12		1		2	3	4
A13		7		8	1	1
A14	1		2		3	1
A15		7		5	1	4
A16		10		1	1	4
A17		6		6	3	4
A18		7		6	3	1
A19		7		8	2	4
A20		4		2	3	1
A21		4		3	1	1
A22	4		3		3	1
A23		5		4	1	1
A24		3		2	1	2
A25		2		2	1	4
A26	4		3		2	2
A27	2		2		3	4
A28	3		1		1	1
A29		5		4	3	3
A30		4		6	3	2
A31	2		3		1	1

ID	View 1					
	P4	P10	E4	E10	Location	Feature
A32	2		1		3	1
A33	3		3		3	1
A34	1		1		1	1
A35	1		1		1	1
A36		2		1	1	3
A37	1		1		1	1
A38	3		3		3	4
A39		4		6	1	3
A40		2		3	1	1
A41	2		2		2	1
A42		3		3	1	4
A43		2		3	3	2
A44	2		2		3	4
A45	1		2		1	4
A46	1		1		3	4
A47		3		4	3	4
A48	3		3		3	3
A49		6		4	1	4
A50		3		5	3	4
A51		7		4	1	4
A52		2		3	1	4
A53	2		2		3	1
A54	1		1		1	1
A55	2		2		1	1
A56		1		1	1	1
A57		4		7	3	4
A58		4		6	3	4
A59	2		3		1	2
A60	2		2		3	4
A61	1		2		1	1
A62	1		1		1	1

ID	View 2					
	P4	P10	E4	E10	Location	Feature
A01		4		3	3	2
A02		6		6	3	3
A03	1		1		1	1
A04	3		3		3	4
A05		6		5	3	2
A06	3		3		3	4
A07		7		7	4	4
A08	2		2		3	1
A09		7		6	3	4
A10	4		3		4	1
A11		8		9	4	4
A12	3		3		4	4
A13	2		1		1	4
A14	2		2		3	3
A15		8		8	4	4
A16	4		4		4	4
A17	3		3		3	4
A18		6		5	3	4
A19		8		7	2	1
A20	3		3		2	4
A21	4		3		4	1
A22		8		7	4	4
A23		8		6	4	2
A24		4		2	2	2
A25	2		1		1	3
A26		9		8	4	1
A27	3		3		1	4
A28	4		3		3	4
A29		8		8	4	1
A30	2		2		3	4
A31		6		6	4	1

ID	View 2					
	P4	P10	E4	E10	Location	Feature
A32		8		5	1	4
A33		4		4	3	2
A34	1		1		3	4
A35	3		2		1	4
A36	3		3		4	4
A37		7		8	4	4
A38	2		2		3	4
A39		7		6	3	1
A40	3		3		3	4
A41		4		4	3	2
A42	2		2		1	4
A43	2		2		3	1
A44		8		7	4	4
A45		5		5	3	3
A46	2		3		3	1
A47	3		2		3	4
A48	3		3		4	4
A49	4		4		4	4
A50		6		6	3	1
A51		7		5	3	4
A52		6		5	4	4
A53		7		7	4	2
A54		4		3	1	4
A55		4		3	1	4
A56	1		1		1	1
A57	2		4		4	4
A58	3		2		4	2
A59	4		3		4	4
A60		3		2	1	4
A61		6		6	3	2
A62		5		4	3	3

ID	View 3					
	P4	P10	E4	E10	Location	Feature
A01		1		1	1	1
A02		4		4	3	3
A03	1		3		1	4
A04	1		1		1	4
A05		2		1	1	4
A06		1		1	1	1
A07	3		2		3	4
A08	2		1		1	4
A09	3		3		3	4
A10	1		1		1	2
A11	2		1		3	4
A12		1		1	1	1
A13		8		3	3	4
A14	1		1		1	1
A15		5		4	1	4
A16	4		4		4	4
A17		8		8	3	4
A18		6		5	3	4
A19	2		3		3	2
A20	3		1		4	1
A21	3		2		3	1
A22		5		4	3	2
A23		2		1	1	2
A24	1		1		1	4
A25		3		2	1	2
A26	1		1		1	4
A27		4		3	3	4
A28	1		1		1	1
A29		1		1	1	4
A30		3		4	3	1
A31		4		4	1	4

ID	View 3					
	P4	P10	E4	E10	Location	Feature
A32		6		6	3	4
A33	3		2		1	1
A34	1		1		1	4
A35	2		3		1	4
A36	2		1		3	4
A37		8		5	3	3
A38	3		3		3	4
A39		3		2	1	3
A40	1		1		1	4
A41		4		4	3	2
A42		2		2	1	3
A43	1		1		1	3
A44		7		4	3	4
A45		1		1	1	3
A46	1		1		1	1
A47	2		1		1	1
A48		8		8	3	1
A49	3		1		1	1
A50	2		3		3	4
A51		4		4	3	4
A52	1		2		1	1
A53	1		1		1	3
A54	1		1		1	3
A55	3		3		3	4
A56		3		2	3	2
A57		2		4	1	2
A58		3		7	1	2
A59	3		3		3	4
A60		3		2	4	4
A61		4		2	1	4
A62		2		1	1	4

ID	View 4					
	P4	P10	E4	E10	Location	Feature
A01		5		5	2	1
A02	1		1		3	1
A03	3		2		3	1
A04		8		8	4	1
A05	2		2		1	1
A06		4		4	1	1
A07	4		4		4	1
A08	3		2		4	1
A09	4		3		4	1
A10		9		8	2	4
A11	3		3		4	1
A12		8		7	4	4
A13		8		9	2	1
A14		3		4	1	1
A15		8		7	2	4
A16	4		4		4	1
A17		5		4	1	2
A18		6		4	3	1
A19		8		8	2	1
A20	3		2		2	2
A21	4		3		2	1
A22		7		5	4	1
A23		4		3	3	2
A24	3		2		3	1
A25		8		6	3	1
A26		7		6	1	1
A27		5		3	2	1
A28	2		2		3	4
A29	2		2		1	1
A30	3		3		2	4
A31		7		7	2	1

ID	View 4					
	P4	P10	E4	E10	Location	Feature
A32	3		3		1	4
A33		5		4	4	1
A34		5		1	3	1
A35	3		2		2	1
A36		4		4	3	4
A37	3		2		2	3
A38	2		2		4	3
A39	3		2		2	1
A40		9		6	2	4
A41	2		2		2	1
A42		4		3	3	1
A43	2		2		1	1
A44		9		6	2	1
A45		8		5	4	1
A46	4		4		3	2
A47		6		4	3	2
A48	3		3		2	1
A49	3		2		2	4
A50		7		2	1	2
A51	3		2		2	4
A52	2		2		1	1
A53		4		5	1	1
A54	3		2		3	1
A55		7		6	4	2
A56	3		2		1	1
A57		7		2	4	4
A58		8		6	4	1
A59	3		2		4	1
A60		4		5	2	1
A61	3		2		4	1
A62	3		1		4	1

ID	View 5					
	P4	P10	E4	E10	Location	Feature
A01		3		3	1	2
A02		1		1	1	1
A03	1		1		1	2
A04	1		1		1	2
A05	3		3		1	4
A06		8		6	4	1
A07	3		3		3	4
A08	3		3		4	2
A09	2		2		4	3
A10		7		7	1	4
A11	4		4		4	2
A12	3		3		4	4
A13	3		3		2	1
A14		6		4	4	3
A15		6		6	1	2
A16	3		2		1	1
A17		7		7	3	3
A18		4		4	3	3
A19	3		3		4	4
A20		4		2	1	4
A21		6		6	4	1
A22		5		4	3	2
A23	2		2		1	4
A24	3		2		3	4
A25	2		1		1	2
A26		6		5	2	2
A27		2		2	1	4
A28	2		2		1	3
A29		5		3	1	1
A30		2		2	3	4
A31	2		2		1	2

ID	View 5					
	P4	P10	E4	E10	Location	Feature
A32		1		1	3	4
A33	2		1		1	1
A34	1		1		1	4
A35		1		1	1	2
A36	1		1		1	4
A37		1		1	1	3
A38	1		1		1	3
A39		2		1	1	3
A40	2		2		3	4
A41		4		4	1	2
A42		2		1	1	4
A43	1		1		1	2
A44		3		2	3	4
A45	1		3		3	3
A46	1		1		1	1
A47		5		5	3	3
A48	4		4		3	1
A49	2		1		3	2
A50	1		1		1	2
A51		5		5	1	1
A52	2		1		1	2
A53		2		1	1	2
A54	2		1		1	1
A55		7		7	4	2
A56		2		1	1	2
A57		1		4	1	2
A58		7		7	4	3
A59	2		3		2	4
A60	2		2		3	1
A61		5		4	4	4
A62		4		2	1	4

ID	View 6					
	P4	P10	E4	E10	Location	Feature
A01		3		3	3	4
A02	1		1		3	1
A03		1		1	1	4
A04	2		2		3	3
A05	4		4		3	2
A06		1		1	1	4
A07		6		5	1	4
A08	1		1		1	2
A09	2		2		3	4
A10	1		2		1	3
A11		10		10	4	3
A12		3		3	1	2
A13		2		1	1	2
A14	2		2		4	2
A15		8		8	4	1
A16	4		4		1	1
A17		9		8	4	4
A18		6		6	4	1
A19		7		8	2	2
A20	1		1		3	2
A21		5		4	3	2
A22	3		3		3	1
A23		6		5	3	2
A24		8		8	2	2
A25	2		1		1	1
A26	3		4		3	1
A27	1		1		3	2
A28	3		2		3	1
A29	1		1		1	2
A30	2		2		4	3
A31		6		6	1	2

Participant ID	View 6					
	P4	P10	E4	E10	Location	Feature
A32	1		1		3	1
A33	3		2		1	1
A34	1		1		1	4
A35		5		2	1	3
A36		2		1	1	2
A37		2		1	1	2
A38		4		3	3	1
A39		3		1	1	1
A40		7		4	3	3
A41	2		2		3	1
A42	1		1		1	3
A43		3		2	3	1
A44	3		3		3	1
A45		7		7	3	1
A46	4		3		4	1
A47		6		7	4	1
A48		10		10	4	4
A49		7		5	1	2
A50		2		2	1	3
A51	3		3		3	1
A52	2		1		3	1
A53	4		4		4	2
A54	3		3		3	4
A55	3		2		3	3
A56		1		1	1	2
A57		6		4	3	2
A58		1		1	1	1
A59	1		1		1	4
A60	2		2		3	4
A61		6		6	3	2
A62	1		1		3	4

ID	View 7					
	P4	P10	E4	E10	Location	Feature
A01	2		2		4	1
A02	1		1		3	1
A03		6		6	4	1
A04	2		2		3	1
A05	1		1		1	1
A06		6		7	4	1
A07	4		3		4	1
A08	1		1		1	1
A09	3		2		2	1
A10	2		1		1	1
A11		7		8	4	1
A12		6		7	4	1
A13	4		3		4	1
A14		3		1	2	1
A15		7		7	2	1
A16		8		8	2	3
A17	2		2		3	1
A18		5		4	3	1
A19		8		7	4	1
A20	2		2		4	1
A21		7		6	4	1
A22		5		5	1	1
A23	3		2		2	1
A24		6		2	1	1
A25		8		7	3	1
A26		1		1	1	4
A27		8		7	4	2
A28	4		3		2	1
A29	2		2		2	1
A30		1		1	3	1
A31	2		2		3	4

ID	View 7					
	P4	P10	E4	E10	Location	Feature
A32	3		2		1	1
A33	3		3		2	2
A34		4		3	3	4
A35		7		5	4	4
A36		7		7	4	4
A37	3		2		4	1
A38		2		2	1	4
A39	2		2		2	1
A40	1		1		1	1
A41		1		1	1	4
A42		3		3	3	1
A43	2		3		2	4
A44	2		1		1	1
A45		1		1	1	1
A46		4		3	3	3
A47	2		2		3	3
A48		6		7	1	1
A49		10		9	4	1
A50		6		3	1	1
A51		5		5	2	1
A52	3		1		4	1
A53	1		2		1	1
A54	3		2		3	1
A55		5		5	4	3
A56		7		5	3	1
A57	3		2		2	3
A58	4		3		4	4
A59	3		1		2	1
A60	2		2		4	4
A61	2		3		4	1
A62		6		5	3	1

ID	View 8					
	P4	P10	E4	E10	Location	Feature
A01		4		4	3	4
A02		3		3	3	1
A03	2		2		3	2
A04		4		3	3	1
A05	2		1		2	2
A06	1		1		1	2
A07		2		2	3	3
A08		7		4	3	1
A09		5		5	3	2
A10	1		1		3	2
A11		7		6	3	1
A12	1		1		1	2
A13		7		3	1	1
A14		2		2	1	4
A15		7		7	4	4
A16		10		10	4	4
A17		9		9	4	1
A18		8		6	3	4
A19	3		3		3	4
A20	3		3		3	1
A21	2		2		3	1
A22	4		3		4	4
A23	2		1		1	1
A24	4		3		3	1
A25	3		2		3	4
A26	2		3		3	4
A27	3		3		4	4
A28	4		4		4	3
A29	2		2		3	4
A30	4		4		4	1
A31	1		1		3	2

ID	View 8					
	P4	P10	E4	E10	Location	Feature
A32	2		1		3	4
A33	3		2		3	4
A34		2		1	1	4
A35		5		5	3	4
A36		3		3	3	4
A37		8		5	3	4
A38		4		5	3	1
A39	3		3		3	4
A40		6		4	3	1
A41	3		2		3	4
A42	1		1		1	4
A43		4		4	3	4
A44		8		7	3	4
A45		4		1	1	2
A46	2		2		4	2
A47		6		5	3	4
A48		9		10	3	1
A49	2		2		1	2
A50		4		2	3	2
A51	2		2		1	2
A52	2		2		3	2
A53		9		10	3	2
A54	3		3		4	4
A55	3		3		4	1
A56	3		1		3	1
A57		6		4	3	2
A58		3		8	1	2
A59	2		3		3	1
A60		5		3	3	4
A61		7		6	3	4
A62		6		6	3	1

ID	View 9					
	P4	P10	E4	E10	Location	Feature
A01	3		3		4	2
A02		7		6	4	2
A03	3		3		4	1
A04	3		2		4	1
A05		5		6	2	1
A06	3		3		3	1
A07		10		10	4	4
A08		8		5	4	1
A09		9		8	4	2
A10		10		9	4	2
A11		9		8	4	2
A12		2		1	1	3
A13		6		3	4	3
A14		2		2	3	2
A15		8		8	4	1
A16		10		10	4	1
A17		9		8	4	1
A18		7		7	4	2
A19	4		3		4	1
A20	4		4		3	1
A21	4		3		4	1
A22	4		3		2	2
A23	4		4		4	1
A24	4		4		4	2
A25	2		2		3	1
A26	3		3		4	2
A27	3		3		4	2
A28	3		4		4	1
A29	3		2		4	3
A30	3		3		4	2
A31	3		3		3	4

ID	View 9					
	P4	P10	E4	E10	Location	Feature
A32	3		3		4	2
A33	3		3		2	1
A34		5		3	4	3
A35		9		7	4	2
A36	2		2		4	2
A37		8		7	4	2
A38		2		2	2	3
A39	3		3		2	3
A40		9		6	4	1
A41		5		5	4	2
A42	3		3		4	2
A43	3		3		4	2
A44		8		7	4	4
A45		6		3	3	2
A46		7		8	4	2
A47	4		2		4	3
A48		10		10	4	4
A49		5		6	2	2
A50		4		2	1	4
A51	3		3		2	2
A52	2		2		4	4
A53	4		4		4	1
A54	4		4		4	2
A55	3		3		2	3
A56		8		8	4	2
A57	4		2		2	2
A58		9		10	4	2
A59		10		10	4	2
A60	3		3		2	2
A61		9		7	4	2
A62		7		7	4	1

ID	View 10					
	P4	P10	E4	E10	Location	Feature
A01		1		1	1	4
A02		7		7	4	2
A03	2		2		3	3
A04	1		1		1	2
A05		4		5	1	2
A06		2		2	1	1
A07		9		9	4	1
A08		6		5	4	1
A09		10		6	4	1
A10		7		6	4	1
A11		9		7	4	1
A12		1		1	1	2
A13		3		3	1	1
A14		6		4	1	1
A15		6		6	4	2
A16		10		10	2	2
A17		9		9	4	3
A18		8		7	4	1
A19	3		2		2	1
A20	3		3		4	2
A21	3		3		4	4
A22	4		3		4	1
A23	3		3		2	1
A24	3		2		2	1
A25		7		8	2	1
A26	2		1		4	1
A27		8		8	4	1
A28	4		3		3	2
A29	3		3		2	1
A30	3		3		4	3
A31	2		2		1	1

ID	View 10					
	P4	P10	E4	E10	Location	Feature
A32	1		1		1	1
A33	4		3		4	1
A34	1		1		4	3
A35	3		2		4	1
A36	1		1		1	4
A37		5		3	1	4
A38	2		1		1	1
A39	3		2		3	1
A40	1		1		1	1
A41	2		2		3	1
A42	1		1		1	2
A43		4		5	4	1
A44		8		7	4	3
A45	2		1		1	2
A46	2		2		3	2
A47		7		6	4	2
A48	3		3		3	1
A49	1		2		1	1
A50	3		2		2	1
A51		4		4	2	1
A52		2		2	1	2
A53		10		10	4	1
A54		7		7	4	1
A55		8		8	2	2
A56		9		7	4	1
A57	4		3		4	1
A58	4		4		4	2
A59		8		9	4	1
A60	2		2		3	4
A61		5		4	3	1
A62		5		6	3	1

ID	View 11					
	P4	P10	E4	E10	Location	Feature
A01		5		5	4	4
A02	4		4		4	2
A03	3		2		4	4
A04		6		5	3	4
A05	3		2		1	4
A06		10		10	4	1
A07		10		10	4	1
A08		8		8	4	1
A09		8		6	4	2
A10		9		9	4	3
A11		8		7	4	2
A12		6		6	4	2
A13		8		7	4	2
A14		2		1	1	4
A15		9		8	4	4
A16	4		4		4	3
A17		10		9	2	3
A18		8		8	2	4
A19	3		4		3	4
A20	3		3		4	4
A21	3		2		3	2
A22		8		8	4	2
A23	2		2		1	2
A24	2		2		3	3
A25	2		3		4	2
A26		7		3	4	3
A27	3		3		2	4
A28	2		1		3	2
A29	3		4		4	4
A30	3		3		4	4
A31	3		3		2	2

ID	View 11					
	P4	P10	E4	E10	Location	Feature
A32	3		3		4	3
A33	4		3		4	4
A34		4		3	4	3
A35	3		3		4	3
A36	3		3		4	2
A37		8		8	4	2
A38	3		3		2	4
A39	3		2		4	4
A40		7		6	4	4
A41	3		3		4	3
A42	2		2		3	4
A43		6		5	4	3
A44	4		3		4	3
A45	3		3		4	2
A46		7		6	2	4
A47		9		7	4	1
A48		10		10	4	3
A49	3		3		4	2
A50	2		2		1	2
A51		5		5	3	3
A52		2		2	3	2
A53	3		3		3	3
A54	4		4		4	3
A55		5		5	4	1
A56		8		9	4	2
A57		3		7	1	2
A58	4		4		4	2
A59		9		9	4	2
A60	3		3		4	1
A61		6		3	2	1
A62		5		5	3	3

ID	View 12					
	P4	P10	E4	E10	Location	Feature
A01	3		3		4	2
A02	3		3		4	1
A03	2		2		3	1
A04		1		1	1	1
A05		4		6	3	1
A06		7		7	3	1
A07		8		8	3	1
A08		6		5	3	1
A09	3		3		4	2
A10	2		2		3	1
A11	2		2		4	1
A12		3		3	1	1
A13		4		4	3	2
A14		1		1	3	1
A15		8		7	3	1
A16		8		8	3	1
A17		7		7	3	1
A18		6		6	3	2
A19		9		8	4	1
A20		6		4	3	4
A21	2		1		3	3
A22		7		5	4	1
A23	2		1		1	2
A24		2		2	1	1
A25	2		2		3	2
A26		1		1	1	1
A27	2		2		3	2
A28	1		1		3	2
A29	3		3		3	1
A30	2		2		3	1
A31	2		2		1	1

ID	View 12					
	P4	P10	E4	E10	Location	Feature
A32	3		2		3	1
A33	3		3		3	1
A34		3		2	3	1
A35	2		1		3	2
A36		4		3	3	4
A37		6		4	4	1
A38	4		4		3	4
A39	3		3		3	1
A40	1		1		1	1
A41		5		5	3	1
A42		3		3	3	1
A43	2		2		3	1
A44	3		3		3	1
A45		6		5	3	2
A46	2		1		3	1
A47	3		2		3	1
A48	4		4		4	2
A49		5		6	3	1
A50		4		3	3	1
A51	2		2		3	1
A52		4		2	3	1
A53		2		1	1	2
A54	2		2		3	1
A55	2		2		3	1
A56	3		3		3	1
A57		3		5	3	1
A58		6		3	3	1
A59	3		2		3	2
A60		3		3	1	4
A61	2		2		3	1
A62		5		6	3	1

Appendix E2:
Data tabulation for Experiment 2 (image view)

Notes

"ID"	: Participant's ID
"Age"	: Age group – "1" (18-40); "2" (41-60); "3" (61-80); "4" (81 or above)
"Gender"	: Gender – "1" (Male); "2" (Female)
"Occup"	: Occupation – "1" (Art and design); "2" (Engineering); "3" (Administration); "4" (Public service); "5" (Student); "6" (Other)
"Window"	: Perceived importance of window at workplace or home – "1" (Important); "2" (Not important); "3" (No preference)
"Reason"	: Main reason for the perceived importance – "1" (Daylight); "2" (View); "3" (Natural ventilation); "4" (Other reasons)
"Prefer"	: The most preferred item to look at through the window at workplace or home – "1" (Water (landscape elements)); "2" (Mountains); "3" (Greenery); "4" (Cultivated landscape); "5" (Urban landscape); "6" (Human activities)

"P4"	: "Pleasantness of view" (POV) rating on a 4-point scale
"P10"	: "Pleasantness of view" (POV) rating on a 10-point scale
"E4"	: "Excitingness of view" (EOV) rating on a 4-point scale
"E10"	: "Excitingness of view" (EOV) rating on a 10-point scale
"Location"	: Perceived suitability of location for that particular view – "1" (Neither for my home nor my workplace); "2" (OK for my home but not my workplace); "3" (OK for my workplace but not my home); "4" (OK for both my home and my workplace)
"Feature"	: Participant's ranking on the presumably most dominant feature as perceived by the majority in the sample group for that particular view.

ID	Age	Gender	Occup	Window	Reason	Prefer
B01	1	2	5	1	1	3
B02	1	2	5	1	3	3
B03	1	2	5	1	1	1
B04	1	1	5	1	4	2
B05	1	2	5	1	1	3
B06	1	1	5	1	1	5
B07	1	1	5	1	3	1
B08	1	2	5	1	3	3
B09	1	2	5	1	1	3
B10	1	2	5	1	3	2
B11	1	2	5	1	1	1
B12	1	2	5	1	2	3
B13	1	2	5	1	2	6
B14	1	2	5	1	2	3
B15	1	2	5	1	3	3
B16	1	1	5	1	1	4
B17	1	1	5	1	2	3
B18	1	1	5	1	2	2
B19	1	2	5	1	1	2
B20	1	1	5	1	3	5
B21	1	1	5	1	1	4
B22	1	1	5	1	2	2
B23	1	1	5	1	1	2
B24	1	2	5	1	3	4
B25	1	2	5	1	3	3
B26	1	2	5	1	2	4
B27	1	2	5	1	3	3
B28	1	2	5	1	2	3
B29	1	2	5	1	1	1
B30	1	1	5	1	1	1
B31	1	1	5	1	1	5

ID	Age	Gender	Occup	Window	Reason	Prefer
B32	1	1	5	1	1	4
B33	1	2	5	1	1	1
B34	1	2	5	1	3	2
B35	1	1	5	1	1	3
B36	1	2	5	1	3	1
B37	1	2	5	1	2	3
B38	1	1	5	1	2	3
B39	1	1	5	1	2	2
B40	1	2	5	1	1	5
B41	1	2	6	1	1	2
B42	1	1	5	1	3	2
B43	1	2	5	1	2	3
B44	1	2	5	1	2	3
B45	1	2	5	1	2	5
B46	1	1	5	1	4	2
B47	1	2	5	1	2	5
B48	1	1	5	1	2	5
B49	1	2	5	1	1	4
B50	1	1	5	1	2	5
B51	1	2	5	1	2	4
B52	1	1	5	1	3	2
B53	1	1	5	1	1	3
B54	1	1	5	1	2	3
B55	1	2	5	1	3	3
B56	1	2	5	1	1	3
B57	1	1	5	1	1	4
B58	1	1	5	1	1	3
B59	1	2	5	1	3	5
B60	1	1	5	1	1	3
B61	1	2	5	1	1	3
B62	1	1	5	1	1	1

ID	View 1					
	P4	P10	E4	E10	Location	Feature
B01		3		4	3	1
B02	2		2		1	3
B03		1		1	1	4
B04	2		1		1	1
B05	2		2		1	2
B06	1		2		1	4
B07	3		3		3	2
B08	2		2		3	4
B09	3		4		3	4
B10		5		3	1	4
B11	2		2		1	4
B12	2		1		1	1
B13		4		3	1	1
B14		2		2	1	4
B15		3		1	1	4
B16		4		4	1	1
B17		7		7	3	2
B18	1		2		1	4
B19		2		1	1	4
B20		6		5	3	1
B21		1		1	1	1
B22		2		5	1	4
B23		7		5	3	4
B24		6		3	3	4
B25		2		1	3	4
B26	3		2		1	4
B27	2		2		3	4
B28	2		3		1	4
B29	2		1		1	4
B30	1		2		1	1
B31		6		4	1	1

ID	View 1					
	P4	P10	E4	E10	Location	Feature
B32		3		6	1	1
B33		2		3	3	4
B34	1		1		1	1
B35	1		1		3	1
B36	3		3		1	1
B37	1		1		1	1
B38	2		1		1	4
B39	1		1		1	4
B40		4		4	3	4
B41		2		2	1	3
B42	2		1		1	1
B43	2		2		1	4
B44		3		2	3	4
B45		5		3	3	4
B46		2		2	3	1
B47		3		3	1	4
B48		5		5	1	3
B49		4		3	1	1
B50		5		3	1	4
B51		5		4	1	4
B52		5		3	1	1
B53		2		1	1	3
B54	1		1		1	2
B55	2		1		3	4
B56	2		2		1	4
B57		5		4	1	4
B58	2		2		3	4
B59	1		1		1	1
B60	4		3		3	4
B61	2		3		4	4
B62	1		1		1	1

ID	View 2					
	P4	P10	E4	E10	Location	Feature
B01		4		3	3	1
B02	3		3		3	3
B03		9		10	3	4
B04	1		2		3	4
B05	2		2		3	3
B06	2		2		1	1
B07	2		2		1	2
B08		6		7	4	2
B09	4		3		4	1
B10		6		4	2	4
B11	1		1		1	2
B12	2		2		4	4
B13		5		6	3	2
B14		4		4	3	4
B15		5		5	3	1
B16		6		8	4	1
B17	4		4		3	4
B18	3		2		1	2
B19	2		2		1	1
B20	2		2		1	1
B21		4		2	3	1
B22	2		2		1	4
B23	2		3		3	2
B24	3		3		3	1
B25		2		1	3	1
B26		7		4	3	2
B27		4		4	3	1
B28		7		6	3	3
B29	3		2		2	2
B30		6		6	3	1
B31		7		6	3	1

ID	View 2					
	P4	P10	E4	E10	Location	Feature
B32		6		8	3	4
B33		1		1	1	2
B34	2		2		3	1
B35		3		1	3	1
B36		4		4	2	1
B37		6		6	3	1
B38		7		4	3	1
B39		4		5	3	3
B40	2		2		3	1
B41	2		2		1	1
B42	2		2		1	1
B43	3		2		3	4
B44	2		1		1	1
B45	2		3		4	2
B46	2		1		3	2
B47	3		3		3	1
B48	3		3		3	3
B49	2		2		3	2
B50		5		6	3	1
B51		7		4	3	1
B52		8		8	4	4
B53		4		3	1	1
B54		4		6	3	1
B55		4		4	3	1
B56		5		7	1	4
B57		8		7	3	3
B58	3		3		3	3
B59	1		1		1	1
B60	4		3		1	2
B61	2		3		3	4
B62		4		5	3	3

ID	View 3					
	P4	P10	E4	E10	Location	Feature
B01		3		2	1	1
B02		2		1	1	4
B03		1		2	1	1
B04	1		1		1	1
B05	2		2		1	4
B06	2		2		1	1
B07		6		6	2	1
B08	1		1		3	4
B09		3		2	1	4
B10		4		4	1	4
B11		2		2	1	4
B12		1		1	1	1
B13		5		7	2	1
B14		6		5	3	2
B15		1		1	1	4
B16		8		4	3	1
B17		2		2	1	1
B18	1		1		1	1
B19		3		1	1	3
B20	3		4		3	1
B21	1		1		1	1
B22		4		5	1	1
B23		3		3	1	4
B24		3		3	1	1
B25		8		8	3	4
B26		3		1	1	4
B27		3		4	1	1
B28		8		8	3	2
B29		5		5	3	4
B30		7		2	3	1
B31	2		1		1	1

ID	View 3					
	P4	P10	E4	E10	Location	Feature
B32	3		2		3	1
B33	1		1		1	4
B34	1		2		1	1
B35	3		2		4	1
B36	3		3		3	1
B37	2		1		3	1
B38	3		1		1	4
B39	3		4		3	1
B40	2		2		1	1
B41	2		2		1	1
B42	1		1		1	1
B43	2		1		1	2
B44	3		3		3	4
B45	2		1		1	4
B46	1		1		3	4
B47		10		9	3	4
B48	2		2		1	1
B49	3		3		3	1
B50	3		2		1	1
B51	2		2		1	1
B52	1		1		3	1
B53	2		1		1	2
B54	3		3		4	1
B55		6		4	4	4
B56		4		5	1	2
B57		5		4	1	1
B58		5		4	1	4
B59		5		3	4	1
B60		3		2	1	3
B61		6		6	4	4
B62	2		1		1	1

ID	View 4					
	P4	P10	E4	E10	Location	Feature
B01	2		1		1	1
B02	3		1		1	3
B03		10		9	3	1
B04		7		6	1	2
B05		8		9	2	1
B06	3		3		2	2
B07		4		4	1	1
B08	1		1		2	3
B09		6		6	1	1
B10		7		4	2	1
B11		5		5	1	1
B12		5		3	1	1
B13		4		4	3	2
B14		3		2	1	1
B15		7		8	2	1
B16		6		4	2	2
B17		7		5	2	4
B18	3		2		2	1
B19		4		4	2	1
B20		4		3	1	4
B21		6		4	3	1
B22		5		1	2	4
B23	4		3		4	3
B24		8		6	4	4
B25		4		1	1	1
B26	4		3		2	2
B27	2		2		1	2
B28	3		2		1	2
B29		4		3	3	1
B30	3		2		4	4
B31	3		2		2	1

ID	View 4					
	P4	P10	E4	E10	Location	Feature
B32	3		2		2	2
B33	1		1		1	4
B34	2		1		3	2
B35	1		2		1	1
B36		6		6	3	1
B37		7		8	4	1
B38		7		3	3	4
B39	2		3		2	2
B40	3		2		3	1
B41	3		2		1	3
B42	2		1		1	4
B43	3		4		2	1
B44	2		2		1	1
B45		7		3	1	4
B46		3		1	2	1
B47	2		2		1	1
B48	2		2		1	1
B49	3		2		2	1
B50		5		4	1	1
B51		6		7	2	1
B52		6		3	3	1
B53		7		5	2	4
B54		5		2	3	2
B55	3		2		1	1
B56	3		2		1	1
B57	4		3		2	2
B58	3		2		1	1
B59		5		3	3	2
B60	3		3		3	2
B61	3		2		2	2
B62	3		1		3	1

ID	View 5					
	P4	P10	E4	E10	Location	Feature
B01	2		2		1	3
B02		8		9	4	3
B03	1		1		3	2
B04	3		2		3	3
B05	3		3		3	2
B06	1		1		1	3
B07		8		8	4	2
B08	2		1		1	3
B09		7		6	3	1
B10		5		5	4	2
B11	1		1		1	4
B12		2		1	1	4
B13	3		3		4	3
B14	3		2		3	3
B15	2		2		3	2
B16	2		1		1	4
B17		1		1	1	3
B18	2		1		1	4
B19	3		3		3	3
B20		2		1	1	3
B21		1		1	1	3
B22	2		2		3	4
B23		7		7	4	3
B24	3		4		4	2
B25		1		1	1	4
B26		1		1	1	2
B27		4		4	4	2
B28		7		5	1	3
B29	2		1		1	3
B30		3		1	1	4
B31	1		1		1	3

ID	View 5					
	P4	P10	E4	E10	Location	Feature
B32		3		2	1	3
B33		5		5	4	4
B34		4		3	3	3
B35	2		1		1	2
B36		4		4	1	3
B37		6		5	4	3
B38		6		6	3	2
B39	2		2		1	2
B40	2		1		1	2
B41	2		2		1	2
B42		1		2	1	3
B43	3		2		3	3
B44		4		3	3	3
B45		6		4	4	3
B46		4		7	1	3
B47		8		6	1	2
B48		4		4	1	1
B49		7		6	4	3
B50	2		2		2	2
B51	3		2		1	3
B52	2		2		1	4
B53	2		1		1	3
B54	2		1		3	2
B55		8		7	4	3
B56	3		2		1	2
B57	4		3		3	2
B58	2		2		3	2
B59	2		1		1	3
B60		8		4	3	2
B61		5		3	1	4
B62		5		5	3	2

ID	View 6					
	P4	P10	E4	E10	Location	Feature
B01	2		1		1	2
B02	2		1		4	4
B03	4		4		3	4
B04		4		5	3	2
B05		5		5	3	4
B06		4		4	1	3
B07	3		3		3	4
B08		6		4	3	1
B09		8		5	1	4
B10		8		4	3	1
B11	1		1		1	1
B12		3		2	3	1
B13	2		2		3	4
B14	3		2		3	4
B15	1		1		3	1
B16	1		1		1	1
B17		5		5	3	1
B18	3		2		1	4
B19	3		3		3	1
B20		2		3	1	1
B21		3		2	1	1
B22	2		3		3	4
B23	2		1		3	2
B24	3		2		3	1
B25	2		1		3	4
B26	3		2		1	1
B27		5		5	4	1
B28		5		7	3	1
B29		4		4	1	4
B30		6		3	3	3
B31	2		1		1	1

ID	View 6					
	P4	P10	E4	E10	Location	Feature
B32		4		2	3	2
B33		3		2	1	4
B34		6		5	3	1
B35		5		5	3	1
B36		7		7	4	2
B37	2		2		3	1
B38		8		2	3	1
B39	3		4		3	2
B40	3		2		3	1
B41		3		2	1	2
B42		4		4	3	2
B43		6		4	2	2
B44		5		4	3	4
B45	3		3		4	4
B46	4		3		4	3
B47	3		2		1	2
B48		6		6	3	1
B49		8		8	3	2
B50	2		2		3	4
B51		7		4	3	4
B52	3		2		3	1
B53	1		1		1	1
B54	3		3		3	4
B55		6		8	4	1
B56	2		2		1	4
B57	3		2		1	4
B58		7		6	3	2
B59	2		1		1	2
B60	4		3		4	2
B61		4		4	3	4
B62		4		4	3	1

ID	View 7					
	P4	P10	E4	E10	Location	Feature
B01	2		1		2	1
B02		2		2	3	1
B03		1		1	1	1
B04		3		6	3	4
B05		6		6	2	1
B06		6		7	4	1
B07		8		8	4	1
B08		3		1	4	1
B09		5		4	1	1
B10	3		3		2	1
B11	2		2		2	1
B12		2		1	4	1
B13	2		2		1	1
B14	3		2		2	1
B15	3		2		4	1
B16	3		1		2	1
B17	1		1		2	1
B18		8		5	4	4
B19		4		3	3	1
B20		2		1	1	1
B21		4		2	3	1
B22		4		2	4	1
B23	1		1		1	1
B24	2		1		2	4
B25	3		2		4	1
B26		5		3	1	1
B27	3		3		2	1
B28		6		6	2	1
B29		5		5	2	1
B30	2		1		2	1
B31		4		3	2	1

ID	View 7					
	P4	P10	E4	E10	Location	Feature
B32		5		2	3	1
B33		3		2	3	4
B34		1		1	1	1
B35		5		4	2	1
B36	3		2		4	1
B37	3		3		4	1
B38	4		2		4	1
B39	2		1		1	1
B40		6		5	4	1
B41	2		2		1	1
B42		5		4	3	1
B43		7		6	4	1
B44		7		6	2	1
B45	2		1		1	1
B46	2		1		2	1
B47	4		4		4	1
B48	2		2		2	1
B49		3		2	2	1
B50		3		2	1	1
B51	1		2		2	1
B52		7		5	4	1
B53	3		2		3	1
B54	2		1		3	1
B55	4		4		4	1
B56	3		3		2	1
B57	4		3		2	1
B58	3		3		2	1
B59		5		2	2	1
B60		6		4	2	1
B61	3		2		2	1
B62	3		3		4	1

ID	View 8					
	P4	P10	E4	E10	Location	Feature
B01		3		2	1	3
B02	4		3		4	3
B03		9		9	3	3
B04	2		2		3	3
B05		3		3	1	3
B06		5		4	3	3
B07		6		6	1	1
B08		5		5	4	2
B09		8		6	4	2
B10		5		5	4	1
B11		6		3	3	3
B12		2		2	3	3
B13		6		4	1	4
B14	2		1		3	3
B15		3		3	3	3
B16	3		4		4	4
B17		9		4	4	3
B18		4		3	3	2
B19	3		3		4	2
B20	2		2		3	3
B21		3		1	3	3
B22	4		4		3	4
B23	3		2		3	1
B24		6		7	3	3
B25	2		2		3	2
B26	1		1		1	3
B27		4		4	3	4
B28		7		6	3	2
B29	3		3		4	3
B30	2		1		1	4
B31	2		2		3	4

ID	View 8					
	P4	P10	E4	E10	Location	Feature
B32	1		1		1	3
B33	3		2		4	3
B34	2		1		1	2
B35	2		3		3	4
B36		5		6	3	2
B37		5		5	3	3
B38	3		2		3	3
B39	3		4		3	3
B40		5		5	3	3
B41		4		3	1	1
B42		5		5	3	4
B43		5		5	3	1
B44	3		3		4	1
B45		6		7	4	2
B46	1		2		3	3
B47	3		3		3	3
B48	3		3		3	3
B49	2		1		3	3
B50	2		2		3	4
B51	3		2		3	2
B52		8		7	4	4
B53	1		3		1	4
B54	2		1		3	2
B55	2		2		3	2
B56		7		5	2	1
B57	4		2		3	1
B58		8		7	4	2
B59		6		5	2	3
B60		8		5	4	1
B61	3		3		3	2
B62		4		6	3	4

ID	View 9					
	P4	P10	E4	E10	Location	Feature
B01		4		2	3	2
B02		9		9	4	1
B03	4		4		1	4
B04		8		7	4	1
B05	3		3		2	2
B06	3		3		4	1
B07	3		3		3	2
B08	4		4		4	4
B09	4		4		4	4
B10		8		7	4	3
B11	3		3		4	4
B12		3		3	4	4
B13		6		7	4	1
B14		8		7	2	1
B15		7		6	4	1
B16		9		9	4	3
B17		10		4	4	4
B18		9		8	2	4
B19		7		8	4	2
B20	2		1		1	3
B21	2		1		4	2
B22	3		3		4	3
B23	3		3		4	4
B24	4		4		2	4
B25		4		2	3	4
B26		7		5	2	4
B27		5		5	4	2
B28		8		9	2	2
B29		8		7	4	1
B30	3		2		4	3
B31		5		5	3	2

ID	View 9					
	P4	P10	E4	E10	Location	Feature
B32		5		4	3	3
B33	3		3		4	4
B34	3		2		2	3
B35	3		3		4	4
B36		7		7	4	2
B37	3		3		4	3
B38	4		2		4	3
B39	3		3		4	2
B40	3		2		4	4
B41	2		2		1	4
B42	3		3		2	3
B43	3		4		4	3
B44		6		6	2	3
B45		8		6	4	3
B46		9		7	4	2
B47	2		3		1	3
B48		9		9	4	3
B49	2		2		4	4
B50	2		2		3	2
B51	4		2		2	3
B52	4		3		4	1
B53		4		5	1	4
B54		6		3	4	4
B55		10		10	4	3
B56		7		8	4	3
B57	3		1		1	3
B58		8		8	4	2
B59		5		5	4	2
B60		9		7	4	4
B61	3		3		4	4
B62	3		3		4	3

ID	View 10					
	P4	P10	E4	E10	Location	Feature
B01		3		3	1	1
B02		7		6	4	1
B03		9		9	2	1
B04		6		5	3	1
B05		4		4	3	1
B06		3		2	1	1
B07		8		8	4	1
B08		10		10	4	1
B09		9		8	3	1
B10		6		5	3	1
B11		6		4	4	1
B12	2		2		3	1
B13		5		5	4	1
B14		7		6	3	1
B15	3		2		3	1
B16	3		2		4	1
B17		8		6	4	1
B18	2		1		1	1
B19	3		3		4	1
B20	3		2		4	1
B21	2		1		4	1
B22		4		4	3	2
B23	3		2		4	1
B24	3		1		2	1
B25	2		2		3	2
B26		8		6	2	3
B27	2		2		3	1
B28		7		5	2	1
B29	3		3		4	2
B30	3		2		4	1
B31	2		2		2	1

ID	View 10					
	P4	P10	E4	E10	Location	Feature
B32	2		3		2	2
B33	3		2		3	1
B34	2		2		1	1
B35		3		3	3	2
B36	4		4		4	1
B37		6		5	4	1
B38		9		7	4	1
B39	3		4		4	1
B40	2		2		3	2
B41		4		3	1	1
B42	2		2		3	1
B43	3		3		2	1
B44		5		5	3	1
B45	3		2		3	1
B46	2		1		3	1
B47		7		7	1	1
B48		7		7	2	1
B49		5		5	2	1
B50		6		6	2	1
B51		5		7	3	1
B52	4		2		4	1
B53	2		2		1	1
B54		6		4	4	1
B55		8		8	4	1
B56		7		5	2	2
B57	3		2		4	1
B58		6		6	4	1
B59	3		3		4	1
B60	4		3		2	2
B61	2		2		2	1
B62	3		3		4	1

ID	View 11					
	P4	P10	E4	E10	Location	Feature
B01	3		2		2	2
B02		5		6	4	2
B03	1		1		2	1
B04		6		6	3	2
B05	3		3		3	2
B06	3		3		3	2
B07	4		4		4	2
B08		10		10	4	2
B09	2		1		3	1
B10	3		2		3	2
B11	2		2		4	1
B12	2		2		3	1
B13		7		5	4	3
B14		6		5	3	1
B15		7		7	3	2
B16	4		3		4	2
B17		10		9	4	2
B18	2		1		1	1
B19	3		3		4	1
B20		5		4	4	1
B21		3		3	3	1
B22		5		5	3	3
B23		6		6	4	2
B24	2		1		3	2
B25	2		1		3	2
B26		4		2	1	2
B27	4		3		2	2
B28	4		4		4	4
B29	4		4		4	4
B30		7		3	3	1
B31	3		3		2	1

ID	View 11					
	P4	P10	E4	E10	Location	Feature
B32		4		3	1	2
B33		3		3	3	1
B34		7		5	1	2
B35		2		2	1	3
B36		6		6	3	2
B37		5		4	3	1
B38		8		7	3	4
B39	3		3		3	1
B40	3		2		3	2
B41	2		2		1	2
B42	3		3		3	2
B43		8		6	3	3
B44	2		2		3	1
B45		7		6	2	2
B46		6		4	1	1
B47	4		4		3	1
B48		7		7	3	2
B49	2		2		4	1
B50	3		3		4	3
B51	4		2		4	1
B52		8		4	4	3
B53		2		1	1	2
B54		5		4	3	3
B55		9		9	3	3
B56	3		4		4	2
B57		8		6	3	2
B58		6		6	3	2
B59	2		2		2	2
B60		9		7	4	2
B61	3		3		4	4
B62	3		3		4	1

ID	View 12					
	P4	P10	E4	E10	Location	Feature
B01		5		3	3	1
B02	3		3		4	2
B03		9		9	4	1
B04	3		2		3	2
B05	2		2		1	2
B06	3		2		3	1
B07		8		8	4	1
B08	4		1		2	1
B09	2		2		3	1
B10		5		4	3	1
B11		4		2	3	1
B12		4		3	3	1
B13	3		2		3	1
B14	3		2		3	1
B15	3		2		3	1
B16	2		2		3	1
B17		7		7	3	3
B18	1		1		1	3
B19		5		5	4	1
B20	2		2		3	1
B21	1		1		3	1
B22		4		3	3	2
B23		5		3	3	1
B24	2		1		3	2
B25		2		1	3	2
B26		3		1	1	2
B27		6		6	4	2
B28		7		6	3	1
B29	3		2		3	2
B30	3		2		3	1
B31		5		3	1	1

ID	View 12					
	P4	P10	E4	E10	Location	Feature
B32		4		5	3	2
B33		3		3	3	1
B34	2		2		3	1
B35	1		1		1	1
B36	3		3		3	1
B37	2		2		3	1
B38	3		1		3	1
B39		7		8	3	1
B40	2		2		3	2
B41		4		3	1	2
B42	3		3		3	2
B43	3		3		3	1
B44	3		3		4	1
B45	2		2		3	1
B46	1		1		3	1
B47		7		6	3	1
B48		8		8	3	1
B49		4		3	4	1
B50		3		3	3	2
B51		7		6	4	1
B52	3		2		3	2
B53		2		1	1	2
B54		7		6	3	3
B55		3		1	1	1
B56		6		6	3	2
B57		8		5	3	2
B58	3		3		3	1
B59	2		1		1	1
B60		8		7	4	2
B61		3		4	3	1
B62	2		2		3	1

Appendix E3:

Data tabulation for Experiment 3 (image view)

Notes

"ID"	: Participant's ID
"P10"	: "Pleasantness of view" (POV) rating on a 10-point scale
"E10"	: "Excitingness of view" (EOV) rating on a 10-point scale

ID	View 1a		View 2a		View 3a		View 4a	
	P10	E10	P10	E10	P10	E10	P10	E10
C01	10	7	6	5	7	6	10	7
C02	9	9	3	5	6	7	3	2
C03	9	8	9	9	9	9	9	9
C04	8	7	2	2	4	4	10	10
C05	4	3	6	7	2	2	9	9
C06	8	6	4	4	5	5	9	9
C07	8	6	6	4	7	8	10	8
C08	7	7	7	8	6	7	9	9
C10	5	5	4	3	4	4	8	8
C11	6	7	5	6	6	6	6	7
C12	8	8	5	5	5	5	9	9
C13	6	6	6	6	5	5	8	8
C14	8	8	7	6	7	8	7	7
C15	5	4	6	6	8	7	9	9
C16	5	5	5	5	5	5	7	7
C17	8	8	5	4	4	4	8	8
C18	9	9	6	3	3	3	8	8
C19	7	5	5	6	7	6	9	5
C20	9	8	9	9	9	8	10	9
C21	8	7	7	8	8	8	9	9

ID	View 1a		View 2a		View 3a		View 4a	
	P10	E10	P10	E10	P10	E10	P10	E10
C22	8	6	6	5	5	6	7	7
C23	5	7	3	3	4	4	7	6
C24	6	5	2	4	5	2	8	5
C25	8	6	7	6	5	5	8	7
C26	8	7	6	5	6	5	8	6
C27	6	5	6	6	1	1	5	6
C28	7	6	4	4	4	6	7	5
C29	9	7	8	6	7	5	9	8
C30	4	5	4	5	4	6	8	7
C31	7	6	6	5	7	7	8	6
C32	8	8	7	8	6	6	9	9
C33	8	8	7	7	9	9	10	10
C35	7	4	2	2	3	3	8	7
C36	9	9	5	3	6	5	8	7
C37	8	7	7	6	6	7	10	8
C38	6	6	6	6	5	5	8	8
C39	7	5	8	6	6	6	9	8
C40	7	7	5	5	5	5	6	6
C41	8	7	2	2	7	6	8	8
C42	8	6	3	1	4	4	5	5

ID	View 5a		View 6a		View 7a		View 8a	
	P10	E10	P10	E10	P10	E10	P10	E10
C01	4	3	9	7	9	6	6	5
C02	7	5	2	1	4	4	8	6
C03	9	9	9	9	9	9	9	9
C04	2	3	5	5	8	8	8	8
C05	6	7	8	9	6	7	5	5
C06	7	7	6	7	6	7	6	7
C07	6	6	6	5	6	6	9	8
C08	5	5	7	6	5	6	5	5
C10	6	6	6	6	5	5	7	7
C11	6	7	6	9	5	8	6	9
C12	7	5	7	4	6	5	6	4
C13	7	7	7	7	7	7	4	4
C14	6	7	4	5	5	5	7	10
C15	9	8	6	5	7	6	6	6
C16	4	4	3	3	1	1	1	1
C17	6	6	7	7	5	5	6	6
C18	5	3	5	3	4	3	6	6
C19	7	7	5	5	6	8	7	6
C20	10	10	8	9	7	8	8	8
C21	7	7	5	4	5	5	4	4

ID	View 5a		View 6a		View 7a		View 8a	
	P10	E10	P10	E10	P10	E10	P10	E10
C22	6	6	5	4	5	5	6	5
C23	7	4	4	4	6	4	5	6
C24	6	5	6	5	7	6	5	6
C25	6	6	6	7	7	6	8	6
C26	9	9	7	7	6	5	10	9
C27	3	1	4	3	5	5	4	4
C28	5	3	3	3	4	4	6	7
C29	7	7	8	7	7	6	8	7
C30	6	6	8	7	5	5	4	5
C31	7	6	6	4	6	5	8	8
C32	6	6	7	7	6	6	7	7
C33	8	8	7	7	8	8	9	9
C35	5	3	4	2	6	4	6	4
C36	3	2	5	4	4	3	5	5
C37	6	3	7	6	6	4	4	3
C38	6	6	7	7	6	5	6	6
C39	7	7	6	6	7	7	7	7
C40	8	8	6	6	7	7	7	7
C41	4	2	2	2	3	2	7	6
C42	2	2	5	3	6	4	6	5

ID	View 9a		View 10a		View 11a		View 12a	
	P10	E10	P10	E10	P10	E10	P10	E10
C01	2	1	7	6	3	2	5	6
C02	2	1	6	4	5	5	8	9
C03	9	9	9	9	9	9	9	9
C04	3	3	10	10	7	7	4	4
C05	4	3	7	7	9	9	6	7
C06	3	3	8	8	7	6	5	5
C07	4	4	8	8	7	6	8	9
C08	5	5	5	5	4	6	4	4
C10	3	3	8	7	5	5	4	4
C11	6	7	6	6	5	8	6	8
C12	7	4	9	8	7	5	6	5
C13	8	8	6	6	6	6	5	5
C14	3	3	9	9	3	3	9	9
C15	5	5	9	9	5	5	7	6
C16	1	1	5	5	6	6	4	4
C17	8	8	7	7	7	8	8	8
C18	4	3	8	7	4	3	3	3
C19	4	5	8	7	6	6	6	6
C20	6	7	9	9	7	7	9	8
C21	4	4	4	4	4	4	4	4

ID	View 9a		View 10a		View 11a		View 12a	
	P10	E10	P10	E10	P10	E10	P10	E10
C22	6	4	8	7	4	3	5	3
C23	6	6	8	8	4	5	6	3
C24	3	2	9	6	6	3	4	10
C25	7	6	9	6	7	6	6	7
C26	8	7	8	8	7	7	7	6
C27	1	1	7	6	5	4	3	4
C28	7	5	8	7	7	6	6	8
C29	6	4	8	8	7	6	7	8
C30	3	3	6	6	8	9	6	7
C31	5	5	9	8	8	6	5	4
C32	5	5	8	8	7	7	5	5
C33	7	7	10	10	7	7	10	10
C35	5	3	7	8	6	5	4	5
C36	2	2	7	8	5	5	4	4
C37	4	4	7	6	8	7	6	5
C38	2	1	7	7	2	2	3	3
C39	7	7	9	9	8	8	7	7
C40	6	6	7	7	6	6	5	5
C41	2	2	9	8	6	5	4	5
C42	1	1	8	7	3	3	3	7

ID	View 13a		View 14a		View 15a		View 16a	
	P10	E10	P10	E10	P10	E10	P10	E10
C01	5	5	7	6	6	6	7	6
C02	5	3	8	5	6	4	7	5
C03	9	9	9	9	9	9	9	9
C04	8	8	9	9	10	10	10	10
C05	7	6	7	5	8	9	6	7
C06	6	6	8	8	7	7	9	9
C07	7	5	9	9	8	9	8	7
C08	5	4	6	7	5	5	6	6
C10	4	4	6	6	6	6	6	6
C11	6	8	5	7	5	6	5	7
C12	7	5	9	7	9	8	7	7
C13	5	5	6	6	7	7	8	8
C14	4	4	7	7	3	4	9	9
C15	4	4	6	6	8	8	6	5
C16	2	2	5	5	8	8	5	5
C17	5	6	3	3	8	9	6	5
C18	4	3	6	4	6	5	4	3
C19	5	5	8	8	9	8	7	6
C20	6	7	7	8	7	8	9	8
C21	6	6	4	4	5	4	5	4

ID	View 13a		View 14a		View 15a		View 16a	
	P10	E10	P10	E10	P10	E10	P10	E10
C22	6	3	6	5	6	3	6	4
C23	6	5	7	8	9	7	8	7
C24	5	2	8	7	8	5	8	7
C25	7	6	7	6	9	7	7	7
C26	8	7	9	9	7	7	10	10
C27	3	3	6	6	6	5	4	4
C28	4	5	8	7	7	7	6	6
C29	7	7	8	7	8	7	8	6
C30	7	6	8	8	8	9	8	7
C31	6	5	6	6	5	4	6	4
C32	6	6	7	7	7	7	6	6
C33	8	8	9	9	7	7	9	9
C35	6	3	6	5	6	4	5	3
C36	4	4	6	6	6	6	6	6
C37	7	7	8	7	7	7	8	8
C38	2	2	5	5	2	2	6	6
C39	5	5	5	5	8	8	7	7
C40	5	5	7	7	4	4	6	6
C41	6	5	7	8	4	2	6	5
C42	2	2	1	6	5	6	7	8

Appendix F1:

Reliability Analysis on Rating Scales

Reliability Analysis on the Rating Scale Used in Experiment 1 (Actual View)
Items in Rating Scale: “Pleasantness” and “Excitingness”

View No.	Rating Scale Format (No. of Points)	Internal Consistency	Interrater Reliability ($p < 0.05$)		
		Cronbach’s Alpha (α)	Intraclass Correlation Coefficient (ICC)	95% Confidence Interval	
				Lower Bound	Upper Bound
1	4	0.828	0.833	0.651	0.919
	10	0.654	0.654	0.274	0.834
2	4	0.848	0.840	0.671	0.923
	10	0.933	0.899	0.608	0.962
3	4	0.745	0.745	0.475	0.876
	10	0.858	0.847	0.678	0.927
4	4	0.824	0.711	0.031	0.891
	10	0.774	0.681	0.135	0.866
5	4	0.880	0.879	0.751	0.941
	10	0.944	0.934	0.839	0.970
6	4	0.941	0.939	0.874	0.971
	10	0.968	0.958	0.869	0.983
7	4	0.722	0.672	0.286	0.846
	10	0.941	0.928	0.822	0.968
8	4	0.870	0.855	0.685	0.931
	10	0.867	0.852	0.680	0.930
9	4	0.676	0.648	0.283	0.829
	10	0.939	0.918	0.756	0.966
10	4	0.909	0.878	0.643	0.950
	10	0.951	0.946	0.883	0.975
11	4	0.808	0.805	0.601	0.906
	10	0.915	0.906	0.795	0.956
12	4	0.920	0.901	0.752	0.956
	10	0.932	0.926	0.839	0.965

Reliability Analysis on the Rating Scale Used in Experiment 2 (Image View)
Items in Rating Scale: "Pleasantness" and "Excitingness"

View No.	Rating Scale Format (No. of Points)	Internal Consistency	Interrater Reliability ($p < 0.05$)		
		Cronbach's Alpha (α)	Intraclass Correlation Coefficient (ICC)	95% Confidence Interval	
				Lower Bound	Upper Bound
1	4	0.779	0.783	0.549	0.896
	10	0.796	0.773	0.516	0.892
2	4	0.820	0.820	0.630	0.913
	10	0.843	0.844	0.679	0.925
3	4	0.814	0.797	0.575	0.903
	10	0.890	0.875	0.724	0.942
4	4	0.683	0.571	0.000	0.808
	10	0.819	0.719	0.106	0.891
5	4	0.839	0.765	0.271	0.906
	10	0.927	0.915	0.799	0.961
6	4	0.857	0.801	0.406	0.919
	10	0.665	0.621	0.219	0.817
7	4	0.828	0.747	0.224	0.899
	10	0.894	0.842	0.440	0.939
8	4	0.720	0.716	0.418	0.862
	10	0.826	0.795	0.532	0.906
9	4	0.689	0.658	0.297	0.834
	10	0.852	0.824	0.591	0.920
10	4	0.649	0.577	0.103	0.799
	10	0.931	0.904	0.690	0.962
11	4	0.873	0.846	0.625	0.931
	10	0.918	0.871	0.481	0.953
12	4	0.666	0.585	0.093	0.806
	10	0.944	0.915	0.657	0.969

Appendix G1:

F-Test on the difference between Two Cronbach's Alpha Coefficients

Steps in determining the degrees of freedom, $\vartheta_1$and ϑ_2 for F-Test on the difference between Two Cronbach's Alpha Coefficients

(Feldt & Kim, 2006)

Step 1:

Calculate a, b, c and d where

$a = N_1 - 1$

$b = (N_1 - 1)(k_1 - 1)$

$c = (N_2 - 1)(k_2 - 1)$

$d = N_2 - 1$

N is the sample size; k is the number of items in the scale - for Test 1 and Test 2.

Step 2:

Calculate A and B where

$$A = \frac{d}{d-2} \times \frac{b}{b-2}$$

$$B = \frac{(a+2)(d^2)}{(d-2)(d-4)(a)} \times \frac{(c+2)(b^2)}{(b-2)(b-4)(c)}$$

Step 3:

Calculate the degrees of freedom, $\vartheta_1$and ϑ_2 where

$$\vartheta_2 = \frac{2A}{A-1}$$

$$\vartheta_1 = \frac{2A^2}{2B - AB - A^2}$$

In each of the studies (i.e. Window Views 1 – 12) for both Experiments 1 and 2, we have:

$N_1 = N_2 = 31$

$k_1 = k_2 = 2$

Hence a = 30, b = 30, c = 30, d = 30

A = 1.148, and B = 1.739

Therefore, the degrees of freedom for the F-test,

$\vartheta_2 = 15.514$ → 15

$\vartheta_1 = 16.099$ → 16

(As a conservative measure, the figures were rounded down)

To control the Type I error rate in this multiple testing, Bonferroni correction was applied to the critical level of significance. Since there were 12 cases for either scale format (4-point or 10-point scale), the new critical level of significance (alpha level) after Bonferroni correction was 0.05/12 = 0.0042.

The critical F-value with degrees of freedom 16 and 15 at the corrected level of significance (0.0042):

$\boldsymbol{F_{16,15} = 4.17}$

calculated using "F Critical Value Calculator" online:
https://www.easycalculation.com/statistics/f-critical-value.php

The test statistic, $W = \frac{1-\alpha_2}{1-\alpha_1}$ where α_1 and α_2 are the Cronbach's alpha coefficients of the two studies (4-point vs 10-point scales), and α_1 being the higher value among the two. If W > F, then we can reject the null hypothesis and conclude that there is a significant difference between the two Cronbach alpha coefficients. Otherwise, we cannot reject the null hypothesis.

Test on the difference between Two Cronbach's Alpha Coefficients:

Experiment 1 (actual view)

View	α(4p)	α(10p)	Higher α_1	Lower α_2	Test stat W	F (16,15) p=0.0042	
1	0.828	0.654	0.828	0.654	2.01	4.17	
2	0.848	0.933	0.933	0.848	2.27	4.17	
3	0.745	0.858	0.858	0.745	1.80	4.17	
4	0.824	0.774	0.824	0.774	1.28	4.17	
5	0.880	0.944	0.944	0.880	2.14	4.17	
6	0.941	0.968	0.968	0.941	1.84	4.17	
7	0.722	0.941	0.941	0.722	4.71	4.17	***
8	0.870	0.867	0.870	0.867	1.02	4.17	
9	0.676	0.939	0.939	0.676	5.31	4.17	***
10	0.909	0.951	0.951	0.909	1.86	4.17	
11	0.808	0.915	0.915	0.808	2.26	4.17	
12	0.920	0.932	0.932	0.920	1.18	4.17	

Note:

H_0: α(4p) = α(10p) ; H_1: α(4p) ≠ α(10p)

Test statistic, $W = (1-\alpha_2)/(1-\alpha_1)$

Test results:

*** W > F at the corrected alpha level (0.0042). Therefore, H_0 is rejected.

Test on the difference between Two Cronbach's Alpha Coefficients:

Experiment 2 (image view)

View	α(4p)	α(10p)	Higher α_1	Lower α_2	Test stat W	F (16,15) p=0.0042	
1	0.779	0.796	0.796	0.779	1.08	4.17	
2	0.820	0.843	0.843	0.820	1.15	4.17	
3	0.814	0.890	0.890	0.814	1.69	4.17	
4	0.683	0.819	0.819	0.683	1.75	4.17	
5	0.839	0.927	0.927	0.839	2.21	4.17	
6	0.857	0.665	0.857	0.665	2.34	4.17	
7	0.828	0.894	0.894	0.828	1.62	4.17	
8	0.720	0.826	0.826	0.720	1.61	4.17	
9	0.689	0.852	0.852	0.689	2.10	4.17	
10	0.649	0.931	0.931	0.649	5.09	4.17	***
11	0.873	0.918	0.918	0.873	1.55	4.17	
12	0.666	0.944	0.944	0.666	5.96	4.17	***

Note:

H_0: α(4p) = α(10p) ; H_1: α(4p) ≠ α(10p)

Test statistic, W = $(1-\alpha_2)/(1-\alpha_1)$

Test results:

*** W > F at the corrected alpha level (0.0042). Therefore, H_0 is rejected.

Appendix H1:
Ethics Approval

This project has been ethically approved via the University of Sheffield's Ethics Review Procedure as administered by the Sheffield School of Architecture.

The following documents are appended to this thesis:

1. Letter of ethics approval (dated 26 June 2018)

2. Participant information sheet 1045352 version 1 (Experiment 1)

3. Participant information sheet 1045353 version 1 (Experiments 2 & 3)

4. Participant consent form 1045354 version 1

Downloaded: 03/07/2018
Approved: 26/06/2018

Choong Yew Chang
Registration number: 110280228
School of Architecture
Programme: PhD

Dear Choong Yew

PROJECT TITLE: Methodology for Assessment of Window View Quality
APPLICATION: Reference Number 020098

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 26/06/2018 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 020098 (dated 31/05/2018).
- Participant information sheet 1045353 version 1 (31/05/2018).
- Participant information sheet 1045352 version 1 (31/05/2018).
- Participant consent form 1045354 version 1 (31/05/2018).

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

Information Sheet

You are invited to take part in a research project. Before you decide whether or not to participate, it is important for you to understand why the research is being done and what it will involve. Please take your time to read the following information and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information.

Title of Research Project: Methodology for Assessment of Window View Quality

Name of Researcher: Choong Yew Chang

This project is a PhD research study about ways to investigate the quality of the view from a window. The results of this experiment will help architects to plan windows in future buildings.

The objective of this experiment is to evaluate the views from a series of windows. The evaluations will be recorded using two rating scales measuring the pleasantness and beauty of the view. About 60 participants will be asked to carry out this survey. Each will visit five public buildings in Kuala Lumpur, and in each building they will evaluate the views from two different windows

Q: What are the possible benefits of taking part?

A: Participation in the research is entirely voluntary. If you agree to take part and complete the study we will give you a shopping voucher of value MYR 20.00 as a token of appreciation.

Q: What are the possible disadvantages and risks of taking part?

A: There is no foreseeable discomfort or risk to participants. All experiments above will be conducted indoors. Participation is voluntary: you can withdraw from the study at any time. You do not have to give any reasons for why you no longer want to take part and there will be no adverse consequences if you choose to withdraw.

All the information that we collect about you during the course of the research will be kept strictly confidential and will only be accessible to members of the research team. It will not be able to identify you in any reports or publications. If you agree to us sharing the information you provide with other researchers (e.g. by making it available in a data archive) we can confirm that your personal details will not be included.

The University of Sheffield will act as the Data Controller for this study. This means that the University is responsible for looking after your information and using it properly.

This project has been ethically approved via the University of Sheffield's Ethics Review Procedure, as administered by the Sheffield School of Architecture.

Thank you for taking part in this project!

Project contact details for further information:

Researcher:
Mr Choong Yew Chang   Email: c.y.chang@sheffield.ac.uk   Contact No. :

Supervisor:
Professor Steve Fotios   Email: steve.fotios@sheffield.ac.uk   Contact No. :

The University Of Sheffield.

Information Sheet

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Title of Research Project: Methodology for Assessment of Window View Quality

Name of Researcher: Choong Yew Chang

This project is a PhD research study about ways to investigate the quality of the view from a window. The results of this experiment will help architects to plan windows in future buildings.

The objective of this experiment is to evaluate photographs of the views from a series of windows. In this experiment, the observed windows will be photographs presented on a display screen. The evaluations will be recorded using two rating scales measuring the pleasantness and beauty of the view, and also a paired comparison. About 60 participants will be asked to carry out this survey. The experiment will be conducted in an indoor space.

Q: What are the possible benefits of taking part?

A: Participation in the research is entirely voluntary. If you agree to take part and complete the study we will give you a shopping voucher of value MYR 20.00 as a token of appreciation.

Q: What are the possible disadvantages and risks of taking part?

A: There is no foreseeable discomfort or risk to the participants of this project. All experiments above will be conducted indoors. Since the participation is voluntary, you can withdraw from the study at any time. You do not have to give any reasons for why you no longer want to take part and there will be no adverse consequences if you choose to withdraw.

All the information that we collect about you during the course of the research will be kept strictly confidential and will only be accessible to members of the research team. You will not be able to be identified in any reports or publications unless you have given your explicit consent for this. If you agree to us sharing the information you provide with other researchers (e.g. by making it available in a data archive) then your personal details will not be included unless you explicitly request this.

The University of Sheffield will act as the Data Controller for this study. This means that the University is responsible for looking after your information and using it properly.

This project has been ethically approved via the University of Sheffield's Ethics Review Procedure, as administered by the Sheffield School of Architecture.

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Researcher:
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Supervisor:
Professor Steve Fotios Email: steve.fotios@sheffield.ac.uk Contact No. :

The University Of Sheffield.

Participant Consent Form

Title of Research Project: Methodology for Assessment of Window View Quality

Please tick the appropriate boxes	**Yes**	**No**
Taking Part in the Project		
I have read and understood the project information sheet or the project has been fully explained to me. (If you will answer No to this question please do not proceed with this consent form until you are fully aware of what your participation in the project will mean.)	☐	☐
I have been given the opportunity to ask questions about the project.	☐	☐
I agree to take part in the project. I understand that my participation in the project will include taking part in an experiment on window view assessment (based on actual window or photograph) and completing a questionnaire.	☐	☐
I understand that my taking part is voluntary and that I can withdraw from the study at any time; I do not have to give any reasons for why I no longer want to take part and there will be no adverse consequences if I choose to withdraw.	☐	☐
How my information will be used during and after the project		
I understand my personal details such as name, phone number, address and email address etc. will not be revealed to people outside the project.	☐	☐
I understand and agree that my words may be quoted in publications, reports, web pages, and other research outputs. I understand that I will not be named in these outputs unless I specifically request this.	☐	☐
I understand and agree that other authorised researchers will have access to this data only if they agree to preserve the confidentiality of the information as requested in this form.	☐	☐
I understand and agree that other authorised researchers may use my data in publications, reports, web pages, and other research outputs, only if they agree to preserve the confidentiality of the information as requested in this form.	☐	☐
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 will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research.	☐	☐
So that the information you provide can be used legally by the researchers		
I agree to assign the copyright I hold in any materials generated as part of this project to The University of Sheffield.	☐	☐

Name of participant: Signature Date

Name of Researcher: Choong Yew Chang Signature Date

Project contact details for further information:
Researcher: Choong Yew Chang Email: c.y.chang@sheffield.ac.uk Tel:
Supervisor: Professor Steve Fotios Email: steve.fotios@sheffield.ac.uk Tel: