DEPARTMENT OF LANDSCAPE

Doctoral Thesis

3D Landscape Visualization on Mobile Devices for Participatory Planning and Design:

A Comparison of Off-site versus On-site Engagement

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Abstract

This research combines landscape visualization and public participation, testing the potential of mobile devices displaying a 3D visualization of future design proposals to enhance public participation. On-site and off-site perceptions of users are compared, and the appeal of mobile devices is demonstrated through studies undertaken at the location of the case study area: Edward Street, Sheffield (UK).

Landscape visualizations have long been used as a tool to facilitate public participation in forms of maps, drawing, images or physical models. Participatory planning and design seeks the active involvement of stakeholders and focuses on users' feedback and input, considering their needs, concerns and demands. It helps with harmonizing views and prevents conflict by allowing stakeholders to discuss and negotiate ideas. It also provides an opportunity for marginalized groups to take part in these processes, though it does not always function as planned. Engaging citizens can be a substantial problem, especially when communication between the affected parties is compromised.

Technological improvements in computer and mobile device platforms have opened new doors for landscape visualizations and their use during participatory approaches. Mobile technology has begun to be used for landscape visualizations thanks to its ubiquity, portability and context-awareness. This thesis investigates the use of mobile devices as a participatory design tool and how their on-site and off-site use affects understanding and perception with actual users during the participatory planning and design processes.

Three research questions guide this research. The main aim is using the mobile devices as a design tool and comparing on-site and off-site use of 3D visualizations on mobile devices. So the first research question posed is: does the level of accuracy of 3D visualization on mobile devices affect the understanding of participants? To answer that question, a preparatory study has been conducted on-site with two experiments, using mobile devices to display a walkthrough video of a 3D visualization of Edward Street Park, Sheffield, UK with different levels of accuracy within the context of a VALUE+ Project. Actual users' responses have been examined for understanding and perception and the effects of users' characteristics. The second research question is: can mobile devices as a design tool help in engaging the public to identify problems and bring solutions when used in participatory design process? Participants were asked to make sketches using an iPad as a design tool for solution(s) to the problems they identified. The drawings have been analysed for frequency and variety in order to identify the needs, and the to prepare 3D visualizations with design proposals to test mobile device use on-site and off-site. Visualizations have been used during the process of answering the final and main question: how does the on-site and off-site use of mobile devices affect perception and understanding of participants? To answer the research questions preparatory experiments (only on-site), one-to-one consultation sessions and finally a questionnaire were conducted both on-site and off-site.

The results indicate that perception and understanding are affected by different levels of accuracy on 3D visualizations. Understanding of spatial representation and perception are enhanced by more accurate 3D mobile device visualization, even for people who are not familiar with the site. The results have provided evidence that for on-site users, accurate representation of 3D visualizations is essential, especially for younger generations. It appears that using the mobile devices as a participatory design tool have a high potential to engage people both on-site and off-site, allowing active involvement with a higher level of participation during planning and design processes. Viewing proposed changes on a mobile device on-site and off-site: understanding was not affected, yet there was a significant difference in perception between the two groups. Even though both on-site and off-site use has their own advantages and disadvantages, evidence is provided that ‘on-site’ and ‘off-site’ users perceive the environment more accurately than ‘off-site’ users.

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List of abbreviations and terms

2D: Two Dimensional

3D: Three Dimensional

Abs. err.: Absolute error (How much difference to actual measurement)

Adj. Sig.: Adjusted p-value after Dunn-Bonferroni error correction

AR: Augmented Reality

CAD: Computer Aided Design

CAR: Collaborative Augmented Reality

DB.: The Dunn-Bonferronni test

GIS: Geographic Information System

KW.: The Kruskal-Wallis test

MR: Mixed Reality

PPGIS: Public Participation Geographic Information System

Sig.: p-value to check significance

Simp. err.: Simple error (Actual difference compared to actual measurement)

SPSS: Statistical Package for the Social Sciences

VR: Virtual Reality

CHAPTER 1

1 Introduction

1.1 Introduction

Landscape planning and design processes have an impact on lay people, so local governments in the UK and other countries have increasingly used public participation when planning landscape and architecture projects. Public participation aims to engage actual or potential users of a given project with various visualization tools: maps, images, videos and more recently augmented reality and virtual reality facilities. Even though it is necessary to understand user needs and concerns for a successful design with public participation, it is also essential that stakeholders' aims and perspectives should be taken into consideration. Visualization is used during participation as a tool, its main aim to enhance communication between experts and stakeholders.

Humans have connections with the environment in which they spend time, live, visit or work. Asking and giving opportunities to these people to understand and potentially contribute to the changes planned in their environment gives them the chance to influence the plans in a way which depends on their degree of skill in communication, collaboration, experience of and support for the project in question.

Participatory planning and design aims to enable rather than control: it focuses on the public's needs and demands, and is a form of empowerment. Public participation has progressively become a significant part of democratic governance. It gives more equal shares to stakeholders during the planning process. The main aim of participatory planning and design is communicating in a fair and understandable way, to build a consensus for the implementation of projects collaboratively, on the basis of the knowledge gathered from different parties and different levels of stakeholders.

It has been strongly argued that visualization tools facilitate communication and increase transparency and accountability (Lange and Bishop, 2005; Sheppard and Meitner 2005; Downes and Lange, 2015). It has been argued that visualization has the strength to bring all parties, professionals, experts, politics and the public together during planning and design processes (Schroth, 2010) and has the potential to become a ‘common currency’ in these processes (Appleton, 2004). Visualizations give viewers a chance to display, understand and experience the environment before planned changes occur (Lange and Bishop, 2005), helping to build consensus between stakeholders and encouraging them to take part in the decision-making process.

Visualization helps landscape architects and planners make their designs understandable for the public. Better understanding leads to more meaningful suggestions and contributions for the projects, as well as making participants feel satisfied that they can make a difference. Participation also has benefits for the project areas, as participants would make their needs and preferences clear and the area may be used more efficiently as a result.

Traditional methods for public participation start by sharing information (drawings, visualizations, models) with the public, then seeking their feedback or input regarding the proposals. The key point in the first step of participation is presenting easily understandable information to engage people. Complex information may preclude participation and lead to expert-led planning and design processes. The approach to collecting the suggestions, feedback and input from the public is also important, as it influences who can participate in the process.

Research to date has tended to focus on traditional and digital tools and how they affect the public participation process, but it has been argued that non-technological tools are inadequate for more complex analysis and larger data sets. Enhanced display and visualization can allow people to deduce relationships and lay outs in a more informed way (Cartwright, Miller and Pettit, 2004; Lange and Bishop, 2005; Lovett, 2005; Pettit, Cartwright and Barry, 2006; Pettit, Raymond and Bryan 2011). Digital tools can be utilized to support public engagement interactively (Al-Kodmany, 2001; Pert, Lieske and Hill, 2013; Schroth, 2010). Although traditional tools may create an interactive learning environment that enables participants to talk about the project together and to share their ideas with other stakeholders (Al-Kodmany, 2001), new tools have the potential to raise public awareness and public participation during the decision-making process, if participants find the tools convenient, attractive and easy to use (Schroth, Wissen and Schmid, 2006).

Ideally, computer-based visualization tools should be easily understandable, manageable and should not be complicated or overwhelming to use, in order to enhance public participation. Al-Kodmany suggests that It has been argued that a higher degree of realism should be employed in images in order to help lay people understand them more easily (Al-Kodmany, 2001), and to avoid the potential distraction of computerized inaccuracies (Appleton and Lovett, 2003). As yet little is known about the level of accuracy adequate for the use of on-site visualizations in order to obtain valid and reliable responses from the public.

There have been numerous studies in the investigation of human perceptions and reactions to visualizations, mostly for future project scenarios. Understanding human reactions to future environmental change and its representation is necessary in assessing future scenarios (Lange, Hehl-Lange and Brewer, 2008). According to Bishop (2005), people may be provided with data to support interpretation of illustrations, and then asked to develop their alternative future scenarios individually or with a group by using the relevant software. Different types of software may be employed for specific projects. Although extensive research has been carried out on visualization and participatory planning, further study is required to ensure constant collaboration during the decision-making process, especially regarding the integration of new media (Lange et al., 2008).

Advancement in technology is now offering new opportunities for tools, media and techniques to allow communication during the landscape planning and design processes. These advancements facilitate how experts (including planners, architects, landscape planners) interact with lay people, thanks to these new technologies' being more user-friendly, more ubiquitous and more powerful. Computers provide a unique ability to visualize and process almost all kinds and volumes of data and information, allowing people to take part in the processes to discuss, to communicate, to generate ideas and to make decisions. Rapid developments in mobile technology and the increasing ubiquity of mobile devices, particularly smart phones, has provided new opportunities for users to be engaged whenever and wherever it is convenient for them. It brings about the question of whether this mobile technology can increase participation during participatory planning and design processes. As the technology is timeless (can be used anytime) and placeless (can be used anywhere), it also raises the question of whether the on and off-site use of mobile devices during participation affects understanding and perceptions. As it is suggested that experiencing the actual site has an impact on perception (Rice, 2003) and understanding (Bishop, 2015), it is essential to address the questions of whether their degree of accuracy has any effect on understanding and perception and how use of mobile technology on-site and off-site differs.

The number of people owning a smart phone has increased rapidly in recent years: the UK Office of Communications (OFCOM, 2016) reported that 71% of the UK population owned a smartphone in the first quarter of 2016, and these numbers have been increasing each year. Considering that the majority of the British population owns smart phones, and that they have great potential in displaying landscape visualizations, mobile devices are the focus of this research. The use of mobile devices to display 3D landscape visualization has the potential to increase greatly public participation in consultative planning processes.

Even though it has been suggested that off-site visualizations are required to achieve a certain level of accuracy (Sheppard and Salter, 2004; Lewis, 2012), to the best of our knowledge, there is no in-depth research exploring the impact of degree of accuracy of visualization on 3D mobile devices on-site. As the use of mobile technology in participatory planning and design is relatively new, there is no research comparing ‘on-site’ and ‘off-site’ use of mobile device visualization technology, and how each affects understanding, perception and public participation.

1.2 Scope of the thesis

This thesis examines different levels of accuracy in 3D mobile device visualizations and their effects on understanding. It also explores the differences between on-site and off-site engagement of stakeholders by assessing the effect of relatively new visualization tools, 3D mobile device visualization on participatory planning and design processes in an urban park, Edward Street Park, Sheffield, UK. ZoomNotes and WalkAbout3D applications, which are explained in section 4.1.1.1, are adopted as visualization tools and used both on-site and off-site with the help of a fourth generation iPad as the mobile device. As sketching is heavily used at the early stages of planning while making design decisions, ZoomNotes, a note taking application, is adopted to engage the public to contribute to preparation for further design modifications and generating ideas according to the needs and concerns of them. WalkAbout3D, an interactive mobile application, is adopted to display the future proposals prepared according to participants' needs that they commented on and identified during consultations while sketching. On-site and off-site participation are compared regarding their effect on experience, understanding and perception in an urban development project, and whether they enhance public engagement by testing residents as well as experience and acceptance within the study area.

VALUE+ was a project funded by the European Union aiming to increase public participation in the selected six real-world sites throughout North West Europe. Edward Street Park was one of the sites selected to increase public participation by using a novel visualization technique. Before the research itself began, it plan was to have three phases, a completed model experiment, a charrette and a future scenario experiment. The aim was to have three studies for three research questions. However, there were issues regarding participatory planning and design processes, about the data received from Sheffield City Council, and its quality, and about the process which had been followed. The first study in this research showed a model of the current condition of the space on 28th September, 2013. The reason for this was Sheffield City Council's rapid action in planning and designing the area with very little public input. The city council was already planning to redesign the park before they applied for VALUE+ Project, and Edward Street Park project was first identified in St Vincent's Action plan in 2004, then mentioned in City Centre Master Plan in 2008 and City Centre Breathing Spaces Strategy in 2011. As explained in section 4.1.1.2, draft ideas for the park were completed in 2009 and a consultation meeting was held in February 2010. The public input came from the consultation meeting and draft ideas were modified. All the preparation for the implementation of the park was completed in June 2010 before the application for VALUE+ Project was completed in July 2010. The site was closed for construction in March 2011. Even though the project provided adequate time for collaboration until July 2015, the city council did not make further changes, and completed the project in 2013. Fortunately, there was extra funding available to make around 30 per cent changes within the site. It was an opportunity to use 3D visualizations before planning or implementing the changes. It was used as an opportunity to engage people as they were able to experience the site, whereas for a normal project it would have been an area where public is not allowed to enter therefore not able to experience.

One of the main aims of this research is to find out how the use of mobile devices on-site and off-site affects the understanding, perception and public participation. VALUE+ project started in the same year as the research in 2012 and the researcher and supervisor were associated with the project. As the project aimed at using interactive and innovative visualization tools for inclusive design approaches, the site was imposed for this research.

1.3 Definition of Terms

It is necessary to define the fundamental terms used throughout the thesis.

Visualization is the generation of images representing abstract or concrete ideas with the help of graphical aids (Blaser, Sester and Egenhofer, 2000). These graphical aids can be traditional sketching methods as well as computer-generated visual imagery. In this thesis visualization refers to the images and 3D models created by Trimble SketchUp software and displayed through an interactive mobile application called WalkAbout3D (which is explained in section 4.1.1.1).

Landscape visualization is the representation of visual landscape with the help of 3D imagery and modeling with different level of realism, interactivity and immersion. The visualization of landscape can be represented as static or dynamic, and as animation or simulations (Lange and Bishop, 2005; Sheppard and Salter, 2004).

Mobile devices are portable computing devices that facilitate communication and computational services such as smartphone and tablet computers. In this research a fourth generation iPad is used as a mobile device.

Public participation is ‘the involvement of stakeholders in administrative functions and decision making, which is achieved through the availability of participation modes, participation in functions, and participation in the decision-making process. Participation modes are organizational establishments that enable or facilitate participation.’ (Wang and Wan Wart, 2007, p. 271).

Accuracy refers to ‘replicating the physical and visual qualities, (Sheppard, 1982, p.14-15) and in this thesis it is specifically used for scale, texture and structures.

Virtual environment is a ‘landscape that simulates the real physical space at a certain place while displaying elements that do not exist in the real space’ (Liestøl, 2011).

In this research, familiarity is used as having knowledge of the site by recognizing the place either with its name, location, 3D model and having an interaction with the park (Gale, Golledge, Halperin, & Couclelis, 1990).

In visualization context, scenario refers to ‘a description of the current situation, of a possible or desirable future state as well as of the series of events that could lead from the current state of affairs to this future state.’ (Van Berg and Veeneklaas, 2012, p. 11). In this research scenario referred to a future design proposal for a specific part of the park.

1.4 Research questions, aims and objectives

The aim of the research is to examine a new form of participation during planning and design processes at a local level, and to reveal the potential impacts of the level of accuracy on understanding and perception especially when on-site, as it is already known that off-site visualization requires a certain level of accuracy. Finally, the research compares the use of on-site and off-site mobile device visualization during public participation, how they affect understanding, perception and experience of participants and how they differ from each other.

The research aimed to answer following questions:

- Does the degree of accuracy of 3D visualization on mobile devices affect the understanding and perception of participants?
- Can mobile devices as a design tool help engaging the public to identify problems and bring solutions when used in a participatory design process?
- How does on-site and off-site use of mobile devices affect perception and understanding of participants?

1.5 Contribution to knowledge

This thesis contributes to the body of knowledge by exploring the potential of utilizing 3D visualizations on mobile devices during participatory design and planning processes both on-site and off site. In order to accomplish that, this research:

- Establishes an argument for the contribution of the use of mobile devices in terms of experience, understanding and perceptions.
- Adopts a new participatory approach towards presenting and experiencing space in future design proposals. It lets real stakeholders make sketches on a mobile device (ZoomNotes mobile application) and experience the virtual environment created considering their needs through 3D mobile technology off-site and on-site.
- Evaluates the user experience of suggested interventions in a 3D virtual environment with the help of a mobile device.
- Compares off-site and on-site participation with 3D landscape visualization on mobile devices in terms of understanding and perception.

1.6 Thesis outline

The thesis is presented in seven chapters. The first chapter gives an overview of the research, research questions, aims and objectives, scope of the research and its contribution to knowledge.

Chapter 2 gives background information and address the gaps in literature regarding landscape visualization and public participation.

Chapter 3 presents VALUE+ project and the study site with the details of selection criteria and design of the park.

Chapter 4 details the general methodology used in the thesis by explaining the links between three studies conducted for this research. It also gives information about the study site, Edward Street Park, its characteristics, the process for selection and the design.

Chapter 5 presents the first study, which is a preliminary study for the following main studies: 'Effects of the level of accuracy of 3D visualization on mobile devices on understanding and perception'. This chapter elaborates the processes of two different experiments conducted with different levels of accuracy in methods, followed by results of the study and discussion of its results.

Chapter 6 describes the process of study 2: 'Gathering design ideas through a mobile device' under methods. It also presents the results and discussion of the study.

Chapter 7 presents study 3: 'Comparison of On-site and Off-site use of mobile devices with future scenarios' with methods used, the results of the experiment conducted and discussion of the results.

Chapter 8 concludes the thesis and provides recommendations for future research.

Chapter 2

2 Literature Review

In recent years, public participation has been considered a fundamental part of the planning process; as technology and social interaction change, public participation should adapt and evolve too. This research focuses on the usefulness of the concept of 3D landscape visualization and its application through mobile devices for participatory planning and design processes. This chapter describes the literature related to two main issues: public participation and the use of landscape visualization in public participation, highlighting key issues of this research.

2.1 Public participation

Public participation is one of the most important parts of the planning process because it allows policymakers, public officials and decision makers to receive feedback from the population and identify possible alternatives to solve a problem. Public participation literature focuses can be organised as belonging to three different groups: public participation seen as political engagement in democratic life (Ebbesson, 2008; Nisbet, 2011); public participation as part of strategic planning aiming at the future (Plein, Green and Williams, 1998; Brown and Weber, 2011); and public participation in design and spatial planning (Hazer Sancar, 1993; Prilenska and Liias, 2015). In this research I will focus on the third.

Beckley, Parkins and Sheppard (2006) define the public participation process as a series of actions that can include meetings with the public for information sessions, workshops, charrette and final information events, or a combination of different participation instruments and tools. Various tools can be adopted during the participation process, which may require gathering the public 'direct contact' participation (charrette, focus groups and workshops) or 'indirect contact' participation, gathering information remotely through websites, online surveys and phone surveys. The aim of these tools is to facilitate participatory planning and stakeholder integration. The choice of participation tools will vary in terms such as the degree of participation and interactivity desired as well as costs and limitations (Beckley et al., 2006).

2.1.1 Participatory planning and stakeholder integration

Public participation offers an opportunity for effective communication between stakeholders and decision makers. It also can provide an 'early warning system for public concerns to distribute accurate and timely information' (Wouters et al., 2011) that supports better decision-making. Meaningful contributions lead to effective participation and eventually more legitimate decisions and improved results, by reducing conflict and overcoming the barriers regarding future implementations (Jami and Walsh, 2014).

Public participation also aims to protect, conserve and wisely manage resources in environmental planning by collecting ideas, thoughts and perspectives at an early stage of the process from all affected parties, local people, stakeholders and, developers. One of the major questions that public participation aims to answer is 'who are citizens?' and its logical follow up: 'how do they participate?' (Hansen and Mäenpää, 2008).

Once the stakeholders have been identified, it is important to communicate with them thoroughly, to identify any divergence in interests and to engage with all the stakeholder groups (Cooper, Bryer and Meek, 2006). Depending on the project, the level of willingness of the decision-makers, such as the city council, to let the public influence the project should be ascertained. From the level of flexibility in decision-making allowed in the project, is derived the level of participation sought from the public. The aims for public participation become clearer once the researcher, or the project's team, has determined where and how the public is expected to participate, and how their input is expected to influence the decisions the aims for public participation become clearer. At this stage, the proper participation tools should be selected according to the level of the participation desired from the public (Quick et al., 2013).

To be able to obtain a meaningful participation from a project's stakeholders including the general public, the project must be first and foremost communicated efficiently. The Environmental Protection Agency (EPA, 2016) has suggested that a successful planning process should include involving the public, at least partially, into decision-making. Ideally it should be ensured that public input is sought rather than just informing them about the predetermined proposals or outcomes of a given project. In order to obtain meaningful public input, it is first important to identify all the stakeholders of a given project (Enserink and Monnikhof, 2003; Bryson, 2004). AL-Kodmany (2000) adds that if a proposal is not understood by participants, their participation would not be meaningful.

The people recruited to a participation exercise are usually the most likely users of the site being modified or created during the project. These members of the public have hands-on knowledge about the area and can also inform the researcher about what they consider their most important needs and concerns (Al-Kodmany, 2000). Some of the most convenient and reasonable solutions for problems that planning and design proposals are trying to solve might come from the public.

Participants are sometimes the only ones that can inform the researcher about the specificities of the site's users, especially when it comes to the community or local levels: cultural and traditional values notably can be otherwise difficult to collect or anticipate (Warren-Kretzschmar, 2011). Since these participants represent the users experiencing the area, their attitude to the project can influence whether the planning or design proposal will be successful (Luz, 2000). In theory it is most efficient to check the users' satisfaction with a design ahead of completion, but this is not always possible in practice.

2.1.1.1 Degrees of participation

There are many factors that affect the participation of the public. The attitude of the public during the planning and design process is one of the important factors in terms of a given landscape or urban planning proposal's success or failure (Luz, 2000). The attitude of the public is best discussed according to different 'degrees' of participation, since factors such as the significance of the issue being solved, laws and regulations relevant to the project, as well as the project scale or complexity can have a significant influence on the extent of each participants' input (Warren-Kretzschmar, 2011).

The aim of most public participation processes is either to change the opinions of the public about a given planning proposal, to fulfil a legal requirement, as well as to increase transparency, or to identify the needs of the public (Parker, 2002; Petts and Leach, 2000). While in some complex and large scale projects, public participation is only used as a way to inform the public (Perkins and Barnart, 2005), in less complex and smaller-scale projects, it can also refer to various attempts of making decisions together with the public (co-decision). As a result, the public may prove to be opposed to complex and large-scale project proposals, as they may feel that they were not consulted and did not have any chance to give personal input (Lindenau and Bohler-Baedeker, 2014). Often large-scale and complex projects also have the added issue of not leaving room for flexibility that prevents any meaningful input from public participation.

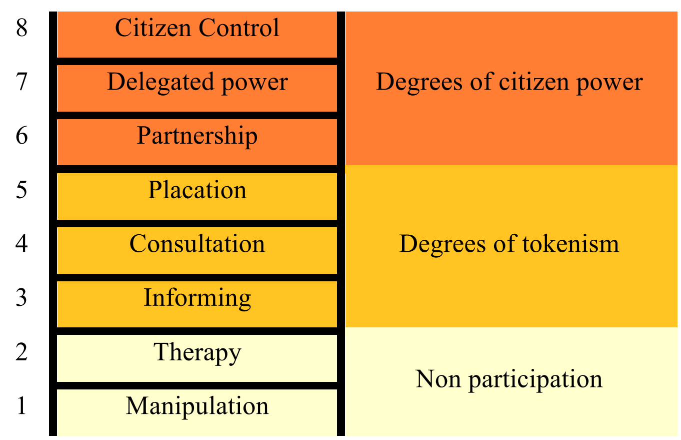


Figure 2.1 A ladder of citizen participation (Arnstein, 1969)

Arnstein's ladder (1969) presents accurately the degrees of public participation and their relative effectiveness: it has been in use for years in the fields of planning, education, and so on. Figure 2.1 shows Arnstein's ladder of participation consist of a range between the two extremes: a complete lack of participation, and a partnership in decision-making between the public and the responsible authority. The International Association for Public Participation (IAP2) also created a widely used simplified version of their spectrum of public participation levels: it does not include Arnstein's first two levels but is otherwise similar in most respects (IAP2, 2014).

There are a variety of tools used in public participation depending on the level of participation aimed for in a project (Creighton, 2005). On the extreme side of Arnstein's ladder, 'non-participation', the public does not have the opportunity to participate, so it cannot suggest any changes or affect any of the decisions made in the project proposals. In this case, only the final decisions taken by the relevant authority would be shared, through newsletters, advertisements, websites and exhibitions and so on. (Schroth, 2010).

In the middle of Arnstein's ladder, three rungs, 'informing', 'consultation' and 'placation', describe the efforts deployed by professionals to educate and inform the public. This level includes citizens who put an effort into participation exercises by attending meetings, answering questionnaires or listening to the planning decisions and making their voice heard during the events planned by professionals. So it refers to public participation that has little effect on the ideas or proposals of the relevant authority. This means that the public gets plenty of information and is consulted, but that ultimately their suggestions will not be implemented. One of the weaknesses of tokenism is that it can be used to pretend to listen to the needs of the public and gain their acceptance for a project, while actually following what is most convenient budget-wise or for other reasons.

At the other extreme of the ladder, maximum power is given to the citizen in a deep exchange of ideas, intense discussions and negotiations among the public, participants and decision-makers. Arnstein (1969) calls this 'empowered participation'. Depending on whether the aim is to inform or empower the public, elicit feedback, generate alternative options or select pre-prepared options (Petts and Leach, 2000), a number of tools are available as will be discussed later in this chapter.

2.1.2 Methods and tools for public participation

Depending on the level of participation required by the project, the tools and methods employed should vary accordingly. To address each degree of participation with the most efficient method is how the theory is put into practice. To achieve the lowest level in participation, 'information exchange', the method employed should be indirect communication. By contrast, direct communication is necessary at the highest level of participation, 'co-decision' (Figure 2.2). The figure showing the continuum of public participation represents the changes from indirect to direct communication by a progressive darkening of colour as participation deepens.

Figure 2.2 Continuum of public participation (Beckley et al., 2006)

The most traditional method of encouraging public participation is that of public information meetings and design meetings. Unlike public information meetings, design meetings are usually held with people who have been selected: they were either nominated as delegates, or volunteered to be part of the design workshop or charrette process. In addition to meetings, surveys, games, walk-throughs on the site or in simulations have also been used to encourage participation (Sanoff, 2000).

There are different public participation techniques or tools used to involve the public in the planning and design processes (Quick et al., 2013). In general, visualization tools are categorized into two groups. Abelson et al. (2010) cites as many as 17 tools for public participation, among which the most commons are public hearings, surveys, community meeting, workshops and focus groups. These tools are usually labelled as traditional or innovative as follows:

- Traditional tools include: leaflets, newsletters, exhibitions, advertisement, newspapers (local or national), site visits, phone lines, surveys, public meetings, and so on.

- innovative tools include: consensus conference, visioning, visualization, citizen jury, planning for real, internet, teleconferencing, and so on.

Digital and traditional each have their advantages and disadvantages (Al-Kodmany, 2001). Digital tools such as digitized maps, virtual reality and GIS (Geographic Information System) are important components in participatory planning and design, while traditional tools play a key role in expressing people's feelings and helping them to understand in an interactive way by utilizing drawing tools such as pen, paper, maps and models (Al-Kodmany, 2001; van Lammeren, Houtkamp and Colijn, 2010).

Each tool has strengths and weaknesses in the way it helps achieving the different degrees of public participation. According to Petts and Leach (2000) traditional methods are usually used for the lower level of participation such as educating participants, informing them or seeking feedback, while innovative consultative methods are for involvement and consultation and innovative deliberative methods are for extended and empowered participation. Petts and Leach (2000) and Abelson et al. (2010) described all the methods and their uses, and explained the aims, strengths and weaknesses of each.

Baker, Coaffee and Sherriff (2007) suggest that traditional methods are usually considered out-of-date, but are still used as an important part of current policy developments. They are still heavily used in participatory approaches (Sykes, 2003). Public hearings, public comments, open houses and other traditional public participation methods have not reached the level of success desired in terms of public involvement in the planning process (Warren-Kretzschmar, 2011). It has been shown that the public is unlikely to feel motivated to participate by providing opportunities alone (Buchecker et al., 2003).

For efficient public participation it is also important to provide the public with information that is interesting and easy to understand for lay people. In order to reach a maximum number of participants, it is important to set the public participation process up with an easy access and an understandable information as to the mode of participation (Kunze et al., 2002). Typically public hearings and similar tools require of the participant to be available at a certain time, and to come at a certain place; it is unlikely to fit the schedule and transportation means of a majority of the relevant public. Even though Sykes (2003) and Kitchen and Whitney (2004) stated that exhibitions and public meetings are dominating other consultation techniques, Petts and Leach (2000) specifically pointed out that public meetings are not an effective means of participation. In the case of controversial or complex topics, an individual or several may dominate the rest of the group, or the consultation meeting may end up as information provision.

Jami and Walsch (2016) used the traditional methods like public meetings and interviews for a renewable energy investment project in Ontario, Canada to overcome the barrier of public being opposed to it. The aim was to inform the public and receive feedback. After holding a number of public meetings, they arranged a teleconference to share the visualization and allowed public to ask questions and share their concerns. Even though the developers believed that the communication and consultation processes went smoothly, after the interview results it turned out that the public believed that open houses would have been more appropriate method for participation rather than public meetings. Even though the meetings reached a large number of public, the interview results showed that participants were not happy with the level of participation they were offered and felt powerless to act on their concerns and questions during the process.

The so-called innovative deliberative techniques allow for both participation and deliberation: examples of such tools are consensus conference, citizen’s juries and community advisory committees (Petts and Leach, 2000). Innovative consultative techniques are mostly efficient for consensus building during the planning or design process. Examples include workshops, focus groups, interactive visualizations, the use of videos or internet. Consensus does not refer to public’s full agreement: it refers to allowing discussions and negotiations with a bottom-up approach. Ideally this approach allows participants to either come up with the initial proposals, or review and consider the prepared proposals. Perkins and Barnhart (2005) suggest that visualizations facilitate participation by allowing citizens to share opinions, concepts and ideas as well as to discuss them, make decisions and negotiate, but visualization alone cannot empower public participation to its highest level.

The use of computer-based visualization is increasing in planning process (Walz, Gloor, Bebi and Fisch, 2008); and new visualization tools, techniques and media enhance the interaction between the public, professionals and experts (Al-Kodmany, 2001). Raymond et al. (2016) adopted PPGIS (Public Participation Geographic Information System), to examine various components of environmental justice in an urban area Helsinki, Finland. They aimed at examining various activities undertaken related to water, users with different income levels and age and finally the issues that are considered problematic and unpleasant in the area. They used an online PPGIS tool, Maptionnaire, by sending only one email to Finnish residents. There was no face-to-face meeting or interaction. Participants were only able to drop digital points on the map and answer the close-ended questions. At the end of the study, researchers were able to reach large number of participants (2,151 survey responses), but the degree of education was too high to be representative. The study contributed to knowledge on environmental justice and it multiple dimensions regarding relationships between ideal activities to be undertaken in the park and size or type of the park. Their research showed how mobile devices are being used in conjunction with a form of visualization although large-scale. However, as a limitation they noticed that the results they had only reflected current needs as they only focused on activities undertaken rather than activities preferred. As they did not talk to people, they acknowledged that qualitative research would have helped to improve the results and understand generalizations made in the research.

2.1.2.1 Engaging and informing the public

Visualization techniques have long been used in order to enhance public participation in the process of decision-making for city planning or landscape projects. At first reliance was placed on traditional techniques such as graph illustrations, brochures and posters, which were used to disseminate information and encourage dialogue. The information was shared through public meetings, presentations or information sheets were sent to citizens (Hislop and Twery, 2001). Visualizing data is an effective way to help the public or lay people understand proposals faster than they would be able to do through written or spoken explanations: so 2D maps, plans, sections, vignettes, physical models, perspective drawings and photographs have been widely used.

Engagement of the public concerned with a given project must not only be achieved, but must also take place efficiently. In order to increase interactivity and the quality and efficiency of participation, the use of interactive physical models allowing users to move pieces have recently become more frequent in architecture studies. Using physical models encourages individuals, adults and children alike to take an active part in the decision-making process and to share their ideas in a straightforward way (Boyd and Chan, 2002; Spohn, 2007).

Changes in the understanding of public participation were brought about in the 1990s by improvements in the technological and environmental fields (Hansen, Mäenpää, 2008). These improvements took the form of a raised awareness about environmental issues and sustainable planning as well as the arrival of advanced technology, especially with the beginning of the internet era and its worldwide ubiquity. It is now possible to engage the public through other tools like computerized animations of 3D sequences, which are easily transported to the project site.

2.1.2.2 Public Participation in the UK

Public participation has been a matter of interest internationally in the recent decades, as many governments have adopted participation as part of their policy (Lange and Hehl-Lange, 2011; Rowe and Frewer, 2005). The United Kingdom is a country which employs participation in many fields of governmental projects, including planning and the environment. With the increased importance of participation at both national and local level, there has been an increased need for a diversity of mechanisms and methods to encourage participation. As mentioned before, participation has different levels and situations with various participants and needs (Rowe and Frewer, 2005). In order to have an effective and successful public participation, public understanding should be facilitated and enhanced (Kaplan and Kaplan, 2009). The UK government's Localism Act has applied to decision-making processes since 2011.

Localism act

Participatory planning became a significant part of planning procedure in the UK with the Localism Act of November 2011. Clark (2010) acknowledges that localism does not give full authority to local governments, but focuses attention on the local level and empowers the local community. Local people are given a voice to contribute to the decision-making process, an opportunity to state their needs; then the government tries to meet these needs. Localism is defined as 'a radical devolution of power to local level' by the government (Communities and Local Government Committee, 2011) with the prioritization of local decision making.

> Key elements of the Localism Act include new community rights to bid for land and buildings, new neighbourhood planning rights, the transfer of public functions to local authorities in order to improve local accountability or promote economic growth, and the creation of a general power of competence for local authorities to develop innovative approaches to service delivery and governance (Lawton and Macaulay, 2014).

Encourage feelings of ownership over planning and landscape projects

The Localism Act encourages participation in particular ways as it supports the feeling of ownership of local citizens. The Act is related to all decisions concerning the public for the benefit of communities, ranging from street lighting to social care. The main aim is to let the representatives of the lowest practical level, those who are affected the most by the decisions made, have the freedom to share what they want and do not want, instead of being told what they are going to have in the future by the government.

Although the Localism Act brings reform to the planning process, the government specifically mentions that complete assurance as to the timing being respected cannot be given. This leads to some projects being decided before public consultation being achieved: there is a discrepancy between the planning and consultation despite temporarily increasing the impression of ownership in local communities, can become a waste of resources or create a loss of trust between project and community stakeholders.

Merritt and Stubbs (2012) criticise the Localism Act by saying that developers might take unfair advantage of the fact that the process is becoming more time-consuming and less cost effective. Also, communities without resources and ability to build capacity are at risk in terms of climate change and environmental impacts as they are responsible to make the decision for the neighbourhood. Local governments would be in need of resources to be able to implement the act. It is unreasonable to expect capacity would come from communities. With the Localism Act, the planning process requires changes in the authorities that hold the power, the organisations that guide decision-making and people who are the major role in the localism for decision-making.

The Department for Communities and Local Government*, Decentralisation and the Localism Bill: an essential guide* (2010) 1 presents it as 'a power shift away from central government to the people, families and communities of Britain' but Bevan (2014, p.981-2) underlines that 'a tension exists as to precisely for whom localism is in fact operating (…), reforms to housing can be interpreted as operating in favour of local authorities and to the detriment of local people', and says that 'the new Act has missed an opportunity to truly empower local communities and local people. Far too great an emphasis was placed on reducing the burden and duties owed by local authorities and far too little on protecting the needy.'

2.1.3 Location of participation: off-site, on-site and combined

Environmental perception researchers have studied the comparability of on-site and off-site surveys (Daniel and Boster 1976; Kellomaki and Savolianen 1984; Shuttleworth 1980). An emphasis was put on the comparison of the effects of the survey location, on and off site (Brunson and Shelby 1992; Cole and Stewart 2002; Shelby and Harris 1985). These studies usually combined two different on-site methods to collect the data in a certain recreational area (Kim and Shelby, 2006). The first method allows researchers to collect the data on the exact location, while the second uses a location where researchers can reach more people, most commonly the exit points of a public space (Kim and Shelby, 2006). The first method might be considered as more valid than the second, as the participants are given a chance to view the actual site without 'recall bias' (Kim and Shelby, 2006), though they warn that being on the actual site might affect the perception data due to the visitors' experience (Taylor, Czarnowski, Sexton and Flick, 1995; Dorwart, Moore and Leung, 2007).

Setting the experiment on-site might influence the participation either in a positive or negative way. Participants might be reluctant to participate, particularly in recreational areas that are used to rest and engage in entertaining activities. Users unwilling to participate lead to less information gathered, as participants would tend to spend less time on questions. Surveying users at the exiting points of the site also heighten the risks 'recall bias': it potentially means gathering less accurate data about the particular points within the area, especially when the participants do not have sufficient experience on the points in question (Kim, Lee and Shelby, 2003). Insufficient experience might cause participants to answer with an overall impression rather than being specific about the point or the experience (Kim and Shelby, 2006).

Conversely, off-site survey data can be collected from the potential users. It can be advantageous, as it does not interrupt participants' experience, so it might easily generate more data in a controlled environment. Off-site surveys are considered less realistic, less expensive and more convenient (Dorwart et al., 2007). Data collected could be less accurate as the participants are expected to response the questions depending on what they remember. It has the same disadvantage as surveying users at the exit points because participants are again expected to rely on their memory while they are responding the questions.

It has also been shown that physical interaction with an actual site influences how people feel subjectively when they are on-site (Hull, 1990). Deinet and Krisch (2006) developed the methodology of 'walk through', in which the researcher takes the participants for a walk around the site and elicits information regarding their feelings and opinions on specific objects. Deinet and Krisch showed that people feel differently when on-site or off-site, and when seeing the environment by using a third party device. Hull and Steward (1992) made a comparison of preferences between on-site experience of individuals and photography based off-site interviews. They pointed out that seeing the photographs off-site would give less accurate information about the environment compared to on-site experiences. Hull (1990) added that having an interaction with the actual site would give more noticeable results than viewing photographs without experiencing the environment. This supports the idea that interaction level and method influences the experience in a way that affects the perceived environment and evaluations of the participants (Gilligan and Bower, 1985; Kim and Shelby, 2006). So for this research, two different approaches using the 3D mobile devices to participate are adopted to engage public and to test the effects of location on understanding and perception.

While deciding on an experiment, the researcher has to keep in mind that humans perceive and assess their surrounding environment differently from each other (Wergles and Muhar, 2009). The same person can have their perception affected by time and the information available, as well as how the latter is presented (Bell 2001). Familiarity also makes a difference to perception as it affects people's understanding of a project and proposals. These factors should be considered while testing the differences on understanding, usefulness and perception of realism.

While the most studies mainly used static imagery to assess public perception, Bishop and Rohrmann (2003) compared perceptions towards a real landscape in an urban park and animated walk-through of computer generated model, during both daytime and night-time. Bishop and Rohrmann (2003) have found that computer generated visualizations do not provide exactly the same (equivalent) responses as real landscapes. Even though it is difficult for visualizations to have the richness and intricacy of real environments and impossible to have the same responses, the observations found that differences in user's responses between daytime and night-time were similar whether the experiment used computer generated or real landscapes. The responses to computer generated visualizations were usually valid and reliable for urban park settings (Bishop and Rohrmann, 2003). These studies have illustrated that visualization with high level of realism can serve as valid surrogates for real environments.

Experience, understanding and perception of participants

In recent years, there has been growing interest in landscape visualization use during participatory planning and design (Cartwright et al., 2004; Lange and Bishop, 2005; Lovett, 2005; Pettit et al., 2006). Previous research suggests that experience (Pettit et al., 2011), understanding (Sheppard, 2005; Kaplan and Kaplan, 2009) perception (Pettit et al., 2005) and preferences (Tveit, 2009) are affected by visualizations according to what is shown and hidden on them.

Visualizations are used during the public participation process to allow lay people to understand the proposals comprehensively. The effectiveness of participatory design could be measured with the understanding of the design projects for the citizens and quality of feedback that they gave (Kaplan and Kaplan, 2009; Pettit et al., 2011). To enhance the effectiveness of the participation understanding of the users could be supported with 3D visualizations.

Participants might not have any experience in design or they might only have limited knowledge and experience regarding the planning and design processes. For this reason, visualization should be simple enough to attract peoples' attention and not to preclude participation because of its complexity. The mechanism adopted to gather information from the public affects the turnout and who is going to participate.

There is evidence that landscape visualizations have the potential to engage people during planning and design (Orland et al., 2001; Pettit et al., 2011) and to help improve the quality of decision-making (Orland et al., 2001). Pettit et al. (2011) assess a set of visualizations prepared to communicate projections of future landscapes with current users (environmental planners and managers) and future users (students of environmental management and spatial information science). According to Pettit et al. (2011), current users tend to focus on nature, the public and visualization, whereas future users care more about the visual clarity and definition.

2.2 Landscape visualization in public participation

According to Blaser et al. (2000, p. 60): 'Visualization is the action of forming a mental image or becoming aware of something through graphical aids'. Vizualisation is, according to another definition, the materialisation of abstract ideas into simulations and models, with the aim of ‘seeing the unseen’ (McCormick, Defanti and Brown, 1987). Bruce, Green, and Georgeson, (1996) claim that approximately eighty per cent of what we learn is acquired through visual perception. Reljic, Sawada, Poitevin and Sunders (2005) state that compared to audio and textual information, visual information is perceived in a more effective way by the human brain. Batty, Steadman and Xie (2006) argue that various tools are being adopted and constantly improved as technology advances.

Lange (2001) suggested that the English landscape architect Humphry Repton (1803, cited in Lange, 2001) might be considered as the pioneer in landscape visualization. By presenting ‘before and after’ paintings for a design proposal, he developed a novel technique for landscape representation (Figure 2.3). The concept was subsequently adopted in planning and design related professions. In architecture and landscape architecture especially, this concept is used to present design and planning proposals. Perspective presentations (Sheppard and Salter, 2004) are an improvement on previous traditional methods such as drawings, sketches, physical models and colour renderings. Perspective presentations use convenient and accessible photographs and photo-simulations (Lange, 1990) to allow comparisons between the previous and later conditions of a proposal.

Figure 2.3 Before and after sketches in ‘Red Book’ by Repton (Languille. 2012)

Landscape visualization aims to represent the real world through 3D simulations: it is used to reproduce the experience of a person standing at predetermined viewpoints, through the display of fixed scenes (Lewis and Sheppard, 2006). One key aspect of landscape visualization is that it allows for the result to be presented with different levels of realism and simplification (Schroth, 2010) for different time frames: it is possible, for example, to compare past and present conditions and future scenarios (Lewis, Sheppard and Sutherland, 2005). Scenes which do not exist in reality (for example alterations of land use, possible or proposed future scenarios, retrospective scenarios) can be presented in static or dynamic visual representations, depending on the aim of the visualization. These can include animated and interactive features (Sheppard and Salter, 2004) in an immersive or non-immersive environment (Danahy, 2001; Lange, 2001).

Ever since the Renaissance, landscape illustration, planning and design have been extensively analysed, practiced and developed. There have been few studies that have focused on understanding people's perception of landscapes and illustrations. It was only in the 1980s that this area became a topic of research (Taylor, Zube and Sell, 1987). Visualization has long been used to determine people's preferences and reactions to environmental changes, as well as to provide an opportunity for the public to explore different current and future scenarios as shown in Figure 2.4 (Kwartler, 2005).

Figure 2.4 Visualization of future (left), visualization of status quo (middle), real site (right)

Technology did not notably affect landscape visualization techniques until the arrival of computer graphics (Danahy, 2001): landscape architects typically made use of technologies designed and developed for various other fields (Steinitz, 1992). Visualizations were first used during the 1970s for planning and design purposes, and have become an increasingly popular technique over time. The quality of the visualizations has become more realistic and efficient. Lange and Bishop, (2005) provided a thorough history of 3D digital visualization: at first conception, all visualizations were constructed manually, until the advent of Geographic Information System (GIS) in the 1980s, which allowed for automated construction (Pettit et al., 2006). The 1990s brought photorealistic visualizations and GIS data. Innovation in 3D landscape visualization has occurred with the emergence of image-processing and geometric modelling (Paar, 2006).

Formerly, traditional visualization techniques involved maps, but it has been shown that most lay people struggle to read and understand them. Lewis and Sheppard (2006) conducted a study to improve forest management consultation and found that maps tend to cause confusion and errors in orientation and understanding of options.

Visualization is employed to help determine people's preferences, their reactions to environmental changes and to provide an opportunity for the public to explore different current and future scenarios (Kwartler, 2005). Landscape illustration, planning and design have been extensively analysed, practiced and developed (Danahy, 2001).

2.2.1 Introduction to visualization as a tool in landscape research

Different forms of visualizations have been used in the fields of landscape planning, design and environment, in order to enhance understanding of the project and facilitate decision-making in the context of public participation (Zube, Simcox and Law, 1987). Visualization has been used as a communication tool for decades, in the form of landscape and architecture plans, physical models, sketches and paintings. Starting from 1960s with technological advancement, photos and photomontages have been added to the list (e.g. Lange, 1990; Al-Kodmany, 1999). Finally, in the last three decades, there have been further improvements with the advent of digital technology, bringing enhancement in both the way visualizations can be interacted with, and the level of realism in which a landscape can be represented.

2.2.1.1 Advantages of landscape visualization

Landscape visualizations present demonstrated advantages for communication and collaboration during the planning and design processes, thanks to their efficiency and flexibility (Lewis, 2012). Computer generated landscape visualizations are one step ahead compared to traditional ones, because of the ever-greater developments in software and technologies to present the environments accurately and realistically with the support of spatial data.

Visualizations have been utilized for numerous projects associated with the participatory planning approach (Al-Kodmany, 2001; Hayek, 2011; Lange and Hehl-Lange, 2005; Tyrväinen et al., 2006) including use of rural landscapes (Lange and Hehl-Lange, 2005), improvement of forest management consultation (Lewis and Sheppard, 2006), conservation and assessment of green space quality (Lange et al., 2008), and the siting of wind turbines (Lange and Hehl-Lange, 2005). There is reliable evidence to suggest that visualizations can enhance public participation by allowing 'lay' people to interact with experts and professionals for proposed projects (Wissen Hayek, 2011; Kwartler, 2005; Schroth, 2010).

Research on visualization evaluation has focused on tools and their usability: for example effectiveness to enhance communication (Al-kodmany, 2000; Appleton and Lovett, 2003; Sheppard, 2005; Sheppard and Meitner, 2005) and the ability to self-report and engage lay-people (Lewis and Sheppard, 2006). It is claimed that the more complex interactive 3D visualizations are, the more stimulating learning is for users in terms of environmental issues and changes (Winn, 1997).

Landscape visualizations are used during the planning and design processes to provide a common language to connect all parties involved (Kwartler, 2005). They are useful to facilitate the sharing of information between different groups regardless of their individual background and level of skill in landscape design (Lovett et al., 2015). Visualizations provide a common base among stakeholders for understanding, and then deliberating, the alternatives to the status quo offered in a given project site: in other words, it allows the presentation of the project site's issues in a condensed and easily understood manner (Sheppard, 2006). Visualizing landscape designs and planning proposals allows the viewer to consider and question different perspectives and proposals in new ways: visualization allow them to see what is as yet 'unseen', for example the future appearance of a site if proposals were carried out (Meitner et al., 2005).

In the context of public participation, Lovett et al. (2015) add that visualizations can also be helpful in several ways. In terms of to informing the users of a site about a specific project, visual tools can help raise interest in a specific issue, more straightforwardly than written or spoken words. When a potential participant's interest has been raised, visualization then also offers a versatile support for collaboration in order to reach an agreement on a project. Alternatively if there is a conflict among involved parties, it is useful to have a visual to discuss the specific issues where people disagree.

There are different ways to use the visualization for decision-making. The traditional method is to prepare visualizations and disseminate them during public meetings, exhibitions or on leaflets sent to the public (Gill and Lange, 2015). The improvement in technology now allows the planning proposals to be disseminated online. Mobile devices have come to the forefront of public participation tools, as they can be used to convey research data to the public, with applications being developed specifically for this purpose. Research in the use of mobile devices in the context of education has shown that they are attractive as teaching tools, as they allow for a varied approach to learning. In the Rossing experiment, students from Indiana and Purdue Universities agreed that using an iPad helped them to 'participate in the course activity in ways that enhanced' (Rossing et al 2012, p.16). Public participation relies on attracting enough participants: although there are not been enough studies yet to demonstrate the appeal of mobile devices in the context of public participation, it is probable that it would be similar to the appeal of mobile devices in the context of education.

Gill and Lange (2015) categorized the visualization tools employed during the design and planning processes as 'Virtual Reality (VR) lab, Personal Computer (PC) mobile, Internet PC, Augmented Reality (AR) mobile, pre-prepared mobile and on-demand mobile' by using several criteria as shown in Table 2.1. These criteria included: the tools' flexibility to be used on-site, size of the user groups who would be interested in using, illustration elaborateness of the model to what extent it displays the details, level of the interactivity during the use and finally, connectivity of the tool during use considering if it is possible to display the visualization whenever and wherever thank to Internet connectivity (Gill and Lange, 2015).

Of these tools, ‘PC mobile, AR mobile, pre-prepared mobile and on-demand mobile’ provide 3D mobile visualization presentations (Gill and Lange, 2015). They describe these tools as follows: ‘VR lab’ utilizes an immersive and non-portable setting in the lab environment for interactive 3D landscape visualizations. ‘PC mobile’ gives the opportunity to take 3D models out to a different site with a laptop or transferring it to a desktop computer. ‘Internet PC’ refers to the dissemination of 3D models through the Internet to PCs to allow users to render and view the models on location. It can be a complicated process for lay people as these visualizations may require specific software to display the models.

Table 2.1: Landscape models and presentation methods and their capabilities (Gill and Lange, 2015)

Visualization Technology	On-site	Potential Audience	Model complexity	Interactivity	Data connectivity
VR Lab	No	Small	High	High	No
PC mobile	Yes	Small	High	High	No
Internet PC	No	Large	Low to High	Low to High	Yes
AR mobile	Yes	Large	Low	High	Yes
Pre-prepared mobile	Yes	Large	High	Low	Yes
On-demand mobile	Yes	Large	High	Low to High	Yes

The software may also require particular hardware to be able view the 3D models interactively on users’ PCs. ‘AR mobile’ superimposes 3D virtual model layers over reality and represents it at a higher level of realism. ‘Pre-prepared mobile’ displays the visualizations, which are rendered on the users’ display in real time; they are usually only available on certain, pre-determined areas of a model. Finally, ‘on demand mobile’ represents a procedure that allows the remote display of user specific images or panoramas of the 3D visualization through a mobile device (Gill and Lange, 2015)

Dynamic media have increasingly become the focus of interest in recent years and mobile devices are repeatedly used for planning and design processes in urban settings, mostly tested with students. Even though there are a variety of choices for visualizing the landscape, the technical and practical parts of landscape visualization use still require more research (Lange, 2011; Orland et al., 2001; Pettit et al., 2011).

The very mobility of mobile devices is their most important strength: if the targeted public does not have access to the internet, these mobile devices can be brought on-site by the project team, and be used immediately to help any passer-by to understand the proposals. Wherever used, mobile devices allow for the displaying of different types of landscape visualization, and help participants understand a project site and its related issues at the time, as well as the project proposal to remedy the issues or to suggest changes to the site's landscape design. There is no obligation to rely on inviting participants to come to a specific site for a specific time, as the mobile device can be deployed whenever convenient for both the project team and the targeted public.

2.2.1.2 Limitations of landscape visualization

Even though there have been various improvements in the field of landscape visualizations, there are still weaknesses to be taken into consideration before using them in public participation.

The reliability and validity of visualizations has been studied in recent decades to establish eventual disadvantages (Lange and Bishop, 2005; Lange, 2001; Sheppard and Cizek, 2009). It has been found that even though the visualizations use high quality images, at times they may still be unreliable, inaccurate and invalid (Daniel, 1992; Perkins, 1991). There is a possibility of creating misleading representations because of the exclusion of some important environmental factors in the visualizations: for example litter, noise or smell.

During the preparation phase of the visualizations, inadvertent interpretations related to the style or interests of the preparer may cause misinterpretations by viewers in terms of planning projects' stages or objectives (Luymes, 2001; Seward-Barry, 1997; Sheppard, 2001). Even though technology is constantly improving and visualization tools and dissemination media are becoming more ubiquitous and accessible by the day, recognised visualization preparation and presentations standards are still lacking (Sheppard, 2001).

Assessments of environmental visualizations and perceptual research with new media are relatively rare.

To assess whether computer based landscape visualization is a better surrogate than photography, a number of studies compared the two media by using static computer visualizations and photographs of sites (Bishop and Leahy, 1989; Daniel and Meitner, 1997; Oh, 1994; Bergen et al., 1995). Lange (2001) presented visualizations with different levels of realism and details by asking local and non-local public and experts. A further experiment compared differences in perception between slides and 360° panoramas (Meitner, 2004). It has been found that the more realistic the visualization, the more effective, valid and reliable it proves in terms of users' perception and their responses towards landscapes (Zube, Simcox and Law, 1987).

Although 3D landscape visualization compares favourably to other media in terms of users' perception (Furness et al., 1998; Danahy, 2001), it has limitations. The versatility that makes a visualization tool attractive may also become a limitation if other functions of the tool distract the user from the task at hand (MacEachren, 2001). Even though virtual environments help learning, it is important to differentiate learning correctly and learning quickly (Winn, 1997; Lewis, 2000; Salter 2005), as in reality learning quickly might not be as complete as it appears (MacEachren, 1994).

Studies have demonstrated that when using visualizations, perceptual research mostly focus on landscape quality assessments rather than evaluating the psychological reasons behind the preferences and perceptions of users towards visualizations (Wergles and Muhar, 2009). In other words, research to date commonly explores how people see the imagery in comparison to the real landscape yet neglects the perceptual aspects of people's responses.

In order to evaluate how people see the imagery, preferences are assessed with ratings which are directly pertinent to real life landscape experience and exposure to landscapes' surrogates (Daniel and Meitner, 2001). Photographs were previously the most common surrogates (Bergen et al., 1995). Research in the area mostly focuses on surrogates and which particular ways they have to look to create a similar or same responses rather than how to decide an appropriate surrogate.

Visualizations should ideally convey trustworthy data, and users should be able to understand the proposal's alternatives with transparency in order to maintain the trust between users and the producers (Lovett et al., 2015). Steinitz (2012) noted that visualizing a site, including the problems and/or possible solutions, does not automatically mean that it would help the understanding of the viewers. Static photos can easily be misinterpreted or misunderstood, unless there are staff committed to spend time to help the participants understand by answering questions or providing context. The visualizations are only helpful if prepared by considering the stage of the planning and design processes, the context and the various types of users in order to find common ground in terms of understanding (Wissen Hayek, 2011).

When using traditional visualization methods, the targeted public is usually expected to go to a specific location to attend public meetings or exhibitions. Travelling to a specific place can be time consuming for participants, especially if the location is far from the project site in question. The time they would be spending on travelling can also put people off participating. Nowadays the choice of mobile device visualization can be made in order to allow the site's users to participate whenever it was most convenient for them, and the closest possible to the project's site, but despite their convenience, mobile device visualizations have their own set of disadvantages that need to be taken into account.

Compared to computer systems, mobile devices still have weaknesses as their capabilities are limited. Mobile devices do not provide much advantage in terms of speed, graphics and batteries (Mosmondor et al., 2006, Noguera and Torres, 2012). The small screen size of mobile devices can be considered as a weakness: although it does not prevent user's understanding, a small screen can only display a small part of panoramic images which are essential for landscape visualization. The battery of a mobile device can run low very fast, making it an inconvenient tool when used outdoors far from any electricity source. Additionally, mobile devices typically cannot be used efficiently as a group: only one active person at a time would use the mobile device during an experiment. Since mobile devices are inconvenient to reach a large group of people (Lovett et al., 2015) the researcher might have to combine the use of mobile device with traditional forms of public participation, such as printed questionnaires, in order to process a larger number of participants in a shorter time.

Although mobile devices are highly ubiquitous nowadays, in most projects there will be part of the user population whom do not have access to the internet or mobile technology, whether because of a low income, a lack of interest or lack of education in how to use such technology and so on. (Saltes, 2016). Not including those groups would result in an unbalance in the responses gathered during public participation, and potentially result in further isolation of less privileged populations from being informed and giving feedback on a project (Mossberger, Tolbert and Gilbert, 2006).

To avoid such an outcome, instead of asking participants to download an application and input their answers individually on their own mobile devices, the project team can bring mobile devices to the site in order for participants to use them regardless of owning such technology themselves. Despite such a solution being available, some of the targeted public is bound to feel uncomfortable with unknown technology. There is also a risk of the mobile device becoming the target of thievery if it is seen as a precious commodity, or the researcher not being capable to use, or not being able to access such technology (Slotterback, 2011). These two issues should be taken into account when planning public participation experiments with mobile devices.

2.2.2 Potential of 3D landscape visualization as a tool for public participation

Various visualization tools have been used during participatory landscape planning and design processes to ensure effective communication between stakeholders (Gill, Lange, Morgan and Romano, 2013; Lange and Hehl-Lange, 2005). Traditional visualization methods include models, paintings, sketches and photographs (Sheppard, 1989; Al-Kodmany, 1999). Photographs are one of the oldest valid surrogates, particularly for on-site landscape experiences (Al-Kodmany, 1999; Kroh and Gimblett, 1992; Rabinowitz and

Coughlin, 1971; Sheppard, 1989; Shuttleworth, 1980; Stamps, 1990). Sheppard (1982) classifies the validity of photographs used according to their accuracy and their level of realism. To be considered valid, these particular, specialised kind of photographs are expected to physically and visually replicate essential features of the environment, in a both accurate and realistic way. Essential features are colour, texture, shapes and forms, proportion, scale and position: these can individually or collectively serve as criteria during evaluation (Palmer and Hoffman, 2001).

The use of mobile devices to display visualization as a tool for public participation in planning and design processes is slowly starting to attract academic attention. The opening of this very specific field depends on timeline of the development of the relevant technology, which is then tested in diverse areas including public participation.

2.2.3 Overview of the technology available

The latest developments in mobile devices technology have provided more tools for public participation. Seeger (2008) claimed that having easier access to the Internet either through wi-fi or built-in internet options on mobile devices would open the field for the public to make contributions and participate during landscape planning and design.

Bishop (2015) believes that informing the public about the pros and cons of a project has a positive effect on citizens' willingness to accept potential changes to the landscape. Various visualization techniques have been used in order to inform the public and enhance communication between planners and users. In recent years, the web (Bishop, 2012; Marcy, Brooks and Draganov et al., 2011), games (Bishop, 2011; Pak and Brieva, 2010) and smartphones (Lange, 2011; Chen and Bishop, 2013; Westhead, Smith and Shelley et al., 2012) have increasingly become significant tools to reach the public thanks to their being easily accessible. These tools present the advantage of effortlessly attracting people's interests (Bishop, 2015) in today's digital world.

The latest development is that computers are no longer the only tool providing easy access to the web and gaming. The appearance of smartphones gave access to more people:

smartphone owners constitute a significant percentage of the population (OFCOM, 2016). The general public has become progressively more familiar with visual communication: so in the context of landscape planning, communication between the stakeholders has been enhanced, particularly in the generation of images from the public (Bishop, 2015).

Augmented Reality is another 'communication enhancement' tool commonly used during the collaborative planning process. The AR (Augmented Reality) used during collaborative actions is known as 'Collaborative Augmented Reality (CAR)' (Billinghurts and Kato, 2002). The use of CAR during collaborative planning and design processes gives an opportunity to participants to view 3D models simultaneously and interactively, and it leads to discussions and negotiations in the community. The increasing use of AR applications as an intermediary between users and planners during the planning process brings challenges as well as advantages, including offering new potential for human interactions (Wang, 2009). There have been studies employing a mixed reality environment and collaborative planning, utilizing either the web or one-to-one interaction to enhance the spatial perception and understanding of the public (Wang, Shin and Dunston, 2003).

Despite the use of various formats to convey planning and design proposals and to ask for feedback from the public, there is still little knowledge about the effectiveness of the methods used from the users' perspective. So far there has been little discussion regarding the role of augmented reality on mobile devices and its use during the collaborative participation process.

One of most promising technology advancements has been the use of Augmented Reality (AR): 'It allows [us] to overlay virtual models in perspective view over existing landscapes using a mobile device and to experience the landscape directly whilst on site' (Gill et al. 2013, p. 255). So recent research has focused on investigating various ways of displaying virtual environments on site (Gill and Lange, 2015) to be able to combine a 3D virtual environment and the real world (Haynes and Lange, 2016). Ideally such a solution would allow the public to perceive multi-sensory environments (Lindquist, 2016). When Howard and Gaborit (2007) compared virtual environment and traditional consultation for public participation in a 3D generated non-existent city, that is, a virtual city not based on a real-world example, and their conclusion was that virtual reality technology enhanced public participation. The ideal public participation tool would ‘generate an interactive virtual environment that allows respondents to modify the modelled scenarios and different elements, in addition to allowing them to freely navigate inside the modelling space.’ (Velarde et al., 2017).

Figure 2.5: AR use on design projects (Ziius, 2016)

There have been some technology hurdles to break through in order to truly make 3D visualization usable on mobile devices for the purpose of public participation. Perhaps the most challenging was to deal with the limits of mobile devices owned by the targeted public, as opposed to that of specialist equipment. Among the solutions found was to use a ‘Cloud’ based rendering of a video then sent to the public: this is more realistic than to expect the public to own a device able to render appropriately geometric data (Lamberti and Sanna, 2007). Another way is to use a number of the project’s mobile devices and bring them to the site as participation tools instead of expecting the public to download an application or video. At the moment a number of software are available to researchers in order to create a 3D model and then display it in different ways on mobile devices. The different merits of these software will be discussed in the methodology chapter.

Mobile devices

Mobile devices have become an inseparable part of daily life with the benefits they provide, not only in communication, but also in numerous other areas. As tools for landscape visualization, mobile devices present both advantages and inconveniences. Mobile devices allow users to access information rapidly with less effort (Chi, Kang and Wang, 2013). The current advantages of mobile devices include being ubiquitous, portable and context aware compared to their predecessors (Mosmondor, Komericki and Pandzic, 2006; Lebusa, Thinyane and Sieborger 2015). They are notably paired successfully with GIS to help foster public participation (Brovelli, Minghini, and Zamboni, 2016). As they do not require extra time or effort to display the visualizations in comparison to other techniques, they may be considered as a departure point for future developments in the landscape visualization field, which may accept them as a conventional facility in the future.

With the development of technology, mobile device use for visualizations has increased, considering their applicability and usability (Chi et al., 2013). Mobile devices could become a standard approach in landscape planning and design, as they allow the display of visualizations out of lab and on-site (Lange, 2011; Gill and Lange, 2015). They display the visualizations without requiring any specific time or location by constantly being available. Mobile devices also offer interactivity, which is one of the substantial aspects of 3D visualizations (Lovett et al., 2015, Lange and Bishop 2005), not with physical buttons but with new methods being examined recently (Harrison et al., 2013).

Figure 2.6: Mobile device landscape visualization on a smartphone and on an iPad.

Immersion offered by these ‘movable windows’ (Lovett et al., 2015) can be interpreted differently according to location. Immersion has been enhanced with the gyroscope mounted in the device, which helps users locate and orient themselves while navigating the area (Figure 2.4). Use of these portable tools on site offers a high level of immersion while their use off-site lacks immersion to a large extent. Even though real-time display of the environment on-mobile devices gives opportunities to users, there are still some aspects which require development (Harrison et al., 2013; Mekni and Lemieux, 2014; Lovett et al., 2015).

Even though mobile devices are promising as landscape visualization tools, there are still some barriers for them to overcome. Realism is one of the elements these tools need to make improvements in: virtual environments are always smaller than reality, in this case even smaller on mobile device screens. Previously, graphic cards and their inefficiency on mobile devices were a concern, but they have gradually improved in the last decade (Mekni and Lemieux, 2014). There is still room for improvements in display, details and realism on mobile devices (Harrison et al., 2013; Lovett et al., 2015). It is said that large panoramic displays enhance the participatory planning and design processes by triggering discussion and negotiation (Salter et al., 2009). Mobile devices allow only one user to display the visualization at a time and the devices cannot provide full immersion.

The use of these devices can also be disadvantageous because surrounding the user’s real environment, alongside other applications, may easily distract users, and turn them into hazards for other people. As mobile devices are not primarily designed for displaying visualization in an interactive, detailed and realistic way, small screen sizes and smaller storage spaces can cause disruption as well as ending up with drained powered batteries owing to use of visualization applications (Mosmondor et al., 2006, Noguera and Torres, 2013).

The focus in this research specifically is on ‘on-demand mobile’ and ‘pre-prepared mobile’ visualizations, and on comparison of the use of both on-site and off-site strategies during the decision-making, planning and design process. To the best of our knowledge, there has not been any research conducted on the comparison of on-site and off-site use of 3D landscape visualization mobile devices during these processes.

2.3 Summary

Although a variety of tools are available, there are still a number of gaps in the current research about how those visualization tools should be used in public participation. Among those issues exploring the impact of the level of accuracy of a 3D model on participants' perception when using mobile devices on-site; whether mobile devices can be used as a participatory design tool to engage public, the comparative usefulness of mobile devices whether used when on site or off site are the ones this research will address.

The impact of the level of accuracy of a 3D model on participants' perception

The strength of a 3D visualization is best represented in terms of showing the unseen: in other words, as a tool, 3D visualizations are more powerful than photographs when it comes to showing what a given proposal might look like 'in the future'. Howard and Gaborit (2007) used 3D visualization as an alternative to traditional consultation methods to help participants visualize future scenarios for an urban planning project. Representing what 'used to be', but is 'not there' anymore has also been successfully attempted by visualizing a historical archaeological site (Liestøl, 2009). In the case of a 3D visualization, this means that the researcher determines if the higher level of accuracy and details are on-site mobile device visualization are needed for the targeted public understands the scenario best. In the words of a landscape designer, 'building an engaging and realistic prototype of an interactive virtual environment' (Schroth et al., 2014, p.418).

So it is a matter of accuracy in the relationship between the 3D model and reality, and a decision about how much of a compromise between abstraction and realism should be aimed for. It is important to test to which extent rendering the environment realistically would create a sense of spatial and emotional immersion for the participants. Even though it is known that visualization should have certain level of accuracy for better understanding (Sheppard and Salter, 2004), Watzek and Ellseworth (1994, p.31) states 'certain visual simulations do not require complete accuracy and that there is a range of scale variation'.

Testing the impact of a 3D model's accuracy on the use on mobile devices on-site is crucial. Going forward, researchers will need to know if the participants are able to understand the project just as well from their home visiting the site while using an application on mobile device; or if being on site while seeing the visualization does improve significantly their understanding of a project. There has so far not been enough research on the impact of accuracy on the understanding and spatial immersion of 3D visualization when displayed on mobile devices.

Number of people reached with a limited time, budget and staff

One of the constant challenges of public participation is to increase the quantity of participants without losing in quality of the participation input. The quantity of participants informs the reliability of the findings, whereas the quality of the input gives more value to the finding's content.

Conventionally in public participation, one of the easiest ways to increase the number of participants is offering convenience by not forcing face-to-face contact, which is time consuming and requires trained staff to implement. For example, (Raymond et al., 2016) the team could gather more than 2,000 participants by recruiting by mail to participate online. The participants used an online PPGIS system to pinpoint their activities on a map, and the researcher's findings were numerous enough to gain credibility. Yet removing the interaction between the participants and the project's team brings a series of issues such as: misunderstandings of what is expected of the participant, or the participant's negative perception of the process such as thinking the research is only meant to appease their fears but will not actually bring concrete changes (Diduck and Sinclair, 2002). Research needs to come to terms with the fact that face-to-face contact has been used as the most successful communication technique to facilitate consensus and resolve conflicts in the context of community problems compared to computer based communication (Roberts, 2015; Watson, 1988).

As Schroth (2010) suggests, online visualization tools are important and their importance will increase with time, however for planning with public participation face-to-face interaction will still be the needed. Sectors such as retail or direct selling have experimented similar struggles: ‘The traditional notion of direct selling is of an industry that is face-to-face and people oriented, with a focus on building strong personal relationships with consumers’ (Ferrell, 2010, p.157) so using new technology challenges the traditional aspect of face-to-face contact between the two parties (Ferrell, Gonzalez-Padron and Ferrell, 2010; Hoyle, Hitchmough and Jorgensen, 2017).

It is increasingly evident that mobile devices combined with 3D visualization software have the potential to erase the difficulty of increasing quantity while keeping the quality of public participation, notably by allowing the combination of face-to-face contact with high numbers of participants.

Another way to improve the quality of public participation is to improve the level of participation achieved, from the lowest level of informing to a considerably higher level of allowing decision-making. Such a level of public participation typically has less chances to recruit large numbers of participants, because of factors such as: the time-consuming aspect of the task, the necessity to be available at a certain time and come to a certain place, the difficulty in making the targeted public interested in giving their opinion. Previous research examining the use of landscape visualizations in the context of public participation, and including face-to-face meetings, have recruited on average 10-25 participants (for example Warren-Kretzschmar and Tiedtke, 2005; Pettit et al., 2011).

Petts and Leach (2000) gave examples of innovative methods used in projects before 2000: all of the studies cited only recruited around 10-16 participants to build consensus at that time. For example, the citizens’ jury held by Lancashire waste disposal authority only recruited 16 representative people. The community groups held by Hampshire waste services only recruited 10 people, and deemed this to be sufficient to claim that they had had direct public input into the planning process. Depending on the way the participants were recruited, such a small number of participants underlie a higher risk that the results would be biased towards a certain type of population's demographics. The only exception to these small numbers in Petts and Leach (2000) was the case of the UK CEED (UK Centre for Economic and Environmental Development, May 1999) where a consensus conference with 200 delegates was organised: this is the order of numbers that the current study is aiming to replicate and surpass.

It is very likely that using mobile devices can increase the efficiency of public participation in terms of increasing the number of participants interested in given a higher level of participation. Mobile devices tend to be attractive to audiences otherwise less likely to participate such as young age groups and 'millennials', which are also traditionally the age groups less likely to vote (Clark et al., 2013; Harris, 2009). The fact that iPads and other tablets are attractive and flexible in use has perhaps been best put to use in commercial sectors. In the retail and services sectors, mobile devices are used to obtain quick feedbacks from customers, whether by applications or by staff carrying tablets and conducting surveys with customers on the ground. They have been in use since the 2010s in different companies to facilitate communication between employees or training. For example, Meister, Kaganer and Von Feldt reported in 2011 that 'Hilton is distributing 1,000 iPads to senior executives, who use the media tablet as a business and learning tool when sharing information and best practices.' (Meister, Kaganer, and Von Feldt, 2011, p. 29)

The issue of gathering a significant number of participants is sometimes linked with the location where the study takes place. Allen, Regenbrecht and Abbott (2011) used mobile devices with augmented reality features in order to enhance the public participation during planning. They aimed at examining whether having access to augmented reality on mobile device would affect the willingness of the participants and recruited 18 people on-site: their method was to display an overlaid view of visualizations on a calibrated mobile device for a specific building in Dunedin, NZ, and then asked participants to complete a survey. It is difficult to accept the study's conclusion that 18 participants are sufficient to give credibility to their results. The amounts of participants should ideally be increased in order to improve the reliability of research in the field, and using mobile devices on-site for public participation is certainly one of the alleys to explore.

Giving the targeted population some flexibility about the timing and location of participation has the potential to increase the number of participants: for example letting residents of an area participate on the spot as they are passing-by can be deemed more convenient and likely to succeed than inviting them to a traditional type of public participation methods such as a charrette. The more participants can be reached, the more representative of the participant's opinion should the research's results be, notably when it comes to decision-making. There have so far not been many studies comparing results between using mobile devices on site or off site in the context of landscape visualization for public participation.

Chapter 3

3 Study site: Edward Street Park, Sheffield, UK

3.1 VALUE+ project and Edward Street Park

3.1.1 Project-led selection of the site

In social sciences, when using a case study approach, the choice of the research site is usually linked with the project's aims and objectives. Thus the site selection is either research-led – the site is chosen according to the research questions – or project-led – the site is already selected and researcher is working on improving the site. Perecman and Curran (2006) listed a number of appropriate conditions for a case study to be conducted that can be used as guidelines when choosing a research site. Among those, the most relevant for our research are the following:

- 'When it promises to yield fundamental insight into a rare but important process or event that offers no obvious point of comparison'
- 'When no adequate body of theory exists, and the relevant hypothesis or control group is therefore unclear' (Perecman and Curran, 2006; p. 173).

In the context of this thesis, the site was not chosen but imposed by the fact that the researcher and their supervisors were associated with the VALUE+ project involving Edward Street Park. Although this site was imposed by the project, Edward Street Park is a valid site for research on the use of mobile device 3D visualization for public participation in landscape design.

First of all, Edward Street Park promises to yield important insight in a relatively rare process: the Value+ project was partly completed for the researcher to obtain all the data necessary to pursue such research. It would have been challenging to test a novel approach to participatory design process on a site on which construction had not started, or was at its initial stage, because, when a park is under construction, users are not allowed to go in and experience the site, so participants would have had to exert their sole imagination in order to find things to suggest, instead of experiencing the site and coming up with suggestions according to their needs and concerns. However, a partly finished site is accessible for lay people and all users as, ‘knowing the weaknesses and opportunities of the present situation derived from daily experience makes it easier for lay people to envision change’ (Morello and Piga, 2013). So, in this case it was an advantage that the park was open to the public and not completely finished. There could also have been unexpected delays in construction that would have been in conflict with the thesis timing. Although a longer-frame research could have looked at the site before, during and after the construction, the timing of the present research was optimal because the users of a site are more likely to have fresh ideas during the period immediately after the completion of a new space.

Being associated with the VALUE+ project allowed the researcher to have access information regarding the site including design proposals, photos of the process of implementation. Sheffield City Council shared all the documents used during the design and planning processes including planting and detail drawings. Being loosely attached to the project Value+ also gave the researcher credibility when talking with the park users, so that they would see the researcher as someone both with insider's knowledge and enough neutrality to accept criticism.

As for Perecman and Curran’ second point, it has been seen in the literature review that there have been few comprehensive studies of the use of mobile device 3D visualization for participatory design process in landscape studies. Since there is no adequate body of theory to refer to, the case study can be located on any convenient site, so long as it allows for collecting relevant data. The project is as close as possible to a typical example of urban development project. The team behind the Value+ project evaluated the site of Edward Street Park, and their criteria will be explained below.

3.1.2 EU-INTERREG VALUE+ Project

Unless otherwise cited, all the information in this section is derived from INTERREG North West Europe Application Form (INTERREG IVB, 2010).

VALUE+ was a European Union project, a collaborative INTERREG IVB project, to increase and enhance local public participation with a bottom-up strategy in cities throughout North West Europe (NWE) started in June, 2012. VALUE+ adopted six real-world project sites in North West Europe including Bruges and Liege in Belgium, Stuttgart in Germany, Amersfoort in the Netherlands and Manchester and Sheffield in the UK. This project aimed at creating a welcoming site to bring the diverse residents together and make them all feel involved in the community, to feel ownership of the area and to reduce intrusive and aggressive behaviour. It also aimed to improve brownfield sites that are neglected, vacant and under-utilized in NWE (INTERREG IVB, 2010). The sites were chosen because they made their residents feel ostracized and alienated, or under-represented during decision-making processes (INTERREG IVB, 2010).

The EU developed policies requiring public participation with more local inclusion, enhanced territorial cohesion and growth to meet communities' needs. The starting point of VALUE+ was to combine former industrial areas' development and inclusive green growth by utilizing novel tools and strategies. The project aimed to develop the selected areas by means of innovative design and the use of visualization tools to increase public participation by engaging local communities. Strategies were developed to establish equality in society, which has become less equal in recent years due to economic development and environmental quality as well as other factors, by involving excluded groups with a trans-national approach in deprived areas. These deprived areas, where building cohesion is challenging, where investors are least willing to consider investing, resulting in market failure and areas gradually becoming less attractive, would be a turning point from which to strengthen social cohesion to broaden inclusion, encourage regeneration and to promote sustainable development.

For the Sheffield site, The VALUE+ project aimed at empowering communities and 'the creation of a multi-functional inner city breathing-space in central Sheffield' (Figure 3.1) (INTERREG IVB, 2010). The aim was to meet the needs of local population in order to increase public participation on a local level for sustainable planning, while adopting inclusive design tools and techniques including visualization tools. Technological innovations were to be employed to engage all citizens directly in the process. All the stakeholders' views were to be taken after which various problems were to be addressed. These included lack of communication between residents, disruptive behaviour, noise pollution, traffic and heat impacts. As a result, expressed preferences were to be established and implemented for design investments while participatory planning activities were to be performed and tested. VALUE+ also aimed at developing the quality of the urban area and open space by creating a social environment for people to gather, socialize and relax (INTERREG IVB, 2010).

3.1.2.1 Value+ criteria for the site selection of Edward Street Park, Sheffield, UK

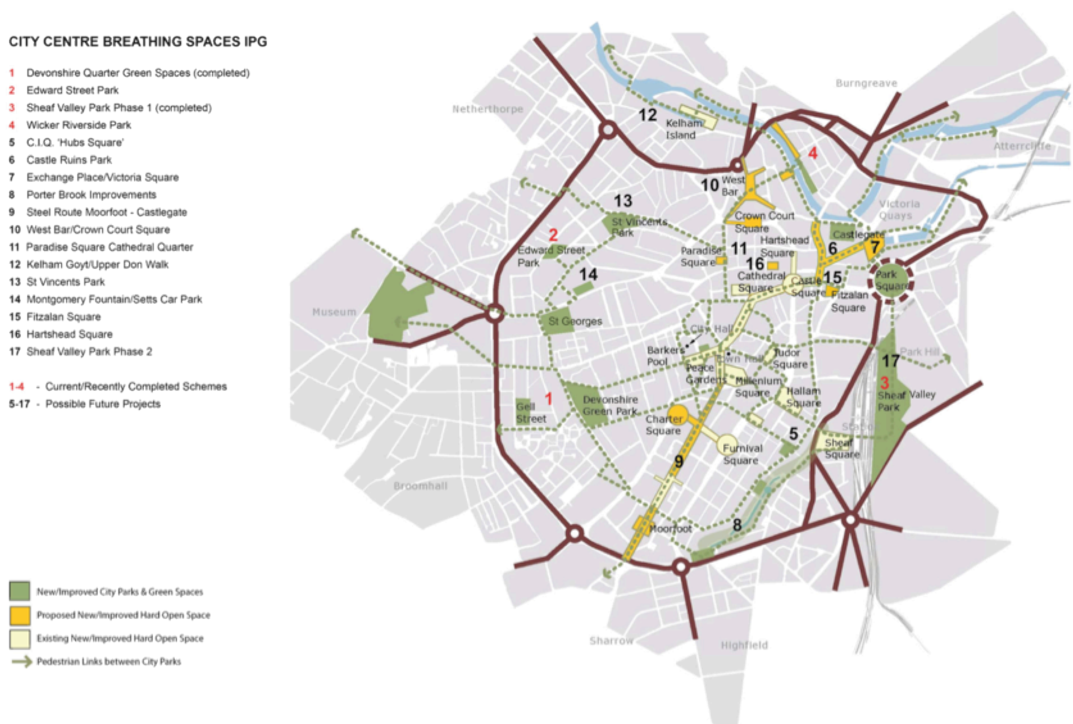


Figure 3.1 Green areas and breathing spaces (Sheffield City Council, 2011)

Being close to a university campus and new residential development areas made the area more attractive for VALUE+ (INTERREG IVB, 2010). As VALUE+ suggested using inclusive design tools to communicate with residents mobile device visualization was chosen as an interactive visualization tool for inclusive and novel design tools and 3D visualization techniques for potential future scenarios. The study area, Edward Street Park, was chosen for the research by considering social and physical aspects.

Edward Street Park was the ideal setting to demonstrate the improvements in the area to meet VALUE+ requirements for creating more welcoming and diverse places, providing an environment for the public to feel ownership and get involved in the process of improvement in their area. The area was one of the problematic areas in Sheffield due to its deep-rooted problems with drugs, vagrancy, prostitution, vandalism and insecurity. The park was planned as a 'multi-functional inner city breathing space' in its dense urban setting to help in the reduction of aggressive behaviours and social offences within the area as well as urban heat island effects and noise pollution.

The implementations suggested for the area created a sports and events area, provided security throughout the area with lighting and landscaping, improved accessibility, and built a café terrace and a community garden for growing food or flowers. The site was designed, managed and implemented in collaboration with ZEST, a Sheffield based community enterprise featuring local project champions for community integration.

3.1.3 Edward Street Park

3.1.3.1 Location

Figure 3.2 Edward Street Park, Sheffield, UK (Google Maps, 2016)

Figure 3.3 Sheffield City Quarters (Sheffield City Council, 2004)

Edward Street Park is one of the city centre breathing spaces in Sheffield. It is located in the St. Vincent Quarter, northwest of Sheffield city centre (Figure.3.2). St. Vincent Quarter is one of eleven city quarters in Sheffield (Figure 3.3). Every quarter has its uniqueness in terms of character, identity and role (Sheffield City Council, 2004). St. Vincent' uniqueness lies in its topography, townscape and history (industrial, cultural and sociological). The park is bounded by Upper Allen Street, Kenyon Alley, Edward Street and Edward Street Flats.

3.1.3.2 History

Edward Street Park, then called Kenyon Park, was established with a basketball court and grass on all the sides during the second half of the 1980s. Figure 3.4 illustrates the plan of the basketball court and its surroundings, Figure 3.5 shows the basketball court and the open space.

Figure 3.4 Basketball court plan (Sheffield City Council, 2013b)

Figure 3.5 Basketball court (Sheffield City Council, 2013b)

The park was in a derelict condition by 2010, with no street furniture or specific landscaping. The only public realm elements on the site were basic lighting that reflected its former industrial land use. Edward Street flat residents and Solly Street student inhabitants rarely used the park. Some of the public used one side of the park as an informal parking lot (Figure 3.6).

Figure 3.6 Edward Street / Kenyon Alley in 2010 (Sheffield City Council, 2013b)

Edward Street Park was unattractive for investment compared to other part of the city centre (INTERREG IVB, 2010), which led to resentment amongst residents of the area. When anti-social behaviour arose, the area became a 'no-go' area, especially at night (INTERREG IVB, 2010). Sheffield City Council reviewed the facilities in Sheffield and identified improvements to make. These improvements included increasing green areas in the city; promoting public spaces, their condition, management and connectivity; improving the safety in the city centre; and creating more inclusive and welcoming spaces to allow people to gather in a multicultural and diverse environment (Sheffield City Council, 2013a).

3.1.3.3 A brief history of the design process behind VALUE+ project for Edward Street Park

Edward Street Park was one of the projects funded by S106 for City Centre open space as part of 'City Centre Breathing Spaces Programme'. For the programme, it was agreed that use of open space would be maximised with the enhancement of users' safety.

The design process started with a site survey, evaluation and analysis. During the site visit photos were taken for the features, boundaries, structures and vegetation. Statutory services records were assessed for future design options. The closure of the road was on the agenda for the design. Initial illustrations were prepared with the help of traffic engineers to elaborate objectives. The materials to be used during the implementation were specified.

Potential changes in topography and new site elements were assessed with the section and detailed drawings. After the consideration of all the material choices and site elements, a cost assessment was prepared and a report presented.

Figure 3.7 Extent of park and public consultation plan (Sheffield City Council, 2013b)

The project included demolition of the existing basketball court, its surrounding walls and old site furniture, with expansion of the open space (Figure 3.7). Instead of these, a new sports and events area was to be introduced to the area, with an artificial grass surface and terraced benches around it for people to gather, socialize or watch sports and events. Accessibility was improved with new roads, paths, ramps and stairs and a new lighting pattern. A café terrace was planned in front of the existing shop to enhance gathering and market stalls. Vegetation was a significant part of the new design, with the creation of new flowerbeds including the planting of perennials and trees. As the topography was somewhat steep, sloped areas were to be vegetated with wildflower meadows and grass (Figure 3.8). The roadway was closed to traffic and a more pedestrian friendly environment was planned for the area (Figure 3.9).

Figure 3.8 Initial Design of Edward Street Park (Sheffield City Council, 2013b)

Figure 3.9 Initial Design Sketch (Sheffield City Council, 2013b)

Draft ideas were completed in 2009 and a public consultation event held in February 2010 (Figure 3.10). A consultation plan (Figure 3.11) was prepared to make sketches for possible design ideas and initial design project was shared with the public. After the consultation meeting, which only few members of public attended, a design leaflet survey sent to all residents to be posted back to Sheffield City Council after completion. A post consultation adjustment with cost assessment was completed in March 2010 (Figure 3.12). A traffic regulation order was prepared in May 2010 to enact the road closure. Sheffield City Council worked up detailed design and planning applications that were submitted in June 2010. The project implementation started on site in March 2011.

Figure 3.10: Pre-public consultation final design (Sheffield City Council, 2013b)

Figure 3.11 Public consultation modifications (Sheffield City Council, 2013b)

Figure 3.12 Post consultation adjustment (Sheffield City Council, 2013b)

Figure 3.13 Final design (Sheffield City Council, 2013b)

The aim was to use more interactive and novel visualization tools to establish the connection between inhabitants and to adopt a bottom-up approach for the participatory design and planning process. Sheffield City Council informed the public for a meeting to be engaged before the council started design process. However, it did not draw enough attention from the public and only a few participants attended the meeting. Those who attended were not actively engaged but were consulted. As a result, the council decided to design the site with the minimum participation rate (Figure 3.13). The researcher's studies and methods had to be adapted to the changes in VALUE+, as explained in general methodology chapter and each study chapters.

Chapter 4

4 General Methodology

In this research, the use of mixed methods has been dictated by the limitations which would arise if using either quantitative or qualitative methods alone. ‘Numerical data, or numbers, are considered quantitative data. Qualitative data are more diverse in contrast and can include texts as well as images, movies, audio-recordings, cultural artifacts, and more.’ (Kuckartz, 2014). Quantitative methods used alone would not be adequate for the assessment of 3D visualizations during participatory landscape planning (Wissen et al., 2008). Qualitative methods help to interpret and examine fundamental propositions of a case study and allow for explanation of the higher-level questions or data, for example by focusing on a community as a whole instead of its residents as individuals (Yin, 2009).

Johnson and Onwuegbuzie (2004) defined mixed methods as a ‘class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study’, and these combinations leads to production of general picture (Bryman, 2015) by facilitating the answering of various research questions. In this way, the quality of the collected data can be enhanced (Denscombe, 2007; Bryman, 2015). Although using mixed methods requires more time and resources compared to qualitative or quantitative methods (Robson and McCartan, 2016), it augments the validity of results by using qualitative methods to explain the results generated from quantitative data (Bryman, 2006). Interdisciplinary research is best carried out through mixed methods as it facilitates collaboration between different fields using various methods and also helps in drawing a stronger conclusion by overcoming the barriers of each method (Bryman, 2006). This research is interdisciplinary to the extent that public participation methods are different from landscape visualization approaches, and need to be combined in the present thesis.

Both quantitative and qualitative data were collected from a total of 555 participants, asking them to use mobile devices as a visualization tool to be used during participatory design and planning processes. Quantitative data was collected from the surveys while qualitative data, which helps interpreting the quantitative data (Robson and McCartan, 2016), was gathered from open-ended questions in the surveys and one-to-one consultations. For this research, the mixed methods approach produced results that can be described as composite, including quantitative data in the form of numbers and qualitative data in the form of text or images, which in turn can be quantified and informal interview comments made during one-to-one consultation that help interpret drawings.

4.1 Design of studies

For this research, a social-empirical research design was adopted to collect responses and examine the reactions and perceptions of participants about the use of mobile devices as participatory tool on different locations. To gather necessary information during this study, both open and closed-ended data collection methods were employed. Surveys, considered a closed mechanism, also allowed participants to respond freely to open-ended questions. In one-to-one consultations, participants were asked to use a mobile device as a design tool to suggest design ideas or changes addressing their needs or concerns within the site without any restrictions or limitations. Future design proposals visualized on a mobile device allowed a visually common language for on-site and off-site participants enhancing communication between professionals and lay people as well as supporting consensus building.

4.1.1 Preparation of the 3D model

The preparation process of the 3D model that was used as a base for all three studies is explained below before getting into the specifics of each study.

4.1.1.1 Choices of software and applications

Trimble SketchUp

The 3D model used during the research for was created using Trimble Sketchup, formerly known as Google SketchUp, with data gathered from Google Earth and the photos taken on-site. Singh, Jain and Mandla (2014) suggested that Trimble SketchUp is appropriate software to use as it is easily available, relatively easy to learn and use, it allows free downloads to everyone, and is also cost-efficient. The software allows the presentation and visualization of all kinds of 3D models and provides users with free access to a great choice of vegetation to use in the models (Fonseca et al., 2014). Since Edward Street Park's planting plan contains a variety of vegetation, it was thought that for an accurate visualization, representing clearly the planting choices, especially perennials, was important.

ZoomNotes application

ZoomNotes is an application developed by Deliverance software for iOS (iPhone Operating System). The application is used for note taking, annotating, planning or sketching, providing a variety of pens, line thicknesses, fonts and colours. It allows easy drawing and writing with a stylus pen, and helps users to create editable sketches by converting the rough drawings into the precise geometric shapes. It is also possible to add JPEG files and modify them with provided features with the advantage of unlimited zooming ability.

The application was adopted in order to create future design scenarios because it is easy, simple and fun to use, its variety of selections for colours and pen styles (ZoomNotes, 2017). It allowed users to make sketches to suggest changes for the parts identified as problematic. Images from the 3D model were used as a base and the app was used to test mobile devices as a participatory design tool while actively engaging the public.

WalkAbout3D Mobile application and future proposals

SketchUp is easy to learn and use, but it is not ideal for high-speed navigation and walk-through (Singh et al., 2014) and therefore interactivity. To be able to have real-time interactive landscape visualization, WalkAbout3D was chosen because of its compatibility with SketchUp.

WalkAbout3D is an interactive product which allows viewing stereoscopic views of a design and sharing these views with clients or potential users (WalkAbout3D, 2017). WalkAbout3D works alone and also as a plug-in to SketchUp, and WalkAbout3D Mobile is an easy to use application designed for iOS devices allowing to view the virtual environment as a panoramic view or as a real-time walkthrough.

This application is freely available to the public, so that design proposals prepared in SketchUp can easily be distributed. Those proposals can be geo-referenced to help the users find the exact location for the views designed: the application stores the details regarding a specific location by using geographic coordinates. When users visit the site corresponding to this geographic coordinates, the application allows them to view the interactive panoramas superimposed with the corresponding actual view (WalkAbout3D, 2017). When the user moves the device or changes their position, the view on the screen changes accordingly (Gill and Lange, 2015). For this research, the application was used to view design proposals on the mobile device interactively both on-site while overlaying 3D visualizations onto the real world and off-site.

4.1.1.2 Timeline of the 3D model preparation process

It is usually the case that 3D models are prepared prior to the design stage of a specific project. However in the case of the Edwards Street Park project, the Sheffield City Council had already been working on the design drafts since 2009, before the VALUE+ project started to provide funding. It is important to note that Sheffield City Council completed the design process and started construction in 2011, without having completed the 3D model requirement for VALUE+. The construction was partially completed in 2013 and the park was officially opened to the public in September, 2013. Extra funding provided for additional improvements in the area gave a chance to use 3D visualizations before decisions were finalised for the additional changes, which is when this researcher started to contribute to the project.

As the aim was testing mobile device visualization as a participatory tool during planning and design both on-site and off-site, the study site was not changed as a park in use would allow public to experience the area and to know about its issues and needs. It would be easier for lay people to be engaged actively and meaningfully and to envision the changes (Morello and Piga, 2013) rather than making suggestions for an empty site.

The model preparation was started on the basis of a meeting in December 2012 with the landscape architect who designed the park and the development officer from Sheffield City Council and Value+ project. All the required documents were obtained to create the 3D model for the site: a proposed plan, a topographic map, the cut and fill plans, with details of planting. Early in the model preparation a first hurdle appeared: the proposed plan had been modified by the construction workers during the implementation of the project, so the information provided by the City Council was not accurate enough to create a proper 3D model of the area. After inspecting the differences between the original plans and the reality on the site, it was thought that making the connection between the implemented plan and the suggested plan was too difficult. So a 3D modelling expert was recruited and paid for from the budget of the Value+ Project to prepare an accurate 3D model for the site. The expert, used the provided data, the site surveys, a number of real world photos and Google Earth street view in order to create the 3D model. The first initial model was delivered on 15 June 2013.

Another hurdle appeared as soon as the model was delivered. As a result of adding details to the model, the size of the file increased remarkably, to the extent that a mobile device would not be able to display it. There were two main reasons for the large file size: the complexity of the terrain and the three-dimensional geometry of the vegetation. To counter this issue, the expert suggested concentrating on the accurate and simple representation of geometry and vegetation, rather than imposing a further burden on the size and complexity of the model by adding photo textures to the buildings (Figure 4.1 and 4.2). So the 3D model was not fully completed by the due date of the inauguration event and showed some inaccuracies. This is why it is called 'initial model' or 'versionA'. The researcher expected that several scaling inaccuracies regarding buildings, vegetation and lampposts were to be revised later, but that the inauguration day was an important opportunity to reach public to inform them about the improvements and to use the model version A on a mobile device.

Figure 4.1 Version A, initial 3D model with building blocks, terrain and plantation

Figure 4.2 Version B, revised 3D model with textures, correct scale and plants

After using version A for the first experiment, the 3D model was modified and textures were applied to surrounding buildings to create a more accurate and realistic 3D environment for the users. Inaccuracies regarding scale of buildings, plants and lampposts were fixed in version B. Correct 3D representations of plant species replaced the wrong ones (Figure 3.2) and the grass area on the upper garden was added. In order to reduce the file size, simplified version of plants were added from SketchUp 3D warehouse for Magnolia kobus, Gleditsia triacanthos 'inermis', Ulmus americana, Prunus yedoensis, Betula pubescens, Tilia platyphyllos, Quercus rubra, Magnolia 'Galaxy'. Although it increased the file size, textures were added to the buildings with the photos taken on-site to improve representativeness of the model (MacFarlane et al., 2005).

WalkAbout3D was used to prepare a one-minute-long walk-through video for the first study. Both, version A for inaugural day and version B for one year later used videos to be displayed to examine the level of accuracy on mobile device visualizations and its effect on understanding by comparing the two results (chapter 5). Version B was also used to gather design ideas from the public through an iPad for the second stage of the research (chapter 6). For the last stage of the research, version B was used as a base model and proposed changes were added as design proposals to compare on-site and off-site mobile device visualization use and the influence on understanding and perception during participation.

Disclaimers: There were some changes within the area while the research was being conducted. When research began there was an empty space just next to Kenyon Alley (at the north-east corner of the park): the building, which began construction from the middle of the second year of the research, was completed at the beginning of the third year and named Corner House. Corner House was not part of the 3D model of the site during the accuracy study. A formerly derelict area on the west side of the park, now a student accommodation block named Century Square, was not part of the research as its construction only commenced at the beginning of January 2016, after all data collection was completed. These additional buildings were not included in the models used in the accuracy study. They were added to the 3D model before gathering design ideas and also used during the comparison of on-site and off-site use of mobile devices.

4.1.2 Research design

Among the common techniques used in social sciences such as surveys, interviews, observations, theories and case studies, Bakis et al. (2006) suggests that using case studies is the most convenient method while examining information technologies. Case studies use real data as part of a specific project with specific project characteristics (Barlish and Sullivan, 2012). Edward Street Park is used as a case study site to investigate the use of mobile device landscape visualizations for public participation in the context of an urban park.

One of the requirements for legitimate off-site visualization is to have a certain level of accuracy (Sheppard and Salter, 2004; Lindquist, 2006; Lewis, 2012). To compare on-site and off-site use of 3D visualization on mobile devices, accuracy is tested with on-site participants. In order to decide if accuracy affects understanding when on-site, this study tested participants' responses with two models with different level of accuracy for the representation of landscape elements (for example buildings, vegetation, lampposts) at different times.

To engage the public actively in participatory design process, participants were first invited to a charrette, to be held at University of Sheffield, to create an environment to share ideas and reach a consensus. But no members of the public attended the charrette, which was therefore held with professionals from three different universities and international students (See section 6.1.1); a master plan was prepared for the whole site (Appendix D). To reach the public, the researcher decided to hold one-to-one consultation sessions (Rowe and Frewer, 2005) to gather design ideas using the ZoomNotes app on an iPad as a participatory design tool to provide engaging hands-on experience, sketching on the iPad. Participants identified the problems and suggested solutions addressing them through their sketches both on-site and off-site.

For the last stage of the research, results from the two previous studies as well as the master plan prepared during the charrette were used to prepare future design proposals for the site. WalkAbout3D mobile app was used viewing the proposals interactively on-site and off-site. Users' engagement on these locations were compared in terms of spatial perception and understanding of space and future proposals for the participatory planning and design.

To summarise, the three studies conducted in this research were connected to each other and aimed to analyse the understanding and perception of users when using 3D visualizations on mobile devices, and to check whether those had an impact on engagement. Figure 4.3 shows that each study feeds into the next one, exploring the potential of mobile devices as a visualization and participatory tool for public engagement, notably by comparison of their use on-site and off-site. First, participants' understanding of space was examined for different accuracy levels on 3D mobile visualization with on-site participants. Then mobile devices were adopted as a design tool to give a chance to residents to get actively involved in the design process. Finally, proposals were created in the light of the data collected during the first two studies regarding the suggestions of participants. The proposals were shown on a mobile device off-site and superimposed on-site to explore differences in terms of perception and understanding during public participation.

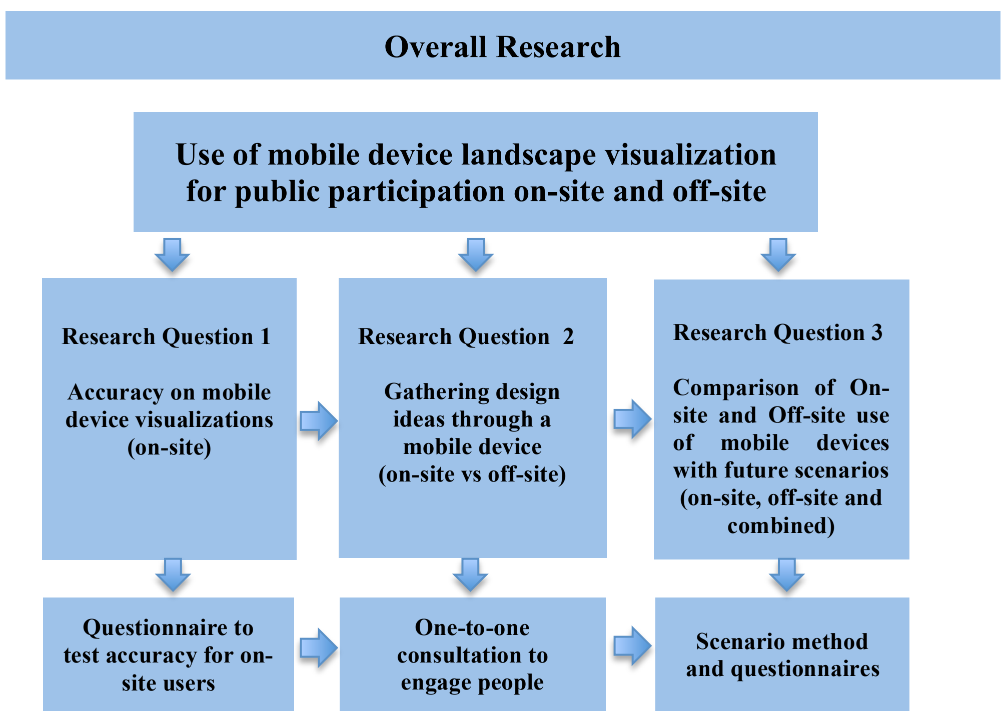


Figure 4.3 The diagram of overall research for research questions and methods

Reaching participants

For this research, people were chosen by non-probabilistic sampling in order to generalize information not necessarily aiming to make estimates for population (Lazar, Feng and

Hochheiser, 2010). There are researchers in social science who believe that only random sampling survey data is valid (Deitchler et al., 2008; O'Regan, G., 2017). In human-computer interaction research, however, there usually is not a specific population, so data collected can still be considered valid (Lazar et al., 2010). This data collection method allows making a generalization with the information obtained from the participants to other people (Neuman, 2011).

To be able to reach a more diverse and broader group of people including both residents and casual users of the site, a combination of passers-by recruitment and email recruitment was adopted. It was decided not to try to access the inhabitants of the local community by visiting households door to door, or by using the registration data from Sheffield City Council, because of safety concerns for the researcher and to respect the privacy of the inhabitants. Door-to-door surveys are considered as expensive and unsafe for the researchers and intrusive or annoying for participants especially when other methods are applicable and usable (Corey and Freeman, 1990; Taylor, Wilson and Wakefield, 1998; Hillier et al., 2014). Instead a large number of participants, 555 in total, were reached to avoid inferential bias (Lauer, 2012).

One of the approaches used was to recruit passers-by by using convenience sampling. This allowed the researcher to reach diverse communities within the site by obtaining quick access to them and their opinions (Allen, Regenbrecht and Abbot, 2011). Recruiting passers-by gave a chance to reach anyone passing by on the days surveying took place without any discrimination. Participation was voluntary, and participants were clearly informed that they could withdraw at anytime if they wanted so. For all three studies, it was hoped that recruiting passers-by with face-to-face contact would bridge the gap between the community members, casual users and the researcher. For the first study only passers-by were recruited. Thanks to the inauguration day, it was easier to recruit people from all groups, students, low-income groups and professionals as well as outsiders.

For the second and third study, another recruitment approach was added: emails were sent to the University of Sheffield students and staff members. The aim was to increase the participation rate of young people and professionals, in addition to recruiting passers-by on the street. This group, young people and professionals, were likely to feel at ease with mobile devices and to make a good control group sample. Recruiting emails provide a cost efficient way to reach large numbers of potential participants. Lefever, Dal and Matthíasdóttir (2006) used e-mails and e-surveys to collect qualitative data from teachers and students in Iceland. They used online data collection considering the efficiency both in time and cost. They sent 9481 emails and received 2516 responses. Even though they reached a large number of users in a short time in a cost efficient way, they suggested that paper-and-pencil surveys would help increasing the quality and quantity of participation with their higher response rate and efficient participation. That is why in this research, the researcher used emails to recruit participants. Traditional paper-and-pencil surveys were used for meaningful and effective participation. They offered a quick way of reaching more participants at once with the help of technology while organizing the meeting times. Using such a method does include an issue of possible discrimination against computer illiterate people, however the researcher decided that this was balanced by using random passer-by recruitment. For the last two studies, potential participants were also offered chocolate as an incentive for their participation.

4.2 Analysing results

4.2.1 Coding the collected data

To categorise the data collected, the use of open coding was a preliminary step before in-depth analysis of general results. This coding regroups content analysis of the qualitative data, and deconstruction of quantitative data (Sargeant, 2012).

The quantitative data that was collected from studies includes user characteristics and their responses to the experience using different scales. All the responses were later recoded in SPSS22, depending on the extent to which participants showed a positive attitude towards an item, ranging from 1 to 5, to be able to interpret the data. Higher scores represented a greater quality or acceptance. Various statistical tests were used as relevant with the help of different statisticians from the University of Sheffield. Statistical analysis methods are explained under section 4.2.2.

Qualitative data was collected as a mixture of images and texts. It included written answers to open-ended questions, site surveys and design proposals from the charrette, and sketches made during one-to-one consultation sessions or informal comments. The informal comments made by participants during one-to-one sessions notably helped the researcher interpret their drawn proposals, although image analysis was not chosen as a key method of the study. Qualitative content analysis was used for responses for open-ended questions and one-to-one consultation suggestions, which were coded by classifying the suggestions based on the locations and themes, then converted to quantitative data to obtain the frequency of transcribed suggestions sketched by different users.

The basic quantitative data was categorised by the characteristics of the participants such as age, gender, studentship status, and familiarity with the site or ownership of mobile device and responses for closed-ended questions. The rest of the data collected was a composite of quantitative and qualitative representations of opinions and perceptions of the participants, reacting to the individual studies. In the case of Edward Street Park, the queries were about understanding the space and proposals, perception of the surrounding environment and the mobile device experience. For the mobile device experience, the experiments already contained themes corresponding to elements tested, with themes corresponding to the questions. These themes were selected: users' perceived usefulness; ease of use; willingness (Yang and Shin, 2010; Joo, Lee and Ham, 2014); perceived level of realism displayed and satisfaction and usefulness with mobile devices (Zünd et al., 2014). Joo, Lee and Ham (2014) showed that when users perceive the tools as useful and easy to use, satisfaction could be improved. They added that improved satisfaction with the support of usefulness would enhance the willingness to use the devices in the future.

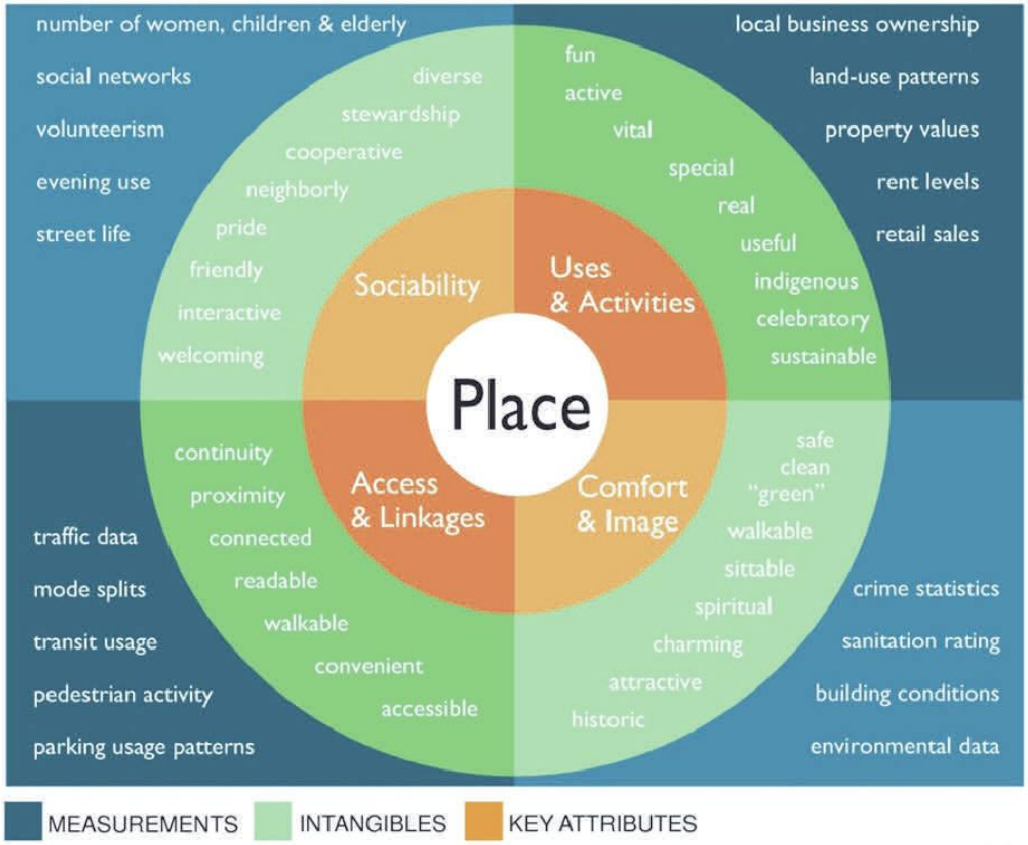


Figure 4.4 Placemaking diagram (PPS, 2000, p. 17)

Participatory design aims to engage all stakeholders during the design process in order to create a usable place that meets their needs and addresses their concerns. While testing the mobile devices as participatory design tools to engage the public, participants were asked to identify the issues of the site and suggest solutions. In order to create a sustainable space that enhances the relationship between the space and people who use it, the placemaking approach was applied to identify a number of themes for this research.The suggestions made by participants were classified using the themes correspond to key attributes of a place represented in Placemaking diagram (Project for Public Spaces, 2010).

After the answers had been collected, the contents of this graph were adapted to be relevant to the answers of the present study. Four main themes were identified, and the answers coded correspondingly:

Safety: corresponding to the 'safe' keyword in the 'comfort and image' section in PPS's graph. Issues included poor lighting or design favouring hiding places in the space;

Accessibility: corresponding to the proximity, connected, walkable, convenient, accessible keywords in the 'Access and Linkages' section in PPS's graph. Issues included the design and materials of paths and stairs;

Attractiveness: corresponding to the clean, green, inviting, attractive keywords in the 'Comfort and image' in PPS's graph. Issues included the aesthetics and uniqueness of the park's design, the amount of vegetation and benches;

Sense of community and interactivity: corresponding to both 'Sociability' and 'Uses and Activities' sections of PPS's graph. Issues included the basketball court's design and materials, events to be organised, the design of the café terrace.

4.2.2 Analysis methods

Besides the participants' demographics and their opinions on the site and mobile device experience, one of the most important elements of the data was the location of the experiments: on-site, off-site or combined (combination of both first off-site then on-site). Both quantitative and qualitative data were analysed in three different ways: general results; demographic-specific results; location-specific (on-site, off-site or combined) results.

Two different sets of statistical analysis were used for quantitative data in this research. The first was performed using rank-based tests (studies 1 and 3) and the other weighted the responses in SPSS according to the number of suggestions (study 2) or preferences for favourite proposal (study 3) and their frequency (studies 2 and 3).

Quantitative data collected from studies 1 and 3 was analysed using the same methods. Descriptive statistics were run to help categorizing the results as graphs. As the data was not normally distributed, nonparametric tests were carried on to examine the association between independent and dependent variables by comparing the differences within the independent groups. The Mann-Whitney U and Kruskal-Wallis H tests were performed to distinguish possible significant differences between respondent groups and the responses. A p value less than 0.05 was considered significant. As the Mann-Whitney U test is a rank-order and the Kruskal-Wallis H test is rank-based nonparametric tests, significances were presented by using ‘mean ranks’ in the results. Higher mean ranks represented a greater quality or acceptance. Statistical software SPSS22 was adopted to perform the tests.

While analysing study 2’s qualitative results, all the sketches were re-coded to SPSS considering the themes and suggested modifications. Schroth (2010) suggests that collaboration, requires being fair to all stakeholders by providing equal shares during the development of the planning and design strategy. So, regardless of the number of suggestions made by a participant, it was considered that every individual had one equal share. To see the frequency of the suggestions, all the sketches suggested were weighted in SPSS so that each participant could contribute equally to the final results. In other words, everyone who participated had one share and if one person suggested more than one change, their share would be divided by the sum of the number of suggestions made by them. To give an example, if a person proposed one suggestion, it was considered as ‘one’ point. If another person made five different suggestions, every suggestion of this individual would be counted as a fifth of a point to give the equal share of one point during the evaluation.

To analyse the results of participants’ preferences for favourite scenarios fairly in study 3, their votes were weighted for the same reason and the same method explained above.

While analysing the data regarding factual characteristics of the site, the assumptions of participants were calculated to find the simple error and the absolute error for each participant. The simple error revealed how much difference there was in comparison with the actual measurement showing whether the guesses are different. The absolute error revealed how much the difference actually was. After calculation of the errors, Kruskal-Wallis H test was run for the respondent groups to check significant differences for the assumptions the survey groups (on-site, off-site, combined) guessed the factual characteristics of the site more accurately. For the significant results of error analyses, both simple and absolute errors, the higher the mean ranks represented a higher error level, therefore, less accurate estimates.

Chapter 5

5 Effects of the level of accuracy of 3D visualization on mobile devices on understanding: initial and completed model

The first study was designed to investigate how the level of accuracy of 3D model used for visualization on mobile devices might affect participants' understanding during public participation. Section 5.1 details the methods used during the first study, including the research narrative, the pilot study, the experiment choreography, and information concerning the study's participants. Section 5.2 presents the quantitative and qualitative results for all the experiments in the first study, individually and comparatively. Section 5.3 discusses the results presented in the previous section.

5.1 Method

5.1.1 Research narrative for study 1

The first 3D model that was created had scaling inaccuracies for buildings, plants and lampposts; for convenience we will call it 'version A'. The reasons why version A was considered inaccurate were explained in general methodology chapter (section 4.1.1.2). During experiment 1, the main visualization tool used was a walk-through video featuring the main viewpoints of the site using model version A and displayed on a mobile device, that is, on an iPad tablet. Experiment 1 took place on the inaugural day of Edward Street Park on 28 September 2013. After viewing the video, the participants were asked to fill a questionnaire. One part of the questionnaire evaluated the participants' satisfaction with the park, whose different parts they had just viewed in the video. The questions aimed to estimate whether the park's users had noticed the same issues in the park's landscape design as the landscape designers and other stakeholders had done. A number of questions aimed to evaluate whether the model's level of realism had an impact on the participants' evaluation of the site, and of the participation experience. Another set of questions measured whether the participants found the mobile device visualizations useful as a tool for participation. The flow diagram of study 1 is shown in Figure 5.1.

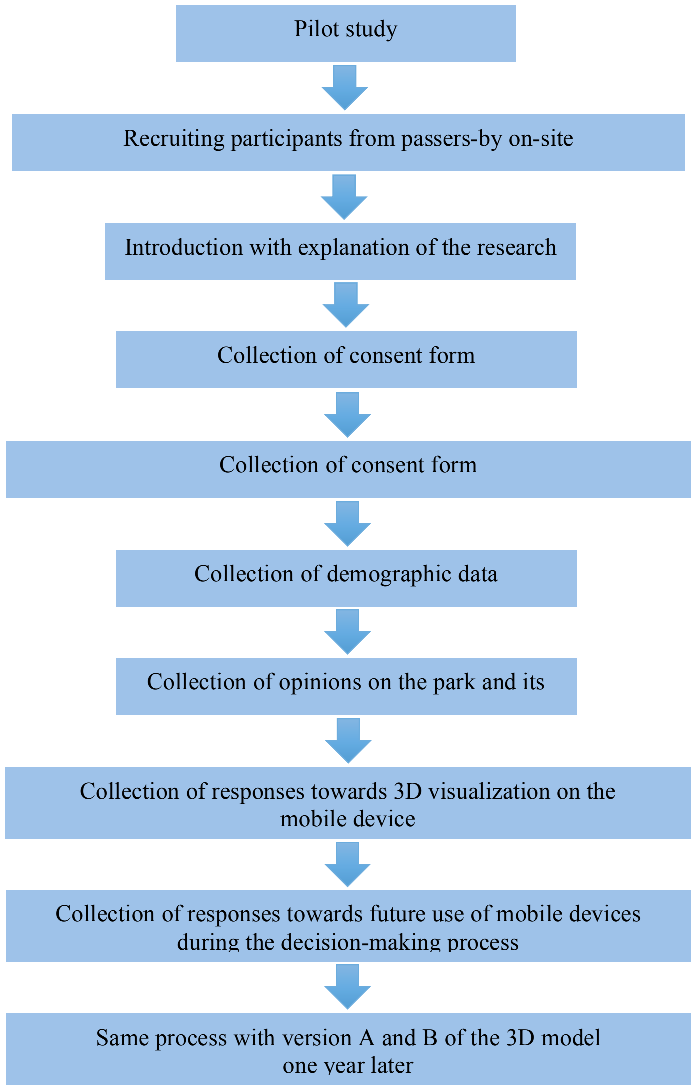


Figure 5.1 Flow diagram of study 1

Following experiment 1, a more accurate 3D model was produced; for convenience we will call it 'version B'. Version B was a 3D model with the most important issues presented by version A fixed; see the general methodology chapter (Chapter 3) for more about the making of the 3D models. One year after experiment 1, experiment 2 was carried out in Edward Street Park on 28 September 2014. During experiment 2, most of the participants were shown version B on an iPad. Some of the participants were shown the video made using model version A. This time there was no specific event taking place in the park, and the participants filled the same questionnaire as in experiment 1. The aim of this second experiment was to provide a comparison between the participants' answers when using version A or B of the 3D model visualization. It was expected that the participants who viewed version B would find it more useful for participation purposes than model version A, as B was more accurate.

To sum up, study 1 helped the researcher examine the participants' understanding of and satisfaction with both the park and the usefulness of the 3D model as a tool for participation. Experiments 1 and 2 offered insights into the participants' reactions when invited to take part in decision-making using 3D model visualization.

5.1.2 Questionnaire design

This study tried to test the effects of level of accuracy on understanding when two different models with different level of accuracy were displayed on a mobile device on-site. Questions that are directly or indirectly related to accuracy of the 3D model were asked. These questions were related to:

- realism, as accuracy in representation of buildings and vegetation plays a key role for perceived realism (Bishop and Rohrmann, 2003),
- understanding, as scale is a critical element of visualizations for understanding (Watzek and Ellsworth, 1994)
- satisfaction with the new design of the park to see if different accuracy levels on the visualization had an influence on the actual on-site experience (Zube et al., 1987)
- feedback on the park by asking what is liked and disliked in the park to create a base for the next phase of the studies collecting data related to needs and concerns related to the park.
- usefulness of the visualization tool , to test perceived usefulness as it is considered that visualizations tools do not provide adequate opportunity to engage users(Pettit et al., 2011) and
- willingness to use these visualization tools in the future if offered (Yang and Shin, 2010).

The quantitative part of the questionnaire used a 5-point Likert scale (1 being the most negative response and 5 being the most positive). The questionnaire can be found in Appendix A.

5.1.3 Pilot study

A pilot study was carried out as a preamble for the first study and five participants were recruited to undertake the survey in its draft form. Running a pilot study was necessary to clarify and amend the questionnaire. Virzi (1992) suggested that five participants are enough to identify 80% of the problems that would occur during the actual survey. The pilot study was conducted in the same way as experiment 1. The potential technical difficulties related to displaying the video on the iPad were fixed, and the length of time necessary to display the video and fill the questionnaire were recorded roughly. All the answers were checked and encoded to run preliminary tests. Following the pilot study, no changes were deemed necessary for experiments 1 or 2.

5.1.4 Experiment choreography

Figure 5.2 Location of the researcher during study 1

Experiment 1

The researcher was located at the corner of Edward Street so as to reach as many of the people visiting the inauguration day as possible (Figure 5.2).

After showing a short walk-through video of the park on a tablet, and providing brief information about the research, the researcher asked the participants to answer a paper-based questionnaire.

Figure 5.3 Opening day events

Figure 5.4 Opening day stalls

The VALUE+ champion and the Sheffield City Council planning team were present at the event in order to facilitate the connection between students, professionals and residents from Edward Street flats. The opening event started at 10.00 am and ended with a film screening event at 9.00 pm organized by Sensoria. Throughout the day, different activities were offered for various age groups including a bouncy castle, a basketball challenge, drumming, street dance, a magic show and live music (Figure 5.3). Stalls located in the café terrace area were offering food and drinks to buy (Figure 5.4). The artist in charge of decorating the gates of the park was also invited to have a consultation with the public and establish an identity for the area. The opening event was announced in local newspapers, local event magazines such as SKINN, a non-profit organization to help the development of Shalesmoor, Kelham Island, and Neepsend areas, and leaflets (Appendix B) were left in the common rooms of Edward Street flats.

Experiment 2

This experiment aimed to examine whether the improved accuracy of model version B would cause any changes in participants' responses. The video displayed the same itinerary as in the park, but using version B. The same paper-based questionnaire was used in a face-to-face setting in order to compare the participants' responses when displaying model version A or B. There were no special events on the day of experiment 2. The researcher stood at the corner of Edward Street, at the same spot as for experiment 1 (Figure 5.2).

5.1.5 Participant sampling

For the general methodology adopted to recruit participants, please refer to the General Methodology chapter.

Experiment 1

The public attending the inauguration of Edward Street Park were the potential respondents for the survey. Participants were recruited among the residents and visitors present on the site during the inauguration day (Figure 5.5). During the event, the researcher asked every attending person, without discrimination, to take part in the experiment. No incentive was offered to those who completed the survey.

Figure 5.5 Presentation of walkthrough of the 3D model on an iPad to residents

Experiment 2

It was not possible to reach the same participants as in the previous year. The previous participants who had agreed to leave their contact details were informed, but none of them answered the call for participation. The researcher approached passers-by systematically without discrimination, and asked whether they would be willing to take part in research. For the first 74 respondents, the video with the model version B was shown. For the next 26 people, the video with model version A was displayed. After the display of the video, they were asked to fill the same paper-based questionnaire, with no incentives offered.

5.1.6 Participant characteristics

After analysis, it appears that participants ranged from visitors from other cities who visited the site for the first time, to locals who had lived here for 27 years. Details of participant characteristics for both experiments are provided in Table 5.1.

Table 5.1 Participant characteristics for experiment 1 and 2

	Experiment 1 Version A (n=80)	**Experiment 2 Version A** (n=26)	**Experiment 2 Version B** (n=73)	**Total** (n=179)
Gender				
Male	43	21	49	113
Female	37	5	24	66
Age groups				
18-24 years	38	22	59	119
25-44 years	31	3	13	47
45-64 years	11	1	1	13
65+ years	0	0	0	0
Studentship status				
Student	39	21	56	116
Non-student	41	5	17	63
Familiarity				
Familiar	58	14	54	126
Not-familiar	22	12	19	53
Place of Residence				
Edward Street Flats	12	2	9	23
Allen Court	4	7	2	13
Atlantic1	0	0	3	3
Impact	2	0	0	2
Omnia Space	8	2	24	34
IQ	6	4	1	11
Aspect	4	4	6	14
Corner House	0	0	5	5
Other	44	7	23	74

Experiment 1

For experiment 1, a total of 85 questionnaires were filled on the inaugural day, with 80 completed thoroughly. Four responses had to be ignored for the analysis because the participants only answered the questions, without adding their personal information or signing the consent form.

Respondents were mostly students from the student accommodation (Opal2, Omnia Space, Aspect, IQ, Q4) around the area. There were also several visitors as well as non-students residing in Impact and Atlantic1, housing for high-middle income households, and Edward Street flats, which are council housing mostly for low-income groups and immigrants. It was especially difficult to find residents of Edward Street flats in the streets, although a number of the residents were seen to observe the activities from their balconies. A small number of Edward Street flats residents did take part in the experiment: as their English fluency was limited, they asked their children to translate the consent form, questions and answers.

Experiment 2

In experiment 2, a total of 100 people completed the questionnaire with 74 for the revised model, and 26 for the initial model. All of the questionnaires were filled thoroughly.

The sample characteristics were similar to experiment 1, with most participants being students residing in the accommodations located around the park, as well as a few professionals, and some residents from Edward Street flats. Throughout the day, it was observed that the site was much more used by students than other inhabitants. It was difficult to meet residents from Edward Street flats except when they came out for grocery shopping at the Tesco supermarket.

5.2 Results

It was expected that during participatory planning and design processes, the users' understanding and perception of the park would have been proportionally affected by the level of accuracy of the mobile device visualization. This research question was designed to determine whether participants' understanding and perception of the park changed proportionally with the level of accuracy and detail of the model. Some of the questions measured whether the participants found the visualization tool useful during the participation process. The following section presents the results of two experiments individually then comparatively by sing the analyses explained in section 4.2.2. The methodology can be found in section 5.1 and raw data tables for study 1 can be found in Appendix C. For each experiment the quantitative results are analysed first, followed by qualitative results.

5.2.1 Results experiment 1, model version A

5.2.1.1 Quantitative results

In order to determine whether model's accuracy has an impact on understanding of the space, participants were asked to rate several aspects (section 5.1.2) of their experience first with version A. Table 5.2 and Figure 5.6 show the mean scores, median and standard deviation values for each question. The results are consistently at the higher end of the spectrum, with participants generally satisfied with each aspect. The general result for willingness was that 79.2 % of the participants were willing to use mobile devices if offered during the participatory decision-making process.

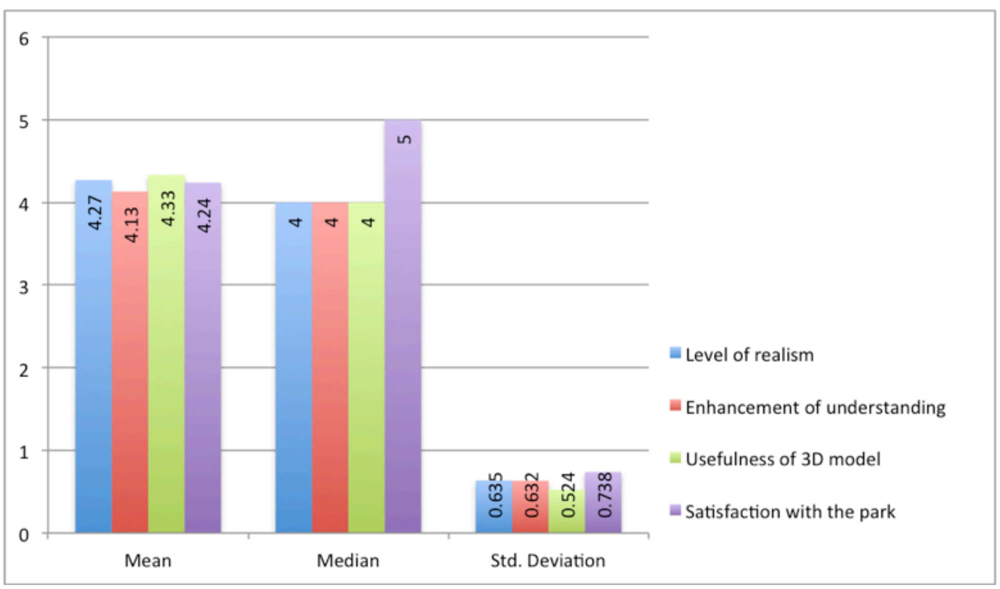


Figure 5.6 Bar chart of statistics for experiment 1 with the model version A

Table 5.2 Frequency statistics of responses for experiment 1 questions with the model version A

		Level of realism	Enhancement of understanding	Usefulness of 3D model	Satisfaction with the park
N	Valid	79	78	79	79
	Missing	1	2	1	1
Mean		4.27	4.13	4.33	4.24
Median		4.00	4.00	4.00	5.00
Std. Deviation		.635	.632	.524	0.738

Analysis of responses: Participant characteristics across questions

The significant results across questions according to the participant characteristics are explained below.

Age groups

Generally, the ratings for each question were proportional to the age of the participants. The results on Table 5.3 show that the distribution of rating for the 3D model enhancement of understanding seem significantly different across age categories ($p < .05$, $p = .039$). As the Kruskal-Wallis H test does not illustrate which groups show significantly different distributions, a Dunn-Bonferroni test was performed to obtain multiple comparisons between pairs. Pairwise comparison between age groups with the Dunn-Bonferroni test showed that there was not a significant difference (Adj. sig.) between the age groups (Table 5.4).

Table 5.3 Results of Kruskal-Wallis test to compare the age groups with the model version A in experiment 1

	Satisfaction with the park	Level of realism	Enhancement of understanding	Usefulness of 3D model
Chi-Square	4.898	2.539	6.501	1.200
df	2	2	2	2
Asymp. Sig.	.086	.281	.039	.549

Kruskal Wallis Test, Grouping Variable: age

Table 5.4 Pairwise Comparisons of age for enhancement of understanding with Dunn- Bonferroni test

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
25-44-18-24	10.064	4.441	2.266	.023	.070
25-44-45-64	-13.142	6.948	-1.891	.059	.176
18-24-45-64	-3.077	6.803	-.452	.651	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Studentship

The Mann-Whitney U test was used to verify if any result was statistically significant. Table 5.5 reveals that distribution of the ratings for the level of realism was significantly different for students and non-students ($p < .05$, $p = .049$). Those who participated as students rated the level of realism in the 3D model in the model higher than non-students (Table 5.6 and Figure 5.7). It means that students considered that the 3D model was closer to reality (mean rank= 42.90) compared to non-students who rated the realism lower (mean rank=33.94).

Table 5.5 Results of Mann-Whitney U test to compare the groups for studentship status

	Level of realism	Enhancement of understanding	Usefulness of 3D model	Satisfaction with the park
Mann-Whitney U	530.500	587.000	630.500	614.000
Wilcoxon W	1391.500	1148.000	1491.500	1434.000
Z	-1.968	-1.198	-.839	-1.014
Asymp. Sig. (2-tailed)	.049	.231	.402	.311

Grouping Variable: Studentship status

	Being a student	N	Mean Rank
Satisfaction with the park	Yes	35	40.46
	No	40	35.85
Level of realism	Yes	33	34.79
	No	41	39.68
Enhancement of understanding	Yes	34	42.90
	No	41	33.94
Usefulness of 3D model	Yes	34	39.96
	No	41	36.38

Table 5.6 Comparison of mean ranks of the responses for studentship status with model version A (experiment 1)

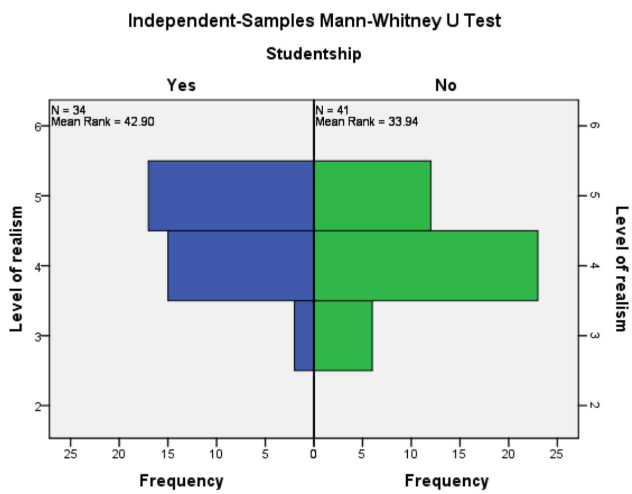


Figure 5.7 Comparison of mean ranks of the responses for studentship status and level of realism in the model version A

Even though it was not significant, students also rated their satisfaction with the park and the usefulness of the 3D model in decision-making more highly. Unlike the other questions, students gave a lower rating to the 3D model than non-students concerning how it helps with understanding the space. Students were more critical than non-students of the 3D model's ability to enhance understanding the space.

Familiarity with the site

In this part, whether the familiarity with the site has an influence on the participants' ratings was tested with the Mann-Whitney U test. The results show that being familiar with the site had an influence on the rating of the 3D model in enhancing the participants' understanding of the space. However, familiarity did not significantly affect participants' perception of realism or their ratings for the usefulness of the 3D model on mobile devices in decision-making (Table 5.7).

Table 5.7 Results of Mann-Whitney U test to compare the participants' familiarity with the site with the model version A in experiment 1

	Level of realism	Enhancement of understanding	Usefulness of 3D model	Satisfaction with the park
Mann-Whitney U	545.500	471.000	533.500	602.000
Wilcoxon W	2256.500	724.000	786.500	2255.000
Z	-.788	-1.988	-1.208	-.303
Asymp. Sig. (2-tailed)	.431	.047	.227	.762

Grouping Variable: Being familiar

	Being familiar	N	Mean Rank
Satisfaction with the park	Yes	57	39.56
	No	22	41.14
Enhancement of understanding	Yes	56	42.09
	No	22	32.91
Level of realism	Yes	58	38.91
	No	21	43.02
Usefulness of 3D model	Yes	57	41.64
	No	22	35.75

Table 5.8 Comparison of mean ranks of the responses for being familiar with the model version A in experiment 1

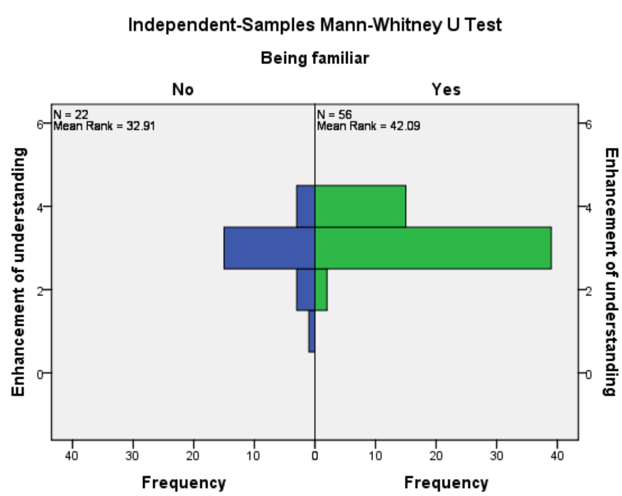


Figure 5.8 Results of Mann-Whitney U test to compare the groups for familiarity with the site for model version A in experiment 1

The distribution of the ratings for 3D model's enhancement of understanding was found to be significantly different for participants who declared that they were familiar with the site and those who were not familiar with it ($p < .05$, $p = .047$; Table 5.7). Table 5.8 and Figure 5.8 show that those who were familiar with the site considered that the 3D model was more helpful in understanding the space (mean rank= 42.09) compared to people who did not know the site (mean rank= 32.91).

5.2.1.2 Qualitative Results

Participants were asked about their opinions about the park and the positive aspects of it. The answers were arranged according to the themes explained in section 4.2.1. This is the list of findings regarding what the participants said the park provides:

Table 5.9 Positive aspects of Edward Street Park acknowledged for the model version A during Experiment 1

Safety	- Safe open space compared to its previous condition and safe area for children to play
Accessibility	- Close proximity to universities as it is a convenient location for students - An accessible environment for all residents as it is located in the heart of the community
Attractiveness	- Peaceful, clean and inviting environment in densely built up area - Utilities for residents (for example, a basketball ground) - Green environment with flowers and meadows
Sense of community and integration	- Multiple spaces for diverse activities and various events (for example cinema screen and music on the day) - A space for community to gather and socialize.

Even when participants rated the new design of the park as 'good' and 'very good', they still requested improvements under the question of 'what are the problems you would like to see being solved about Edward Street Park?'. The issues they were concerned with could be identified as follows:

Table 5.10 Negative aspects of Edward Street Park pointed out for the model version A during experiment 1

Safety	- Inefficient / insufficient street lighting during night time - Drunk people present at night particularly around the stairs, making noise
Accessibility	- Lack of shortcuts within the area: there were requests for redesigning the park taking circulation flow into consideration
Attractiveness	- Littering: participants estimated that there were too few trash bins, which tend to overflow and drop rubbish in the area - Noise: identified as produced from construction sites, basketball players and drinkers - Scarcity of facilities: such as playground or outdoor fitness equipment; participants tended to point at the upper garden as a potential location as there is no specific identified use for this part; as well as in the 'main event' space as it is only used for basketball - Inconvenience of basketball ground: as the basketball ground material is often selected as it was too soft and not suitable for bouncing basketballs - Inadequacy of greenery and vegetation within the area
Sense of community and integration	- Lack of community involvement: such as events and appropriate communication (information boards) about existing events - Lack of social gathering spaces: such as a café, a bookstore or an entertainment space

As these results are part of the simulation of participation, their content was used to prepare different improved future scenarios to use in the other studies. Additionally, the relative quantity and detail of the participants' feedback and the themes identified were compared with model B, see later in this chapter.

5.2.2 Results Experiment 2, Model versionB

5.2.2.1 Quantitative Results

The same questionnaire was used in experiment 2 as in experiment 1. Figure 5.9 and Table 5.11 show the mean scores, median and standard deviation values for the participants' answers to questions related directly or indirectly to realism during experiment 2 (version B). The general answers are favourable, with most answers being 'good' and 'very good'. 76.4% of the participants who viewed the model version B expressed their interest in using the mobile devices in future as a tool during a participatory decision-making process.

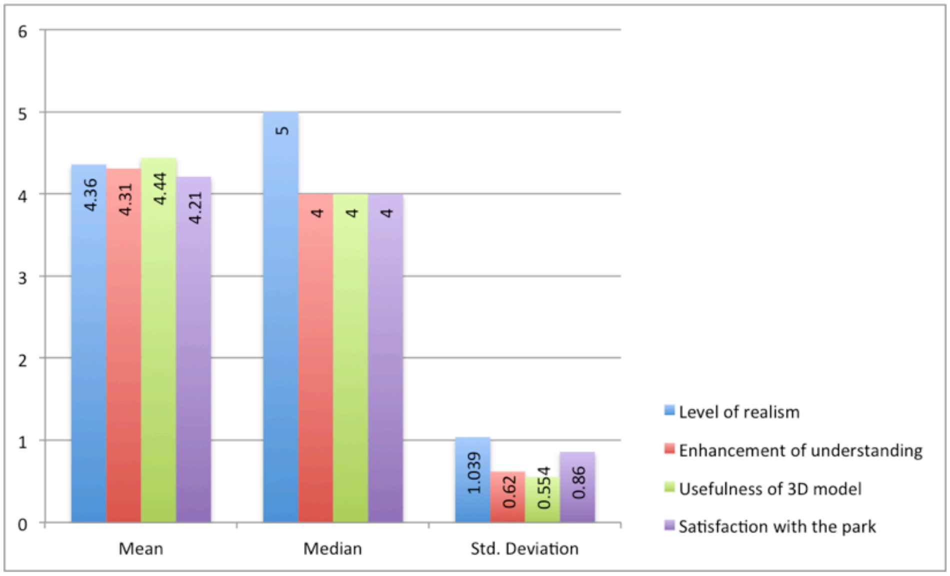


Figure 5.9 Bar chart of statistics for experiment 2 with the model version B

Table 5.11 Statistics for experiment 2 questions for the model version B

		Level of realism	Enhancement of understanding	Usefulness of 3D model	Satisfaction with the park
N	Valid	72	72	71	72
	Missing	1	1	2	1
Mean		4.36	4.31	4.44	4.21
Median		5.00	4.00	4.00	4.00
Std. Deviation		1.039	.620	.554	.860

Analysis of responses: Participant characteristics across questions

The significant results across questions according to the participant characteristics are explained below.

Age group

There was only one participant from the 45-64 age group, and none of the participants were over 65 years old. As a consequence, it was not possible to see the distribution and comparison of these categories.

Table 5.12 Results of Kruskal Wallis test to compare age groups for Experiment 2 for version B

	Level of realism	Enhancement of understanding	Usefulness of 3D model	Satisfaction with the park
Chi-Square	3.483	10.171	10.486	8.657
df	2	2	2	2
Asymp. Sig.	.175	.006	.005	.013

Kruskal Wallis Test, Grouping Variable: Age

The difference in age groups had a significant impact in the distribution for enhancement of understanding, usefulness of the 3D model and satisfaction with the park (Table 5.12). Kruskal-Wallis H tests shows that there is a significant difference, but does not indicate where the differences lie. So additional Dunn-Bonferroni post hoc tests were performed for the three pairs of groups (Table 5.13).

Table 5.13 Pairwise Comparisons of age on enhancement of understanding with model version B during experiment 2

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
45-64-18-24	7.678	18.514	.415	.678	1.000
45-64-25-44	26.591	19.176	1.387	.166	.497
18-24-25-44	-18.913	6.030	-3.137	.002	.005

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Table 5.14 Comparison of mean ranks of the responses for age groups for experiment 2 version B

	Age	N	Mean Rank
Level of realism	18-24	59	34.23
	25-44	11	44.09
	45-64	1	51.50
Enhancement of understanding	18-24	59	33.18
	25-44	11	52.09
	45-64	1	25.50
Usefulness of 3D model	18-24	59	33.31
	25-44	11	51.86
	45-64	1	20.50
Satisfaction with the park	18-24	57	32.38
	25-44	12	48.63
	45-64	1	56.00

The Dunn-Bonferroni post hoc test provided very strong evidence of significance between the age groups categories for this question. The adjusted p value (Adj. Sig.) showed that there was evidence of a difference between the 18-24 age group and the 25-44 age group participants ($p < .05$, $p = .006$ Kruskal-Wallis, $p = .005$ Dunn-Bonferroni). Table 5.14 shows that participants who belonged to the 25-44 age group (mean rank= 52.09) thought that the 3D model was more helpful for understanding the space than participants belonging to the younger group age (mean rank = 33.18). Participants belonging to the 45-64 age group rated the model's usefulness slightly lower than the other groups (mean rank = 25.50), though the difference was not significant.

Table 5.15 Pairwise Comparisons of age on usefulness of the 3D model version B during experiment 2

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
45-64-18-24	12.805	18.257	.701	.483	1.000
45-64-25-44	31.364	18.909	1.659	.097	.292
18-24-25-44	-18.559	5.946	-3.121	.002	.005

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

The Kruskal-Wallis test showed a significant difference concerning the usefulness of 3D models during the decision-making process in the participants' age categories (Table 5.12). The Dunn-Bonferroni test provided an adjusted p value smaller than .05 ($p = .005$ Kruskal-Wallis, $p = .005$ Dunn-Bonferroni), evidence of a significant difference in ratings given by participants of the 18-24 age group and those of the 25-44 age group (Table 5.15). According to Table 5.14, participants belonging to the 25-44 age group (mean rank = 51.86) found the 3D model more helpful during the decision making process compared to those belonging to the younger group (mean rank = 33.31). Although participants of the 45-64 age group rated the model's helpfulness lower than the two younger age groups (mean rank = 20.50), statistically it is not a significant difference.

Table 5.16 Pairwise Comparisons of age on satisfaction with the park for experiment 2 with version B

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
18-24-25-44	-16.248	5.955	-2.728	.006	.019
18-24-45-64	-23.623	18.914	-1.249	.212	.635
25-44-45-64	-7.375	19.515	-.378	.706	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

A Kruskal-Wallis H test showed evidence of a difference between the mean ranks of at least one pair of groups across the age categories for the distribution of the rating for satisfaction (Table 5.16). Younger participants rated their satisfaction with the park significantly lower than older participants ($p < .05$, $p = .013$ Kruskal-Wallis, $p = .019$ Dunn-Bonferroni). Table 5.14 shows that participants whose age was between 25 to 44 (mean rank = 48.63) rated the new design of the park higher than 18 to 24 years old participants (mean rank = 32.38).

Studentship

After performing the Mann-Whitney U test, it was observed that the distribution of the answers for all the questions was significantly different for students and non-students (Table 5.17).

Table 5.17 Results of Mann-Whitney U test to compare the groups for studentship status for experiment 2 version B

	Level of Realism	Enhancement of understanding	Usefulness of 3D model	Satisfaction with the park
Mann-Whitney U	282.500	261.000	319.000	200.500
Wilcoxon W	1878.500	1857.000	1915.000	1685.500
Z	-2.558	-2.843	-1.991	-3.783
Asymp. Sig. (2-tailed)	.011	.004	.046	.000

Grouping Variable: student

Table 5.18 Comparison of mean ranks of the responses for studentship status for experiment 2 version B

	Being a student	N	Mean Rank
Level of realism	Yes	56	33.54
	No	16	46.84
Enhancement of understanding	Yes	56	33.16
	No	16	48.19
Usefulness of 3D model	Yes	56	34.20
	No	16	44.56
Satisfaction with the park	Yes	54	31.21
	No	17	51.21

The Mann-Whitney U test demonstrated that the distribution of the ratings for the level of realism was significantly different for students and non-students ($p < .05$, $p = .011$). Those who participated as students rated the level of realism in the 3D model lower than non-students (Table 5.18, Figure 5.10). This means that non-students considered that the 3D model was closer to reality (mean rank = 46.84) compared to students who rated the realism lower (mean rank = 33.54). This result was the exactly opposite of experiment 1 with the model versionA.

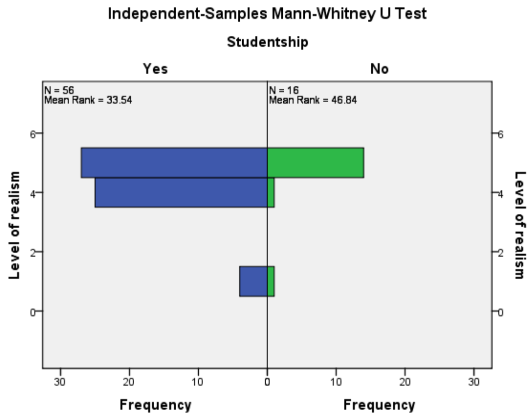


Figure 5.10 Comparison of mean ranks of the responses for studentship status and level of realism in version B

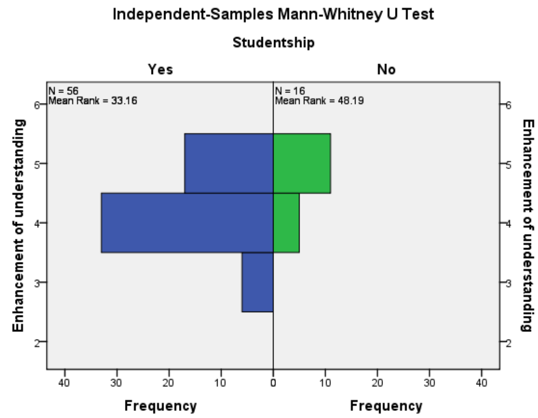


Figure 5.11 Comparison of mean ranks of the responses for studentship status and enhancement of understanding for experiment 2 with version B

The Mann-Whitney U test showed a difference between the ratings' mean given by students and non-students concerning the usefulness of 3D models in enhancing their understanding of the space ($p < .05$, $p = .004$). Non-students rated the model's enhancement of understanding higher than student participants (Table 5.18, Figure 5.11). Non-students rating of the 3D model's usefulness in such contexts showed a mean rank of 48.19, whereas students' rating of the same question only reached a mean rank of 33.16.

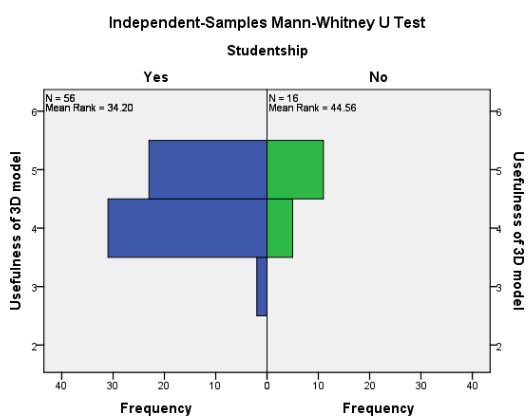


Figure 5.12 Comparison of mean ranks of the responses for studentship status and usefulness of the 3D model version B

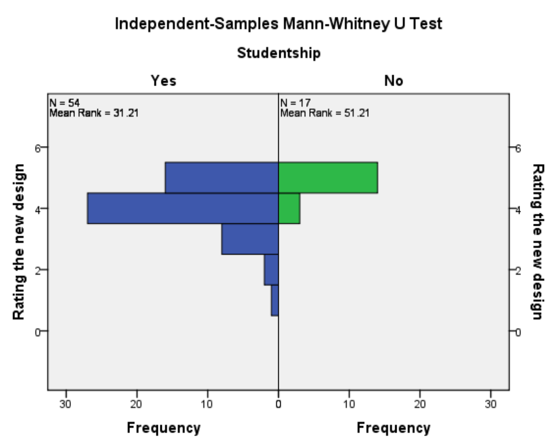


Figure 5.13 Comparison of mean ranks of the responses for studentship status and rating for the design of the park for experiment 2 version B

There was a difference between the ratings' mean given of students and non-students ($p < .05$, $p = .046$) concerning the mobile 3D model's usefulness in the decision-making process. Non-students rating of the 3D model's usefulness in such context showed a mean rank of 44.56, whereas students' rating of the same question only reached a mean rank of 34.20. Non-students thought that 3D mobile device models were more helpful than students (Table 5.18, Figure 5.12).

The Mann-Whitney U test provided evidence of a difference between the mean ranks of students and non-students ($p < .05$, $p = .000$) in terms of satisfaction with the park. Those who participated as students rated the new design lower than non-students (Table 5.18, Figure 5.13). This means that non-students thought that new design of the park was better planned (mean rank = 51.21) compared to students who rated the design lower (mean rank = 31.21).

5.2.2.2 Qualitative Results

When participants were asked what they liked about Edward Street Park, they drew attention to the following positive aspects of the park provided in Table 5.19.

Table 5.19 Positive aspects of Edward Street Park acknowledged during experiment 2, the model version B

Safety	- Lighting of the park is good during the nights and it increased the sense of safety,
Accessibility	- The park is safe as there are mostly students living around the area (especially for participants familiar with the area) - It is located in the heart of the community and in close proximity to both universities and the city centre
Attractiveness	- The park is peaceful, quiet, clean and relaxing with the flowers, particularly during spring time - The area gives the feeling of openness thanks to its view towards the hills and it is considered as spacious - Multi-purpose design and its unique features makes the area more attractive (natural stone use, different levels of terrain)
Sense of community and integration	- Basketball ground gives a chance for individuals to meet, - The main event space provides an environment for resident to meet and socialize; therefore it would encourage the sense of community by bringing people together.

One noticeable difference is that the viewers of version B commented on the spaciousness of the site area, while none of the version A viewers (experiments 1 or 2) made such a comment.

Even though the new design of the park was mostly rated 'good' and 'very good' in experiment 2, participants also pointed out a number of improvements presented in Table 5.20 as follows.

Table 5.20 Negative aspects of Edward Street Park pointed out for the model version B during experiment 2

Safety	- Illuminating the area with more lighting to improve safety, particularly around Solly Street stairs
Accessibility	- Improvement of transportation routes to the site while readjusting the regulations of traffic within the area (cars are not allowed in the area however drivers do not respect that interdiction and it is not enforced)
Attractiveness	- Changing the material of the basketball ground, or reallocate the ground as a multi-use games area - Improvement of management and maintenance within the park (concerning trash and overgrown plants)
Sense of community and integration	- Enlargement of the area with more greenery and more activities zones including new equipment, sports facilities, new games and water features - Planning more events, possibly with a multicultural aspect, to support communication between the residents and add more attractions to the site - Adding new sitting areas with more suitable materials (currently all of them are stone) within the park with tables if possible.

5.2.3 Results for versionA during experiment 2

Below are the results from experiment 2, when showing the model version A to participants. In order to verify participants' ratings during experiment 1, which took place on inauguration day; version A was tested again one year later with the same questions. Table 5.21 and Figure 5.14 shows the mean scores, median and standard deviation values for responses. The responses from the two experiments with the model version A were merged and are analysed in section 5.2.4.

Among the participants, 80.8 % reported that they were willing to use mobile devices in future participation processes.

Table 5.21 Statistics for experiment 2 questions for the model version A

		Level of realism	Enhancement of understanding	Usefulness of 3D model	Satisfaction with the park
N	Valid	26	26	26	26
	Missing	0	0	0	0
Mean		4.04	3.92	4.12	4.21
Median		4.00	4.00	4.00	4.00
Std. Deviation		1.216	.744	.711	.784

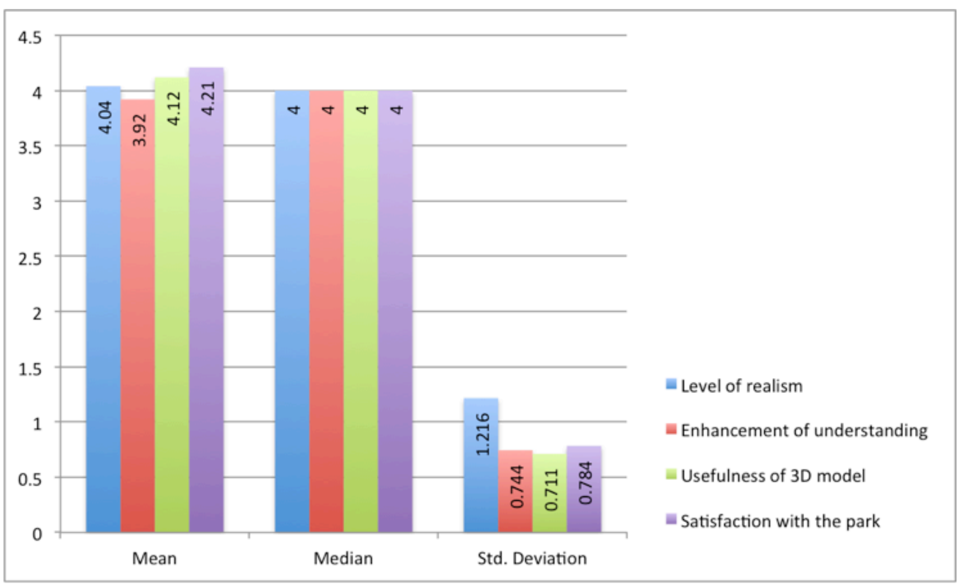


Figure 5.14 Bar chart of statistics for experiment 2 with the model version A

Analysis of responses: Participant characteristics across questions

There was no significant result for user characteristics on perception of realism, enhancement of understanding with mobile devices or willingness to use mobile devices for the decision making process when offered. Only the satisfaction with the park and the usefulness of 3D models regarding decision-making process showed significance for participant characteristic of studentship status.

Studentship

This was the only demographic factor that resulted in significant differences in participants' ratings across two questions. Only satisfaction with the park (p = .041) and usefulness of the 3D model (p = .023) responses significantly differed for studentship status (Table 5.22).

Table 5.22 Results of Mann-Whitney U test to compare the groups for studentship status for experiment 2 with the model version A

	Level of realism	Enhancement of understanding	Usefulness of 3D model	Satisfaction with the park
Mann-Whitney U	37.000	29.500	18.000	21.000
Wilcoxon W	268.000	260.500	249.000	252.000
Z	-1.095	-1.612	-2.449	-2.245
Asymp. Sig. (2-tailed)	.274	.107	.014	.025
Exact Sig. [2*(1-tailed Sig.)]	.340[b]	.138[b]	.023[b]	.041[b]

Grouping Variable: student, Not corrected for ties.

Table 5.23 Comparison of mean ranks of the responses for studentship status for experiment 2 the model version A

	Being a student	N	Mean Rank
Level of realism	Yes	21	12.76
	No	5	16.60
Enhancement of understanding	Yes	21	12.40
	No	5	18.10
Usefulness of 3D model	Yes	21	11.86
	No	5	20.40
Satisfaction with the park	Yes	21	12.00
	No	5	19.80

The Mann-Whitney U test provided a significant difference (p < .05, p = .023) in terms of the participants' rating of the usefulness of the 3D mobile device model during the decision-making process. Non-students agreed that the 3D model was relatively helpful (mean rank = 20.40) compared with students (mean rank = 11.86) as shown in Table 5.23 and Figure 5.15.

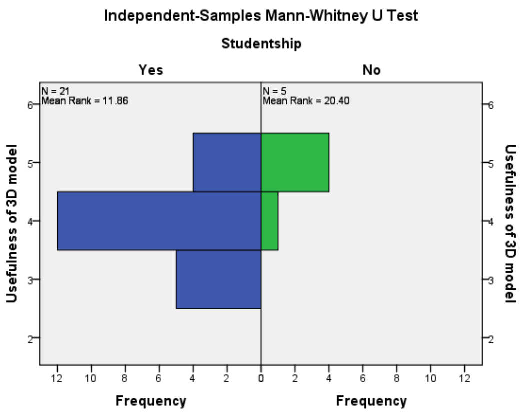


Figure 5.15 Comparison of mean ranks of the responses for studentship status and usefulness of the 3D model for experiment 2 with the model version A

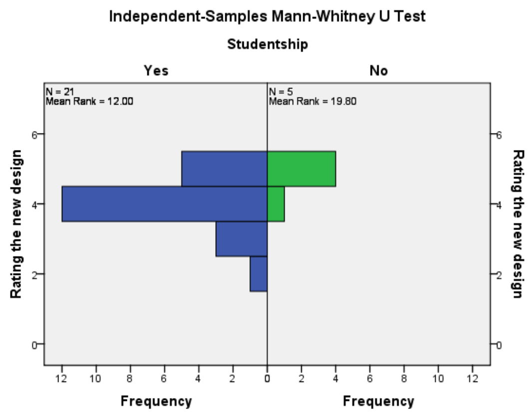


Figure 5.16 Comparison of mean ranks of the responses for studentship status and rating for the new design of the park for experiment 2 with the model version A

The Mann-Whitney U test provided evidence of a difference between the mean ranks of students and non-students ($p < .05$, $p = .041$). Students rated the new design of the park lower than non-students (Table 5.23 and Figure 5.16). This means that non-students (mean rank= 19.80) found the park better designed than students (mean rank=12.00).

5.2.4 Merged Results for model versionA

In order to check the validity of the results in study 1, the responses from both experiments when using model version A were combined. The combined results were then tested to verify if there was any significant change from the individual experiment results.

There was no significant result for the realism of the 3D model on the mobile device or satisfaction with the park. Neither usefulness of 3D mobile devices nor willingness to use these devices in the future for decision making processes provided evidence for significance. Only the usefulness of the 3D model to enhance understanding of the space showed significant differences for studentship status. In total, 77.4 % of all respondents who viewed the model version A would be interested in using the 3D visualization on mobile devices in the future.

Age

The Kruskal-Wallis H test showed possibility that the distribution of 3D model enhancement of understanding could be different across age categories ($p < .05$, $p = .022$). Pairwise comparison between ages showed that there was not a significant difference between the age groups.

Studentship

The only question to which the answers varied significantly were concerning the participants' ratings of the 3D model usefulness to understand the space.

The Mann-Whitney test provided evidence of a significant difference in the model version A merged responses between students and non-students ($p < .05$, $p = .030$, Table 24) for the mobile 3D model's ability on enhancing understanding. Non-students were more in favour of 3D models than students in terms of enhancement of understanding (Figure 5.17). This means that non-students agreed more strongly that the 3D model promoted understanding of the space (mean rank = 56.35) compared to students (mean rank = 45.52).

	Enhancement of understanding
Mann-Whitney U	1,511.000
Wilcoxon W	2,592.000
Test Statistics	1,511.000
Standard Error	124.018
Standardized Test Statistic	2.169
Asymptotic Sig. (2-sided test)	.030

Grouping Variable: student, Not corrected for ties.

Table 5.24 Results of Mann-Whitney U test to compare the groups for studentship status and enhancement of understanding for experiment 1 and 2 merged responses for model version A

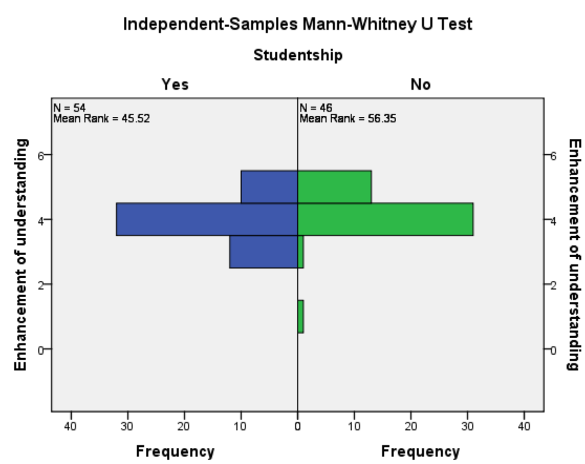


Figure 5.17 Comparison of mean ranks of the responses for studentship status and enhancement of understanding for experiment 1 and 2 with the model version A

5.2.5 Comparison of the two experiments' results

For the last step of this study, the two experiments' (version A merged and version B) results were compared to see whether the differences in accuracy and elaboration of the two 3D models seemed to have influenced the participants' experience and ratings. These results offer an insight for future research regarding the necessity to spend time in improving realistic details while preparing 3D models, deciding whether a conceptual 3D model is enough to yield results during the decision-making processes.

According to mean, median and standard deviation values provided in Table 5.25, the majority of the participants in both experiments gave positive rates for the questionnaire as a whole. Further analyses were run in order to compare the significant differences between the two models, taking into account the merged responses for model version A, and responses from model version B. The significant differences are presented below.

Table 5.25 Comparison of mean, median and standard deviation for experiment 1 and 2

		Satisfaction with the park	Enhancement of understanding	Level of realism	Usefulness of 3D model
Version A Experiment 1	Mean	4.24	4.13	4.33	4.27
	Median	4.00	4.00	4.00	4.00
	Std Deviation	.738	.632	.524	.635
Version A Experiment 2	Mean	4.15	3.92	4.04	4.12
	Median	4.00	4.00	4.00	4.00
	Std Deviation	.784	.744	1.216	.711
Version B Experiment 2	Mean	4.21	4.31	4.36	4.44
	Median	4.00	4.00	5.00	4.00
	Std Deviation	.860	.620	1.039	.554

Realism was generally well rated in the two experiments. Differences can be noted in the ratings when comparing the results of experiments 1 and 2: participants clearly gave model B a higher score than model A in perceived realism, enhancement of understanding and usefulness of 3D models on mobile devices. The highest mean values for these aspects were given for the model version B; mean values for model version A during experiment 1 were second and those for version A during experiment 2 last. Only satisfaction with the park ratings showed a different trend to the others. The inauguration event influenced ratings so mean values show the highest satisfaction, regardless of the model or its accuracy, for experiment 1.

Analysis of responses: Participant characteristics across questions

Age

There were several instances of significance between age and differences of ratings between model A and B, in all cases it was the 25-44 age group that brought significant results.

The Kruskal-Walls indicated significance for realism ($p < .05$, $p = .033$) for different age groups. However, the Dunn-Bonferroni test did not provide any significance after the pairwise comparisons, so there is no evidence to make a conclusion between perception of realism and the participants' ages.

For the enhancement of understanding, the Kruskal-Wallis showed evidence of significance for the age categories ($p < .05$, $p = .003$) followed by Dunn-Bonferroni tests to determine which groups have differences (Table 5.26). Across the 25-44 age groups (Adj. Sig. = .002), the participants rated the model version A lower (mean rank 76.37) for that question, than participants from the same age group rated the version B (mean rank 135.91).

Concerning the usefulness of the 3D model during the decision-making process, this question obtained a significantly different score among the 25-44 age group ($p < .05$, $p = .037$) across the two models. Pairwise comparisons (Adj. Sig. = .040, Table 5.26) showed that people who used version A and were part of the 25-44 age group gave a lower rating (mean rank 87.97) than the participants of the same age group who viewed model version B (mean rank 134.41).

Table 5.26 Pairwise Comparisons of age by models version A and B

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
18-24 & version A - 18-24 & version B (satisfaction)	-3.702	8.590	-.431	.666	1.000
25-44 & version A - 25-44 & version B (satisfaction)	-24.096	15.529	-1.552	.121	1.000
45-64 & version A - 45-64 & version B (satisfaction)	-33.667	48.138	-.699	.484	1.000
45-64 & version A - 45-64 & version B (Understanding)	32.600	46.447	.702	.483	1.000
25-44 & version A - 25-44 & version B (Understanding)	-59.541	15.361	-3.876	.000	.002
18-24 & version A - 18-24 & version B (Understanding)	-8.531	8.120	-1.051	.293	1.000
45-64 & version B - 45-64 & version A (usefulness)	45.545	46.606	.977	.328	1.000
18-24 & version A - 18-24 & version B (usefulness)	-11.929	8.181	-1.458	.145	1.000
25-44 & version A - 25-44 & version B (usefulness)	-46.439	15.478	-3.000	.003	.040
18-24 & version A - 18-24 & version B (realism)	-18.064	8.436	-2.141	.032	.484
25-44 & version A - 25-44 & version B (realism)	-31.545	16.019	-1.969	.049	.734
45-64 & version A - 45-64 & version B (realism)	-33.125	47.891	-.692	.489	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

The Kruskal-Wallis indicated that there was a significant difference between age groups for the satisfaction with the park ($p < .05$, $p = .005$). Dunn-Bonferroni only confirmed one of the significances between different age groups from the experiments, as 18-24 age group with the model version A and 25-44 age group with model version B. The results were not comparable as they were not the same age groups, so the rating of the new design did not differ for the age groups in the experiments.

Studentship

Across the two models, there was a significant difference in the ratings given by non-students for several questions (Table 5.27). A significant difference was found concerning non-students' rating of realism between the two experiment groups viewing different models ($p < .05$, $p = .008$). Pairwise comparison confirmed the significance with Adj. Sig. = 0.004. Non-students participants who viewed version B rated it higher (mean rank of 120.06), than the non-students who viewed model version A (mean rank of 75.02).

Table 5.27 Pairwise Comparisons of studentship by models version A and B

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
student- version B – student - version A (satisfaction)	8.036	8.672	.927	.354	1.000
non-student - version A – non-student - version B (satisfaction)	-40.541	12.945	-3.132	.002	.010
student- version A – student - version B (understanding)	-15.902	8.335	-1.908	.056	.338
non-student - version A – non-student - version B (understanding)	-33.598	12.683	-2.649	.008	.048
student - version A – student - version B (usefulness)	-11.231	8.334	-1.348	.178	1.000
non-student - version A – non-student - version B (usefulness)	-28.353	12.742	-2.225	.026	.156
non-student - version A – non-student - version B (realism)	-45.041	13.129	-3.431	.001	.004
student - version A – student - version B (realism)	-3.564	8.588	-.415	.678	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

The question on enhancement of understanding showed evidence of significant difference ($p < .05$, $p = .000$) across models for non-students (Adj. sig. = .048) as shown in Table 5.27. Non-students who were shown the model version B rated the question higher (mean rank 123.35) than those non-students who saw the model version A (mean rank 89.65).

Similarly, a significant difference could be found regarding the satisfaction with the new design of the park ($p < .05$, $p = .001$). Differences were observed among non-students with 0.010 significance (Adj. Sig.) during the pairwise comparisons (Table 5.27). The non-students that viewed the model version B rated the park higher (mean rank 126.44) than non-students who were shown the model version A (mean rank 85.90). In other words, non-student participants who saw the model version B, rated the new park design better than non-student participants who saw the model version A did.

Even though the Kruskal-Wallis test showed evidence of significant difference for the question of usefulness of the 3D model ($p < .05$, $p = .037$) across models regarding studentship status, further Dunn-Bonferroni tests did not confirm the significance between the pairs.

Familiarity

Concerning the question related to the enhancement of understanding, the Kruskal-Wallis test showed evidence of significance ($p < .05$, $p = .029$) across models. The Dunn-Bonferroni test confirmed that there was significance (Table 5.27), but only for participants who declared not being familiar with the site (Adj. Sig. = .040). Among the participants that were not familiar with the site, those who viewed the model A rated this question lower (mean rank 71.50) than those who viewed the model B (mean rank 106.21). This would seem to indicate that participants that were not familiar with the site found that a detailed and realistic model was useful to make sense of the space for the first time.

Table 5.28 Pairwise Comparisons of familiarity by experiments

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
not familiar & version A – not familiar & version B (understanding)	-34.711	12.778	-2.716	.007	.040
familiar & version A- familiar & version B (understanding)	-7.375	8.123	-.908	.364	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Qualitative results comparison

One noticeable difference is that the viewers of versionB commented on the spaciousness of the site area, while none of the version A viewers (experiments 1 or 2) made such a comment. This suggests that different levels of accuracy have an impact on participants' visualization experience and how they evaluate the site's design.

5.2.6 Tables with 3 volumes for all the parts including qualitative responses

During study 1 participants were asked what they like and dislike about the park with open ending questions. The content of these tables was used to prepare different design proposals to use in study 3. Table 5.29 gives the positive aspects of the park acknowledged by users and what people find attractive about the site.

Table 5.29 Positive aspects of Edward Street park acknowledged by users

Theme	Positive Aspects Version A (Experiment 1)	Version A (Experiment 2)	Version B (Experiment 2)
Safety	- Safer compared to its previous condition - Safe for children to play. - "Better than before"	- It is comforting - It is safe - 'It has made walking about here a lot more safer' - Well-lit during the nights	- Safe environment - 'An improvement from what it looked like before.'
Accessibility	- Close proximity to universities as it is a convenient location for students - Accessible environment for all residents as it is located in the heart of the community.	- Close to the grocery shop - Close proximity to universities, therefore a lot of students - Close to town - Popular for new students	- Close to the grocery - Creative walking paths - Communal for everyone
Attractiveness	- Peaceful, clean and inviting environment in densely built up area, - Utilities for residents (for example, a basketball ground), - Green environment with flowers and meadows - 'Use of stones, tiered construction, flowerbeds'	- Greenery -Flowers - Utilities for residents	- 'I really like to come here and enjoy the sun and look at people playing basketball.' - 'colourful, calm, peaceful and green.' - Utilities for residents (basketball ground) - Spacious, clean and quiet - 'Open Space with good views of the hills and buildings.'
Sense of community	- Multiple spaces for diverse activities and various events ('there is cinema screen and music on the day') - A space for community to gather and socialize ('Now it is very well used all the time')	- A space for students to meet	- Multi-functional area - 'It is really good. The park is perfect for hanging out with friends and relatives. Also it's really good place for relaxing.' - 'More community feeling'

Study 1 was the preliminary study to examine the effects of mobile device use in terms of understanding and perception as well as to reflect on the user needs in the future within the study. The negative aspects pointed out by the users are presented in Table 5.30.

Table 5.30 Negative aspects of Edward Street Park pointed out by users

	Negative Aspects		
Theme	**Version A (Experiment 1)**	**Version A (Experiment 2)**	**Version B (Experiment 2)**
Safety	- Especially during night-time because of the inefficient and insufficient street lighting ('I cannot see any problems but I really concern about the security here') - Drunk people and their being noisy during the nights, particularly around the stairs.	-More lights are required	-Need more lighting
Accessibility	-Lack of shortcuts within the area ('the inside does need redesigning' and 'shortcuts. It is not designed to access the street quicker')	N/A	- It is a bit out of the city centre - Steps are steep - Better links for transportation
Attractiveness	-Littering ('Bins caretaking' and -Noise -Scarcity of facilities -Inadequacy of greenery and vegetation within the area; -Inconvenience of basketball ground	- More greenery - Not enough bins - Proper basketball ground - Vegetation management in the park	- Littering - Current facilities should be improved and more facilities should be added - Basketball ground - Maintenance of the park - More greenery -'There's not enough space for more activities.'
Sense of community	- Lack of community involvement - Lack of social gathering spaces	- More sport facilities -Insufficient events for multicultural community	- It can be more multi-functional

5.3 Discussion

5.3.1 Limitations of the study and results

Study I was a preliminary series of experiments to prepare for the next step of the research, and there were some weaknesses in the experiment design at this first stage of the research. On the official opening day, the 3D model of the site was not yet complete. Since the project designed by Sheffield City Council was implemented before the visualizations were ready, the incomplete model (version A) was used. Eventually the inaccuracies in version A were fixed in model version B as explained in general methodology chapter (Chapter 3).

The fact that the project was already partially implemented and the park was opened when the participants viewed the visualizations could have affected the participants' perception and level of engagement. Even though the project was not finalized and there was additional funding to modify or redesign approximately 30% of the park, there is a possibility that participants did not experience this study as real-life participation. In this sense, study 1 failed to achieve the initial aim to collect participants' feedback to 3D visualization on mobile devices on a landscape project before implementation. This failure was acknowledged and a different approach was developed to adapt to the constraints linked with the independent schedule of the VALUE+ project. This limitation could also be considered as a clear advantage for participation as the park being partly finished gave users an opportunity to experience the park and recognise unsatisfactory features and problems. A site which is under construction would not give this advantage to users, as it would be empty and people would be prohibited from entering.

Apart from this major limitation, smaller issues have been detected during the analysis. Although the pilot study was successful, the researcher failed to notice that two of the statements used in the survey could be considered as leading questions, that is, 'The level of realism in the 3D model was very good' or 'The 3D Model enhanced understanding of the space and proposed plan'. It should be taken into consideration that these statements may have had an effect on participants' responses for these two specific statements.

Another issue was that the participants' sample was not homogenous. Notably it contained a large number of students, while some categories of local residents could not be reached at all. One of the reasons for this imbalance is a characteristic of the site: located close to the university, it is heavily inhabited by students that tend to not be as invested in their neighbourhood as non-students. Since the research was linked to the VALUE+ project, the site could not be changed. Another reason for the sample's heterogeneity was that the researcher chose to take her own safety into account when recruiting passer-by on the site. By avoiding door-to-door recruiting, the researcher could not reach all kinds of the site's users. In future research such issue could be avoided by having a team collect data rather than an individual alone. To improve reaching out to local residents, future research could rely more heavily on the help of the city council or local societies. Another way to reach residents more widely could be to use a downloadable application for them to use at home or on-site whenever time allows. As mentioned in literature review not only would this method lose some degree of person-to-person contact that was a specific part of this research, but it would also potentially exclude population such as elderly or impaired people, as well as those who do not own mobile devices.

Among the underrepresented groups in the participant samples, one demographic group was notably small: participants over 45 years old. From their oral and written comments, it appears that some of the over 45 year old participants that were recruited were enticed to participate thanks to the inauguration event, so it is possible that the lack of events taking place within the site impeded the participation process. Since two third of the participants were from students from the age group 18 to 25 years old, the results for this population are convincing in number and are expected to be replicable in other studies.

5.3.2 Discussion of results linked to demographics

Age

From the results of study 1, the participants' age appeared to correlate with how they understood and perceived their surroundings (the park) and the participation tool. For example, when using model version B, the 18-24 and 25-44 age groups showed significant differences in their answers when asked about the usefulness of the visualization tool. The younger age group was significantly more critical in this respect than the older participants. Not surprisingly, the same age groups showed significance for mobile devices' enhancement of understanding for the latest version of the model. Younger respondents rated the visualization tool's enhancement of understanding lower than 25-44 age group. Appleton and Lovett (2003) suggested that people who are less familiar with computer graphics might have lower confidence while interpreting visualizations and higher expectation from the visualizations as they may compare the effects they see in movies, while Schroth and Schmid (2006) stated that young people, 'generation Playstation', would have higher expectations as they are used to more complex 3D images and tools. So the interpretation of this difference of ratings in this research could be that young participants are more likely to use mobile devices daily and would therefore be more familiar with them and have a keener awareness and higher expectations of the model's quality than older generations.

Comparatively speaking, the 25-44 age group seemed more receptive to the degree of realism of the model than other age groups. This age groups' rating of several questions was proportionate with the level of accuracy of the model. When both model versions were compared, there was a significant difference between participants of 25-44 year-old groups regarding their rating of the usefulness of the 3D mobile device visualizations. The more accurate the model was, the higher it was rated. Similarly, the same age group rated the visualization tool as enhancing their understanding of the space higher with model B than model A. For this specific age group, it seems that participants' understanding of the model was affected by the level of accuracy of the model. Viewing a detailed and accurate visualization of the area appeared to help 25-44 year old participants to understand the space.

Despite such results being in line with the expectations, the ratings across all participants were generally positive. Watzek and Ellsworth (1994) suggest that 'certain visual simulations do not require complete accuracy and that there is a range of scale variation for a project's depiction that viewers essentially perceive as being identical to the base of comparison, and thus to the existing reality'. Depending on the budget and time available in participation projects, it might not always be essential to invest in a more detailed model to obtain meaningful participation. Watzek and Ellsworth (1994) still warn that the existence or absence of landscape elements in the visualizations may affect the perception of participants, so the exact level of accuracy needed for the participation to yield meaningful results would require fine-tuning and repeated experimentation.

Studentship

Students were the most represented demographic in the study, and studentship was often shown as significant in the results obtained. One of the significant results, the most difficult to interpret, was that students found the model version A more realistic compared to non-students. Yet one year later, when shown model version B, students rated it as less realistic, while non-students rated model B better in terms of realism. When comparing the results of both experiments, it could be seen that non-student participants were generally more aware of the level of accuracy of the models. One possible interpretation is that students who participated during the inauguration day were influenced by the event to give higher ratings than normal. Most of these students were spontaneously taking part in the inauguration event. During experiment 2, all students were recruited from passers-by who were probably in a different frame of mind to the participants on the inauguration day. Smith (2012a) suggests that events organized around urban regeneration projects can help to promote positive effects.

Even though students were more difficult to satisfy with the model and the design (except the inauguration day) they are also easier to attract with mobile devices. Previous research indicates that use of technology encourages greater student engagement and understanding (Roca and Gagné, 2008; Shen, Liu and Wang, 2013, Fonseca et al., 2014). Students might expect good graphics from their use of games and movies be more used to mobile devices and better quality computer graphics (Bishop, 2011), and so be more critical. Despite their difference in ratings, the student participants still generally said that they understood the idea being conveyed.

Rice (2003) said that scale and details in the spatial structure do not have an impact on understanding the visualizations for design students. However, in this research when comparing the results of both versions of the model, there were significant differences between non-students who saw version A and those who saw version B. Non-students rated versionB as more realistic than version A. Participants' view of what is realistic could depend on their expectations (Appleton and Lovett, 2003; Schroth and Schmid, 2006). Similarly, non-students rated version B as enhancing their understanding of the space more than version A. There seemed to be a correlation between non-students' appreciation of the park's design and the level of accuracy of the model, with their satisfaction higher with model B. Since non-students were also seen to be more aware of the model's accuracy, perhaps this population considered the visualization as a tool to evaluate advantages and disadvantages of the park more objectively.

Familiarity

It was the researcher's expectation that participants' familiarity with the site would have an influence on their perception of the park (Lange, 2001; Appleton and Lovett, 2005; Karjalainen and Tyrvainen, 2002; Belveze and Miller, 2005). It has been shown that their familiarity with the site can affect participants' notions of realism (Appleton and Lovett, 2005; Lange, 2001). During the experiment 1, participants who were familiar with the site rated the 3D model on mobile devices as enhancing their understanding of the space higher than those who were not familiar with the site. However, when the two models were compared, the participants who were not familiar with the site showed a significant difference. The participants who were not familiar with the site and shown version B rated the visualization tool higher in terms of enhancement of their understanding of the space than people familiar with it who were shown the same model. These results show that for participants who were familiar with the site, the level of accuracy did not matter as much as it did for people who were unfamiliar with it. As Bishop and Rohrmann (2003) suggested in relation to the level of realism of the presentations, it is important for future studies to note that participants who are not familiar with the site tend to be more critical of the model's level of accuracy and realism when it comes to understanding a space and interpreting the visualizations.

5.3.3 Conclusion

Although it is usually difficult to engage participants by traditional means for public participation (Roth, 2006), it was surprisingly easy to recruit passers-by for study 1. The sample size demonstrates that to a certain extent, mobile devices have the power to attract participants spontaneously, especially the younger age groups and students (Fonseca et al., 2014). This was especially encouraging as study 1 was a preparation for the main part of this research, study 3, to test the on-site use of mobile devices, and confirming the fact that participants were readily recruited on-site was essential. The surprising differences of ratings given by students between experiments 1 and 2 also confirmed that on-site participation is affected by a number of factors, some of which are not controllable such as the lack of events in the area.

Despite the large sample size, many results were not significant, but it was very encouraging that overwhelmingly, all participants rated all aspects of the questions linked with the 3D models positively. Despite some significant results linked with demographics (studentship, age, familiarity with the site), study 1 was not conclusive regarding the higher accuracy of the model being crucial to the participants' understanding. Model A, which the researcher considered incomplete in terms of accuracy, could still convey the concepts of the park's design. The question remains to fine-tune the level of accuracy that is needed for a reasonable understanding of the space or proposal represented.

Study 1 was successful in collecting a large amount of feedback on the site and what participants wished to see changed in the future. At this early stage of the research, study 1 provided a foundation for the charrette (Appendix D) whose suggestions were exclusively created by designers and Council stakeholders. Since the focus of study 1 was on accuracy, the researcher used a traditional form of participation to obtain the feedback, a paper-based questionnaire. The walkthrough video of the site used in study 1 was also not interactive. So the researcher designed study 2 as an interactive experiment to collect feedback using mobile devices directly, without any written questionnaire.

Chapter 6

6 Gathering design ideas through a mobile device

6.1 Method

6.1.1 Research narrative for study 2

After examining the impact of the level of accuracy of the model and its possible effects on understanding and satisfaction, the research moved on to the consultations on giving participants increased decision-making power. The aim of this activity was to gain the opinion and feedback of the stakeholders, engage them in collaboration and enhance public participation during the participatory design process.

The public participation event was held on 15 October 2013, during which a three day long charrette was organised by the VALUE+ Project to collect stakeholders' input. The aim of the charrette was to introduce to local people the use of mobile device visualizations for decision-making and to engage them in a participatory design process. Participants would be able to give suggestions on issues relating to the project site by making sketches using a stylus pen on a mobile device. The participants were expected to be a diverse group of stakeholders, including the members of the public who were most concerned by the use of Edward Street Park.

Despite prior dissemination of the charrette's date and aims, none of the local public or citizens attended the charrette, the only participants were international students and teaching staff from the University of Sheffield, Van Hall Larenstein University (The Netherlands) and University of Manchester, alongide VALUE+ partners from Sheffield City Council (design proposals developed during the charrette can be found in Appendix D). Since the charrette failed to appeal to the local users of Edward Street Park, there was a need to rethink how to reach those stakeholders to communicate and collect data about their understanding and perception of visualizations and their surroundings. After consideration, the researcher decided to conduct one-to-one consultations with ZoomNotes application as follows.

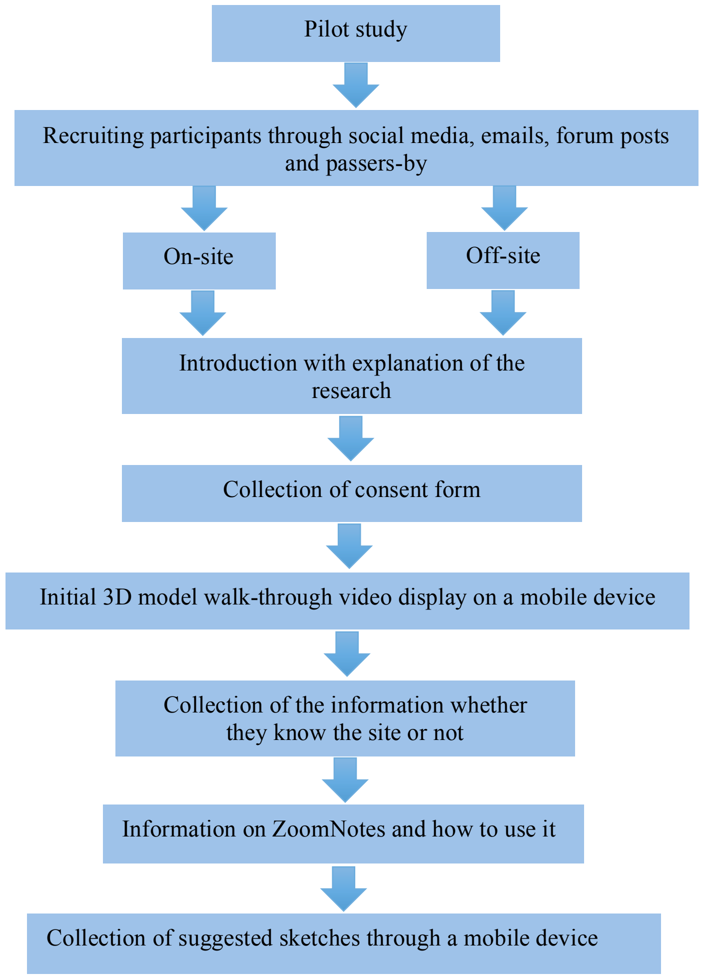


Figure 6.1 Process of gathering design ideas through a mobile device for study 2

During this study, participants were both recruited in advance and spontaneously on the site (4.1.2.1). Once recruited, the participants were given the chance to propose concrete changes within the project area. They were asked to use a stylus pen to sketch their suggestions on one or several digital views of Edward Street Park using the mobile application ZoomNotes following the process shown in Figure 6.1. While holding the mobile device, the participants were encouraged to give their personal input by the researcher, who used casual spoken questions. The focus was on the use of mobile devices as a design tool to engage the public in decision-making both on-site and off-site, identifying issues and envisioning solutions to the problems. This chapter describes this part of the research process.

Sketches made during this study were analysed in terms of frequency of occurrence for each viewpoint. Qualitative data collected during study 1, sketches made during study 2 and design proposals produced during the charrette were taken into consideration while preparing viewpoints to be used in study 3.

6.1.2 One-to-one consultation design

There was no questionnaire for this study. Questions were asked in order to gather ideas aimed at identifying the problems and soliciting solutions to those problems. They included: 'What is wrong with the park in your opinion?', 'How would you improve it?', and asking them to express their ideas through sketching with ZoomNotes application.

6.1.3 Pilot study

A pilot study was conducted with ten people (five on-site and five off-site) to test the application and its use for gathering design ideas for changes and improvements. It also helped to clarify the explanation of the study and what participants were expected to do. During the pilot study, participants were informed that there was additional funding to change approximately 30% of the site. Participants remained hesitant in giving significant suggestions, and when asked why, said that because they were concerned about the funds available. For that reason, during the actual consultation sessions the participants were encouraged to suggest any solution to potential issues within the site, without considering the budget or the percentage of the site which would be affected. They were asked to suggest any possible change or improvement to bring solutions to the problems that they have experienced or noticed.

6.1.4 Consultation choreography

This study was conducted in two different settings, on-site and off-site. On-site participants were asked to take part at the corner of Edward Street where study 1 took place. The off-site participants were asked to complete the task in the Information Commons, a university building. In both cases, the consultation started with icebreaker questions, information about the research and the process of the session. Then participants were shown the video and given brief training in handling the ZoomNotes application before starting to draw sketches as suggestions.

Both off-site and on-site participants were shown the one-minute long 3D model walk-through video of the site and asked to come up with suggestions for the possible issues or improvements. The walk-through video was prepared to allow participants to become familiar with the environment in case they had no prior knowledge of the area. After the video, they were asked to think about the issues the area might have, and make suggestions to bring a solution.

Participants were then trained in using ZoomNotes. The researcher demonstrated the different pens types available, and then the participants were asked to play with different colours and thicknesses until they felt comfortable using both the stylus pen and the application. Later, participants were asked to make sketches of their suggestions for one or more viewpoints. There were six predetermined viewpoints available for participants to modify, chosen among the areas that participants from Study 1 and the charrette had found the most problematic.

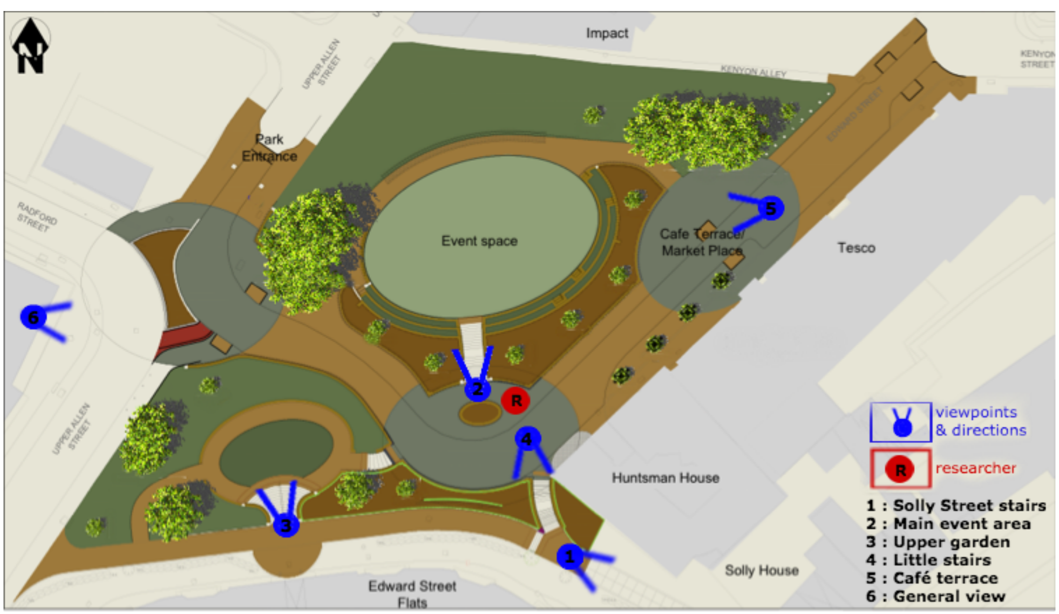


Figure 6.2 One-to-one consultation on-site location for the researcher and directions of the viewpoints

Figure 6.2 shows the six viewpoints and their directions as well as the location where the researcher was located. The viewpoints provided for both on-site and off-site participants were the same as shown in Figure 6.2. Figure 6.3 illustrates the layout of the location for off-site participants.

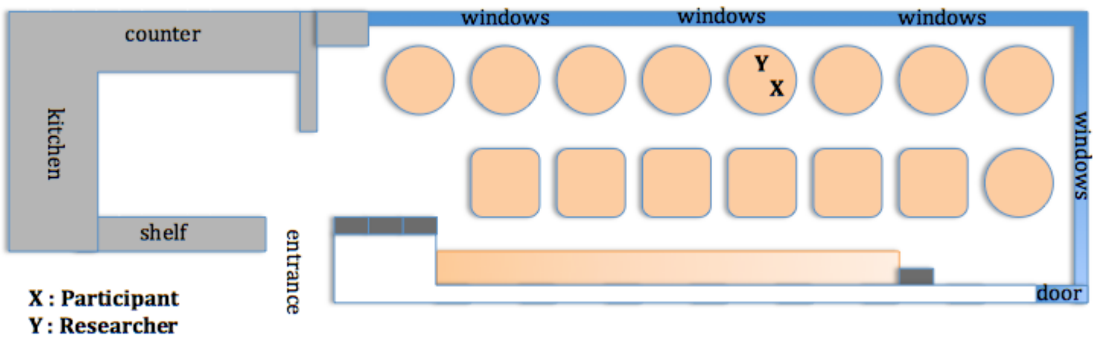


Figure 6.3 One-to-one off-site consultation layout (not to scale)

The participants were only asked open-ended questions regarding how to improve the site. The aim was to encourage the participants to explore the problematic areas of the site looking for solutions, improvements or changes to make, in an interactive and comprehensive way. As Wellington and Szczerbinski (2007) wrote, consultations can often reveal experiences, views and concepts, which other methods cannot. It was hoped that allowing participants to sketch their ideas in addition to giving verbal rather than written explanations would allow them to be creative, imaginative and constructive.

The six viewpoints included rendered images of Solly Street stairs, main event space, upper garden, little stairs, café terrace and a general view (Figure 6.4). The walk-through simulation gave participants the opportunity to move quickly within the location, while the predetermined viewpoint renderings provided a different perspective with detailed landscape features from a static observer's view (Lange, 2001). Each photo represented a different detailed viewpoint. The exception was the 'general view' that presented a bird-eye overview image of the site to allow participants to notice general issues within Edward Street Park.

Figure 6.4 Predetermined viewpoints (top left) Solly Street stairs, (top centre) main event space, (top right) upper garden, (bottom left) little stairs, (bottom centre) café terrace, (bottom right) general view

The participants chose one or more predetermined viewpoint after viewing them all. They then made suggestions regarding changes and improvements by removing or adding parts of the design through sketching on the rendered photos rather than describing them verbally. This also enabled the researcher to observe the participants while they revealed experiences, opinions, and concepts, in casual comments which other participation methods cannot access as comprehensively.

6.1.5 Participant sampling

The participants were recruited both in advance and spontaneously. Advance participants were contacted through emails (General methodology chapter, section 4.1.2). Volunteers who replied to the email sent through the University of Sheffield email list and posts were asked to fill a Doodle pool to book a time slot to meet the researcher with their preference of participation place, either on-site or off-site. The participants were given the flexibility to choose from mid-August to the end of October. Among participants recruited in advance, 104 preferred to meet at the Information Commons (IC) Cafeteria (off-site), while 23 chose to meet at the park (on-site).

During the consultation, a large proportion of participants were recruited from passers-by for on-site group. The researcher went to the Edward Street Park on 27 September 2015 to scout for participants. There was no specific event on that Sunday, chosen because it was easier to reach more residents as they went out for leisure activities at the weekend. The researcher stood at the same location as for the previous study. Passers-by were asked whether they had time to participate in a short study. 111 respondents were recruited directly on-site, not counting the three who decided to withdraw after the information session because they felt they were not good at drawing.

Off-site consultations lasted between 15 to 60 minutes, whereas on-site consultations lasted between 7-20 minutes. Regardless of whether they had been recruited in advance or not, on-site participants all started at the same location, at the corner of Edward Street, in order to avoid any possible bias. All the participants who suggested a modification with a sketch received the chocolate incentive offered.

6.1.6 Participant characteristic

A total of 238 people participated in study 2 (Table 6.1). To keep the study as brief and as interactive as possible, this time demographic information was not collected. The participants were only asked informally whether they were familiar with the site. From the researcher's observations, the sample characteristics were similar to that of the previous study, with mostly student participating. Since the study took place at an identical location to study 1 for on-site participation, and the same recruitment procedures were followed on a weekend without an event, the samples were expected to be comparable.

Table 6.1 Participant characteristics for study 2

	On-site (n=134)		**Off-site** (n=104)	**Total** (n=238)
	Passers-by	Volunteers	Volunteers	
	111	23	104	238
Familiarity				
Familiar	92	3	49	144
Not-familiar	19	20	55	94

6.2 Results

During study 2, the researcher guided the participants through the application tutorial while engaging in casual conversation. Sketches were collected to answer the question, 'Can mobile devices as a design tool help engaging public to identify problems and bring solutions during the planning process?', asking about the problematic parts and solutions for them. The statistical analysis used is explained in section 4.2.2. The results are presented below.

6.2.1 Overall ZoomNotes Results

The focus of this research was not in-depth image analysis, but the sketches were analysed in terms of the use of different viewpoints, the number of modifications made and how colours were used for sketches. Feedback given by participants during the sketching and the sketches themselves give some insight into the results. These results show that more than 54% of participants suggested at least two changes or additions for the site (Table 6.2). Participants tended to identify one specific problem and bring a solution for it by predominantly suggesting modifications on one specific viewpoint (Table 6.3).

Table 6.2 Number of modifications suggested by participants

Number of modifications	Location				All Participants	
	On-site		Off-site		Count	%
	Count	%	Count	%		
0	6	2.5%	7	2.9%	13	5.4%
1	53	22.2%	42	17.7%	95	39.9%
2	27	11.3%	38	16%	65	27.3%
3	12	5%	24	10.1%	36	15.1%
4	3	1.25%	15	6.25%	18	7.5%
5	1	0.5%	5	2%	6	2.5%
6	2	.08%	2	0.8%	4	1.6%
7	-	-	-	-	-	-
8	0	0%%	1	0.4%	1	0.4%

Table 6.3 Use of different viewpoints for participants

Number of viewpoints modified	Location				All Participants	
	On-site		Off-site		Count	%
	Count	%	Count	%		
0	6	2.5%	7	2.9%	13	5.4%
1	85	35.7%	112	47%	197	82.7%
2	10	4.2%	11	4.6%	21	8.8%
3	3	1.25%	3	1.25%	6	2.5%
4	0	0%	1	0.4%	1	0.4%

Almost half of the participants preferred using only one colour during sketching for their suggestions (Table 6.4). Some (27.7% of all) participants tend to use only black to share their preferences, while some others (15.4% of all) chose random colours to make the suggestion to stand out against the background, for example red for disabled ramps, blue for football ground, pink for water fountain and benches (Table 6.5). People who used more than one colour intended to make sense with their choices by choosing closer colours to represent their suggestions. More than half of all participants chose at least one appropriate colour for the changes suggested (such as green for trees, blue for water, yellow for lights, colours for flowers).

Table 6.4 Number of colours used for sketches

Number of colour used	Location				All Participants	
	On-site		Off-site		Count	%
	Count	%	Count	%		
0	6	2.5%	7	2.9%	13	5.4%
1	53	22.3%	67	28.1%	120	50.4%
2	17	7.1%	26	10.9%	43	18%
3	11	4.6%	13	5.4%	24	10%
4	10	4.1%	11	4.7%	21	8.8%
5	4	1.65%	4	1.65%	8	3.3%
6+	3	1.2%	6	2.5%	9	3.7%

Table 6.5 Choice and use of colours for sketches

Use of Colours	Location				All Participants	
	On-site		Off-site		Count	%
	Count	%	Count	%		
No suggestion	6	2.5%	7	2.9%	13	5.4%
Only black use	24	10%	42	17.7%	66	27.7%
One random colour use	22	9.1%	7	3%	29	12.1%
More than one random colour use	6	2.4%	2	0.9%	8	3.3%
One appropriate colour use	7	3%	18	7.5%	25	10.5%
More than one appropriate colour use	39	16.4%	58	24.3%	97	40.7%
Appropriate colour use (**in total**)	46	19.3%	76	31.9%	122	51.2%

Around 19 per cent of on-site participants changed the default colour, which is black, and used at least one appropriate colour. People who used more than one colour were 18.6 per cent of all on-site participants. None of the participants changed the pen style. For off-site participants these percentages were higher. While 25.1 per cent of off-site participants used more than one colour, 31.9 per cent of off-site participants changed the colour to use appropriate colours for their suggestions. 23.8 per cent of the people participating off-site changed the pen style. This suggests that on-site participants pointed out the problems and suggested solutions in a quick way as they were passers-by and probably did not have much time, while off-site participants made more detailed sketches utilizing different features of the application and usually representative colours.

According to casual comments given by participants, and analysis of their sketches, participants seemed to choose colours in two main different ways. First, participants chose colours to differentiate their suggestions from the busy background. This was mostly a matter of choosing vivid colours to make the sketches 'pop out', as one participant remarked. In Figure 6.5 the participant's suggestion was to use the 'café terrace' part of the park fully by using chairs, tables and a kiosk. The participant made their sketch contrast efficiently from the background by drawing the chairs and tables in pink and the kiosk in bright blue and orange. Secondly, the participants chose colours consciously to represent an aesthetic or thematic aspect of their suggestions. In Figure 6.6 the participant literally brought colours to the area by drawing different installations (that is, flowers, colourful living walls or lights for the stairs).

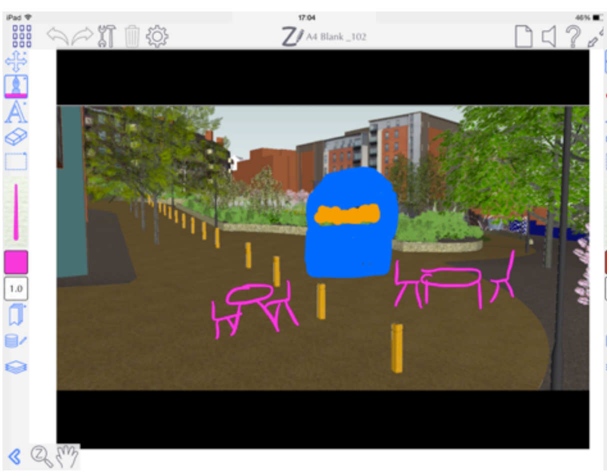


Figure 6.5 Café terrace suggestion with vivid colours (off-site)

Figure 6.6 Solly Street stairs suggestion with appropriate colours (off-site)

Finally, the participants' sketches were analysed viewpoint by viewpoint, to determine which parts of the park attracted the most modifications. The sketches were also analysed according to the type of modifications, in other words verifying how many aspects of a viewpoint were changed, and in which way (Table 6.6). Suggestions were transcribed under the themes (introduced in section 4.2.1 and Figure 4.4) they represented for each viewpoint.

Table 6.6 Number of participants and suggestions for each viewpoint

Viewpoints and suggestions	Off-site		On-site		All
	N	Suggestion	N	Suggestion	N
Solly Street stairs	41	100	31	46	72
Main event space	32	60	33	53	65
Upper garden	32	56	26	35	58
Little stairs	10	21	6	6	16
Café terrace	12	28	4	5	16
General view	16	28	15	25	31
Additional viewpoints	2	2	2	2	4

In order to provide equal shares to all stakeholders during the development of the planning and design proposal, the suggestions participants made were weighted (explained in detail in section 4.2.2). That is the reason some of the data is presented as decimal numbers.

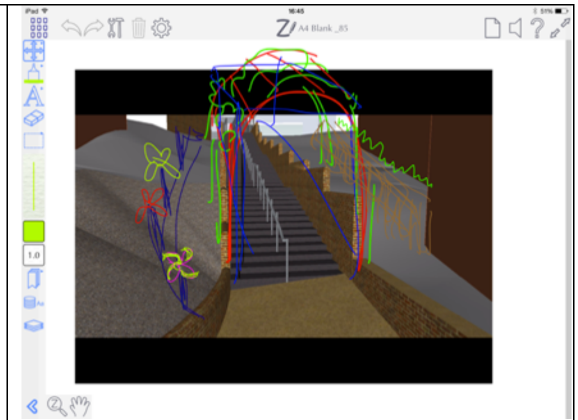
Table 6.7 Weighted numbers for viewpoints by suggestion

Viewpoints and suggestions	Off-site		On-site		All	
	N	%	N	%	N	%
Solly Street stairs	40.33	16.94%	27.28	11.46%	67.61	28.40%
Main event space	27.92	11.73%	26.9	11.30%	54.83	23.03%
Upper garden	26.80	11.26%	24.24	10.18%	51.03	21.44%
Little stairs	9.99	4.19%	3.17	1.33%	13.16	5.52%
Café terrace	9.58	4.02%	4	1.68%	13.58	5.70%
General view	11.18	4.69%	11.83	4.97%	22.99	9.65%
Additional viewpoints	1.20	0.5%	0.58	0.24%	1.78	0.74%
No suggestion	7	2.94%	6	2.52%	13	5.46%

Table 6.7 above shows the weighted numbers of the suggestions and their percentages according to viewpoints. As can be seen, the participants mainly chose to modify the viewpoints of Solly Street Stairs (28.40%), the main event space (23.03%), and upper garden (21.44%). When comparing with the results of the charrette and study 1, these three viewpoints also correspond to the parts of the park where the most issues need solving. The table also shows the comparison of on-site and off-site participants' contribution, which is commented upon further down.

Table 6.8 below presents a synthesis of all the modifications for each viewpoint with an example sketch. On the left-side the modifications are summarised to a bullet point; they were sometimes suggested by more than one participant. The modifications are also coded by themes indicated at the bottom of each viewpoint. On the right side, one of the most representative examples of participants' sketches was chosen to illustrate each viewpoint.

Table 6.8 ZoomNotes sketch examples from participants

View point: Solly Street stairs Suggestion/modification: - Various colours are added - More vegetation - Widened stairs and lower walls - Added a ramp - Added lights Themes: Safety, attractiveness, accessibility	
View point: Main event area Suggestion/modification: - Improved basketball ground - Multiple use for the area - Added signboard and trash bins - Added a shelter and lights Themes: Sense of community and interactivity, safety, attractiveness	
View point: Upper garden Suggestion/modification: - Added flowers and trees - Seating and gathering place - Added lights and ramps for the stairs - Water feature Themes: Sense of community and interactivity, attractiveness	
View point: Little stairs Suggestion/modification: - Various vegetation with colours - No railings and addition of ramps - Bike racks Themes: Accessibility, attractiveness	

View point: Café terrace Suggestion/modification: - Café - Benches/ seating - More vegetation Themes: Sense of community and interactivity, attractiveness	
View point: General view Suggestion/modification: - Benches - Café - Fountain - Basketball ground improvement Themes: Attractiveness, accessibility, sense of community and interactivity	

6.2.2 Results on on-site and off-site differences

One of the most immediate differences between on-site and off-site was the time spent by participants. During on-site consultation, each session took between 7-20 minutes, whereas off-site consultation took on average 15-60 minutes. The participants who volunteered for off-site consultation were recruited in advance and typically spent more time sketching than passers-by asked spontaneously on-site. Such differences were expected, as advance-recruited volunteers were more likely to be involved in the research since they had set time aside for the consultation in their personal schedule.

It is perhaps logical that off-site participants also gave on average more suggestions than on-site users. For each viewpoint, the numbers of participants making how many suggestions is given at the beginning. A table and figure illustrate the weighted number (Table 6.7) of suggested modifications, and whether they were repeatedly suggested or not, on-site and off-site. The modifications to each viewpoint are analysed separately according to location, and are shown below.

Solly Street stairs: This was the most popular viewpoint with 72 participants suggesting modifications around the Solly Street stairs. In total 41 off-site participants sketched 100 modifications and 31 on-site participants thought of 46 suggestions.

Table 6.9 Solly Street stairs suggestions from on-site and off-site participants

Themes	Solly Street Stairs	Location			
		Off-Site		On-Site	
		Count	%	Count	%
Safety	no walls	2.17	1.62%	3.83	3.68%
	shorter walls	.25	0.19%	.50	0.48%
	CCTV	.00	0.00%	1.00	0.96%
	more lights	5.25	3.92%	7.95	7.64%
	narrow steps	1.25	0.93%	3.00	2.88%
	widen the stairs	2.08	1.55%	.25	0.24%
Attractiveness	living walls	3.58	2.67%	.50	0.48%
	more trees	7.00	5.22%	2.42	2.33%
	more flowers	6.00	4.48%	1.75	1.68%
	flower beds or pots	1.42	1.06%	1.00	0.96%
	flower tunnel	1.33	0.99%	.00	0.00%
	colourful stairs	1.42	1.06%	1.50	1.44%
	visual illusion	.00	0.00%	.00	0.00%
	collect water	.25	0.19%	.00	0.00%
	entrance and identity	.75	0.56%	.33	0.32%
Accessibility	Lift/escalator/ramp	3.58	2.67%	1.50	1.44%
	no railings	2.92	2.18%	.75	0.72%
	ramp/no stairs/path	.83	0.62%	1.00	0.96%
	divided stairs	.25	0.19%	.00	0.00%

The issues most frequently highlighted for this viewpoint by off-site participants were related to attractiveness, safety and accessibility respectively (Table 6.9, Figure 6.7). The most frequently suggested change was related to the lack of vegetation (5.22% adding more trees, 4.48% adding more flowers, 2.67% adding living walls). The second most suggested change related to the deficiency of lighting (3.92%) as can be seen in Figures 6.7 and 6.8) followed by the suggestion of having disability-friendly stairs (2.67%).

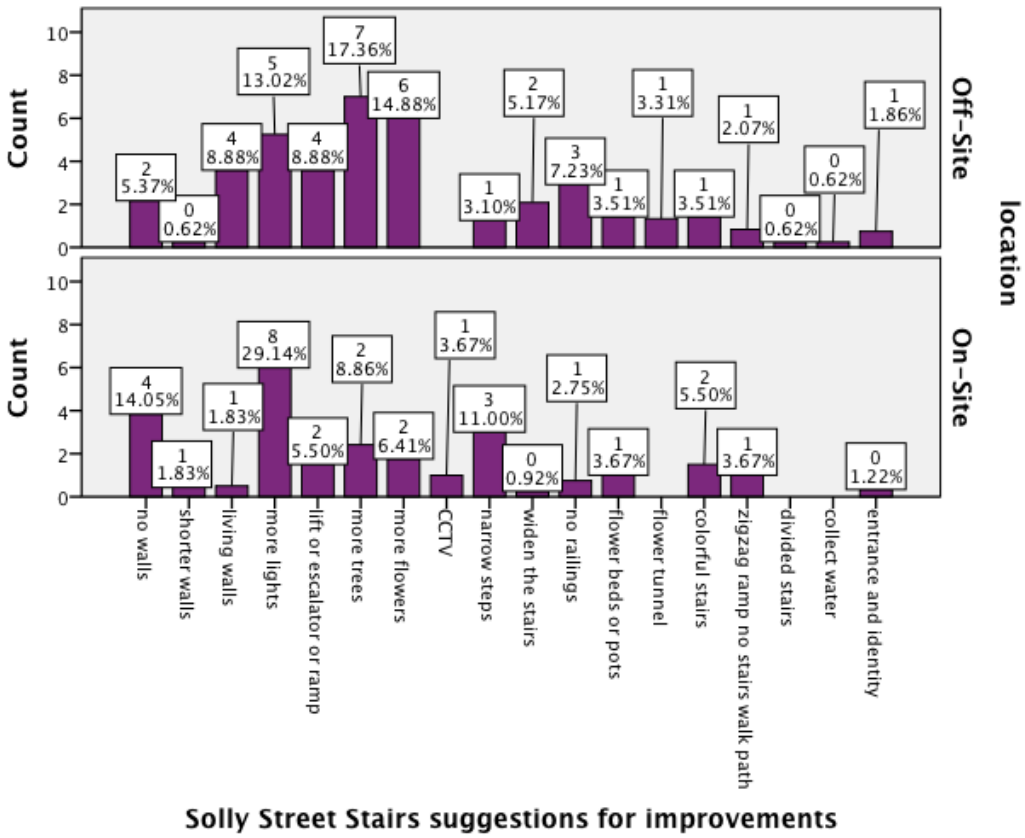


Figure 6.7 Comparison of Solly Street stairs for improvements on-site and off-site

By contrast, on-site participants overwhelmingly suggested modifications linked with safety. The most frequent modification was linked to the lack of streetlights (7.64%). The walls around the stairs also worried some participants as a hiding place for offenders or criminals, and their suggestion was to remove the walls altogether (3.68%). Another suggestion linked safety and accessibility by requesting an enlargement in the width of the steps (2.88%).

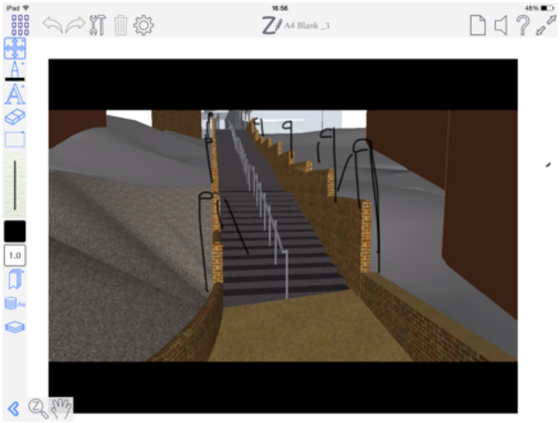


Figure 6.8 On-site lighting suggestion for Solly street stairs

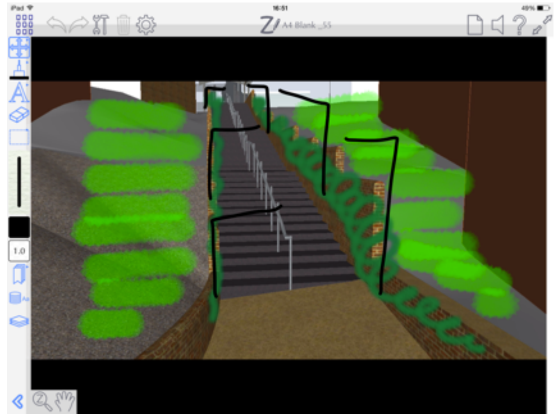


Figure 6.9 Off-site lighting and planting suggestion for Solly Street stairs

Off-site participants modified Solly Street stairs more than on-site ones (Table 6.9) but also provided more types of suggestions (Figure 6.7). While the first group mostly suggested solutions aligned with what they saw in the video, and knew about the site and wanted to develop aesthetic values of the park, the second group brought solutions to the problems they had such as installing CCTV to fight crime within the area, removing the walls and bushes behind the walls to ensure safety.

Finally, there were suggestions for Solly Street Stairs that were exclusively highlighted by off-site participants. They were mostly related to the theme of attractiveness, including introducing colours and adding optical illusions to the stairs or designing a plant tunnel over the stairs to create a shelter from the rain while emphasizing aesthetic appeal and creating an identity for the park. There were also practical suggestions such as collecting rainwater throughout the stairs to use within the park for different activities.

Main event space: In total 65 participants offered modifications for the 'main event' space. In total, 33 on-site participants suggested 53 changes, and 32 off-site participants suggested 60 modifications. Off-site and on-site participants' suggestions differed on the issues and solutions for the 'main event space' although they both tried to improve the attractiveness by adding more vegetation and to enhance sense of community by creating opportunities for gatherings (Table 6.10, Figure 6.10).

Table 6.10 Main event space suggestions from on-site and off-site participants

Themes	Main Event Space	Location			
		Off-Site		On-Site	
		Count	%	Count	%
Attractiveness	widen area	.00	0.00%	1.33	1.28%
	more flowers	1.83	1.37%	.78	0.75%
	more tress	.17	0.13%	1.12	1.08%
	bins	1.20	0.90%	4.83	4.64%
	plantation	1.83	1.37%	3.42	3.29%
Sense of community and interactivity	water fountain	1.50	1.12%	1.00	0.96%
	cafe	.37	0.28%	.50	0.48%
	ground material	4.20	3.13%	2.75	2.64%
	basket net	.00	0.00%	1.50	1.44%
	basketball field line	3.79	2.83%	1.83	1.76%
	benches	2.25	1.68%	1.50	1.44%
	multiple use and convert	5.85	4.37%	.50	0.48%
	cover	1.70	1.27%	.00	0.00%
Safety	more lights	1.73	1.29%	3.17	3.05%
	fence	.50	0.37%	2.67	2.57%
Accessibility	short cut	1.00	0.75%	.00	0.00%

Off-site participants mainly suggested changes that belonged to themes of attractiveness and sense of community. Since a part of the space is a basketball court, most proposals were linked with sports, such as creating a multiuse sports area for the space (4.37%), outlining the field for the games (2.83%) and replacing the basketball pitch with more sustainable and suitable material (3.13%). Two sketches from each location can be seen in Figure 6.11 and 12. Other suggestions related to the sense of community included increasing the number of events in the area, as well as the creation of a platform with a cover for audience and suitable seating to host events, festivals and local tournaments for residents. There were requests to enclose the area with a fence, adding a little café around the corner to make the 'café terrace' truly happen in reality. There was a suggestion linked with accessibility given only by an off-site participant who was not familiar with the site: having shortcuts within the area. Generally, it was observed that off-site participants perceived the area larger than it actually is, and some even suggested unrealistic modifications such as holding bicycle races within the area.

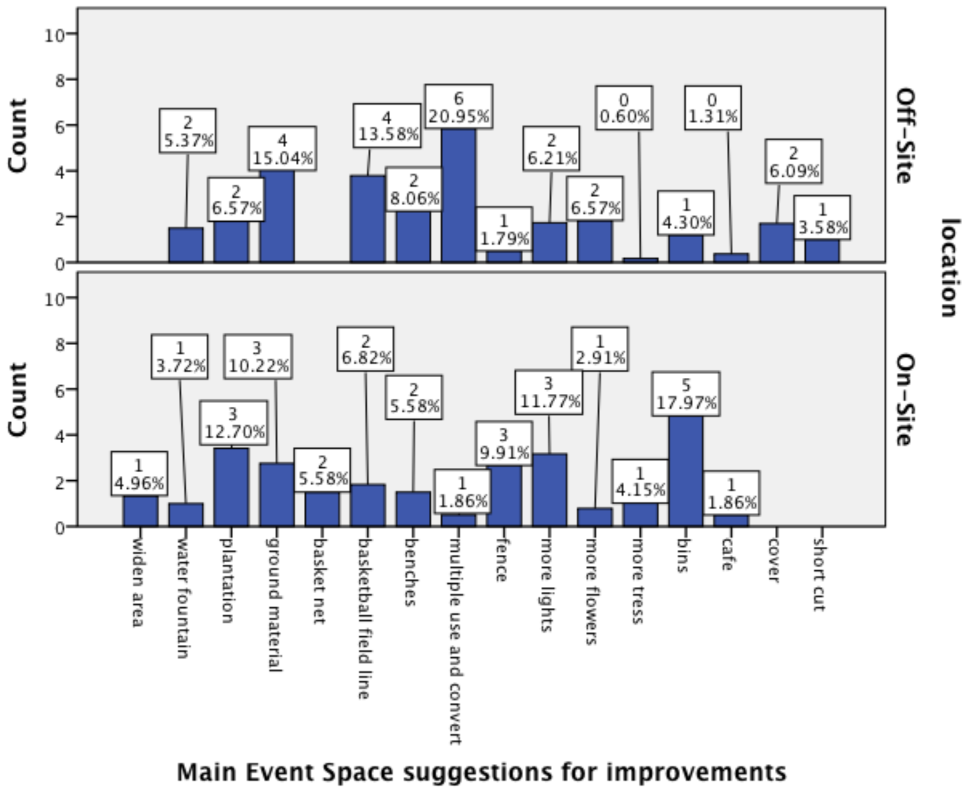


Figure 6.10 Comparison of main event space suggestions for improvements on-site and off-site

Figure 6.11 On-site main event area suggestion for multi-use space with benches

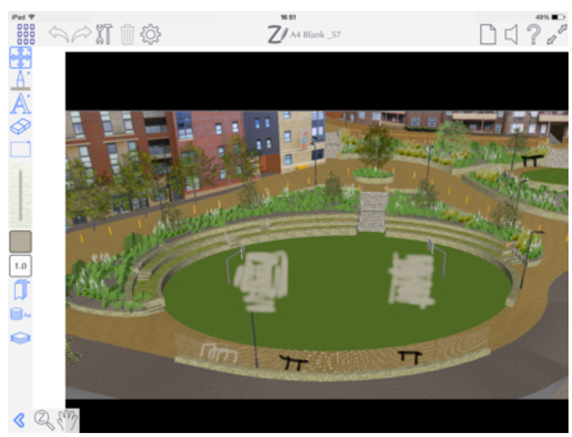


Figure 6.12 Off-site main even area suggestion with multi-use space, benches and bike racks

By contrast, replacing the basket net, which can be considered as part of attractiveness and sense of community and integration, was a suggestion made exclusively by on-site participants. It demonstrated that the participants who were familiar with the site focused on the issues they were personally experiencing in their daily lives while using the park. On-site participants generally suggested changes related to sense of community and safety themes. One of the most recurrent suggestions was to add rubbish bins (4.64%), as the on-site participants had experienced littering within the area themselves. Similarly, on-site participants were concerned with measures to control the planting and its management (3.29%) with specific comments regarding overgrown vegetation in spring and summer time. In terms of safety, the on-site participants asked for greater illumination of the area (3.05%) to ensure the security and usability of the area at night.

Upper garden: In total 58 participants gave suggestions for the 'upper garden' area. There were 26 on-site participants with 35 modifications, and 32 off-site participants with 56 suggestions. For the 'upper garden' viewpoint, there were again more suggestions among off-site participants than on-site participants (Table 6.11).

Table 6.11 Upper garden suggestions from on-site and off-site participants

Themes	Upper Garden	Location			
		Off-Site		On-Site	
		Count	Percent	Count	Percent
Attractiveness	more trees	2.58	1.93%	4.00	3.85%
	more flowers	2.13	1.59%	2.17	2.09%
	plant tunnel	.50	0.37%	.00	0.00%
Sense of community and interactivity	fountain pond pool	4.88	3.64%	5.50	5.29%
	cafe picnic	.25	0.19%	1.70	1.63%
	play ground	3.17	2.37%	2.00	1.92%
	benches	7.29	5.44%	6.00	5.77%
Safety	more lights	2.50	1.87%	1.00	0.96%
Accessibility	ramps	2.50	1.87%	.50	0.48%
	short cut	.00	0.00%	.67	0.64%
	no meadows	.00	0.00%	.20	0.19%
	no walls/no railing/no stairs	1.00	0.75%	.50	0.48%

There was a general sense among both survey groups that the area was not used to its fullest potential: it seems that this viewpoint attracted similar ideas from both off-site and on-site participants (Figure 6.13). The upper garden was originally designed to host small-scale local events, so participants did not identify a specific use for that area. The public consulted asked for a tranquil gathering place for residents and an open space for employees and students to relax under the theme of sense of community and integration. Among off-site participants there was a recurring suggestion to add benches to the area (5.44%), as well as water features (3.64%) or a playground for kids (2.37%). On-site participants also repeatedly demanded benches (5.77%) and water features (5.29%) as can be seen in Figure 6.14 and 6.15. They also suggested planting more trees (3.85%) as there was no specific planting within this part besides the grassed area. In general there was a call to design this area as a space for people to have picnics under the trees (1.93% off-site, 3.85% on-site) with flowers (1.59% off-site and 2.09 on-site). This agreement of both survey groups extended to the need to improve the safety around the site, with more lighting (1.87% off-site and 0.96% on-site) and the removal of the walls and railing.

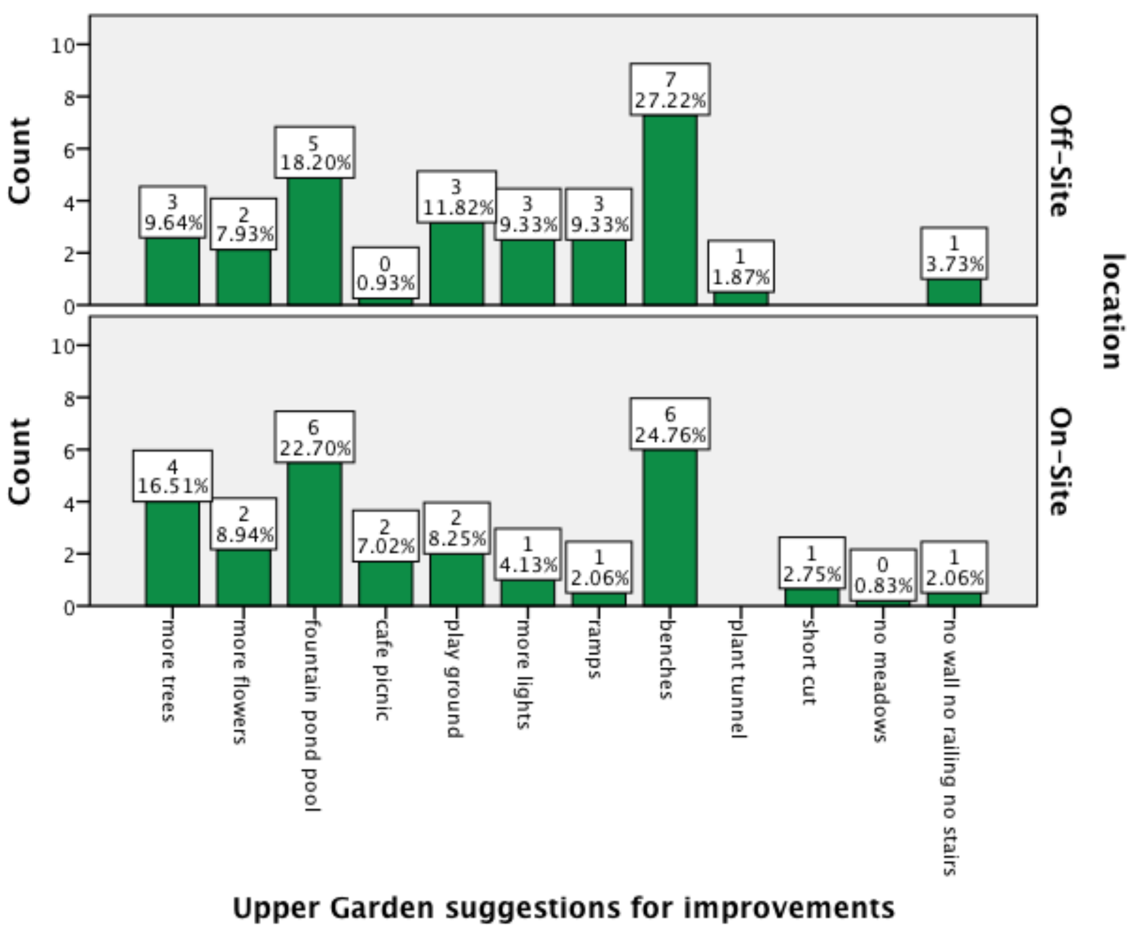


Figure 6.13 Comparison of upper garden suggestions for improvements on-site and off-site

Figure 6.14 On-site suggestion with water feature and benches

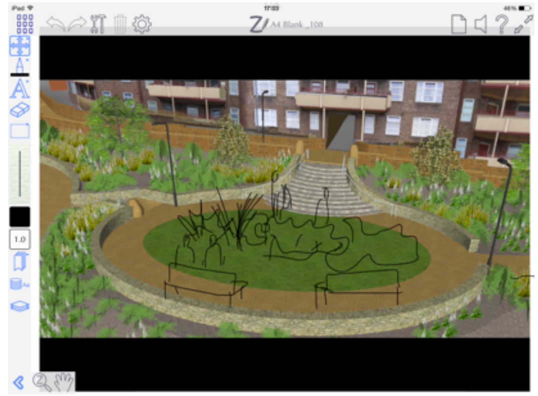


Figure 6.15 Off-site suggestion with water feature, benches

While participants of both survey groups agreed on most aspects related to the themes of attractiveness, safety and sense of community, they differed slightly when it came to accessibility. On-site participants drew shortcuts in the area, involving the removal of the grass from one side. By contrast, off-site subjects made a different suggestion that increased the vegetation by adding a plant tunnel connecting the area to the inner garden of Edward Street Flats, to develop green connectivity and accessibility. The plant tunnel, the picnic area and the fountain with caught rainwater were also changes that were suggested during the master plan of the charrette (Appendix D).

Little stairs: Around the 'little stairs' area, 16 users suggested changes. There were six on-site participants with six proposals, and ten off-site participants with 21 proposals. For the 'little stairs' area, off-site participants also offered more suggestions than on-site participants (Table 6.12 and Figure 6.16). The suggestions from both off-site and on-site participants were typically related to the themes of attractiveness and accessibility. Inside the attractiveness theme, the addition of vegetation was the most recurrent (2.55% more flowers and 1.12% more trees off-site, 0.96% more trees and 0.96% more flowers on-site) as shown in Figure 6.17 and 6.18.

Table 6.12 Little stairs suggestions from on-site and off-site participants

Themes	Little Stairs	Location			
		Off-Site		On-Site	
		Count	%	Count	%
Attractiveness	more flowers	3.42	2.55%	1.00	0.96%
	more trees	1.50	1.12%	1.00	0.96%
	glass railing	.58	0.43%	.00	0.00%
	colorful stairs	.58	0.43%	.00	0.00%
	no railings	1.83	1.37%	.00	0.00%
Accessibility	ramps	1.25	0.93%	.00	0.00%
	bike racks	.00	0.00%	1.17	1.13%
Sense of community and interactivity	bench	.50	0.37%	.00	0.00%
	identity for the area	.33	0.25%	.00	0.00%

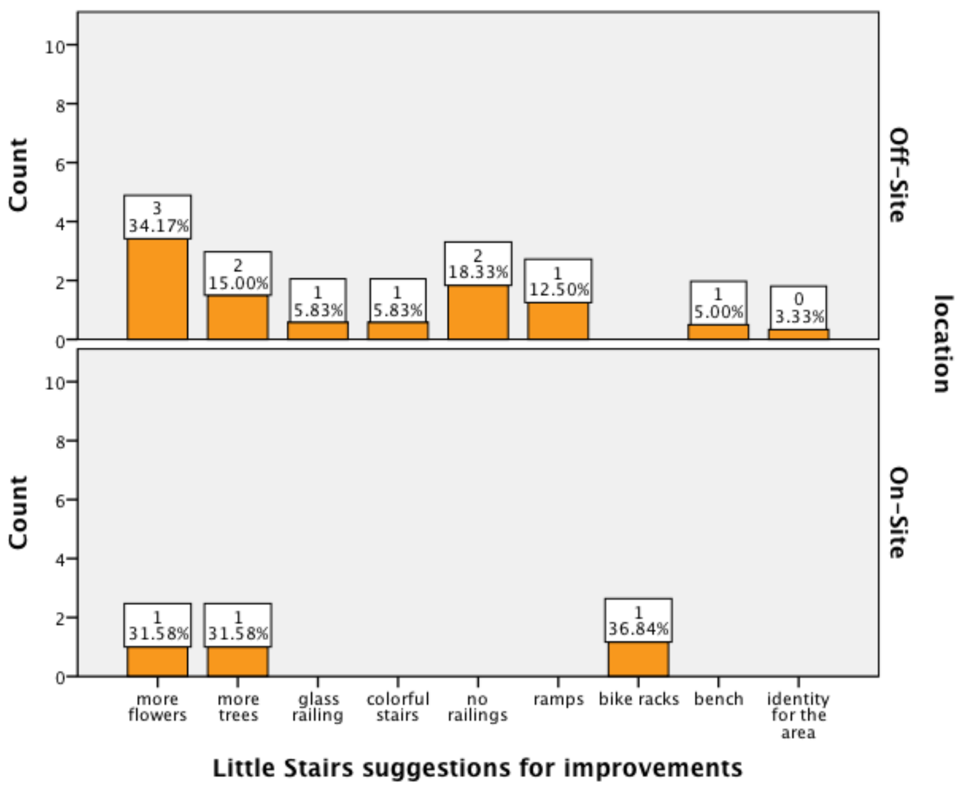


Figure 6.16 Comparison of little stairs suggestions for improvements on-site and off-site

There were suggestions from off-site participants alone linked to the construction of identity, like adding colours and different themes to the decoration. Notably, one off-site participant tried to improve the area by adding a globe-shaped sculpture on the side of the stairs (Figure 6.11). That suggestion also included adding a unique wall design and glass railings, both to solve the safety problems and create a more inviting space.

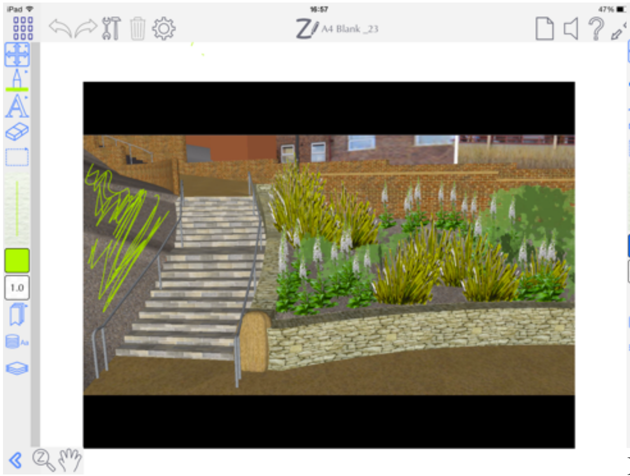


Figure 6.17 On-site little stairs suggestion with more vegetation

Figure 6.18 Off-site little stairs suggestion with world-shaped sculpture, glass railings, colourful flowers and unique wall design

On-site participants seem largely to ignore this viewpoint. From casual comments given by on-site participants, it is possible that they did not find many issues with the ‘little stairs’ area, or at least that they did not perceive it as a priority to be addressed in the site. On-site participants mostly requested changes related to additional planting. There was an emphasis on improving accessibility, notably for bikers. There was an suggestion from on-site participants only to introduce bike-racks around the corner.

Café terrace: There were 16 participants who modified the café terrace viewpoint. There were 12 off-site participants who 28 suggestions and 4 participants on-site with five suggestions.

For the café terrace viewpoint, there were more off-site participants who submitted suggestions than on-site participants (Table 6.13, Figure 6.19). On-site participants generally seem to think that the ‘café terrace’ was well designed as it was (2.88%), and that it only required additional trees and a café to enhance the sense of community (Figure 6.20). Their suggestions were linked with events allowing the residents to gather and interact with each other in a greener environment. The on-site participants did not ask for benches in that area, which suggests that they did not see the area as a ‘café terrace’ but rather an empty space.

Table 6.13 Café terrace suggestions from on-site and off-site participants

Themes	Cafe Terrace	Location			
		Off-Site		On-Site	
		Count	%	Count	%
Attractiveness	more flowers	1.03	0.77%	0	0.00%
	more trees	1.16	0.87%	.50	0.48%
	statue	.33	0.25%	0	0.00%
Sense of community and interactivity	benches	4.07	3.04%	0	0.00%
	umbrella or cover	.73	0.54%	0	0.00%
	cafe	2.06	1.54%	.50	0.48%
	fountain	.20	0.15%	0	0.00%
-	as it is	0	0.00%	3	2.88%

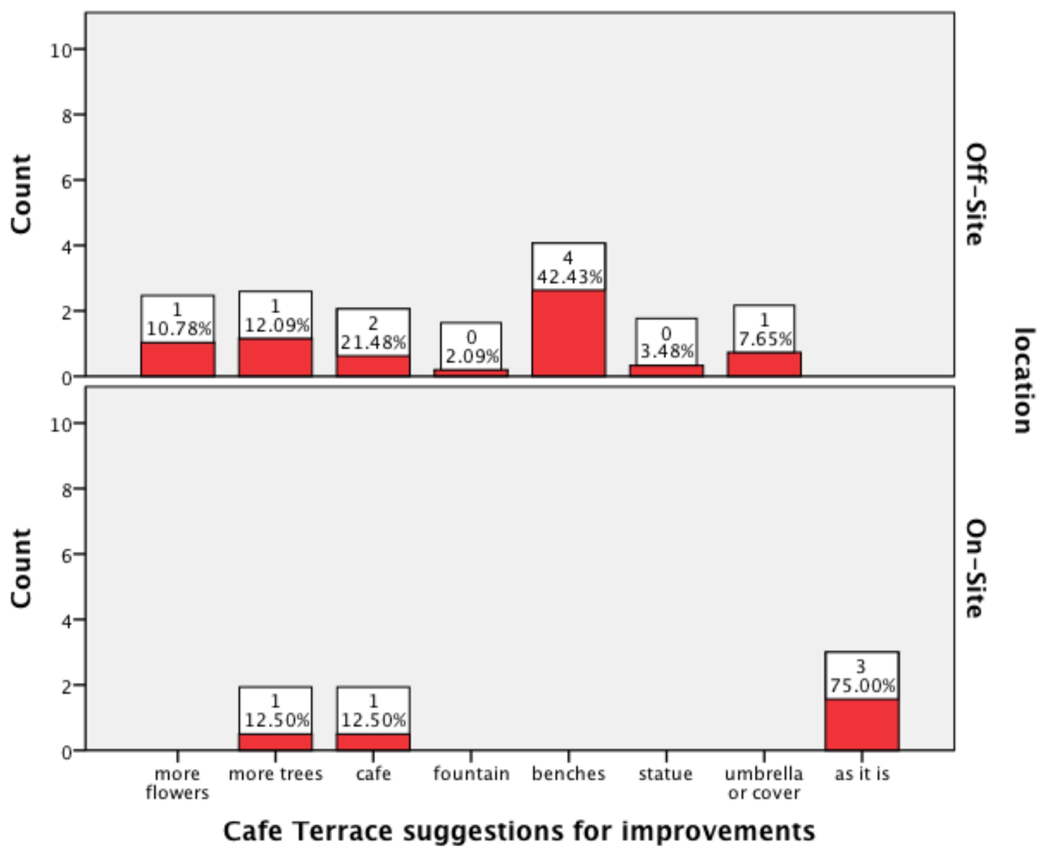


Figure 6.19 Comparison of café terrace suggestions for improvements on-site and off-site

There were suggestions by off-site participants only, like installing a roof or a cover above the café terrace to create a place for gatherings even when it is raining or cold to enhance the sense of community (Figure 6.21). Adding a fountain next to the café was also suggested. Four different off-site participants suggested adding seating whereas none of the on-site participants mentioned benches.

Figure 6.20 On-site café terrace suggestion with a cafe

Figure 6.21 Off-site café terrace suggestion with umbrellas

***Overall area*:** In total 31 participants made suggestions for the area as a whole. Among these, 15 on-site participants sketched 25 proposals and 16 off-site participants suggested 28 proposals. While off-site subjects focused on the problems related to aesthetics and attractiveness, on-site participants again focused on solving issues currently seen within the park, regarding sense of community and integration as well as attractiveness. (Table 6.14, Figure 6.22).

Table 6.14 Overall suggestions from on-site and off-site participants

Themes	Overall	Location			
		Off-Site		On-Site	
		Count	%	Count	%
Attractiveness	more trees	1.45	1.08%	1.83	1.76%
	trash bins	1.00	0.75%	2.25	2.16%
	path pattern design	2.50	1.87%	.17	0.16%
	colourful or no bollards	1.37	1.02%	1.83	1.76%
	oval flower bed modify/demolish	.45	0.34%	1.58	1.52%
	more flowers	1.58	1.18%	.17	0.16%
Sense of community and interactivity	pond/fountain	.25	0.19%	.67	0.64%
	bench	.25	0.19%	.00	0.00%
	signboard	.00	0.00%	.50	0.48%
Safety	more lights	.75	0.56%	.33	0.32%
	no traffic	.20	0.15%	.00	0.00%
	modify walls	.25	0.19%	.00	0.00%
Accessibility	Change path circulation	.38	0.28%	2.17	2.09%
	modify curbs	.50	0.37%	.00	0.00%
	bike racks	.25	0.19%	.33	0.32%

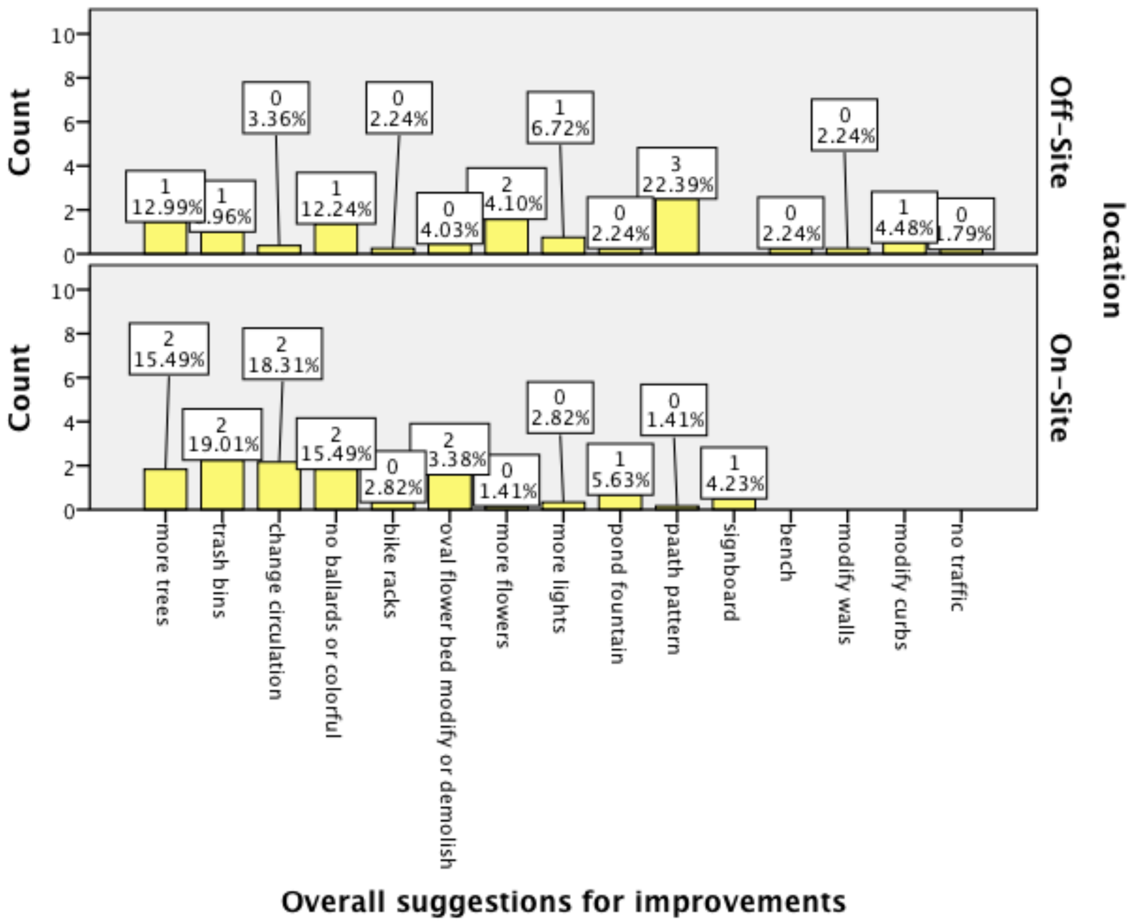


Figure 6.22 Comparison of overall suggestions for improvements on-site and off-site

In this viewpoint, both on-site and off-site participants agreed that more vegetation should be added, and on removing or modifying the bollards. On-site and off-site participants agreed on several issues regarding accessibility, attractiveness and sense of community, like: designing a sustainable water feature to catch the rainwater (0.19% off-site and 0.32% on-site); adding bike racks as (0.19% off-site and 0.32% on-site); and modifying or demolishing the oval flower bed (0.34% off-site and 1.52% offsite). Both off-site and on-site participants suggested adding rubbish bins to the park, the latter laying greater emphasis on the issue, probably due to littering within the area. Two drawing made by on-site and off-site participants can be seen in Figure 6.23 and 6.24.

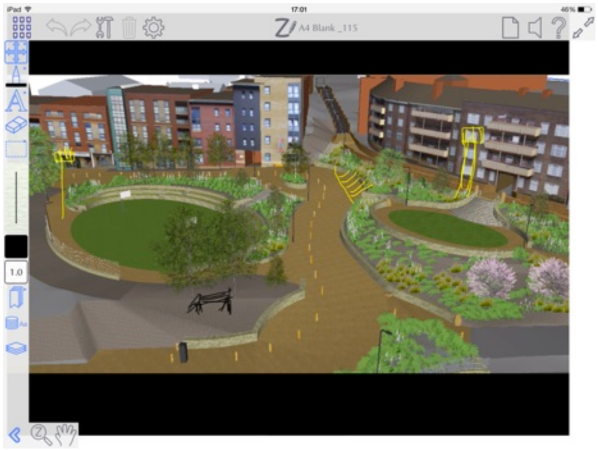


Figure 6.23 On-site suggestion with more lights and a signboard

Figure 6.24 Off-site suggestion with a pond, more vegetation and lights

In terms of paths, on-site participants focused more on accessibility and improving circulation (2.09%), while off-site participants asked to change the pattern design of the paths for attractiveness (1.87%), planting more trees (1.08% off-site and 1.76% on-site) and flowers (1.18% off-site and 0.16% on-site). The issue of lighting was only mentioned by a small number of participants (0.56% off-site and 0.32% on-site).

Despite these common points, there were still some differences between off-site and on-site participants' suggestions to the overall viewpoint. Only on-site participants asked for a signboard within the area (0.48%). None of the on-site participants modified the walls (0.19%) or curbs (0.19%) to design more inviting and a safe place, nor did they try to improve accessibility by routing away the traffic from the park (0.15%). Off-site participants exclusively asked to improve community integration by adding more seats within the park in general.

Additional viewpoints*:* Besides these prepared viewpoints, four participants suggested additional changes to scenes that they selected from the walk-through video (Table 6.15). With the preparation of the screenshots from the final SketchUp model, it was possible to allow them to sketch on these new screenshots. These suggestions were mostly related to attractiveness of the area. Two people on-site and two people off site came up with the proposals. Off-site participants focused on aspects of the buildings. On-site participants demanded a change in planting, particularly in front of the Tesco supermarket, and widening the path in front of Edward Street flats by removing the walls, for safety and security reasons.

Table 6.15 Additional suggestions from on-site and off-site participants

Themes	Additional suggestions not from the viewpoints	Location			
		Off-Site		On-Site	
		Count	%	Count	%
Attractiveness	more flowers in front of Tesco (next to café terrace)	-	-	.20	0.08%
	nicer looking buildings	.25	0.11%	-	-
	buildings without balcony	.33	0.14%	-	-
Accessibility	widen the path in front of Edward St flats	-	-	1.00	0.42%

6.2.3 Qualitative results

Some clues can be taken from the fact that nobody came to the charrette: this event had been advertised in the same way as traditional participation events with posters and handouts. Although it was planned to use mobile devices during the charrette, the users of the site might not have been fully aware of this fact. By contrast, there were volunteers for the ZoomNotes one-to-one experiment designed as a remedy to the no-show in the charrette. The reason might be that there was a difference in flexibility between those two ways of participating, suggesting that mobile devices have the potential to be a standard technique for participation, reaching more people with flexibility.

The ZoomNotes one-to-one consultation required participants to make sketches on an iPad. From casual comments given during the consultations, it seemed that users whom had agreed to participate were experiencing an increase of interest level as the session unfolded. Some participants asked about the name of the application used (ZoomNotes) to prepare the future scenarios mentioned in the emails and the posts, and what its future usage was. As mentioned before, many participants from one-to-one consultations with ZoomNotes volunteered to participate in study 3: as these two studies were relatively close to each other, people were easily reached and appointed a specific time to meet for study 3.

Some potential participants refused to participate: lack of interest and shortage of time were the most common reasons given. Some people withdrew from the consultation with

ZoomNotes after they were informed that they were expected to make sketches using an iPad, saying that they were not good at making sketches. So mobile devices can appear daunting to some users. Perhaps some people are not confident using the stylus pen, or had not had experience of making the most of the tactile screen. This kind of difficulty is to be expected, and there will always be personal preferences to be taken into account regarding to the reasons for not participating: some people also might use their supposed lack of skill as a polite excuse to drop out, as is their right.

6.3 Discussion

6.3.1 Limitations of the study and results

The study and its results were subject to a number of limitations. First of all, to ensure the brevity of the study, during the data collection participants were only asked to complete the task without filling a questionnaire. The large number of participants recruited was considered to be representative of the public using the site in daytime. It is likely that the study's findings can be generalized to other studies for 18-24 and 25-44 years old participants, who were the most numerous among the sample.

Another limitation is that most of the participants (82.7 %) only chose one viewpoint to modify. Considering the small size of the site, it could have been more convenient to give users fewer viewpoint selections, in order to gather a possibly larger amount of suggestions on one specific aspect of the site.

Finally, the fact that the study involved drawing made it inaccessible to some potential participants. Three on-site passers-by withdrew from the study after being informed about the sketching part with the reason that their drawing skills were poor, they could not design and they did not have time. Smith (2012b) reported similar concerns by users about different aspects of conceptual drawing for design charrette. Al-Kodmany (2001) tested freehand sketching with the help of co-design artist as one of the methods to facilitate design process. He suggested that allowing participants to draw 'preliminary ideas' would promote face-to-face dialogue and be more engaging and interactive. Considering the numbers of participants and pros and cons, mobile device sketching have great potential to engage people when integrated in participatory design processes.

6.3.2 Discussion of on-site and off-site comparison

The results proved to be generally in line with the expectation that there would be differences for on-site and off-site participants in terms of engagement and identification of issues within the park design. To assess whether this was the case, several factors were taken into consideration, including the time spent by participants, the number of modifications suggested, and the degree of interest displayed by the way suggestions were drawn (for example how many colours or strokes used to draw a suggestion).

Generally, on-site participants spent less time sketching than off-site participants. This is not to say that shorter participation was less meaningful. It could be interpreted that people produced the ideas with existing knowledge and experience with the possibility of ideas being more original (Stroebe et al. 2010) and solution-oriented. Considering the detail put into their drawings, off-site participants were more willing to give details to convey their ideas than on-site participants. The latter were more concerned with the concept of what they wanted to suggest. Typically, off-site participants suggested more modifications than on-site participants. This number of modifications was calculated in terms of suggesting different changes rather than by the number of strokes drawn. It seems logical that off-site participants gave more time (for example, Kim and Shelby, 2006) and precision to the task as they were all advance-recruited volunteers, whereas on-site participants were a mixture of passers-by and advance-recruited volunteers.

Last but not least, the type and number of strokes drawn also differed across the survey groups. On-site participants usually made brief but to the point sketches to highlight their chosen issue (Dorwant, Moore and Leung, 2007) without paying much attention to colours or different pen styles, while for off-site participants the percentage of different pen style and appropriate colour use was higher. The latter survey group also provided drawings containing more details, drawn with more pen strokes. It seems that off-site participants were keen on delivering high quality sketches. This is not to say that the detailed sketches were necessarily more meaningful than less detailed ones, since the latter can still deliver the same idea in a shorter period of time depending on the context (Rice, 2003).

6.3.3 Discussion of engagement and problem identification

The general results for study 2 appear to be consistent with the expectations. Mobile devices used as a design tool were seen to help engaging the general public to identify problems and bring solutions during the participatory design process.

As mentioned earlier in discussing study 1 and the charrette, the researcher already knew that the Solly Street stairs, main event space and upper garden were the viewpoints presenting the most issues. For example, Solly Street stairs presented numerous safety concerns: the main area was heavily used and the design and material of this part was not deemed convenient, and the upper garden was seen as an empty space with no function. So the results of study 2 are in line with expectations.

For Edward Street Park, the most problematic area was Solly Street stairs. Its image was not the most appealing viewpoint compared to the others, because the stairs were grey and the area only decorated with a hedge. Yet this was still the most chosen viewpoint to be modified, among both on-site and off-site participants, suggesting that participants tended to choose the most problematic areas to modify, regardless of location, in this case Solly Street stairs, main event area and the upper garden. These areas were also the parts mentioned with more issues during study 1 and the charrette conducted by professional and postgraduate planning and design students. This result indicates that participants were trying to ensure meaningful participation (Beckley et al., 2006) by pointing out the viewpoints with issues rather than picking viewpoints at random or because of their aesthetic quality.

On-site participants were expected to identify problems more easily than off-site participants as they had the advantage of experiencing the real environment (Dorwant, Moore and Leung, 2007).

Another finding was that on-site participants were mostly focusing on current urgent issues within the park, while off-site participants gave various suggestions, mostly to make the area more attractive. On-site participants were, for example, concerned about safety around Solly Street stairs, while on and off-site users were suggesting changes to make this area more attractive. Off-site users were also suggesting modifications related to accessibility more often than on-site users. This might be because there was a difference of perception between on-site and off-site participants, who might have thought that the stairs presented more challenges than they actually did (Dorwant, Moore and Leung, 2007), so perception was tested in study 3.

The main event space was a popular choice for modifications across both survey groups, Different survey groups pointed out different issues for this part. Off-site participants were good at identifying the problems and giving additional suggestions that were almost completely neglected by on-site users. Off-site users brought up solutions to improve the current conditions, suggesting different uses for this section of the park. Increasing the attractiveness of the park especially with additional vegetation, was suggested more by on-site users than off-site users. This can be explained by the fact that off-site participants who suggested changes for this part were more familiar with the site (Daniel and Meitner, 2001) and therefore more likely to know about site-specific issues like that regarding the basketball ground.

Across all survey groups, the participants agreed that the upper garden could have an actual function, with suggestions usually related to the sense of community. The biggest issue with this part of the park was that although it was relatively large, the area did not have any specific use for the public. As there was a grass area in the middle of the garden, it was suggested that flowers and trees should be planted, as well as a gathering area built around it. When residents take part in design or planning processes, they reflect on their needs and concerns related to the site. Al-Kodmany (2000) says, ‘The greater the participation, the greater is the sense of ownership that people have about the plan, which can translate into a greater determination on their part to see that the plan gets implemented’.

6.3.4 Conclusion

It was noteworthy that all the problems identified in this study were similar to the themes identified in previous sections (section 4.2.1) of the thesis. Even though there were differences in terms of suggestions and focus for different locations, the mobile devices were shown to have a potential to help as a design tool with the meaningful engagement of the public by assisting with the identification of issues and soliciting solutions to them from different perspectives.

The two locations were useful, as participants tended to have different foci across the future design proposals. For example, on-site users tended to notice more practical and realistic details (Wergles and Muhar, 2009) about safety whereas off-site participants were focused on more aesthetic aspects. Off-site participants were more prone to make unrealistic demands, such as extraordinary activity in a relatively small space. Since this was thought to be related to their perception of the scale and size of the site, the third study takes into account issues of perception.

According to the results of study 2, there is already confirmation of the potential for mobile devices to be used in the future (Lange, 2011; Bilge, Hehl-Lange and Lange, 2016). Their use varies from identifying problems after implementation to engagement in participatory design processes in cloud-based applications (Lebusa, Thinyane and Sieborger, 2015), thanks to their portability and being an important part of daily life (Chi, Kang and Wang, 2013).

The results gathered from the feedback in study 1 and design solutions prepared by professionals during the charrette were combined with the sketches made on ZoomNotes during this study to shape a series of improved future proposals for study 3.

Chapter 7

7 Comparison of on-site and off-site use of mobile devices with future proposals

The third study aimed to compare the use of 3D visualizations on mobile devices on-site and off-site, and their influence on the participants in terms of perception and understanding. Section 7.1 details the methods used during the study. This section details the research narrative, how the previous studies' results were fed into visualizations and displayed on the WalkAbout3D application. The section also contains the pilot study, experiment choreography and participants' information. Section 7.2 presents the quantitative and qualitative results for the study, while section 7.3 contains the discussion.

7.1 Method

7.1.1 Research Narrative for study 3

The third study represented the final stage of the research, combining an assessment of users' understanding and perception of the 3D model visualization with a lesser emphasis on decision making, by letting users give feedback on the site. First, an iPad was used to display a walkthrough video of the 3D model of the park for all participants. The iPad was used with the WalkAbout3D application to view future proposals in one of three settings: while on-site, while off-site or 'combined' (first off-site then on-site). WalkAbout3D allows the person holding the mobile device to see proposals overlaid onto the real world in the shape of a 360° 3D panorama unfolding on the screen as they move around.

The 3D proposals displayed represented a new model of Edward Street Park created by combining some of the most compelling suggestions from participants collected during the charrette and studies 1 and 2. Study 3 aimed to investigate whether people's understanding and perception regarding the site seemed to have changed when they participated in the experiment on-site or off-site, so study 3 uses the potential of mobile devices and 3D visualization to determine whether people's answers changed when participating in an area remote from the site, when standing on site in Edward Street Park, and when combining all of the above (Figure 7.1).

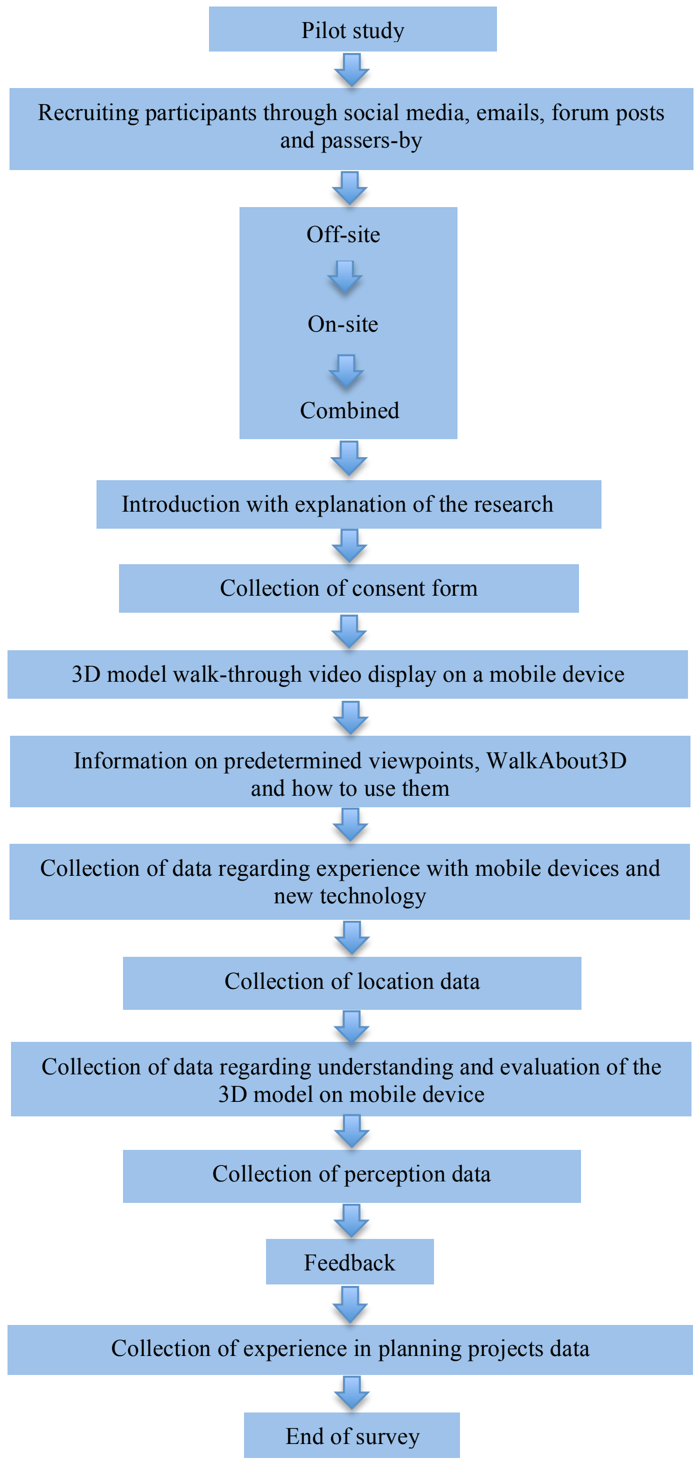


Figure 7.1 Flow chart of comparison of on-site and off-site use of mobile devices with future proposals

7.1.2 Questionnaire Design

The questions related to mobile device use for 3D visualization were prepared to test the experience of users on-site and off-site. Ownership and experience with mobile technology (Appleton and Lovett, 2003), recognising the area and viewpoints, ease of use and usefulness of the mobile devices, willingness to use them (Yang and Shin, 2010; Joo, Lee and Ham, 2014), understanding (Bishop, 2015), disorientation, perception-specific, preference, factual characteristics of the site to be guessed to compare on-site and off-site perception (Roth, 2006; Kim and Shelby, 2006) questions were asked as they affect the user experience. These questions were designed using a 5-point Likert scale. The questionnaire can be found in Appendix E.

7.1.3 Pilot study

A pilot study was conducted to detect possible issues with the questionnaire, the mobile device tool and the application used during the process. The number of participants was ten, as suggested by Virzi (1992): five were recruited on-site and five off-site. All the questions in the questionnaire were checked. The participants were observed during the experiment as they used WalkAbout3D on an iPad, and the length of the experiment was recorded roughly. Only one issue was noted: the participants tried to see all the scenarios from one specific location instead of walking around to overlay the proposal on to reality. Naturally this was mostly observed among on-site users. As a result, in the actual experiment, care was taken to explain step-by-step the viewpoints and their location, to make sure that this would not happen again.

7.1.4 Experiment choreography

For study 3, different settings were chosen in order to be able to compare on-site and off-site use. In all cases, an iPad was used to first display the 3D model walk-through video with the current condition of the park without any modifications to the model. Then future proposals were shown and the researcher briefly explained how to switch between the scenarios and how to view the proposals while moving the display. After showing each participant the six panoramic visualization using the WalkAbout3D mobile application, they were asked to fill out a questionnaire relating to their experience. After completion, the participants were offered sweets. The detailed responses of each participant are presented in the Appendix F.

On-site experiment

The researcher was located on the corner of Edward Street as in previous studies. For this study, on-site participants were asked to walk around the park to match the views on the iPad screen with reality, so that they could juxtapose future scenarios with the current park (Figure 7.2 and 7.3). The on-site experiment took around 15-20 minutes for participants, including the process of walking, viewing the scenarios and filling in the questionnaire.

Figure 7.2: On-site participant viewing the café terrace proposal

Figure 7.3: On-site participant viewing upper garden proposal

Off-site experiment

The experiment took place in the Diamond, a university building, (Figure 7.4), which was a convenient shelter from the weather, easy to enter with both students and members of the public, and near St George Terrace (Figure 7.5) where there is enough pedestrian traffic to recruit participants on a spot which is in close proximity to the park.

Figure 7.4: Off-site participants off-site in the Diamond

Figure 7.5 Off-site participants off-site at St George's Terrace

Off-site participants were asked to hold the iPad in front of them and observe the future proposals one after another, simply by moving the screen on the spot. The off-site experiment took up to 15 minutes, including the process of viewing and filling the questionnaire.

A third set of participants first viewed the model off-site in or in front of the Diamond, then immediately conducted a second viewing on-site: these participants are part of the 'combined' group. For this group the survey took up to 35 minutes including the walking time from off-site to on-site and answering the questions on the survey.

Below is a map of the site indicating the direction of the six viewpoints used as a base for study 3 (Figure 7.6). A number was attributed to each viewpoint according to the order of recurrence of suggestions made during study 2 (as Solly Street had the most changes and general view had the least).

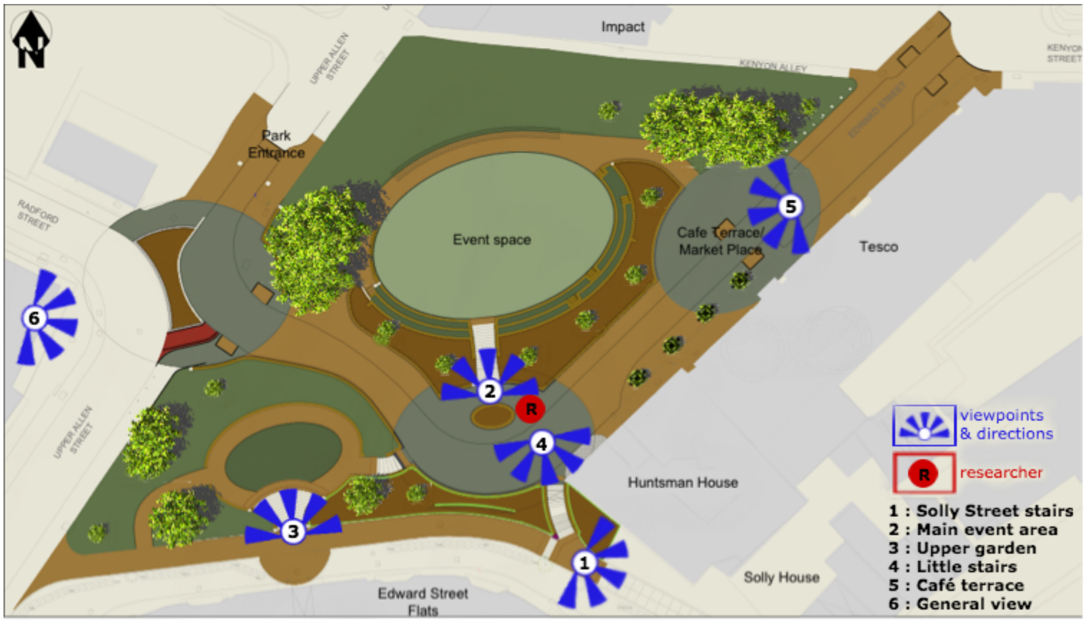


Figure 7.6 Map of the site indicating the direction of the six viewpoints

7.1.5 Future scenarios on WalkAbout3D Mobile application

The third study combined the results of previous studies to produce future proposals, and displayed these proposals in an interactive application, WalkAbout3D (Section 4.1.1.1).

The future proposals displayed on WalkAbout3D were created by compiling the results of data collection during the charrette and studies 1 and 2. The proposals (Figure 7.7, Figure 7.8, Figure 7.9, Figure 7.10, Figure 7.11, Figure 7.12) were prepared after analysing the positive and negative opinions that participants had expressed on each of the viewpoints during the previous studies. Table 7.1 shows the modifications made for each viewpoint while proposals were prepared.

The WalkAbout3D app was used to link each proposal to the different panoramic view of the modified viewpoints with the app's on-demand functionality. Proposals were uploaded to the mobile app after geo-referencing the model within Tremble SketchUp, so that the locations in the model matched reality. Once the model was launched, it stored the exact locations within the mobile app without requiring an internet connection. WalkAbout3D mobile app let users view 360° panoramas of future design proposals on the display of the mobile device overlaying onto reality.

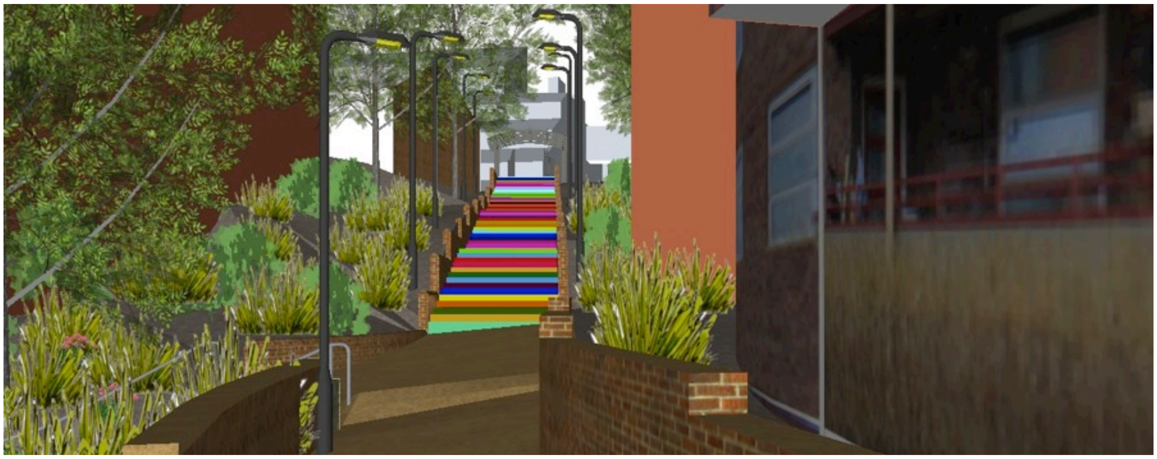


Figure 7.7 Solly Street stairs proposal

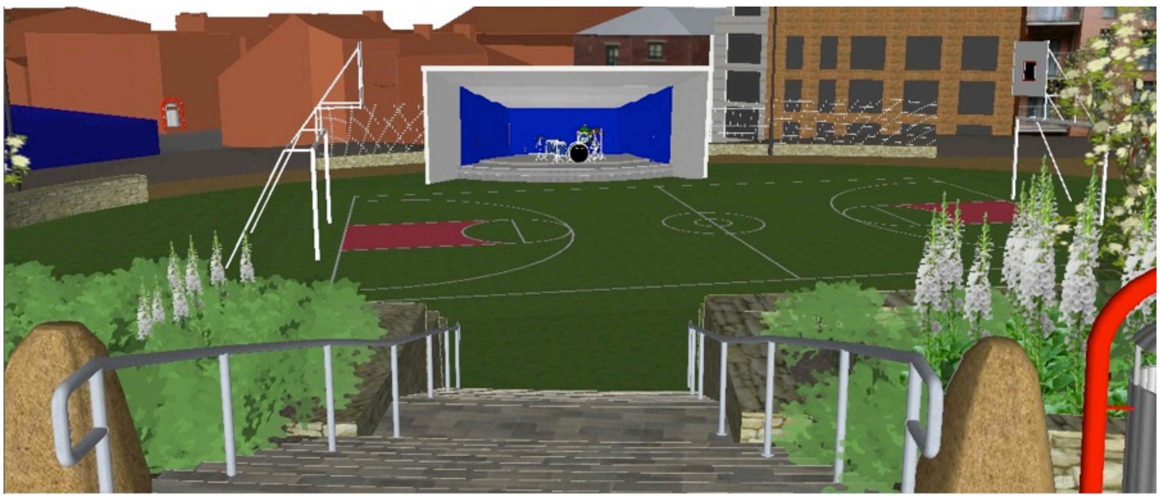


Figure 7.8 Main event area and Tramlines festival proposal


Figure 7.9 Upper garden proposal

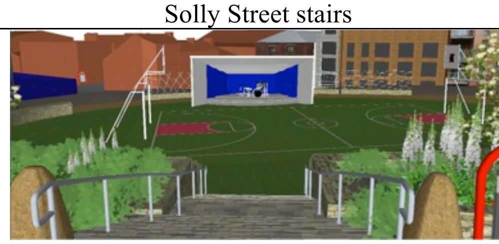
Figure 7.10 Little stairs proposal

Figure 7.11 Café terrace and Eddy's proposal

Figure 7.12 General view proposal

During the preparation of visualizations with proposals, bins and vegetation were added according to the needs of the places. For example, around Solly Street stairs flowers were used to keep the area safer and visible for any kind of threat, mainly at night. While for the upper garden, trees and colourful flowers were introduced to create a welcoming and peaceful environment. Problems within the main event area were solved by bringing multiple use to the sports area, hosting various festivals and events to attract more people. Café terrace was gained a new identity by having an actual café shop (named Eddy's, Appendix D) and a place for gathering with the introduction of colours as well. All the modifications made can be seen in Table 7.1.

Table 7.1 Modifications made for each viewpoint during the preparation of proposals

Modifications Made	Themes	Viewpoint Proposals
-Widened stairs -Added lights -Lowered walls -Gate at the entrance -Added vegetation -Colourful stairs	-Safety -Accessibility -Attractiveness	 Solly Street stairs
-Multiple use sports area -Ground material and lines changed -Added bins -Introducing various events (Tramlines festival)	-Attractiveness -Sense of community and interactivity	 Main event space
-Introducing water to the park (fountain) -Trees and flowers planted -Gathering place -Added benches	-Attractiveness -Sense of community and interactivity	 Upper garden
-Added flowers -Added bins -Bike rack	-Accessibility -Attractiveness -Safety	 Little stairs
-Added a kiosk -Gathering place -A café with outside tables -Added bins -Added umbrellas -Given an identity	-Sense of community and interactivity -Attractiveness	 Café terrace
-More plantation -Added bins around the site -Various use suggested -Given an identity by introducing different colours with plants and material	-Attractiveness -Sense of community and interactivity	 Overall

7.1.6 Participant sampling and characteristics

Regarding the methods used for advance recruitment in study 3, please refer to general methodology chapter (section 4.1.2). Below is an explanation of on the day recruitment.

On-site participants

Only 6.89% of on-site participants had been recruited in advance through email. The researcher recruited most participants (93.10%) from passers-by while standing at the corner of Edward Street.

Off-site participants

Among advance-recruited off-site participants, 8.19% of participants had taken part in study 2 and agreed to return to take part in study 3. An additional 18.03% were recruited through emails.

Most of the participants were recruited on the spot (73.77%). In this instance, the researcher stood at St George's Terrace, a busy intersection, allowing her to ask passers-by to participate in the experiment. This convenient location, also close to the park, allowed the researcher to quickly bring the recruited passers-by inside the Diamond building for the duration of the experiment. The latter was also the location where off-site participants that were recruited in advance were asked to meet with the researcher.

'Combined' participants

Each of the off-site participants were offered the possibility of continuing the experiment on-site after participating in the off-site experiment, becoming participants in the 'combined' group. Among those who agreed to take part in the 'combined' experiment, 63.15% had first participated in study 2 then agreed to come back to participate in study 3's 'combined' experiment. The remaining participants were passers-by who agreed to participate off-site then decided to continue the experiment on-site.

7.1.7 Participant characteristics

A few of the respondents did not complete the questionnaire thoroughly. There were questionnaires without demographic data and missing responses: seven questionnaires were eliminated and not taken into account during the analysis. Questions without responses were treated as 'missing value' during the analysis. In total, 138 responses were included in the analysis (Table 7.2). Among those, roughly 42% were on-site participants, 44% were off-site participants, and 14% participated as part of the 'combined' group.

The sample characteristic was similar to previous studies: the participants were mostly students, with the addition of inhabitants from the surrounding housing and non-locals from other locations. The demographics of the participants are explained in Table 7.2 below.

Table 7.2 Participant characteristics (on-site, off-site and combined)

	On-site (n=58)	**Off-site** (n=61)	**Combined** (n=19)	**Total** (n=138)
Participation				
Emails and Posts	0	11	3	14
Passers-by	54	43	5	102
Consultation Participants	4	7	11	22
Gender				
Male	28	35	10	73
Female	30	26	9	65
Age groups				
18-24 years	31	32	11	74
25-44 years	25	23	8	56
45-64 years	1	6	0	7
65+ years	1	0	0	1
Studentship status				
Student	39	37	9	85
Non-student	19	24	10	53
Familiarity				
Familiar	42	40	15	97
Not-familiar	16	21	4	41
Place of Residence				
Edward Street Flats	2	8	4	14
Allen Court	4	2	0	6
Atlantic1	4	4	0	8
Impact	0	3	0	3
Omnia Space	6	0	2	8

7.2 Results

For study 3, it was expected that the users' perception of realism and scale would vary depending on where the 3D visualization on mobile device was viewed. The researcher also expected that on-site use of mobile devices would increase the participants' understanding of prioritized ideas and possible future scenarios. So the third study was designed to test whether there were any differences or influence on the participation process using 3D landscape visualizations on mobile devices when the later took place on-site, off-site, or both ('combined'). The statistical analyses adopted for this study is explained in section 4.2.2). The following section presents the results of this study.

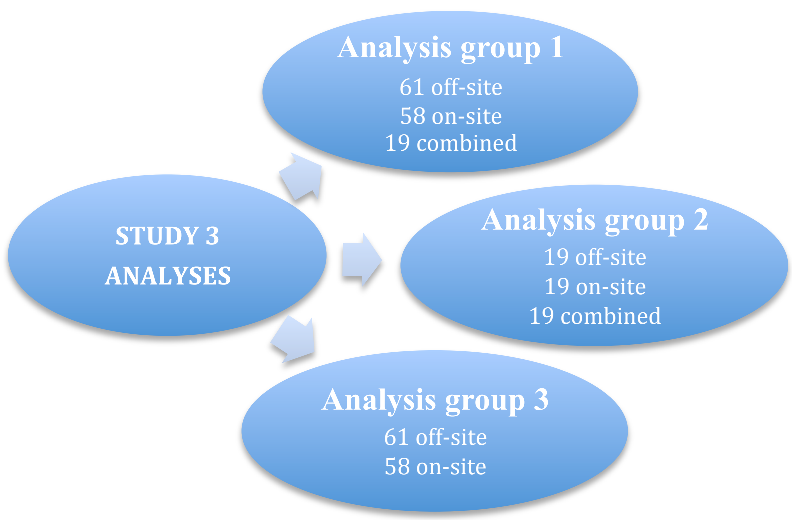


Figure 7.13 Study 3 analyses groups and number of participants in each group

In this experiment, most of the questions about the use of mobile devices were assessed on a 5-point Likert scale. During the preparation of the data for analysis, the coding scheme explained in section 4.2.1 was used again for SPSS, with higher scores representing greater quality. There were three analysis groups, as shown in Figure 7.13. Although the 'combined' group was the smallest in terms of numbers of participants, all the responses were analysed without considering the disproportionate number of participants as part of Analysis group 1. In order to balance the unequal number of participants in the previous analysis, 19 random subjects were chosen from the other survey groups (on-site and off-site) by using the similar attributions for studentship status and familiarity (Analysis group

2). In order to obtain a marked comparison, only off-site and on-site participants responses' were compared as part of Analysis group 3.

Overall, the participants gave positive ratings to all elements in the questionnaire (Table 7.3). The results are presented in groups of different thematic questions, which is different from the questionnaire's order. There are a group of questions testing the participants' perception of the 3D model and reality. The next part is concerned with the experiment design, aiming to determine if it was easy to understand. Thirdly the participants were queried about the value of the experiment to facilitate decision-making in participation. Only significant results are presented, with a separate section in each group of questions relative to the demographic aspects of the participants. By putting results related to demographics together, the reaction of specific sets of participants (such as students) are checked across different questions.

Table 7.3 Statistics for study 3, experience of mobile device visualization use

Location		iPad use easiness	Understand scenarios	Easy understand	Recognise viewpoints	MD role in DM	Useful 3D MD	Disoriented /confused
Off-site	N	61	61	60	61	61	61	61
	Mean	4.34	4.66	4.33	4.26	2.61	4.54	4.33
	Median	5.00	5.00	5.00	5.00	3.00	5.00	5.00
	Std. Dev.	.793	.574	.914	.982	.525	.594	.870
On-site	N	58	58	58	58	58	58	58
	Mean	4.45	4.69	4.19	4.17	2.66	4.36	4.55
	Median	5.00	5.00	5.00	5.00	3.00	5.00	5.00
	Std. Dev.	.680	.568	.963	.939	.479	.931	.776
Combined	N	19	19	19	19	19	19	19
	Mean	4.58	4.74	4.47	4.21	2.53	4.68	4.16
	Median	5.00	5.00	5.00	5.00	3.00	5.00	4.00
	Std. Dev.	.769	.653	.841	.976	.513	.478	.765

(MD: Mobile Device, DM: Decision-making;
Feeling of disorientated/confused results were recoded following the trend of "the higher is the rating, the more positive are the responses" while recoding the data).

7.2.1 Perception

7.2.1.1 Perception of space

A series of perception questions about factual characteristics of the site were included in the experiment, to test whether the 3D model offered a credible image of the site that would not mislead the participants and lead to a poorer quality of decision-making. Such questions also helped to understand better whether on or off-site participation might be more suitable for a certain level of participation.

A number of questions were aimed at measuring the participant's capacity for judgment of height, distance, area and so on while using a 3D visualization on a mobile device. It was expected that on-site participants would be better at estimating those different distances and areas inside the park, and that on-site participants would be more likely to interpret the model correctly and engage in meaningful decision-making.

The perception part of the questionnaire started with one objective question, followed by several subjective questions (Table 7.4). In order to test the model for representativeness and visual clarity, participants were asked to evaluate the actual number of trees within the site as an objective measurement. Then the participants were asked to make a judgment about four different distances and areas in the Edward Street Park.

Table 7.4 Real values for the objective measurement and subjective judgement questions in perception questions

Number of trees on the site	19
Percentage of green area	25.7 %
Height of Huntsman House	16.798 m
Height of a lamppost	6 m
Distance between Tesco and Solly Street stairs	55.7 m

Huntsman House is a building at the corner of Edward Street

The comparison between the survey groups was made with the Mann-Whitney and Kruskal-Wallis tests. The tests were run according to the three different 'analysis groups' (see above). As Dunn-Bonferroni test does not provide any chart but vectoral presentations, the results were only included in the figures if the results showed significance with the Kruskal Wallis test. As a guideline, the lower the mean ranks of error rates indicated, the better the survey group was at making estimates.

Number of trees

The participants were asked to count the number of trees in the site. When using Analysis Group 3, the significance in simple error (p = .028) shows that most participants, regardless of being on-site or off-site, counted quite the trees quite accurately (Table 7.5). However, on-site participants still provided more accurate numbers than off-site participants (p = .026). Figure 7.14 and Figure 7.15 shows the mean ranks for on-site and off-site comparison for significances for objective measurement responses.

Table 7.5 The Kruskal-Wallis and the Dunn-Bonferroni significant test results for objective measurement for number of trees

Analysis group	Significant Results	Significance found	Sig.	Adj Sig.	Sample 1	Sample 2
Analysis group 1 (58+61+19)	On-site & male – off-site & male	absolute error	.028	.008	On-site 45.44	Off-site 79.29
Analysis group 3 (58+61)	On-site – off-site	simple error	.028	–	On-site 49.01	Off-site 62.39
Analysis group 3 (58+61)	On-site – off-site	absolute error	0.26	–	On-site 48.94	Off-site 62.45

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

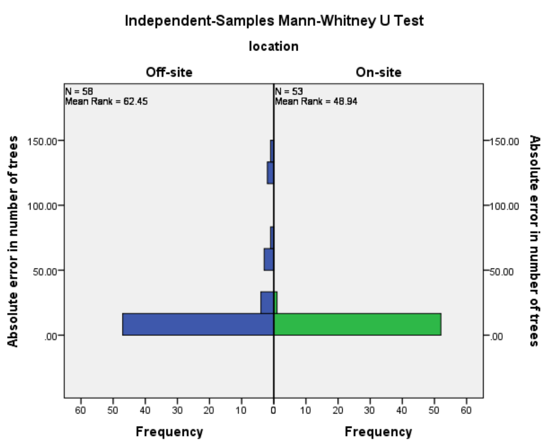


Figure 7.14 Comparison of the mean absolute errors in counted number of trees for on-site and off-site participants

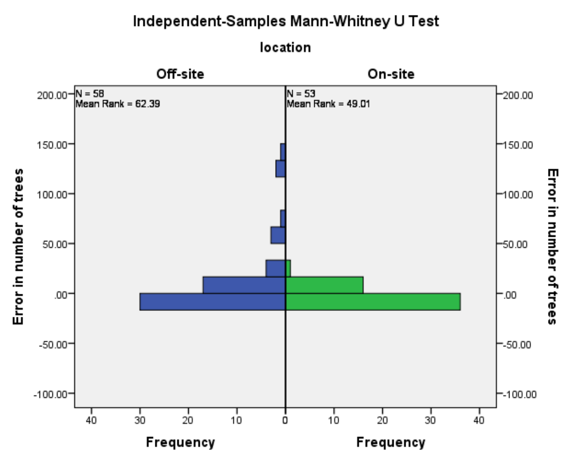


Figure 7.15 Comparison of the mean simple errors in counted number of trees for on-site and off-site participants

Height (of a building)

The participants were asked to estimate the height of the Huntsman House building. There were significant differences between the results of the different survey groups (Table 7.6).

The off-site participants (mean rank = 76.29) did not give answers as accurately as the off-site participants, who were not as good as the ‘combined’ group (mean rank = 45.34) participants (Adj. Sig. = .005). The ‘combined’ group participants viewed the model off-site first and had already been introduced to the site. Once the ‘combined’ participants looked at the model on-site again, it is likely that they had already figured out the difference of scale between the model and reality, so it was reasonable to expect that participants of the ‘combined’ survey participants would make closer estimates than off-site participants.

Among the significant differences between the survey groups using Analysis group 2, on-site and combined survey groups had similar scores (mean rank of on-site = 21.63, combined = 23.11) but off-site participants scored significantly higher (mean rank = 40.59), indicating that off-site participants were estimating the height less accurately than the other two groups.

This was confirmed by the significant differences between the survey groups when using Analysis group 3 (Figure 7.16). On-site users (mean rank = 48,49) were more precisely predicting the building height than off-site users (mean rank = 62.02). The expectation that participants would perceive height projections better perceived when standing on-site was confirmed.

Table 7.6 The Kruskal-Wallis and the Dunn-Bonferroni significant test results for subjective judgments for Huntsman House height

Analysis group	**Significant Results**	**Significance found**	**Sig.**	**Adj Sig.**	**Sample 1**	**Sample 2**
Analysis group 1 (58+61+19)	Combined – off-site	absolute error	.003	.005	Off-site 76.29	Combined 45.34
Analysis group 2 (19+19+19)	On-site – off-site	absolute error	.000	.001	On-site 21.63	Off-site 40.59
Analysis group 2 (19+19+19)	Off-site – combined	absolute error	.000	.003	Combined 23.11	Off-site 40.59
Analysis group 3 (58+61)	On-site – off-site	absolute error	.026	–	On-site 48.49	Off-site 62.02
Analysis group 2 (19+19+19)	Off-site & non-student – off-site & student	simple error	.020	.027	Student 43.61	Non-student 19.56

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Studentship status seemed to have an influence on the guesses made by off-site users (p = .020 KW, p = .027 DB). Students (mean rank= 43.61) guessed the height of the building less accurately than non-students (mean rank= 19.56).

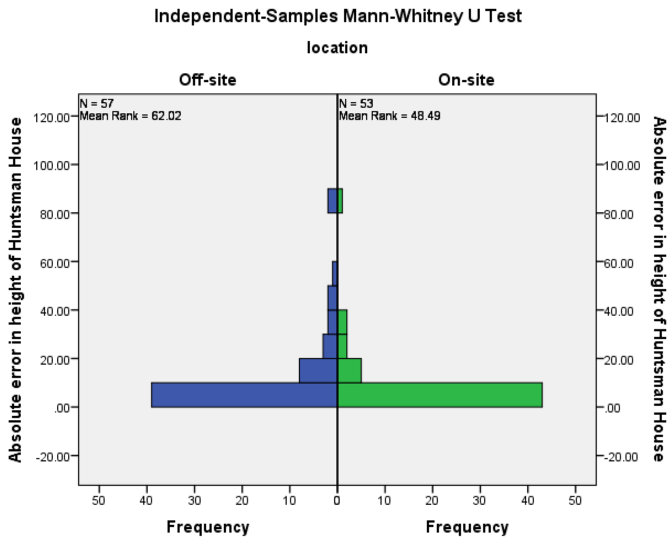


Figure 7.16 Comparison of the mean absolute errors in estimates of on-site and off-site participants for the height of Huntsman House

Height (of a lamppost)

The participants were asked to estimate the height of one of the site's lampposts. As can be seen in Table 7.7 and Figure 7.17, when using Analysis group 1, on-site participants (mean rank = 45.01) guessed the height of the lamppost more accurately than off-site participants (mean rank = 64.91). Similarly, when using Analysis group 3, on-site participants (mean rank = 53.71) gave a significantly more precise (p = .003) estimation of the height of lampposts compared to off-site participants (77.09).

Table 7.7 The Kruskal-Wallis and the Dunn-Bonferroni significant test results for subjective judgments regarding the height of lampposts

Analysis group	Significant Results	Significance found	Sig.	Adj Sig.	Sample 1	Sample 2
Analysis group 1 (58+61+19)	On-site – off-site	absolute error	.003	.002	On-site 53.71	Off-site 77.09
Analysis group 3 (58+61)	On-site – off-site	absolute error	.001	–	On-site 45.01	Off-site 64.91

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

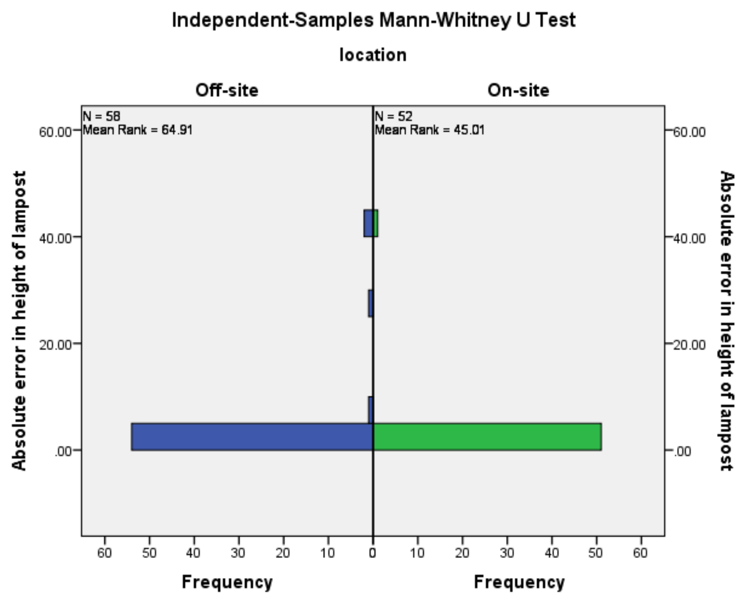


Figure 7.17 Comparison of the mean absolute errors in estimates of on-site and off-site participants for lamppost height

Additionally, off-site participants' estimates varied widely with extreme assumptions, while most of on-site participants guessed with better approximation.

Distance between two points (Tesco and Solly Street stairs)

The participants were asked to guess the distance between the Tesco supermarket and the Solly Street stairs, chosen because they are landmarks in two of the viewpoints. Although the actual distance between these two points was 55.728 m, the off-site participants' guesses varied up to 1000 m. When using Analysis group 1, on-site participants (mean rank = 56.68) guessed the distance significantly more accurately (p = .005 KW and p = .007 DB) than off-site participants (mean rank = 78.66). Once again, when using Analysis group 3, off-site participants (mean rank = 66.12) guessed significantly worse than on-site participants (mean rank = 47.38) as can be seen in Table 7.8 and Figure 7.18.

There was a significant difference between participants who own and do not own a smartphone. Smartphone owners (mean rank = 77.88) were not able to estimate the distance between two points as accurate as participate without a smartphone (mean rank = 2.67).

However, this result should be treated with caution due to the small number of participants without a smartphone.

Table 7.8 The Kruskal-Wallis and the Dunn-Bonferroni significant test results for o subjective judgments for the distance between Tesco and Solly Street stairs

Analysis group	Significant Results	Significance found	Sig.	Adj Sig.	Sample 1	Sample 2
Analysis group 1 (58+61+19)	On-site – off-site	absolute error	.005	.007	On-site 56.68	Off-site 78.66
Analysis group 1 (58+61+19)	Off-site & not own a smartphone – off-site & own a smartphone	simple error	.003	.009	Own 77.88	Do not own 2.67
Analysis group 3 (58+61)	On-site – off-site	absolute error	.002	–	On-site 47.38	Off-site 66.12

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

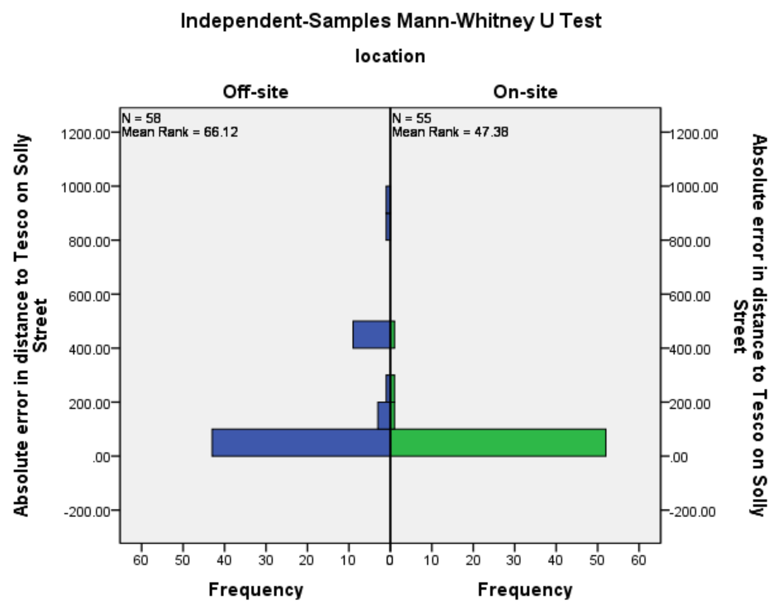


Figure 7.18 Comparison of the mean absolute errors in estimates of on-site and off-site participants for the distance between Tesco and Solly Street stairs

Green Area Percentage

The participants were asked to guess which percentage of the site was covered in vegetation, as a 'Green Area'. When using Analysis group 1, on-site participants made a significantly more accurate estimation compared to off-site participants both with simple error (mean ranks on-site =54.33 and off-site= 76.32) and absolute error (mean ranks on-site =54.33 and off-site= 76.83) as shown in Table 7.9. When using Analysis group 3, on-site participants were again significantly better at guessing the Green Area percentage than off-site participants, both with simple error (mean ranks on-site=45.36, off-site 64.46) as presented in Figure 7.19 and with absolute error (mean ranks on-site=45.75, off-site=64.08) as shown in Figure 7.20.

On-site participants were mostly guessing quite close to reality and estimating more or less accurately with a smaller margin of error compared to off-site participants (Table 7.9). There was a tendency for those who participated off-site to guess the percentage of green area higher than the reality. The results were as expected indicating that participants who viewed the model on site perceived the environment more accurately compared to off-site viewers.

Table 7.9 The Kruskal-Wallis and the Dunn-Bonferroni significant test results for subjective judgments regarding green area percentage

Analysis group	Significant Results	Significance found	Sig.	Adj Sig.	Sample 1	Sample 2
Analysis group 1 (58+61+19)	On-site – off-site	absolute error	.006	.006	On-site 54.35	Off-site 76.32
Analysis group 1 (58+61+19)	On-site – off-site	simple error	.006	.004	On-site 54.33	Off-site 76.32
Analysis group 3 (58+61)	On-site – off-site	simple error	.002	–	On-site 45.36	Off-site 64.46
Analysis group 3 (58+61)	On-site – off-site	simple error	.002	–	On-site 45.75	Off-site 64.08

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

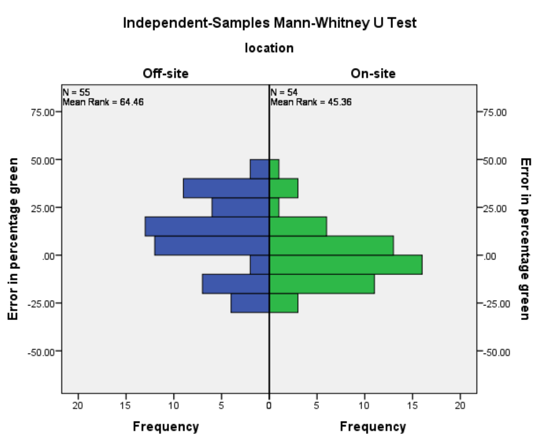


Figure 7.19 Comparison of the mean simple errors in estimates of on-site and off-site participants for the percentage of green area

Figure 7.20 Comparison of the mean absolute errors in estimates of on-site and off-site participants for the percentage of green area

To sum up, there were significant differences in the participants' perception results depending on whether they participated on-site, off-site or both. Off-site users tended to guess the height of the buildings higher than they actually were. On-site participants were also significantly better at guessing the heights than off-site users for both building height and lamppost height. The 'combined' group participants perceived the height significantly better than off-site users regardless of the sample size.

The question regarding the perceived percentage of greenery in the Edward Street Park area and the distance between two points provided similar results: on-site users were better at guessing closer to the actual number than off-site participants, with smaller margins. The 'combined' group participants did consistently well as they benefitted from the opportunity of being able to see both actual and virtual environments, and improve their capacity to compare and contrast the real and virtual dimensions of elements on the site.

Difference between reality and 3D model

To complete the findings from the perception tests, the participants were asked whether they perceived any difference between virtual environment and the reality. The aim was to check if participants would point out any difference related to their perception such as underrepresented visual (for example, graffiti), auditory and olfactory experiences. It was expected for example that they noticed that the 3D model did not represent litter in the site. Off-site participants were, too, asked the same question in case some of them were familiar enough with the site to have an opinion on the matter. It was expected that participants that were not familiar with the site would ignore that question. Table 7.10 shows the results of identifying differences between the virtual and real environment for each survey group.

It appears that it was not clear for some (mostly off-site survey group) participants that the aim of the exercise was to find the differences between the 3D model and reality. So some participants described the modifications made for proposals as differences.

Table 7.10 Results for the difference between 3D model and reality

Location	Difference between 3D and reality	Number of participants	Percentage
Off-site	Yes	21	34.4 %
	No	22	36.1 %
	Missing	18	29.5 %
On-site	Yes	25	43.1 %
	No	32	55.2 %
	Missing	1	1.7 %
Combined	Yes	11	57.9 %
	No	8	42.1 %
	Missing	0	0 %

Across survey groups, several participants recognised that there were differences but could not define them, while some others perhaps thought that the differences were insignificant, therefore should be neglected. Among on-site and 'combined' group participants, some differences were identified as presented below:

- The 3D model does not show any current problems such as littering due to the lack of rubbish bins, dirt around the stairs and unmown lawn in the upper garden as they seemed neat and clean in the model;
- The model depicted a safe environment in an attractive way, however in reality the area seemed derelict to those participants;
- Vegetation cover was not as dense in the model as in reality;
- The colours in the model were not the same as reality, leading to a lower level of realism.

The results show that on-site and 'combined' group participants were able to spot the differences better than the other group; in future studies this aspect should be tested systematically with off-site participants considering their knowledge about the site.

Disorientation

The last question related to perception was to ask the participants directly whether they felt disoriented. There was a possibility that the more the participants would move around, and the more they would feel disoriented.

Only 1.7% (1 person) of on-site group felt exceptionally disoriented, while more than 54% of off-site and 67.2% of on-site participants did not feel disoriented at all. Although significantly more affected generally, about a third of 'combined' participants also reported not feeling disoriented. Combined locations group participants were disadvantaged in this respect as they had to view the 3D model twice, unlike the other participants who only had to orient themselves once. These results fell into line with expectation, and the next set of questions was partially designed to test whether disorientation had significantly impacted the participant's understanding of the experiment (see next section).

7.2.1.2 Perception and participant characteristics

The significant differences between questions related to perception and demographics are summarised below.

Ownership of smartphone and tablet

When assessing distances (Analysis group 1), there was a significant difference between off-site participants who owned a smartphone and those who did not own a smartphone (section 7.2.1.1). Those who did not own a smartphone were significantly better at guessing the distance between Tesco and Solly Streets than people who owned smartphone. However, since only 7 out of 138 participants did not own a smartphone, this significant result is not reliable due to use of mean ranks, and should be verified with a larger sample.

Studentship

From the off-site participants groups, height of the building was guessed significantly different between students and non-students (section 7.2.1.1).

Table 7.11 shows that studentship status seemed to have an influence on the guesses made by off-site users. The estimates students made were considerably higher than the actual building height. Students did not guess the height as precisely as non-students did off-site.

Table 7.11 The Kruskal-Wallis and the Dunn-Bonferroni test results of feeling of disorientation for all participants

Analysis group	Significant Results	Significance found	Sig.	Adj Sig.	Sample 1	Sample 2
Analysis group 2 (19+19+19)	Off-site & non-student – off-site & student	simple error (Building H)	.020	.027	Student 43.61	Non-student 19.56
Analysis group 1 (58+61+19)	On-site & student – combined & student	disorientation	.002	.036	On-site 71.86	Combined 32.00
Analysis group 2 (19+19+19)	Off-site & student – combined & student	disorientation	.004	.036	Off-site 24.72	Combined 11.67
Analysis group1 (58+61+19)	Combined & student – combined & non-student	Recognition of viewpoints	.017	.037	Student 16.17	Non-student 35.05
Analysis group1 (58+61+19)	Combined & student – on-site & student	recognition of viewpoints	.017	.032	Combined 16.17	On-site 35.83

There were significant differences between student groups for different locations regarding disorientation. Student participants of the 'combined' survey group (mean rank = 32.00) were feeling significantly more disoriented than on-site student participants (mean rank = 71.86). Results with downsized group also showed that combined group student participants (mean rank =11.67) were also felt more disoriented than off-site student participants (mean rank = 24.72)

A correlation was shown between feelings of disorientation and problems with guessing the height of Huntsman House right; for this correlation off-site student participants performed consistently worse than the combined group student participants. Student participants in the combined group tended to feel more disoriented than on-site group student participants.

Table 7.12 The Kruskal-Wallis and the Dunn-Bonferroni test results of recognition of viewpoints for all participants

Analysis group	Significant Results	Significance found	Sig.	Adj Sig.	Sample 1	Sample 2
Analysis group 1 (58+61+19)	Combined & student – combined & non-student	Recognition of viewpoints	.017	.037	Student 16.17	Non-student 35.05
Analysis group 1 (58+61+19)	Combined & student – on-site & student	recognition of viewpoints	.017	.032	Combined 16.17	On-site 35.83

Among the participants belonging to the combined group, non-students were significantly better at recognising the viewpoints than students (Table 7.12). Students (mean rank = 16.17) did not recognise the viewpoints as easily as non-students (mean rank = 35.05). In addition, students who took part on-site (mean rank = 35.83) were more perceptive than the students who viewed the model both off-site and on-site (mean rank = 16.17).

This can possibly be explained by the fact that students were usually less familiar with the site than non-students; as mentioned earlier, students typically rent their accommodation for a year in that area, leaving either after finishing their studies or moving out to another area. ‘Combined’ group participants that were students reported that they struggled more in recognising viewpoints than on-site student participants.

7.2.2 Understanding

7.2.2.1 Understanding and participant characteristics

The results between questions related to understanding of proposals and use of mobile devices during participation for participant characteristics are summarised below.

Gender

Without taking into consideration whether the mobile device was used on-site or off site, the role of mobile devices to increase public participation was significantly affected by gender. Even though both females and males thought mobile devices play an important role in increasing public participation, males (mean rank =71.80) were more positive than females (mean rank = 66.92) when answering the question about mobile devices’ role in increasing participation during the planning and the decision-making process.

Age

When ignoring which survey group they belonged to, the willingness to use mobile device with 3D model visualization seem to be significantly affected by age. Participants in the 25-44 age group expressed more interest to use the technology in the future than the 18-24 age group.

Ownership of tablet

When the data was analysed without considering the location of the mobile device use, understanding proposals was significantly affected by the ownership of a tablet. For the all participants, 52.9% of them owned a tablet while 47.1% of them did not have one. Even though tablet owners had difficulties in understanding the scenarios compared to people without one, tablet owners still supported the idea that mobile devices have a positive impact on participation more than non-tablet owners did.

As shown in Table 7.13, the participants who owned a tablet and participated off-site (79.75 = mean rank) expressed a greater willingness to use it to give feedback than the participants of the on-site group (55.06= mean rank).

Table 7.13 The Kruskal-Wallis and the Dunn-Bonferroni test results of willingness to use 3D mobile devices in future for all participants

Analysis group	Significant Results	Significance found	Sig.	Adj Sig.	Sample 1	Sample 2
Analysis group 1 (58+61+19)	On-site & tablet off-site & tablet	Future use	.031	.031	On-site 55.06	Off-site 79.75
Analysis group 1 (58+61+19)	on-site & tablet- on-site- & no-tablet	Future use	.006	.029	Tablet 47.36	No-tablet 68.33

The Kruskal-Wallis test indicated that there was a significant difference related to tablet ownership regarding willingness to participate in the future (p = .006 KW, p = .029 DB). On-site tablet owner participants (mean rank = 47.36) declared that they would be less likely to use this application than on-site non-tablet-owners (mean rank = 68.75) when offered to participate in the planning, design or decision-making processes.

Impact of 3D visualization on mobile devices on the participation process

This group of questions queried the participants to determine if they found the use of the mobile device useful, and found that 3D visualization on mobile devices was considered as a valuable tool for participation purposes.

The participants were directly asked if mobile devices can play a role in increasing active public participation during the planning and the decision-making process. More than a third of participants across survey groups agreed that mobile device is ‘crucial’ for increasing public participation (36.1% off-site, 34.5% on-site and 47.4% combined) while more than half of participants found it useful (62.3 % off-site, 65.5% on-site, 52.6% combined). Only one participant among the off-site survey group, 0.7 % of all participants, estimated that it would not play any role, while none in the other survey groups selected that option. 95% of all participants rated the technology has having potential and being useful for future use during the planning and design processes.

A further question asked the participants about how useful they think 3D models on mobile devices are during the decision-making process. Almost 60% of all participants rated the 3D models on mobile devices as 'very helpful' (59% off-site 53.4% on-site and 68.4% combined). Only 2.9% of all participants rated the 3D models as 'very unhelpful' or 'unhelpful', while other survey groups did not select those options. The most positive feedbacks were given by the participants of the 'combined' survey group. The results suggest that using mobile devices either off-site or on-site might be more convenient, but 'combined' use is even more useful to facilitate participation.

To see whether mobile devices can be used as a participatory tool for engaging communities, participants were asked about their willingness to use the same tool again. Most of the participants agreed that they would be willing to use the technology in the future when offered (68.8 %). Only 2.2% were not interested in using such an app again. Such positive feedback is noteworthy considering only 19.2% of the participants had taken part in urban planning projects before.

Finally, to use mobile devices as an effective participatory tool to reach a consensus, all participants were asked about their favourite proposal addressing the issues within the site. A total of 113 participants selected one favourite viewpoint, while 20 participants chose two different viewpoints, and five participants chose all the proposals as favourite. The little stairs and general view was not chosen at all.

When using the Analysis group 1, across all the survey groups, the most popular proposal was 'café terrace' (Figure 7.21). When looking at the separate survey groups, the same proposals tended to come up in different order (Table 7.14). Among the 'combined' participants, more than half preferred the 'café terrace'. There was a difference among the second most popular scenario between the survey groups. Such difference can be interpreted as showing that on-site participants, having already witnessed the site's condition, giving priority to proposals solving immediately perceivable issues (for example the lack of safety at Solly Street stairs) as explained in chapter 6. In comparison, off-site participants were more prone to discuss more general issues, such as activities to be held within the area and therefore were more interested in the multi-use sports area in the 'main event' viewpoint.

Table 7.14 Analysis group 1 comparisons of preferences for favourite proposal on each group

Favourite Proposals	On-site		Off-site		Combined		Total	
	N	Response %	N	Response %	N	Response %	N	Response %
Café terrace	18.0	31.03%	18.5	30.33%	9.5	50.00%	46.0	33.33%
Main event space	9.0	15.52%	16.5	27.05%	3.0	15.79%	28.5	20.65%
Solly Street stairs	15.0	25.86%	8.0	13.11%	3.0	15.79%	26.0	18.84%
Tramlines	3.0	5.17%	5.0	8.20%	.5	2.63%	8.5	6.16%
Upper garden	13.0	22.41%	13.0	21.31%	3.0	15.79%	29.0	21.01%

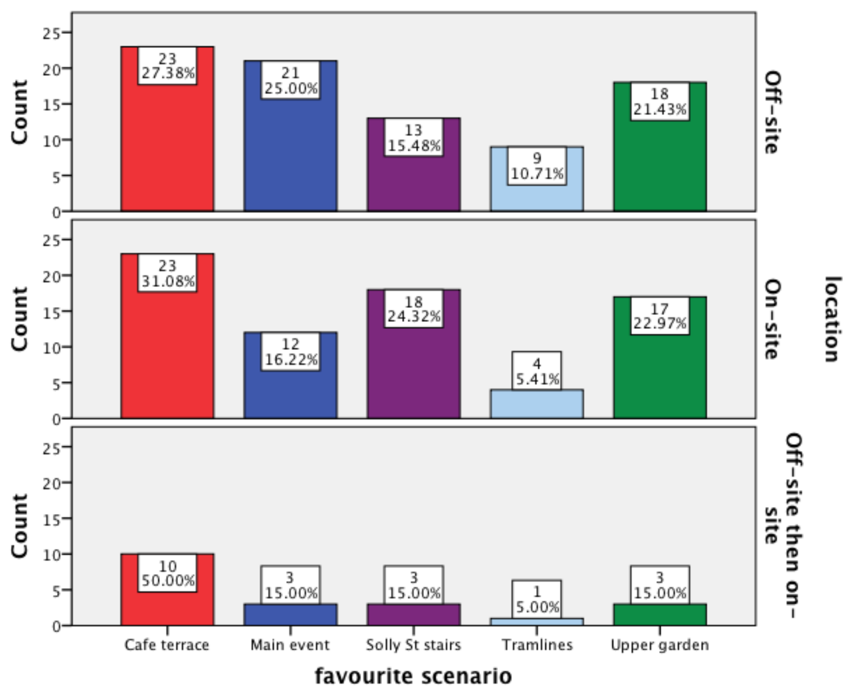


Figure 7.21 Favourite proposal rankings preferred by analysis group 1

Generally, on-site participants tended to choose solutions aligned with issues related to safety; off-site participants preferred proposals improving the attractiveness of the site. Such tendency is made more obvious when looking at the reasons given by participants regarding why they selected a specific viewpoint as favourite (Table 7.15).

Table 7.15 Reasons for choice of favourite proposal

Viewpoints	Reasons for choice			
	Safety	**Accessibility**	**Attractiveness**	**Sense of Community**
Solly Street stairs	-Artificial lights and gate is safer -Lower plants is safer	-Improved layout -Safer route	-Colourful stairs are more attractive	-The colours of stairs give identity to the site
Café Terrace	-Popularity	_	-Realism on the model and perfect fit -More colourful -User-friendly	-Gathering space -Encourages people to stay longer -Umbrellas are useful for rain & sun
Main Event	_	_	_	-Bring people together -Multifunctional sports -Tramlines festival as seasonal activity
Upper Garden	_	_	-Multifunctional use -Fountain and benches as gathering space -Peaceful, relaxing environment	- Helps socializing
Little Stairs	_	_	_	_
General View	_	_	_	_

7.2.2.2 Understanding and use of mobile devices

This group of questions aimed to assess the use of mobile devices as a participatory tool and whether the proposals were easily understood by the participants, notably to determine if the experiment is replicable in future studies.

The easiness of use of the mobile device was questioned and more than 50% of participants across survey groups rated the iPad as 'very easy' to use (52.5% off-site, 55.2% on-site, 68.4% combined). To follow through, the participants were asked if they understood the proposals presented on the iPad and how easy it was to understand them. More than 70% of participants in each survey group replied that they understood 'very well' (70.5% off-site, 74.1% on-site, 84.2% combined). The majority of participants rated the proposals as 'very easy' to understand (63.3% off-site, 56.9% on-site, 68.4% combined). None of the participants rated the scenarios as 'not at all' or 'slightly' easy to understand. The on-site participants' rated the easiness of understanding the proposals relatively lower than the other two survey groups. Even though this latter result was surprising as it was expected that on-site participants would find it is easier to understand the 3D visualization on mobile devices, it was not a significant difference.

Taking the specifics of the experiment into consideration, the fact that the participants had to match the iPad with the actual scenery using WalkAbout3D was potentially the most confusing aspect, especially for on-site participants. An additional question about the viewpoints was aimed to test if the specificity of WalkAbout3D, superimposing real and virtual environment, had been successfully implemented. The participants were asked if was easy to recognise the viewpoints on the model, as they were shown a walkthrough video at the beginning. The participants mostly answered positively, with more than 50% across survey groups finding it 'very easy' (62% off-site, 53.4% on-site and 57.9% combined). Again, the on-site participants gave generally lower ratings than the other groups, which may indicate that for some participants matching the actual landscape with the digital one was not a seamless experience. More than 30% of participants found that it was 'somewhat easy' to distinguish the viewpoints (32.8% off-site, 36.2% on-site, 36.8% combined). In this instance the off-site participants gave slightly higher ratings.

The participants who used the WalkAbout3D application on-site seemed to rate all aspects of understanding lower in comparison to the other survey groups. Even though this result is not significant, this is understandable as the on-site participants viewed both real and virtual landscapes at the same time, which could understandably result in confusion. On-site participants also had to walk around the site to match the proposals overlaying onto the actual viewpoints through the mobile device: it may have caused difficulties for them in understanding which specific area they were viewing. The fact that the site was small might have lowered the possibilities for disorientation; but it should be assumed that it still influenced the ratings slightly.

Pros and cons of WalkAbout3D application

The participants were asked directly about their thoughts on the *WalkAbout3D* application, and any suggestions they might have regarding the app. Some of the participants were concerned with the level of realism of the application itself. For example, participants experienced an issue with the image flickering and lagged when moving the iPad, and argued that a smoother viewing would have made the proposals more realistic. Such issues were not encountered during the pilot study, and would need troubleshooting in future studies using the same application.

Another comment was that the model did not include human figures, which could have helped with scale. The rest of the remarks linked with realism were concerned with the quality of graphics. The textures of the buildings, the colours available, and the image resolution were suggested to be improved. Such suggestions would indeed provide more realistic images with subtle colours, more resolution and better graphics, but they might require using more powerful mobile devices.

Another recurring theme was a series of positive remarks on the fact that WalkAbout3D allowed for interactivity, as discussed in the literature review. For example, some participants found WalkAbout3D helpful to understand future proposals for audiences from different walks of life. The participants even called for more interactivity to provide feedback in various ways, such as the ability to add or delete elements from the proposals or to share feedback for suggestions. There was a call for more complete immersion, such as the possibility of walking through the space while holding the mobile device, and not only moving a panorama for one static point. Another comment suggested the use of Virtual Reality helmets.

Although the application was described as useful, some participants commented that the need to walk in the park to find the viewpoints was not very convenient. This difficulty was possibly unavoidable, though it is particularly important for participants with disabilities, for whom off-site use of the app was preferable. This issue could be solved proposing multiple scenarios for each viewpoint and collecting the data from different participants at different locations at their convenience. So different participants would be able to view scenarios for one specific viewpoint according to their location without the requirement of walking around the site to view proposals.

Some participants picked up on the idea that WalkAbout3D allowed for communication of a concept without words. Such comments may imply that the application is useful to communicate ideas to audiences from different walks of life with different backgrounds, perceptions and preferences. One participant described the application as intuitive, adding that it was a good idea to use it during the design process the app demonstrates better the proposal by rendering them in 3D. Other participants confirmed that the app provided them with a convenient way to comprehend what the proposal would look like in context, especially for individuals who consider themselves as not having good spatial perception.

Some participants asked for the mobile device to display side to side on the screen the viewpoints before and after the proposal was implemented. Such suggestion might work better for off-site participants who cannot see the real park in any case. While acknowledging that WalkAbout3D was a straightforward application, one participant suggested that connecting the app to a platform collecting participants' comments would be a useful addition. Such an addition is likely to increase the quantity and quality of that input during the participation process. These comments could presumably suggest that WalkAbout3D and similar apps have potential to be adopted for participatory planning and design as they use a tool that people use intensively everyday.

7.3 Discussion

7.3.1 Limitations of the study and results

There were limitations for the results and the study 3.

As with studies 1 and 2, some age groups were underrepresented among the participants. There were only seven participants in the 45-64 years old group and one in the 65+ years old group. Similarly, the participants from the 'combined' group were less numerous than the on-site and off-site groups. To counterbalance these issues, three different analysis groups were used in study 3 results. Even though the analyses were used to eliminate coincidental results, there might be external influences such as distractions and environmental factors affecting responses during the study.

One demographic that was overrepresented was that of participants who owned mobile devices (smartphones or tablets). Only seven participants of 238 did not have a smartphone, and five did not own a tablet either. So in study 3 all participants except these five owned at least one mobile device. This suggests that most participants had a reasonable chance of being familiar with the use of mobile phone applications, especially considering the increasing number of smartphone and tablet use and ownership in the UK (OFCOM, 2017). Although the experiment was designed to be intuitive and interactive to attract all kinds of participants, it is likely that this overrepresentation of mobile device owners had an influence on the general ratings for several aspects of the 'perception' and 'understanding' themes. Such participants are perhaps more likely to perceive 3D models less critically and understand the proposals better than participants with no or little exposure to mobile technology (Appleton and Lovett, 2003). As far as could be found, there are not many studies measuring the impact of mobile device ownership on participants' behaviour during a participation process. Further research is required to provide evidence of the relationship between mobile devices ownership and perception, understanding and decision-making during participation.

The limits of the technology used in this experiment were apparent in both the researcher's observation and the participants' comments. For a minority of participants, (both on-site and off-site) it proved difficult to orientate themselves using the Walkabout3D mobile application. There were instances of the mobile device's screen flickering when the participant navigated too fast across the viewpoint and the device was not using gyroscope support at that time. Such issues distracted a few participants and made it more difficult to focus on the experiment. In particular, participants who used the application off-site struggled with the orientation more, as the project was geo-referenced. Unfortunately, as this issue did not occur during the pilot study, it was not possible to provide a remedy, though it was expected that a small proportion of participants would experience disorientation due to this flickering problem. The implications for further studies would be that, despite some experience disorientation, applications such as Walkabout3D might help users benefitting from being on-site and 'combined' on and off-site during experiments.

7.3.2 Discussion of on-site and off-site comparison

The core of the research was to test whether the location of the experiment (on-site, off-site) would affect the understanding and perception of participants while using mobile devices as a tool for participatory planning and design. Results from combined group participants were also tested and compared. Study 3 produced a number of significant results concerning location that demonstrated differences in the quality and quantity of participation when taking place on-site, off-site or in combined locations.

It was expected that on-site participation would allow participants to be more accurate in terms of their perception of the site and of the visualization. As Roth (2006) suggested, environmental studies conducted on-site are more valid. As expressed by (Daniel and Meitner, 2000, p. 4), visualizations have the power 'to affect attention, to alter interpretations of complex concepts and differentially to arouse positive and/or negative emotions'. The perception questions were testing the representativeness and visual clarity of the model through objective measurement and subjective judgments.

The results did show significant differences between participants' perception depending on where they viewed the 3D model. On-site participants provided more accurate evaluation and judgments for the set of perception questions. Notably, on-site participants were more accurate when calculating distances and scales than off-site participants. On-site participants were better than off-site participants at guessing any kind of height, guessing distance and green area surfaces. Despite showing the highest rate of disorientation, the 'combined' group guessed those numbers the more accurately out of all survey groups.

It seems that 'combined' survey group participants benefitted from the opportunity of being able to see both actual and virtual environments. It demonstrated a better grasp of the differences between the real and virtual environment of the park. In one instance a participant from the combined survey group provided almost the exact numbers of actual heights, distances, percentages and numbers: during casual conversation it was revealed that he was an engineer by profession. Such professional skills might account for differences among participants of a smaller sample size, but are less likely to affect a large sample like the present study.

Since combined and on-site participants made better judgments in terms of scale, distances and heights, the researcher's expectation was that these survey groups' understanding of a given project would be improved by using mobile device visualization (Bishop and Rohrmann, 2003). Study 1 also proves that even though on-site participants have advantage of experiencing the space, higher level of accuracy on visualizations are still essential for understanding of the space and proposals. As off-site participants can only rely on the visualization, it is important to present accurate, representative, visually clear, engaging, legitimate and easily accessible visualizations with clear supplementary information (Sheppard and Cizek, 2009). As one off-site participant remarked, despite the researcher's efforts to create an accurate model, current issues such as littering, noise or smell were not, and to a certain extent could not, be represented.

Despite these expectations, the results did not demonstrate that the participants' understanding was significantly affected by the location. The participants of the 'combined' group's ratings of questions pertaining to understanding were in several instances more positive than the other two groups, but not in a statistically significant way. The participants in the 'combined' group found that recognising the viewpoints was slightly more difficult than the participants in other survey groups. There is a possibility that this was due to off-site users not having to match the viewpoints with reality, assuming that they could recognise and understand the views. There is a need for a more research to evaluate such questions, with the help, for example, of eye-tracking technology to evaluate the effects of landscape characteristics (Dupont, Antrop, and Van Eetvelde, 2014) or locations on understanding.

Contrary to Bishop and Rohmann (2003) and to expectations, on-site participants seemed to rate some aspects pertaining to understanding lower than the other groups. Even though it was not significant, it was within expectations that on-site participants would experience some difficulties, as they had to match virtual environment overlay on top of the real environment without benefitting from a previous introduction to the model off-site (as did 'combined' participants). The researcher expected on-site participants to gain more information from the location, yet the latter estimated that they recognised the viewpoints with less ease than the other survey groups. The difference in means between survey groups' ratings was not very high, and should be confirmed in further studies. The results might also be different with a larger or smaller site (Fainstein, 2000), where on-site participants would have a stronger advantage over off-site participants in terms of easiness of understanding the project presented. Considering the large number of participants (238 participants for study 3 and 555 participants in total for all studies), the results can be applied to other studies with different sites and participants

On-site and off-site tablet owners showed significant differences in their willingness to use this tool in the future. Off-site users who own a tablet expressed more willingness to use 3D mobile device visualizations to participate compared to on-site tablet owners. This result supports the idea that off-site users have more time, and so would be more willing to take part and answer questions (Kim and Shelby, 2006). On-site participants who own a tablet were not willing to use this or similar technologies when offered, while the ones who do not have a tablet from the same survey group were more eager to use it in the future. Gorhan, Oncu and Senturk, (2014) suggest that ownership of a tablet would probably have a positive effect on participants' use and frequency of use. In our case, on-site tablet owners being less interested in using the technology in the future might be due to the idea that tablets are usually used at home: Müller, Gove, and Webb (2012) stated that 82% of tablet use occurs at home.

7.3.3 Discussion on participant characteristics

Off-site group students tended to perform worse than non-students when it came to guessing heights. Combined group students struggled more to recognize the viewpoints than non-students. Students who used the application both off-site and on-site felt more disoriented than the two other survey group students. However, for combined group participants feeling disoriented did not lead to lower ratings for elements like easiness or the usefulness of using mobile devices and ease in understanding the proposals. One interpretation for this contradiction might be that, even if they resided there, students were probably less familiar and involved with the site than non-students: as mentioned earlier, students typically rent their accommodation for a year in that area, most often leaving after one year.

Owning a smartphone seemed to have a positive impact on perception: owners of smartphones predicted the distance between two points remarkably close to the actual distance. However, since study 3's sample only contained a small number of people that did not own a smartphone, caution must be applied as the findings might not be transferable to other studies. Further research is required to provide evidence of the relationship between smartphone ownership and perception of distance, height, and areas.

From the results, participants that were familiar with the site found it easier to pinpoint the differences between model and reality (Bishop and Rohrmann, 2003, p. 275). Study 3's results show that this aspect should be tested further in the future. It could potentially allow researchers to justify conducting participation off-site with residents of a given site, since they have a clear idea of the site in mind.

7.3.3 Conclusion

Although all ratings were quite high, the results above could be interpreted in the sense that on-site users of Walkabout3D seem to be less convinced of its usefulness than off-site and combined users: this is less unexpected than it seems, as the concept of virtual reality has not been experienced by many yet, and participants seemingly had a difficult time in dealing with the superimposition of two landscapes. The reason might be that on-site group was the group that was asked to walk and find the viewpoints without previous information off-site. Even though on-site participants did not rate the understanding aspect of these tools high, their responses to objective measurements and subjective judgments were more precise in terms of scale and accuracy than any other group. It could be explained with the use of not only visual but also other sensory experiences (Lindquist and Lange, 2014; Gill and Lange, 2015).

On-site participation, as observed in one-to-one consultations and experiment 3, seems to attract more people by the simple fact of witnessing other participants experimenting with the applications in the site location, while for all the surveying and participation processes, off-site users seemed to have more time available (Kim and Shelby, 2006) for an experiment if it is flexibly arranged around their schedule, and are less likely to get distracted by their surroundings as on-site participants (Daniel and Meitner 2001; Shelby and Harris 1985; Taylor et al., 1995).

Considering all these responses it seems that on-site participation provides great potential for meaningful participation, as people perceive their surroundings more accurately than off-site users. People who live around the site in question or who are familiar with the site can perform better at understanding the proposals when they see the simulation first then the reality. Their understanding helps to increase the chance of meaningful participation as well as its quality, as Al-Kodmany (2000) says: ‘participation is meaningless if participants cannot understand what is being proposed’.

Chapter 8

8 Conclusion

The aim of the thesis was to explore a new form of participatory design and planning by using mobile devices with 3D landscape visualizations on-site and off-site. In order to do so, on and off-site locations for participation were compared to identify similarities and differences in terms of perception and understanding contributing to a meaningful participation process. In current literature, there has been limited research for on-site and off-site use of 3D mobile devices during participation processes, so the significance of this study is that it explores how these different locations affect understanding and perception of participants and the participation process itself.

In recent years, increasing number of studies related to landscape visualization have used mobile devices (for example Mobile Augmented Reality) during participation processes. This study utilises mobile devices to show 3D walkthrough videos and paper-based surveys to understand people's experience with accuracy on 3D models when they are on the site. To be able to identify the needs of users on-site, mobile devices are used to engage the public to make sketches rather than giving verbal or written suggestions. This led to prepare design proposals under the light of the results of the first two studies. The proposals were tested with different participants on-site and off-site allowing them to experience proposals in an interactive panoramic form. Paper-based questionnaires completed after this experience showed that users' perception and understanding, and therefore their participation, were affected by the locations.

8.1 Main Findings

The findings of this research emerged from the three research questions explained and discussed in their respective chapters: Chapter 5 (Effects of the level of accuracy of 3D visualization on mobile devices on understanding: initial and completed model); Chapter 6

(Gathering design ideas through a mobile device to suggest solutions for the problems); and Chapter 7 (Comparison of on-site and off-site use of mobile devices with future proposals. Following part synthesizes the results to answer research questions posed in this study).

Research Question 1: Does the level of accuracy of 3D visualization on mobile devices affect the understanding and perception of participants?

The results from fieldwork conducted during this research show that the level of accuracy on 3D visualizations affects understanding and perception of the participants especially for 25-44 age group and non-student participants. In the experiment conducted in study 1, it is found that these groups are aware of the higher level of accuracy and their results show that higher level of accuracy leads to a perception of a higher level of realism and better understanding of the space. Also, when the completed and more detailed 3D model was shown to non-students, satisfaction with the new design increased. The higher level of accuracy helps understanding the space more than inaccurate and incomplete 3D model specifically for people who are not familiar with the site. This shows that the level of accuracy in 3D visualization matters in terms of decision-making even when users are on-site. 3D models should present accurate information regardless of users' location especially for the generations that grew up with technology, as they are more likely to pay attention to details and expect higher quality from models.

Events taking place within the site also have an influence on the perception of the participants. When different level of accuracy on 3D models was compared for days with and without an event (in this case an opening event): Student participants perceive realism in the inaccurate model as highly realistic compared to non-student users during a day with an event. Conversely, accurate and detailed 3D model is perceived as less realistic by student users in comparison to non-student ones on a day without an event. This shows that as perception is affected by external factors, different strategies could be used to obtain intended results.

Research Question 2: Can mobile devices as a design tool help engaging the public to identify problems and bring solutions when used in a participatory design process?

The two exercises conducted in 2016 in Edward Street Park, Sheffield, have shown that when mobile devices are used as a design tool, they help to engage the public in identifying problems and suggesting solutions. There are differences for on-site and off-site participants in terms of engagement and identification of problems within the site. While on-site users tend to spend less time and convey the idea with a brief sketch, off-site participants usually preferred making more detailed sketches spending more time. Even though both groups focused on the same areas in the park, identified problems and solutions brought for those were relatively different. As the study site, Edward Street Park, was partially completed as part of VALUE+ project in 2013 two years earlier than the project's finish date, it helped increasing meaningful participation by empowering participants in a equity-oriented approach and letting them make decisions considering the issues and challenges they experienced.

Research Question 3: How does on-site and off-site use of mobile devices affect perception and understanding of participants?

The results of the research conducted in two locations in Sheffield show that the use of 3D visualizations on mobile devices on-site and off-site affects understanding and perception of the participants when used during the participation process. Use of mobile devices for landscape visualizations on-site and off-site have their own advantages and disadvantages. On-site participants seemed to perceive their surroundings as more precise than off-site or combined groups. On-site participants had difficulties recognising viewpoints and understanding the future proposals as they are expected to walk around and superimpose the panoramic visualizations and reality. Even though off-site participants were not able to perceive scale as precise, their understanding for the future proposals are more comprehensive. These results provided valuable lessons that could contribute to participatory planning and design projects with more accurate results, since participants have a higher understanding of how projects will exist in reality with the given advantage of freedom to use them whenever and wherever they want.

8.1.1 Reflections on research aims and objectives

This research explored on and off site use of mobile devices both as a participatory design and planning tool. The key issues this research focused on were:

Examining the effects of the mobile device virtual environments and its accuracy on people's perception and understanding of space by considering demographic variables.

Testing whether mobile devices can be meaningfully used as a design tool to engage public through sketches to identify problems and needs for the site and suggest solutions during participatory design process.

Comparing on-site and off-site mobile devices use while experiencing future design proposals in terms of perception and understanding of users and their effects on public participation.

These issues were explored through three series of studies including experiments, one-to-one consultations and questionnaires.

- Experiments were conducted during study 1 using questionnaires to examine participants' understanding of space and perception while using two different 3D mobile device visualizations with different level of accuracies.
- One-to-one consultations are the main body of study 2 and they aimed at gathering design ideas through a mobile device to suggest solutions for the problems for the site by sketching for participatory design process. These sketches were analysed and taken into consideration while 3D future proposal visualizations were being prepared.
- During study 3, questionnaires were used during the experiment 3 to understand differences between on-site and off-site participation with mobile technology and their effects on understanding and perception.

This research achieved the objectives, revealing the effects of accuracy on understanding and perception during the use of 3D mobile device landscape visualizations. The uses of handheld device as a participatory design tool and their on-site and off-site use influences on understanding and perception of participants were also investigated. The three studies showed that different generations and students and non-students have different ways to perceive 3D visualizations. They also showed that working on-site and off-site provides planners and landscape architects two sets of valuable information to consider two different perspectives during the participation processes.

8.1.2 Contribution to knowledge

This study set out to explore a new form of participatory planning and design, testing the use of mobile device 3D landscape visualizations, combined with the effect of different locations, in the participation process of urban planning.

One of the main objectives of the study was to explore participant's understanding and perception of the space and future design proposals when used experiencing the actual site and while away from it. As there seems to be lack of evidence-based studies about comparison of the use of mobile device use for aforementioned locations, understanding the differences would help identifying how participatory design and planning processes could be carried out. One of the main findings of this research is that evidence-based studies are needed to really understand the benefits and problems of using visualization during participation in urban planning. On one hand, it gives an idea of how the design might look like in the end; it might also generate a false expectation for the participants from all locations.

This is the first study of its kind, comparing on-site and off-site uses of mobile device visualizations for participatory planning and design processes; and tests the understanding and perception of participants. Although the results were not clear-cut, different advantages have been linked with on-site and off-site uses of the landscape visualization. The study demonstrates that on-site participants are easier to recruit, display a better perception of the site, but report a lower understanding of space and future design proposals than off-site participants. On the contrary off-site participants reported an enhanced understanding of scenarios, yet are usually recruited among a fewer pool of volunteers which are willing to spend more time participating.

This study also used a novel methodology in two other ways. Firstly, the study enabled the production of design scenarios with stakeholder input on mobile devices: Study 2 allowed participants to use mobile devices as a design tool to make sketches in order to suggest modifications and improvements in landscape. Consultation sessions were received enthusiastically by participants and can be linked to both improvements in quality and quantity of participation. Secondly, the study compared the effects of mobile device use on-site and off-site for understanding and perception. This comparison was made using on-demand streaming system for 3D visualizations to allow users experience future proposals on and off-site.

8.2 Future Research

Limitations of the studies and results were presented under discussion sections in their relevant chapters. Considering the limitations of the research, some recommendations can be made for future research.

As the research shows that mobile device 3D visualization can be used to enhance public participation while identifying problems and bringing solutions, more inclusive methods should be considered to address people who were not being reached because of their age group, language and technological barriers or disabilities. The ZoomNotes and WalkAbout3D applications can be suggested as a method to be used for future research as it has been shown that they are useful during participatory design and helps enhancing understanding and perception for both locations.

One of the biggest advantages that the mobile device visualization technique offers is that participants do not need to interact through a verbal or written form, so it can be considered in future that 3D mobile device visualization can overcome the language barrier by allowing users to participate with adoption of visual representation. There can be further investigation of whether mobile devices can reach all walks of life. The use of mobile technology should be emphasized during the advertisement of the participation and consultation events. As the 45+ year old individuals were not well represented, and the results from the youngest age group who are familiar with the technology did not indicate any difficulty understanding visualizations and use of the mobile device, it would be worth querying the usability of 3D mobile visualization technology with the middle-aged and elderly considering that typically those age groups are more likely to participate actively in public participation.

Although reaching the public who do not own smartphones and tablets is an important matter for future research, smartphone and tablet owners could also be the focus for an extensive perception and understanding study to test the effect of intense use of mobile devices and their possible benefits and disadvantages on participation (for example to see whether users tend to get bored or more critical of those technologies). Since technology advances day by day, the state of the art technology, mobile devices, AR or VR facilities could be combined with the on and off-site perspective.

As the findings imply that understanding of the model improves when people are shown a more accurate, completed model on mobile devices, it can be further investigated in the future. In addition to accuracy of visualizations in terms of scale, texture and vegetation on mobile devices, positioning can be further investigated as the responses of on-site participants indicate that the on-site use of mobile devices does not help understanding the proposals. This would require a more detailed questionnaire and perhaps the use of eye-tracking techniques to analyse users' behaviour while using different models.

From the results of this pioneer study, developing comparisons between on and off-site experiments is set to enhance different aspects of participation depending on the variables of each site. When the research is meant to increase the number of participants, on-site approaches were shown to be the easiest, and yet potentially most confusing for the users as they are expected to match superimpose the pre-prepared views: isolating which elements make the model harder to understand would be an important step forward. Using off-site participation followed by a second wave of on-site experiment for the same participants could allow for stronger involvement, from consultation to decision-making level.

Another suggestion is to investigate community events and their effects on perception through mobile devices, as the first experiment showed unusually enthusiastic responses from participants. The accuracy of 3D mobile devices can also be tested, both during community events and ordinary days, and during the day-time and night-time.

When using the WalkAbout3D application especially, a comparison section could be added in future research. This research represented the status quo during experiment 1 and 2. Future studies should consider whether to offer users to view past and future conditions of the site: understanding of the project could potentially be enhanced, even during the implementation phase of the projects so that people can follow up how their participation made a difference. Having a walkthrough feature as an option, similar to the WalkAbout3D desktop software, could also enhance understanding for users to make more meaningful suggestions.

The efficiency of the use of these technological tools will only be clear when it is used in real-life projects. The ultimate evidence-based study will be going through the whole process: from planning, engaging in participatory design, implementing, and evaluating the satisfaction of the real-life project.

8.3 Conclusion

The research presented here brings about some significant questions for visualization and public participation researchers, especially concerning the validity of on-site 3D mobile visualization experience for participation. Using mobile devices as participatory design tools to engage public and displaying planning and design proposals through mobile devices on-site has the potential to be the standard method in the future because of its ubiquity, accuracy and validity during the participatory planning and design processes. A combination of on-site and off-site use of 3D mobile device visualizations has the potential to enhance understanding, perception and preferences of future proposals for a more informed and meaningful collaboration.

Giving the participant the freedom to use mobile devices, either on-site or off-site, provides an opportunity to communicate with other stakeholders such as professionals and may possibly increase both quality and quantity of the participation. It can be concluded that, even though further research is still required, this research has provided an encouraging starting point for future studies on on-site and off-site use of mobile devices and their use to enhance the participatory planning and design processes.

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Appendices

Appendix A: Questionnaire for study 1 (experiment 1 and 2)

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EDWARD STREET PARK

My name is Gulsah Bilge and I am a PhD student at University of Sheffield, conducting research on the effect of the use of on-site mobile device visualizations on the decision-making process and participatory planning. Future design scenarios will be developed regarding residents' needs for Edward Street Park and visualized via different visualization tools. I would like to ask your collaboration in this study, answering this questionnaire.

What age group are you? ☐ 18-24 ☐25-44 ☐45-64 ☐65+

What is your gender? ☐ Female ☐Male

Where do you live? ☐ Edward Street Flats ☐Opal2 ☐Atlantic1 ☐IQ ☐Impact ☐Omnia Space ☐Aspect ☐Other……………

How would you rate the new design in Edward Street Park?
☐Poor ☐Unsatisfactory ☐Satisfactory ☐ Good ☐Very good

What are the positive things in Edward Street Park?
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………

What are the problems you would like to see being solved about Edward Street Park?
……………………………………………………………………………………………………
……………………………………………………………………………………………………

The level of realism in the 3D model was very good.
☐Strongly agree ☐Agree ☐Neutral ☐Disagree ☐Strongly disagree

The 3D Model enhanced understanding of the space and proposed plan.
☐Strongly agree ☐Agree ☐Neutral ☐Disagree ☐Strongly disagree

How useful do you think 3D models on mobile devices are during the decision-making process?
☐Very helpful ☐Helpful ☐Neither helpful nor unhelpful ☐Unhelpful ☐Very unhelpful

If you had a chance to explore the area and future design scenarios with your mobile device (e.g. tablet, iPad, iPhone, smart phone), would you be interested in using this feature to give feedback? ☐Yes ☐No

If you are you interested in participating in an experiment to try visualization tools and view different scenarios for Edward Street Park, could you please leave your contact details below?
Name:
Contact Telephone Number: Email Address:

Appendix B: Design Leaflet

Have your say

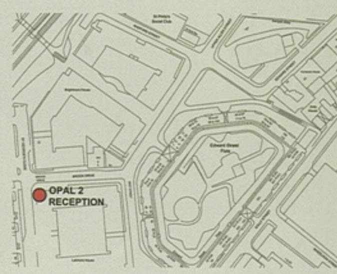
We would like to hear your views on the park design by returning the questionnaire or visiting a public exhibition to be held on the 26th March, 12 - 6pm at the OPAL 2 Reception (Corner of St Georges Close and Brook Drive). Council Officers will be on hand to provide further information and answer any questions on the project.

Next Steps

The results of this consultation will help determine design work which will lead to the submission of a planning application. Subject to the necessary planning and traffic regulation order approvals it is anticipated that work wi commence in 2010/2011. If you wish to be kept informed of progress please provide your contact details on the attached questionnaire.

For further information please contact

Matt Hayman
Development Services
City Development Division
Howden House
1 Union Street
Sheffield S1 2SH
0114 273 5130
matthew.hayman@sheffield.gov.uk




Current view from Upper Allen Street


Current view From Edward Street

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DP6752

Proposals for a new park serving the St Vincent's Quarter

Sheffield City Council is seeking your views on the design for improvements to the existing open space between Edward Street and Upper Allen Street. The work will be funded using contributions received from new housing development in the area.

zest

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2

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Please take a few minutes to help us monitor the service and information we provide.

Q1 Please tick which one applies to you

a) Local resident ☐
b) Own/run a local business ☐
c) Work locally ☐
d) Developer/property owner ☐
e) Visitor to the area ☐
f) Other ☐

Q2 Do you agree with the proposal to improve the existing open space?

a) Strongly agree ☐
b) Agree ☐
c) Neither agree nor disagree ☐
d) Disagree ☐
e) Strongly disagree ☐

Q3 What would you like see the park named?

a) Edward Street Park ☐
b) Kenyon Park ☐
c) Well Meadow Park ☐
d) Something else ☐
Please say below

Q4 How do you rate the following aspects of the proposal?

	Very Important	Important	Not important	Not Sure
a) Proposed road closure/calming	☐	☐	☐	☐
b) The provision for ball games/ performance space	☐	☐	☐	☐
c) The provision of new trees/planting	☐	☐	☐	☐
d) New seating areas	☐	☐	☐	☐
e) New/improved pedestrian routes	☐	☐	☐	☐
f) Terrace for café/restaurant/markets	☐	☐	☐	☐
g) Improved lighting	☐	☐	☐	☐
h) Public art features	☐	☐	☐	☐
i) Childrens play area	☐	☐	☐	☐

Q5 Are there any other features you would like to see incorporated into the park design?

Q6 Any other comments?

Please provide us with your contact details if you wish to be updated on the progress of this project.

Name: ______
Address: ______
______
Phone No: ______
E-mail address: ______

Thank you for completing the survey. Please detach this part of the leaflet, secure the edges and post. No stamp is required. Please return before 09/04/10 to

Sue McGrail, Administration Services Manager, Sheffield City Council, Development Services, Howden House, 1 Union Street, Sheffield S1 2SH Tel: (0114) 273 4404
Email: sue.mcgrail@sheffield.gov.uk

The results will be available at the end of April 2010 at www.sheffield.gov.uk

Equality Monitoring - Sheffield City Council

Service Delivery
The Council needs to monitor who uses our services in order to ensure they are accessible to all. Please help us to do this by ticking the relevant box in the form below.

White
☐ British
☐ Irish
☐ Gypsy/Traveller
☐ Other White background

Black or Black British
☐ Caribbean
☐ Somali
☐ Other African background
☐ Other Black background

Other Ethnic Group
☐ Yemeni
☐ Other ethnic group

Other ______

Gender
☐ Female ☐ Male

Mixed/Dual Heritage
☐ White and Black Caribbean
☐ White and Black African
☐ White and Asian
☐ Other mixed background

Asian or Asian British
☐ Indian
☐ Pakistani
☐ Bangladeshi
☐ Other Asian background

Chinese or Chinese British
☐ Any Chinese background

Disability
Do you consider yourself to be a disabled person
☐ Yes ☐ No

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অনুরোধ জানালে এই ডকুম্যান্টের তথ্যাদি ব্রইলে বা বড় ছাপার হরফে অথবা ইহার অনুবাদ এরাবিক, বাংলা, চাইনীজ, সোমালী এবং উর্দু ভাষাতে পাওয়ার ব্যবস্থা করা যেতে পারে।

بناء عن الطلب يمكن توفير نسخة من هذه الوثيقة بطباعة حروف كبيرة أو بطباعة "برايل" للمكفوفين، أو ترجمتها إلى اللغة العربية، البنغالية، الصينية، الصومالية أو الأردية.

Dikumiintigaan waxaa lagu heli karaa haddii la dalbado isagoo ku qoran far waaweyn ama farta indhoolaha (Braille) ama ku turjuman Carabi, Bengooli, Jayniis, Soomaali ama Urduu

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DP6752

1 **NEW EVENTS ARENA**
- Artificial 'green' surface
- New lighting
- New artist designed fence to lower edge
- New basketball hoops
- Grass terraces overlooking the arena
- Electricity plug in point for events

2 **CAFE TERRACE AND MARKET SPACE**
- Hard surface area for outdoor cafe tables
- Space for occasional markets or support space for events in the central events arena
- Sitting walls
- New trees

ART FEATURES AND SITTING WALLS
- New public art features to create focal points at entrances to the park
- Sitting walls incorporating public art

NEW PLANTING
- New semi-mature trees to replace trees removed adding seasonal variety
- New flower borders to add colour and attract wildlife
- Green walls

NEW LIGHTING
- New column lighting to give good 'white light' and improve safety
- Feature lighting to include colour uplighting of trees and lighting of public art features

Proposed Park Layout

Appendix C: Raw data tables for study 1 (experiment 1 and 2)

	age	gender	student	Familiar	place	rate_newpark	Understanding	useful	Realism	use_again	Part
1	25-44	Male	Yes	Yes	impact	Good	Agree	Helpful	Good	Yes	Initial 1
2	18-24	Male	No	Yes	Aspect	Very good	Agree	Very helpful	Very Good	Yes	Initial 1
3	18-24	Male	No	Yes	Aspect	Good	Agree	Neither he...	Satisfactory	Yes	Initial 1
4	18-24	Male	No	Yes	Omnia Space	Good	Strongly agree	Helpful	Good	Yes	Initial 1
5	18-24	Male	No	Yes	Other	Good	Strongly agree	Very helpful	Good	Yes	Initial 1
6	18-24	Male	No	Yes	Other	Good	Agree	Very helpful	Good	Yes	Initial 1
7	45-64	Male	Yes	Yes	Other	Very good	Strongly agree	Very helpful	Very Good	Yes	Initial 1
8	45-64	Male	Yes	Yes	Other	Very good	Strongly agree	Very helpful	Very Good	Yes	Initial 1
9	25-44	Female	Yes	Yes	Other/ St Ge...	Good	Strongly agree	Very helpful	Very Good	Yes	Initial 1
10	18-24	Male	Yes	Yes	Edward Stree...	Good	Strongly agree	Very helpful	Very Good	Yes	Initial 1
11	18-24	Male	.	No	Other	Good	Agree	Helpful	Good	Yes	Initial 1
12	18-24	Male	No	Yes	Other	Good	Agree	Helpful	Good	No	Initial 1
13	18-24	Male	No	No	Other	Good	Agree	Helpful	Good	No	Initial 1
14	18-24	Male	No	Yes	Aspect	Satisfactory	Agree	Helpful	Very Good	Yes	Initial 1
15	25-44	Female	No	No	Other	Very good	Strongly agree	Very helpful	Very Good	Yes	Initial 1
16	25-44	Male	No	No	Other	Good	Agree	Helpful	Good	No	Initial 1
17	25-44	Female	No	No	Other	Very good	Agree	Helpful	Good	Yes	Initial 1
18	25-44	Female	Yes	Yes	Edward Stree...	Very good	Agree	Very helpful	Very Good	Yes	Initial 1
19	25-44	Female	Yes	Yes	Edward Stree...	Good	Agree	Very helpful	Good	Yes	Initial 1
20	25-44	Female	Yes	Yes	Edward Stree...	Good	Agree	Very helpful	Good	Yes	Initial 1
21	18-24	Male	No	Yes	Edward Stree...	.	Strongly agree	Very helpful	Very Good	No	Initial 1
22	18-24	Male	No	No	Other	Good	Agree	Helpful	Good	Yes	Initial 1
23	18-24	Male	No	Yes	Omnia Space	Very good	Agree	Helpful	Good	No	Initial 1
24	18-24	Male	No	Yes	Other	Poor	Agree	Helpful	Satisfactory	Yes	Initial 1
25	25-44	Female	No	Yes	Other	Satisfactory	Agree	Helpful	Good	Yes	Initial 1
26	18-24	Female	No	Yes	Opal2	Good	Strongly agree	Very helpful	Good	Yes	Initial 1
27	18-24	Female	No	No	Opal2	Good	Neutral	Helpful	Good	Yes	Initial 1
28	45-64	Male	Yes	No	Other	Good	Agree	Very helpful	Very Good	Yes	Initial 1
29	18-24	Male	No	Yes	Omnia Space	Satisfactory	Agree	Very helpful	Good	Yes	Initial 1
30	25-44	Male	Yes	No	Other	Good	Neutral	Helpful	.	No	Initial 1
31	18-24	Male	Yes	No	Other	Good	Agree	Helpful	Very Good	Yes	Initial 1
32	18-24	Male	No	Yes	IQ	Good	Agree	Helpful	Good	No	Initial 1
33	25-44	Male	No	Yes	Other	Very good	Agree	Helpful	Good	Yes	Initial 1
34	25-44	Female	No	Yes	Other	Good	Agree	Helpful	Satisfactory	Yes	Initial 1
35	45-64	Female	Yes	Yes	Other	Very good	Agree	Very helpful	Good	Yes	Initial 1
36	25-44	Male	Yes	Yes	Other	Good	Agree	Very helpful	Good	Yes	Initial 1
37	25-44	Male	.	No	Other	Very good	Strongly agree	Very helpful	Good	Yes	Initial 1
38	25-44	Male	Yes	No	Other	Very good	Agree	Helpful	Good	Yes	Initial 1
39	18-24	Female	No	Yes	Edward Stree...	Very good	Agree	Helpful	Very Good	Yes	Initial 1
40	18-24	Male	No	Yes	Omnia Space	Good	Strongly agree	Very helpful	Very Good	.	Initial 1
41	18-24	Female	No	Yes	Omnia Space	Very good	Agree	Helpful	Good	No	Initial 1
42	18-24	Female	No	Yes	Edward Stree...	Good	Strongly agree	Helpful	Good	No	Initial 1
43	18-24	Female	No	Yes	Edward Stree...	Very good	Agree	Helpful	Satisfactory	Yes	Initial 1
44	25-44	Female	Yes	No	Other	Good	Agree	Helpful	Good	Yes	Initial 1
45	25-44	Male	Yes	No	Other	Good	Agree	Helpful	Good	Yes	Initial 1
46	45-64	Male	Yes	No	Other	Good	Strongly agree	Helpful	Very Good	Yes	Initial 1
47	25-44	Female	.	No	Other	Very good	Agree	Very helpful	Good	Yes	Initial 1
48	25-44	Male	Yes	No	Other	Very good	Agree	Very helpful	Very Good	Yes	Initial 1

	age	gender	student	Familiar	place	rate_newpark	Understanding	useful	Realism	use_again	Part
49	45-64	Female	Yes	Yes	Other	Very good	Agree	Helpful	Very Good	Yes	Initial 1
50	25-44	Female	Yes	Yes	Edward Stree...	Good	Agree	Helpful	Good	Yes	Initial 1
51	18-24	Female	No	Yes	Opal2	Very good	Strongly agree	Very helpful	Very Good	Yes	Initial 1
52	18-24	Female	No	Yes	Opal2	Very good	Strongly agree	Very helpful	Very Good	Yes	Initial 1
53	25-44	Male	.	Yes	Other	Very good	Agree	Helpful	Good	No	Initial 1
54	25-44	Female	Yes	Yes	Other	Very good	Neutral	Helpful	Satisfactory	No	Initial 1
55	45-64	Female	Yes	Yes	Edward Stree...	Very good	.	.	Good	.	Initial 1
56	45-64	Male	Yes	Yes	Edward Stree...	Satisfactory	.	Helpful	Good	Yes	Initial 1
57	18-24	Male	No	Yes	Other	Good	Agree	Helpful	Satisfactory	Yes	Initial 1
58	18-24	Female	No	Yes	Other	Good	Agree	Helpful	Very Good	Yes	Initial 1
59	25-44	Female	Yes	Yes	Other	Very good	Agree	Very helpful	Very Good	Yes	Initial 1
60	25-44	Male	Yes	No	Other	Very good	Agree	Helpful	Very Good	Yes	Initial 1
61	45-64	Male	Yes	Yes	Other	Satisfactory	Agree	Helpful	Good	Yes	Initial 1
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63	18-24	Female	No	Yes	IQ	Very good	Agree	Very helpful	Very Good	Yes	Initial 1
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74	45-64	Male	Yes	Yes	Other	Very good	Strongly agree	Very helpful	Very Good	Yes	Initial 1
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76	25-44	Male	Yes	No	Other	Very good	Agree	Helpful	Very Good	Yes	Initial 1
77	25-44	Male	Yes	No	Other	Good	Neutral	Helpful	Good	Yes	Initial 1
78	25-44	Female	Yes	No	Other	Satisfactory	Agree	Helpful	Very Good	Yes	Initial 1
79	25-44	Male	Yes	Yes	Other	Very good	Agree	Helpful	Very Good	Yes	Initial 1
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81	18-24	Male	Yes	No	Opal2	Good	Agree	Neither he...	Poor	Yes	Initial 2
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84	18-24	Male	Yes	Yes	Omnia Space	Good	Agree	Neither he...	Good	Yes	Initial 2
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86	18-24	Male	Yes	Yes	Aspect	Unsatisfactory	Neutral	Neither he...	Good	No	Initial 2
87	18-24	Male	Yes	Yes	Aspect	Very good	Agree	Very helpful	Very Good	Yes	Initial 2
88	25-44	Male	No	Yes	Edward Stree...	Very good	Agree	Very helpful	Very Good	Yes	Initial 2
89	18-24	Female	Yes	Yes	Other	Good	Neutral	Helpful	Good	Yes	Initial 2
90	25-44	Male	Yes	No	Opal2	Good	Strongly agree	Helpful	Very Good	No	Initial 2
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94	45-64	Male	No	No	Other	Very good	Strongly agree	Very helpful	Very Good	Yes	Initial 2
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96	18-24	Female	Yes	No	Aspect	Good	Agree	Very helpful	Good	Yes	Initial 2

	age	gender	student	Familiar	place	rate_newpark	Understanding	useful	Realism	use_again	Part
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99	18-24	Male	Yes	No	IQ	Satisfactory	Agree	Helpful	Very Good	Yes	Initial 2
100	18-24	Male	Yes	Yes	Edward Stree...	Good	Neutral	Neither he...	Poor	Yes	Initial 2
101	18-24	Male	Yes	No	Opal2	Very good	Neutral	Very helpful	Very Good	No	Initial 2
102	18-24	Male	Yes	Yes	Opal2	Good	Agree	Helpful	Good	No	Initial 2
103	18-24	Male	Yes	Yes	Opal2	Very good	Strongly agree	Helpful	Very Good	Yes	Initial 2
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105	18-24	Female	No	Yes	Other	Very good	Agree	Helpful	Good	Yes	Initial 2
106	18-24	Male	Yes	Yes	Opal2	Satisfactory	Agree	Helpful	Unsatisfact...	Yes	Initial 2
107	.	Male	No	Yes	Atlantic1	Very good	Strongly agree	Very helpful	Very Good	Yes	Completed 1
108	18-24	Female	Yes	No	Other	Very good	Strongly agree	Very helpful	Good	Yes	Completed 1
109	18-24	Female	Yes	Yes	Aspect	Very good	Strongly agree	Very helpful	Very Good	Yes	Completed 1
110	25-44	Male	No	No	Other	Good	Strongly agree	Very helpful	Very Good	Yes	Completed 1
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115	18-24	Male	Yes	Yes	Aspect	Good	Agree	Helpful	Good	Yes	Completed 1
116	18-24	Female	Yes	Yes	Other/Corne...	Very good	Agree	Helpful	Very Good	Yes	Completed 1
117	18-24	Male	Yes	Yes	Aspect	Poor	Strongly agree	Very helpful	Very Good	Yes	Completed 1
118	18-24	Male	Yes	Yes	Other/Corne...	Very good	Agree	Very helpful	Very Good	Yes	Completed 1
119	18-24	Male	Yes	Yes	Other	Good	Neutral	Helpful	Good	Yes	Completed 1
120	25-44	Male	Yes	Yes	Omnia Space	Very good	Strongly agree	Very helpful	Very Good	Yes	Completed 1

	age	gender	student	Familiar	place	rate_newpark	Understanding	useful	Realism	use_again	Part
121	18-24	Male	No	No	Other	Very good	Agree	Helpful	Very Good	Yes	Completed 1
122	25-44	Female	No	No	Other	Very good	Strongly agree	Very helpful	Very Good	No	Completed 1
123	18-24	Male	Yes	No	Other	Good	Agree	Helpful	Very Good	Yes	Completed 1
124	18-24	Male	Yes	No	Other	Good	Agree	Helpful	Very Good	No	Completed 1
125	25-44	Male	Yes	Yes	Other	Very good	Agree	Very helpful	Very Good	Yes	Completed 1
126	18-24	Male	Yes	No	Other	Very good	Agree	Helpful	Good	Yes	Completed 1
127	18-24	Male	Yes	No	Other	Good	Neutral	Helpful	Good	Yes	Completed 1
128	25-44	Female	No	Yes	Edward Stree...	Very good	Strongly agree	Very helpful	Very Good	Yes	Completed 1
129	18-24	Male	Yes	Yes	Edward Stree...	Very good	Strongly agree	Very helpful	Very Good	Yes	Completed 1
130	25-44	Male	No	Yes	Other	Very good	Agree	Helpful	Very Good	Yes	Completed 1
131	18-24	Male	Yes	Yes	Other/Corne...	Very good	Strongly agree	Very helpful	Very Good	Yes	Completed 1
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133	18-24	Female	Yes	No	Other	Very good	Agree	Helpful	Very Good	Yes	Completed 1
134	18-24	Female	No	Yes	Edward Stree...	Very good	Strongly agree	Helpful	Very Good	Yes	Completed 1
135	25-44	Male	No	Yes	Edward Stree...	Very good	Strongly agree	Very helpful	Very Good	Yes	Completed 1
136	18-24	Male	Yes	Yes	Other	Good	Agree	Very helpful	Good	No	Completed 1
137	18-24	Male	Yes	Yes	Other	Good	Agree	Neither he...	Good	No	Completed 1
138	18-24	Male	Yes	No	Aspect	Good	Strongly agree	Very helpful	Very Good	Yes	Completed 1
139	25-44	Male	No	No	Other	Good	Strongly agree	Very helpful	Poor	Yes	Completed 1
140	18-24	Male	Yes	No	Other	Good	Agree	Helpful	Very Good	Yes	Completed 1
141	18-24	Male	Yes	Yes	Edward Stree...	Good	Agree	Helpful	Good	Yes	Completed 1
142	18-24	Female	No	Yes	Atlantic1	Very good	Agree	Helpful	Good	Yes	Completed 1
143	25-44	Male	No	Yes	Atlantic1	Very good	Strongly agree	Very helpful	Very Good	Yes	Completed 1
144	18-24	Female	Yes	No	Other	Good	Agree	Helpful	Good	Yes	Completed 1

	age	gender	student	Familiar	place	rate_newpark	Understanding	useful	Realism	use_again	Part
145	18-24	Male	Yes	No	Other	.	Strongly agree	Very helpful	Very Good	Yes	Completed 1
146	18-24	Female	Yes	Yes	Opal2	Very good	Strongly agree	Very helpful	Very Good	No	Completed 1
147	18-24	Female	Yes	Yes	Aspect	Good	Agree	Helpful	Very Good	Yes	Completed 1
148	18-24	Male	Yes	Yes	Aspect	Very good	Agree	Neither he...	Good	Yes	Completed 1
149	18-24	Female	Yes	Yes	Other/Corne...	Good	Neutral	Very helpful	Poor	Yes	Completed 1
150	18-24	Male	Yes	Yes	Omnia Space	Satisfactory	Agree	Helpful	Very Good	No	Completed 1
151	18-24	Male	Yes	Yes	Omnia Space	Good	Strongly agree	Helpful	Very Good	No	Completed 1
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153	18-24	Male	Yes	Yes	Other/Corne...	Satisfactory	Agree	Helpful	Good	Yes	Completed 1
154	18-24	Female	Yes	Yes	Edward Stree...	Good	Agree	Very helpful	Very Good	Yes	Completed 1
155	18-24	Male	Yes	Yes	Omnia Space	Satisfactory	Agree	Helpful	Good	Yes	Completed 1
156	25-44	Male	No	Yes	Other/ St Ge...	Very good	Strongly agree	Very helpful	Very Good	Yes	Completed 1
157	18-24	Male	Yes	Yes	Omnia Space	Good	Agree	Helpful	Good	Yes	Completed 1
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159	18-24	Male	Yes	Yes	Omnia Space	Good	Strongly agree	Very helpful	Poor	Yes	Completed 1
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161	18-24	Male	No	Yes	Edward Stree...	Very good	Strongly agree	Very helpful	Very Good	Yes	Completed 1
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163	18-24	Female	Yes	Yes	Omnia Space	Good	Agree	Very helpful	Good	No	Completed 1
164	18-24	Male	Yes	Yes	Omnia Space	Good	Neutral	Helpful	Good	Yes	Completed 1
165	18-24	Female	Yes	Yes	Omnia Space	Satisfactory	Neutral	Helpful	Very Good	Yes	Completed 1
166	18-24	Male	Yes	Yes	Omnia Space	.	Agree	Very helpful	Good	Yes	Completed 1
167	45-64	Male	No	No	Other	Very good	Agree	Helpful	Very Good	Yes	Completed 1
168	18-24	Male	Yes	Yes	Omnia Space	Very good	Agree	Very helpful	Good	No	Completed 1
169	18-24	Male	Yes	Yes	Omnia Space	Good	Agree	Helpful	Very Good	No	Completed 1
170	18-24	Male	Yes	Yes	Omnia Space	Good	Strongly agree	Helpful	Very Good	No	Completed 1
171	25-44	Female	No	Yes	Omnia Space	Very good	.	.	.	.	Completed 1
172	18-24	Female	Yes	Yes	Omnia Space	Good	Agree	Helpful	Good	Yes	Completed 1
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175	18-24	Male	Yes	Yes	Omnia Space	Good	Agree	Helpful	Poor	No	Completed 1
176	18-24	Female	Yes	Yes	IQ	Unsatisfactory	Agree	Helpful	Good	No	Completed 1
177	18-24	Female	Yes	Yes	Omnia Space	Satisfactory	Neutral	Helpful	Good	Yes	Completed 1
178	18-24	Female	Yes	No	Omnia Space	Unsatisfactory	Strongly agree	Helpful	Very Good	No	Completed 1
179	18-24	Female	Yes	No	Omnia Space	Good	Strongly agree	Helpful	Very Good	No	Completed 1

Appendix D: Charrette

During the charrette there were four teams, constituted of individuals from different universities and disciplines, and each team conducted site surveys and prepared proposals. The first team focused on sense of community and interactivity within the area (Figure 1). The second team proposed planning and design scenarios for developing safety and security within the site (Figure 2). The third group proposed improvements for the whole area to improve attractiveness (Figure 3). The fourth group focused on accessibility of the park (Figure 4).

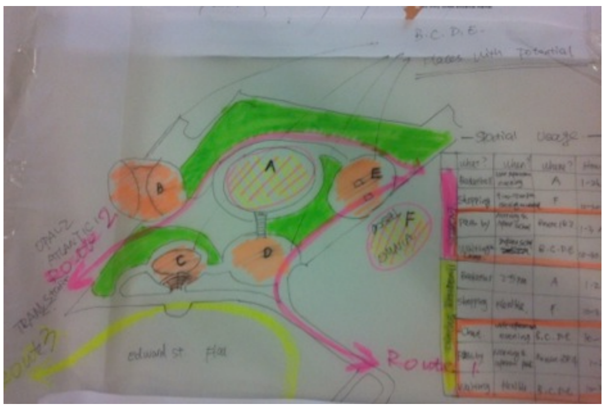

Figure 1 Team 1 site survey

Figure 2 Team 2 site survey

Figure 3 Team 3 site survey

Figure 4 Team 4 site survey

As a result, these groups integrated the plans to create a master plan. Master plan suggested:

Safety:

- Removing the walls around the stairs to increase visibility and safety (Figure 5);
- Illuminating by adding foot level lighting to improve safety at night (Figure 6);
- Installing lampposts on the streets to improve safety (Figure 7, 8);

Figure 5 Realigned colourful stairs without walls and the gate from Solly Street entrance

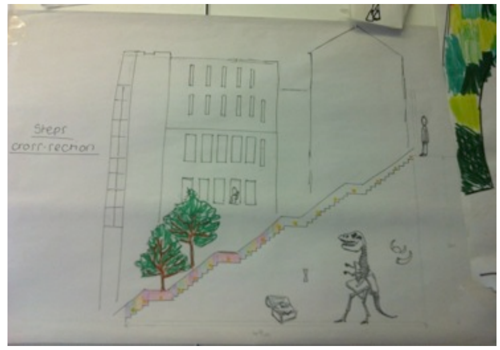

Figure 6 Cross-section of illuminated and widened steps

Figure 7 Green connection to tram stop on Radford Street with suggested moss graffiti and plantation

Figure 8 Illustration of moss graffiti on Radford Street

Accessibility:

- Constructing slopes for trolleys and bikes to increase accessibility (Figure 5);
- Widening, straightening and resurfacing of the steps to Solly Street to improve conditions (Figure 6);
- Improving the connection between green areas with a plant tunnel for Edward Street Flats and living walls for Radford Street (Figure 7, 8);
- Creating a visible and well connected network of routes (Figure 9, 10);

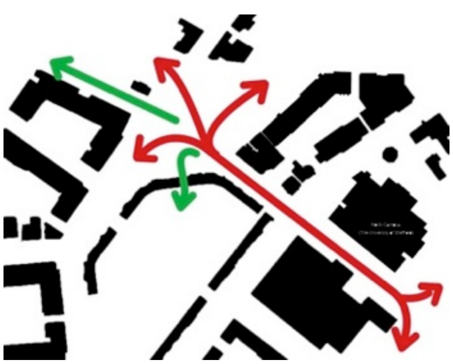

Figure 9 New routes/circulation within the area

Figure 10 Proposal of increase in visibility

Figure 11 Sketch-Up illustration of realigned stairs with a better view of the park from the top of the steps by widening and straightening path

Figure 12 Sketch-Up illustration of the archway at Solly Street entrance

Attractiveness:

- Introducing colours to the stairs, widening/resurfacing to create an inviting area (Figure 5, 6);
- Adding more plants around the park to establish an identity (Figure 7, 8);
- Introducing colour/artwork at the entrances to create identity (Figure 11, 12);
- Catching rainwater and collecting it in a pond and picnic area (Figure 13, 14);
- Creating a multi-use game area and providing protection for the seats (Figure 15);
- Covering the fence next to the basketball ground with seasonal plants;
- Utilising the main event area as an ice rink during winter (Figure 16);

Figure 13 Sketch-Up illustration of pond/benches

Figure 14 Sketch-Up illustration of barbecue

Figure 15 Multi-use game area/ film screen

Figure 16 Ice rink on main event area for winter

Sense of community and interactivity:

- Realigning the steps to improve the sight lines from Solly Street to the park, tram stop and the Pennine scenery which defines the space (Figure 11);
- Creating an archway at Solly Street entrance – helping to create a viewpoint down to the park (Figure 12);

Figure 17 Art wall on the left, multi-use games area in the middle and recycling points on the right

Figure 18 Upper garden rain water collection point/barbeque and Edward Street Flats connection plant tunnel

- Creating a public art wall around upper garden for volunteers to enhance the sense of ownership as shown with brown in Figure 17;
- Creating the pond to attract children and parents to meet and socialize (Figure 13);
- Creating multi-use area: volleyball, football, badminton, ice-skating (Figure 15, 16);
- Installing a temporary film screen during summer days;
- Utilizing the pond suggested in the upper garden as a picnic and barbecue space during the dry season (Figure 18);
- Covering the seats around the main space to increase the use of the space during different seasons (e.g. ice rink, basketball viewers);
- Planting wild flowers/fruit trees in the meadow bank or creating small community garden to improve the sense of ownership;
- Improving the café terrace with new seating / umbrellas / fountains to enhance public interaction (Figure 22, 23 and 24)

Figure 22 Café terrace proposal with umbrellas

Figure 23 Café terrace with new seating areas

Figure 24 Sketch-Up illustration of proposed café terrace

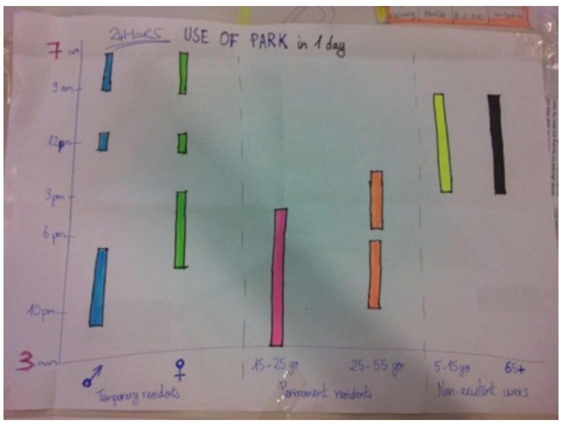

Figure 19 Use of park in one day

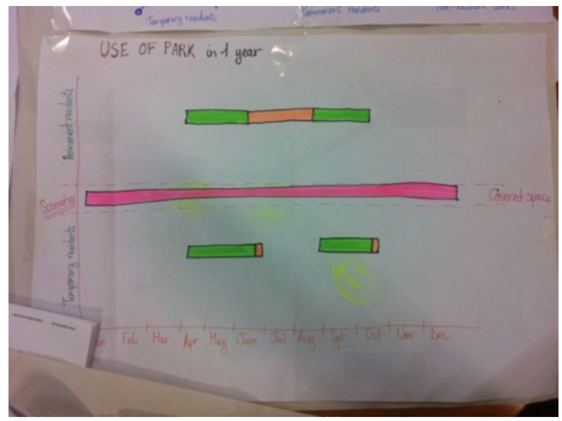

Figure 20 Use of park in one year

- Designing a community centre: preparing programmes for daily events targeting diverse interest groups for different times of the year with EDDY's scheme. EDDY's is a community scheme to bring people together and improve sense of security by creating a shared place. The name EDDY's was formed from the initial idea of '**E**very**D**ay of **D**a **Y**ear' by students after exploring the use of the park on a daily (Figure 19) and yearly (Figure 20) base. It is proposed that EDDY's could be run with the help of funding and policy support, committee or community volunteers, the universities in Sheffield, the city council and the community centre. The potential events that could take place in the area could be added to EDDY's scheme (Figure 21);

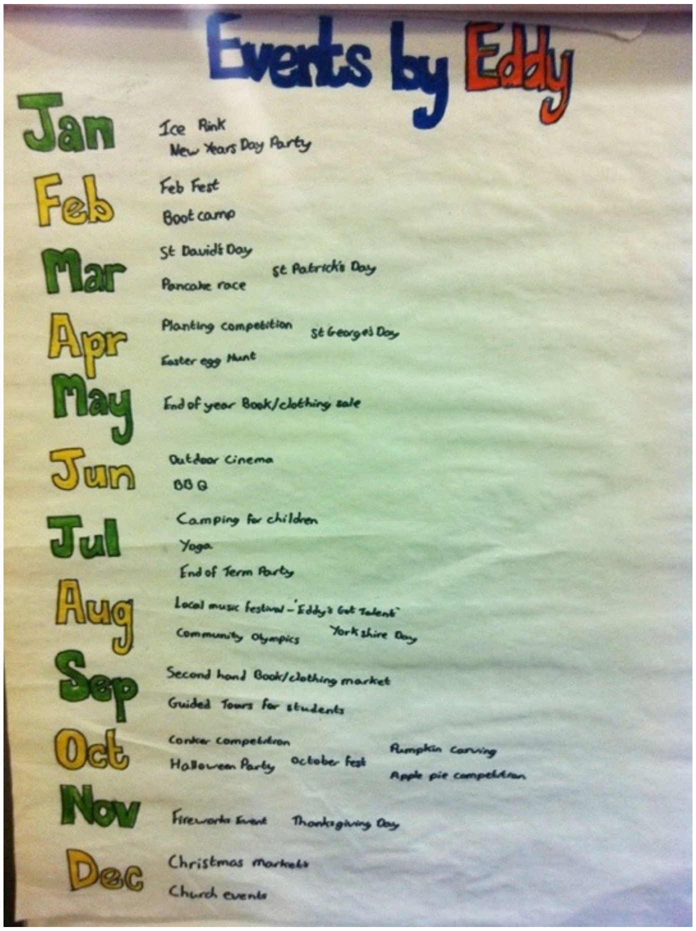

Figure 21 EDDY's Scheme for Edward Street Park

Appendix E: Questionnaire for study 3

EDWARD STREET PARK

My name is Gulsah Bilge and I am a PhD student at University of Sheffield, conducting research on differences between on-site versus off-site engagement of stakeholders using mobile devices and virtual reality facilities. I would like to ask your collaboration in this study, answering this questionnaire.

What age group are you? ☐ 18-24 ☐25-44 ☐45-64 ☐65+

What is your gender? ☐ Female ☐Male

Are you a student? ☐ Yes ☐No

Where are you from?.....................................

Where do you live? ☐ Edward Street Flats ☐Allen Court ☐Atlantic1
☐Impact ☐Omnia Space ☐IQ ☐Aspect
☐Q4 ☐Other…………………………………………………

Do you have a smart phone? ☐ Yes ☐No

Do you have a tablet? ☐ Yes ☐No

How experienced you are with mobile devices?

Not at all	Slightly	Somewhat	Moderately	Very Much
☐	☐	☐	☐	☐

Do you know the site presented to you?

Don't know	I know	I live there
☐	☐	☐

Where did you see the model?

On-site	Off-site then on-site	Off-site
☐	☐	☐

How easy was the use of the iPad?

Not at all	Slightly	Somewhat	Moderately	Very Much
☐	☐	☐	☐	☐

Did you understand the scenarios presented to you?

Not at all	Slightly	Somewhat	Moderately	Very Much
☐	☐	☐	☐	☐

How easy was it to understand the scenarios?

Not at all	Slightly	Somewhat	Moderately	Very Much
☐	☐	☐	☐	☐

How easy was it for you to recognize the viewpoints on the model?

Not at all	Slightly	Somewhat	Moderately	Very Much
☐	☐	☐	☐	☐

Do you think Mobile devices can play a role in increasing active public participation during the planning and the decision-making process?

No	Useful	Crucial
☐	☐	☐

How useful do you think 3D models on mobile devices are during the decision-making process?

Very helpful	Helpful	Neither helpful nor unhelpful	Unhelpful	Very unhelpful
☐	☐	☐	☐	☐

Did you feel confused or disoriented during the session?

Not at all	Slightly	Somewhat	Moderately	Very Much
☐	☐	☐	☐	☐

If you knew that you could have this application to view future scenarios, would you use it to let the City Council know your preferences?

Yes	Maybe	No
☐	☐	☐

Which scenario was your favourite? Why?
……..
....
..............…..
....

Can you guess how tall Huntsman House is?

How many trees are there in the park including Upper Garden and Event Space?

Can you guess the distance from Tesco to the stairs to Solly Street?

What is the height of the lampposts?

What is the percentage of the area covered with flowers and trees?

Is there anything in the model different from reality? ☐ Yes ☐No
If yes, what?
……..
....
....
....

What do you think about the app? Do you have any suggestions related to the app?
……..
....
....
....

Have you ever taken part in any kind of urban planning projects? ☐ Yes ☐No
If yes, what did you do? ....
....
....
....

Appendix F: Raw tables for study 3

1	Location	Huntsman height	Number of trees	Distance Tesco Solly	Lamppost	green percentage	gender	age	student	address	smartphone	tablet	md experience	familiarity site	opinion	ipad use	understand scenario	easy understand scenario	recognising viewpoints	md role pp-dm	useful3d_dm	disoriented	future_use	favourite	difference 3d_real	part_planning
2	Off-site	10	25	50	5	25	Male	45-64	Yes	Other	Yes	No	Slightly	Don't know	Not at all	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Slightly	Yes	Café	N/A	No
3	Off-site	15	12	40	4.5	60	Male	25-44	Yes	Other	Yes	No	Moderately	Don't know	Very Much	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Slightly	Yes	Upper	N/A	Yes
4	Off-site	10	5	10	1.5	10	Male	18-24	Yes	Other	Yes	Yes	Somewhat	Don't know	Somewhat	Somewhat	Somewhat	Moderately	Moderately	Useful	Neither	Somewhat	Maybe	Main	Yes	No
5	Off-site	10	150	500	5	40	Male	45-64	No	Other	Yes	Yes	Very Much	Don't know	Not at all	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Main	N/A	No
6	Off-site	16	8	80	5	60	Male	18-24	Yes	Other	Yes	No	Moderately	Don't know	Very Much	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Main	No	No
7	Off-site	40	30	30	2	30	Male	25-44	Yes	Edward Str	Yes	Yes	Moderately	Don't know	Not at all	Moderately	Moderately	Somewhat	Somewhat	Useful	Very helpful	Slightly	Yes	Main	No	No
8	Off-site	30	40	100	10	50	Male	25-44	Yes	Other	Yes	Yes	Moderately	Don't know	Not at all	Moderately	Very Much	Somewhat	Somewhat	Useful	Helpful	Slightly	Yes	Main	No	No
9	Off-site	15	10	20	2.5		Female	25-44	Yes	Other	Yes	Yes	Moderately	Don't know	Not at all	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Upper	N/A	No
10	Off-site	40	30	30	2	30	Male	18-24	No	Other	Yes	Yes	Moderately	Don't know	Somewhat	Moderately	Moderately	Somewhat	Somewhat	Crucial	Very helpful	Slightly	Yes	General	N/A	N/A
11	Off-site	100	40	100	10	50	Female	45-64	No	Other	Yes	Yes	Moderately	Don't know	Not at all	Very Much	Very Much	Somewhat	Very Much	Useful	Helpful	Moderately	Yes	General	N/A	N/A
12	Off-site	30	75	50	7	70	Female	18-24	Yes	Other	Yes	Yes	Very Much	Don't know	Somewhat	Moderately	Moderately	Somewhat	Somewhat	Useful	Helpful	Somewhat	Yes	Upper	No	No
13	Off-site	15	4	25	4.15	40	Male	25-44	No	Other	Yes	No	Very Much	Don't know	Moderately	Moderately	Very Much	Very Much	Moderately	Useful	Very helpful	Slightly	Yes	Main+Upper	No	No
14	Off-site	30	10	100	4	30	Female	18-24	Yes	Other	Yes	No	Moderately	Don't know	Somewhat	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Stairs+Cafe	Yes	No
15	Off-site	15	80	20	7	60	Female	18-24	Yes	Other	Yes	No	Moderately	Don't know	Not at all	Moderately	Very Much	Very Much	Somewhat	Crucial	Helpful	Not at all	Yes	Upper	No	No
16	Off-site	25	25	500	10	40	Male	25-44	No	Atlantic1	Yes	No	Moderately	Don't know	Not at all	Moderately	Very Much	Very Much	Somewhat	Crucial	Helpful	Not at all	Yes	Upper	N/A	No
17	Off-site		25	50	5	45	Male	25-44	No	Other	Yes	No	Moderately	Don't know	Somewhat	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Stairs	N/A	N/A
18	Off-site	12	100	500	5	40	Male	18-24	Yes	Other	Yes	Yes	Moderately	Don't know	Somewhat	Moderately	Moderately	Somewhat	Somewhat	Crucial	Very helpful	Slightly	Yes	Main	Yes	No
19	Off-site	25	20	200	7	30	Female	18-24	Yes	Other	Yes	Yes	Moderately	Don't know	Not at all	Very Much	Very Much	Somewhat	Very Much	Useful	Helpful	Moderately	Yes	General	Yes	No
20	Off-site	20	160	20	2		Female	18-24	Yes	Other	Yes	Yes	Moderately	Don't know	Very Much	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Stairs	No	No
21	Off-site	15	25	500	3	10	Female	25-44	No	Other	Yes	Yes	Very Much	Don't know	Somewhat	Moderately	Very Much	Very Much	Somewhat	Crucial	Helpful	Not at all	Yes	Café	No	No
22	Off-site	12		27	3	33	Female	25-44	Yes	Other	Yes	Yes	Moderately	Don't know	Moderately	Very Much	Very Much	Somewhat	Somewhat	Useful	Helpful	Slightly	Yes	Upper	N/A	Yes
23	Off-site	15	10	8	4	60	Female	25-44	No	Other	No	No	Very Much	I know	Not at all	Moderately	Very Much	Very Much	Very Much	Useful	Helpful	Not at all	Maybe	Stairs	N/A	No
24	Off-site	100	24	900	50	40	Male	18-24	Yes	Other	Yes	Yes	Very Much	I know	Somewhat	Somewhat	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Maybe	Upper	No	No
25	Off-site	7	10	30	3	30	Male	18-24	Yes	Other	Yes	Yes	Moderately	I live there	Somewhat	Very Much	Very Much	Very Much	Somewhat	Useful	Helpful	Somewhat	Maybe	Stairs	No	No
26	Off-site	12	12	40	4.5	60	Male	45-64	No	Edward Str	Yes	Yes	Moderately	I know	Very Much	Moderately	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Maybe	Main	N/A	N/A
27	Off-site	60	24	1000	50	40	Female	45-64	No	Edward Str	Yes	Yes	Moderately	I know	Somewhat	Very Much	Moderately	Somewhat	Very Much	Useful	Helpful	Not at all	Yes	Café	N/A	N/A
28	Off-site	8	5	10	1.5	70	Female	25-44	No	Impact	Yes	Yes	Moderately	I know	Not at all	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Slightly	Yes	General	N/A	N/A
29	Off-site	10	15	500	5	40	Female	25-44	No	Other	Yes	Yes	Moderately	I know	Not at all	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Tramlines	N/A	No

30	Off-site	50	5	300	10	30	Male	18-24	Yes	Edward Str	Yes	Yes	Moderately	I live there	Not at all	Moderately	Very Much	Very Much	Very Much	Useful	Helpful	Somewhat	Yes	Café	No	No
31	Off-site	30	25	15	5	40	Female	18-24	No	Other	Yes	Yes	Very Much	I know	Moderately	Somewhat	Moderately	Somewhat	Somewhat	Useful	Helpful	Slightly	Yes	Main	No	No
32	Off-site	20	8	80	5	15	Female	18-24	Yes	Other	Yes	Yes	Moderately	I live there	Very Much	Very Much	Very Much	Somewhat	Somewhat	Crucial	Very helpful	Not at all	Yes	Café	Yes	Yes
33	Off-site		10		3		Male	18-24	No	Edward Str	Yes	No	Moderately	I know	Somewhat	Very Much	Moderately	Somewhat	Very Much	Crucial	Very helpful	Not at all	Yes	Café	N/A	N/A
34	Off-site	20	8	80	5	15	Female	18-24	Yes	Other	Yes	No	Moderately	I live there	Very Much	Moderately	Very Much	Very Much	Very Much	Useful	Helpful	Not at all	Yes	Café	Yes	Yes
35	Off-site	35	10	500	3	5	Female	18-24	Yes	Other	Yes	Yes	Moderately	I know	Very Much	Somewhat	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Café	Yes	No
36	Off-site	12	10	10	5	5	Female	18-24	Yes	Other	Yes	No	Very Much	I live there	Very Much	Somewhat	Very Much	Very Much	Very Much	Useful	Neither	Slightly	Yes	Upper	Yes	Yes
37	Off-site	10	20	7	3	5	Female	18-24	Yes	IQ	Yes	Yes	Moderately	I live there	Very Much	Somewhat	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Café	Yes	No
38	Off-site	10	9	30	3	13	Male	18-24	No	Edward Str	Yes	Yes	Moderately	I know	Somewhat	Very Much	Moderately	Somewhat	Very Much	Useful	Helpful	Not at all	Yes	Café	No	No
39	Off-site	15	9	70	2.5	45	Male	25-44	No	Other	Yes	Yes	Moderately	I know	Not at all	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Slightly	Yes	General	Yes	No
40	Off-site	20	40	150	8	2	Female	18-24	Yes	Other	Yes	No	Moderately	I live there	Very Much	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Maybe	Main	No	No
41	Off-site	10	10	8	4	60	Female	25-44	No	Edward Str	No	No	Slightly	I know	Somewhat	Moderately	Very Much	Very Much	Somewhat	Useful	Helpful	Not at all	Maybe	Café	N/A	N/A
42	Off-site	40	150	500	5	40	Male	25-44	No	Impact	Yes	No	Moderately	I live there	Very Much	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Maybe	Main	N/A	N/A
43	Off-site	30	8	80	5	60	Male	25-44	No	Atlantic1	Yes	No	Moderately	I live there	Not at all	Moderately	Moderately	Somewhat	Very Much	Useful	Very helpful	Slightly	Yes	Main	N/A	N/A
44	Off-site	50	8	50	15	48	Male	18-24	Yes	Other	Yes	No	Moderately	I know	Not at all	Moderately	Moderately	Somewhat	Very Much	Useful	Very helpful	Slightly	Yes	Main	Yes	Yes
45	Off-site	15	20	100	5	60	Male	25-44	Yes	Other	Yes	No	Moderately	I live there	Somewhat	Very Much	Moderately	Somewhat	Very Much	Crucial	Very helpful	Not at all	Yes	Café	No	No
46	Off-site	7	50	100	3	30	Male	18-24	Yes	Other	Yes	Yes	Moderately	I live there	Moderately	Somewhat	Moderately	9	Very Much	Useful	Helpful	Slightly	Maybe	Main	Yes	No
47	Off-site	10	20	50	5	40	Female	25-44	No	Other	Yes	No	Very Much	I live there	Very Much	Moderately	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Stairs	Yes	Yes
48	Off-site	20	27	100	5	40	Male	18-24	Yes	Other	Yes	No	Moderately	I live there	Very Much	Very Much	Very Much	Very Much	Very Much	Crucial	Helpful	Not at all	Maybe	Stairs	No	No
49	Off-site	35	5	150	5	18.8	Male	18-24	Yes	Other	Yes	No	Moderately	I know	Somewhat	Moderately	Somewhat	Moderately	Somewhat	Useful	Helpful	Slightly	Maybe	Stairs+Upper	Yes	No
50	Off-site	7	15	500	5	30	Male	18-24	No	Impact	Yes	Yes	Moderately	I know	Somewhat	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Main	Yes	No
51	Off-site	12	10	45	6	35	Male	45-64	No	Other	Yes	No	Somewhat	I live there	Very Much	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Tramlines	Yes	No
52	Off-site	15	20	250	3	10	Female	18-24	Yes	Allen Court	Yes	No	Moderately	I know	Somewhat	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Slightly	Maybe	Upper	No	No
53	Off-site	15	25	500	3	10	Female	25-44	Yes	Allen Court	Yes	No	Moderately	I know	Very Much	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Café	No	No
54	Off-site	60	17	150		27	Female	18-24	No	Other	Yes	No	Moderately	I live there	Not at all	Somewhat	Moderately	Somewhat	Somewhat	Useful	Helpful	Moderately	Maybe	Café	Yes	No
55	Off-site	20	10	18	6	50	Male	18-24	Yes	Edward Str	Yes	Yes	Moderately	I know	Moderately	Very Much	Very Much	Very Much	Very Much	Crucial	Helpful	Not at all	Yes	Café	Yes	No
56	Off-site	10	15	25	5	60	Male	18-24	Yes	Other	Yes	No	Moderately	I know	Not at all	Somewhat	Very Much	Very Much	Somewhat	Useful	Neither	Somewhat	Maybe	Tramlines	No	Yes
57	Off-site	14	15	4	35		Male	25-44	Yes	Other	No	No	Very Much	I know	Not at all	Slightly	Moderately	Somewhat	Somewhat	Useful	Very helpful	Not at all	Maybe	Main	No	No
58	Off-site	75	7	90	4	55	Male	25-44	No	Other	Yes	No	Very Much	I know	Very Much	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Tramlines	Yes	No
59	Off-site	27	30	250	5	35	Male	18-24	Yes	IQ	Yes	Yes	Moderately	I know	Slightly	Very Much	Somewhat	Moderately	Somewhat	Useful	Helpful	Not at all	Yes	Café	Yes	Yes
60	Off-site	15	70	80	9	48	Male	18-24	Yes	Other	Yes	No	Moderately	I live there	Moderately	Very Much	Very Much	Very Much	Somewhat	Useful	Very helpful	Slightly	Yes	Café	Yes	No
61	Off-site						Male	25-44	Yes	Atlantic1	Yes	No	Moderately	I know	Somewhat	Very Much	Very Much	Very Much	Somewhat	Crucial	Very helpful	Somewhat	Yes	Upper	No	N/A
62	Off-site	35	10	500	3	5	Female	25-44	Yes	Atlantic1	Yes	No	Somewhat	I know	Somewhat	Moderately	Moderately	Moderately	Slightly	No	Very helpful	Somewhat	Yes	Upper	No	N/A
63	On-site	50	20	50	4	50	Male	25-44	No	Other	Yes	Yes	Very Much	Don't know	Moderately	Very Much	Very Much	Somewhat	Somewhat	Useful	Very unhelpful	Very Much	Maybe	Upper	No	No
64	On-site	20	10	40	8	30	Female	18-24	Yes	Other	Yes	Yes	Very Much	Don't know	Very Much	Very Much	Very Much	Very Much	Somewhat	Crucial	Helpful	Slightly	Yes	Stairs+Upper	Yes	Yes
65	On-site	25	7	30	7	40	Female	25-44	Yes	Other	Yes	Yes	Very Much	Don't know	Slightly	Moderately	Very Much	Very Much	Somewhat	Crucial	Unhelpful	Not at all	Maybe	Upper	No	No
66	On-site	20	20	20	3	20	Male	25-44	No	Other	Yes	No	Moderately	Don't know	Slightly	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Café	Yes	No

67	On-site	10	20	10	4	30	Male	18-24	Yes	Omnia Spa	Yes	No	Very Much	Don't know	Moderately	Moderately	Very Much	Very Much	Very Much	Useful	Helpful	Not at all	Yes	Main	Yes	No
68	On-site	15	10	20	5	40	Female	25-44	No	Other	Yes	No	Moderately	Don't know	Slightly	Very Much	Very Much	Very Much	Somewhat	Useful	Helpful	Not at all	Yes	Café	No	No
69	On-site	35	12	100	4	35	Female	45-64	No	Other	Yes	No	Somewhat	Don't know	Very Much	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Upper+café	No	No
70	On-site	15	30	30	5	20	Male	25-44	No	Other	Yes	No	Very Much	Don't know	Very Much	Very Much	Very Much	Somewhat	Very Much	Crucial	Very helpful	Not at all	Yes	Main	No	No
71	On-site	15		30	6	20	Male	18-24	Yes	Other	Yes	Yes	Very Much	Don't know	Somewhat	Very Much	Very Much	Somewhat	Moderately	Useful	Very helpful	Not at all	No	Main	No	No
72	On-site	24	5	18	6	40	Male	25-44	No	Other	Yes	Yes	Very Much	Don't know	Not at all	Moderately	Somewhat	Somewhat	Moderately	Useful	Very helpful	Slightly	No	Main	Yes	No
73	On-site	20	10	100	5	30	Male	18-24	Yes	Other	Yes	Yes	Very Much	Don't know	Moderately	Somewhat	Moderately	Somewhat	Somewhat	Useful	Helpful	Not at all	Maybe	Tramlines	Yes	Yes
74	On-site	17	20	50	5.5	25	Male	18-24	No	Other	Yes	Yes	Slightly	Don't know	Slightly	Very Much	Somewhat	Moderately	Moderately	Useful	Helpful	Not at all	Maybe	Main	No	No
75	On-site	15	10	80		4.5	Female	18-24	Yes	Other	Yes	No	Moderately	Don't know	Moderately	Moderately	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Stairs+Café	Yes	No
76	On-site	22	15	50	7	10	Male	18-24	Yes	Other	Yes	No	Moderately	Don't know	Slightly	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Maybe	Tramlines+main	Yes	No
77	On-site	15	12	100	4	25	Female	25-44	Yes	Other	Yes	Yes	Moderately	Don't know	Not at all	Very Much	Very Much	Very Much	Very Much	Useful	Helpful	Slightly	Yes	Café+stairs	No	No
78	On-site	13	20	77	7	20	Male	25-44	Yes	Other	No	Yes	Very Much	Don't know	Slightly	Very Much	Very Much	Very Much	Somewhat	Useful	Very helpful	Not at all	Yes	Café	Yes	No
79	On-site	40	5	100		60	Female	18-24	Yes	Aspect	Yes	Yes	Very Much	I know	Not at all	Very Much	Somewhat	Somewhat	Moderately	Useful	Very helpful	Somewhat	Maybe	Upper	Yes	No
80	On-site	7	20	200	5	10	Female	18-24	Yes	Other	Yes	Yes	Very Much	I know	Not at all	Moderately	Moderately	Somewhat	Somewhat	Useful	Helpful	Somewhat	Maybe	Café	No	No
81	On-site	7	48	300	2.5	20	Female	18-24	Yes	Other	Yes	No	Very Much	I live there	Moderately	Moderately	Very Much	Somewhat	Somewhat	Useful	Helpful	Not at all	Maybe	Stairs+Café	No	No
82	On-site		15			60	Female	18-24	Yes	Other	Yes	Yes	Moderately	I know	Very Much	Moderately	Moderately	Somewhat	Somewhat	Crucial	Very helpful	Not at all	Maybe	Stairs	No	No
83	On-site	15	8	40	6	30	Male	18-24	Yes	Other	Yes	No	Moderately	I live there	Moderately	Moderately	Very Much	Somewhat	Very Much	Crucial	Helpful	Slightly	Yes	Stairs	Yes	No
84	On-site	8	7	10	3	25	Female	18-24	Yes	Aspect	Yes	No	Somewhat	I know	Moderately	Moderately	Very Much	Very Much	Very Much	Useful	Helpful	Slightly	Yes	Stairs	No	No
85	On-site	13	20	50	6.4	20	Female	25-44	Yes	Allen Court	Yes	No	Very Much	I live there	Somewhat	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Café	No	Yes
86	On-site	20	10	39	8	10	Female	25-44	Yes	Omnia Spa	Yes	Yes	Somewhat	I know	Moderately	Somewhat	Moderately	Somewhat	Somewhat	Crucial	Very helpful	Slightly	Yes	Stairs	Yes	Yes
87	On-site		5	30	5	20	Male	25-44	Yes	Allen Court	Yes	No	Moderately	I live there	Moderately	Somewhat	Moderately	Somewhat	Somewhat	Useful	Helpful	Somewhat	Yes	Upper	Yes	No
88	On-site	100	10	20	50	30	Male	18-24	No	Edward Str	Yes	No	Moderately	I know	Very Much	Moderately	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Upper	Yes	No
89	On-site	16	10	60	5	5	Male	25-44	No	Atlantic1	Yes	No	Very Much	I know	Very Much	Moderately	Very Much	Somewhat	Somewhat	Useful	Helpful	Not at all	Yes	Main	Yes	No
90	On-site	16	24	25	4	40	Male	18-24	No	IQ	No	No	Very Much	I know	Very Much	Moderately	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Café	No	Yes
91	On-site	18	7	25	5	30	Female	25-44	Yes	Other	Yes	Yes	Very Much	I live there	Very Much	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Café	No	No
92	On-site	15	15	100	5	45	Female	18-24	Yes	Aspect	Yes	No	Moderately	I know	Very Much	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Stairs	No	No
93	On-site	16.7	10	120	5.4	60	Male	65+	No	Other	No	Yes	Very Much	I know	Very Much	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Upper	No	No
94	On-site	35		150	6	35	Female	18-24	Yes	Aspect	Yes	Yes	Very Much	I live there	Somewhat	Moderately	Moderately	Somewhat	Somewhat	Useful	Helpful	Slightly	Maybe	Tramlines	No	No
95	On-site	16	20	30	5	20	Female	18-24	Yes	Omnia Spa	Yes	Yes	Very Much	I know	Moderately	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Stairs	No	No
96	On-site	30	30	80	3.5	30	Female	18-24	Yes	Q4	Yes	No	Moderately	I know	Moderately	Very Much	Very Much	Very Much	Somewhat	Useful	Helpful	Not at all	Maybe	Stairs	Yes	No
97	On-site	14	10	90	4.5	35	Female	25-44	Yes	Omnia Spa	Yes	Yes	Very Much	I know	Not at all	Very Much	Very Much	Somewhat	Very Much	Useful	Helpful	Not at all	Yes	Upper	Yes	Yes
98	On-site	14	6	30	4	40	Female	25-44	Yes	Omnia Spa	Yes	No	Moderately	I know	Very Much	Moderately	Very Much	Somewhat	Very Much	Crucial	Very unhelpful	Not at all	Yes	Stairs	No	No
99	On-site	20	10	40	5		Female	18-24	Yes	Omnia Spa	Yes	No	Very Much	I know	Somewhat	Moderately	Moderately	Somewhat	Somewhat	Useful	Very helpful	Slightly	Yes	Stairs	Yes	Yes
100	On-site	16	19	34	6	5	Male	18-24	No	Other	Yes	Yes	Moderately	I know	Moderately	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Slightly	Yes	Café	No	No
101	On-site	10	20	80	8	30	Male	18-24	Yes	Aspect	Yes	Yes	Moderately	I know	Moderately	Moderately	Moderately	Moderately	Somewhat	Useful	Unhelpful	Slightly	Maybe	Main+Café	No	No
102	On-site	10	10	20	4	20	Male	18-24	Yes	Other	Yes	Yes	Moderately	I know	Moderately	Very Much	Very Much	Somewhat	Somewhat	Crucial	Helpful	Slightly	Yes	Main+Upper	No	No
103	On-site	10	10	20	4	15	Female	18-24	No	Other	Yes	Yes	Moderately	I live there	Very Much	Moderately	Moderately	Somewhat	Somewhat	Useful	Helpful	Not at all	Maybe	Main+Upper	Yes	No

104	On-site						Female	18-24	No	Atlantic1	Yes	Yes	Moderately	I know	Slightly	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Upper+café	Yes	No
105	On-site	12	5	100	5	30	Female	25-44	Yes	Other	Yes	Yes	Somewhat	I live there	Somewhat	Very Much	Very Much	Very Much	Very Much	Useful	Helpful	Not at all	Maybe	Stairs	Yes	No
106	On-site	10	9	30	6	70	Female	25-44	Yes	Q4	Yes	No	Somewhat	I know	Moderately	Very Much	Very Much	Very Much	Somewhat	Crucial	Helpful	Not at all	Yes	Café	Yes	No
107	On-site	15	20	40	4	20	Male	18-24	Yes	Other	Yes	Yes	Very Much	I live there	Somewhat	Somewhat	Moderately	Somewhat	Moderately	Useful	Helpful	Slightly	Maybe	Stairs	Yes	No
108	On-site	10	4	50	2.5	15	Male	25-44	No	Atlantic1	Yes	Yes	Very Much	I know	Moderately	Moderately	Very Much	Very Much	Somewhat	Useful	Very helpful	Not at all	Yes	Upper+stairs	No	Yes
109	On-site						Male	18-24	Yes	Aspect	Yes	Yes	Moderately	I know	Somewhat	Very Much	Very Much	Very Much	Very Much	Useful	Helpful	Slightly	Maybe	Café	N/A	N/A
110	On-site	30	12	15	5	20	Male	18-24	No	Other	Yes	Yes	Very Much	I live there	Somewhat	Moderately	Moderately	Somewhat	Very Much	Useful	Very helpful	Not at all	Maybe	Stairs+Café	No	No
111	On-site	25	12	15	5.5	10	Male	18-24	Yes	Allen Court	Yes	Yes	Moderately	I know	Very Much	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Upper+café	No	Yes
112	On-site	12	5	100	3	20	Female	25-44	No	Other	Yes	Yes	Moderately	I live there	Very Much	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Café	No	No
113	On-site	18	5	500	3	10	Female	25-44	Yes	Allen Court	Yes	Yes	Moderately	I live there	Moderately	Somewhat	Very Much	Somewhat	Moderately	Useful	Very helpful	Slightly	Maybe	Tramlines+Café	No	Yes
114	On-site	30	14	75	6	25	Male	25-44	Yes	Other	No	No	Somewhat	I know	Slightly	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Maybe	Café	No	No
115	On-site	16.8	19	53	6.5	15	Male	25-44	No	Other	Yes	Yes	Moderately	I live there	Not at all	Very Much	Very Much	Very Much	Very Much	Useful	Helpful	Not at all	Yes	Upper+Main	Yes	No
116	On-site	17	25	20	6	10	Female	25-44	Yes	Atlantic1	Yes	No	Somewhat	I know	Very Much	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Stairs	No	No
117	On-site	40	17	60	6	30	Male	25-44	Yes	Other	Yes	Yes	Moderately	I live there	Very Much	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Main+Café	No	No
118	On-site	50	15	50	5	15	Female	25-44	No	Other	Yes	Yes	Very Much	I live there	Very Much	Moderately	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Café	No	No
119	On-site	20	17	20	4	10	Male	18-24	Yes	Aspect	Yes	No	Moderately	I know	Somewhat	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Upper	Yes	No
120	On-site			100			Female	18-24	Yes	Edward Str	Yes	Yes	Very Much	I know	Somewhat	Somewhat	Moderately	Moderately	Somewhat	Useful	Helpful	Somewhat	Maybe	Upper	Yes	No
121	Combined	21	10	30	5	5	Female	25-44	No	Other	Yes	No	Somewhat	Don't know	Somewhat	Moderately	Very Much	Very Much	Very Much	Crucial	Very helpful	Slightly	Yes	Café	Yes	Yes
122	Combined	15	10	20	5	20	Female	25-44	No	Other	Yes	No	Very Much	Don't know	Slightly	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Slightly	Yes	Café	Yes	Yes
123	Combined	15	20	40	5	40	Female	18-24	No	Other	Yes	Yes	Moderately	Don't know	Moderately	Moderately	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Café	No	No
124	Combined	15	7	100	5	40	Female	18-24	Yes	Other	Yes	No	Moderately	Don't know	Very Much	Very Much	Very Much	Somewhat	Somewhat	Crucial	Very helpful	Slightly	Yes	Café	Yes	Yes
125	Combined	15	10	30	5	20	Female	25-44	No	Other	Yes	No	Very Much	I know	Moderately	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Stairs	Yes	No
126	Combined	20	15	20	6	20	Male	25-44	No	Other	Yes	Yes	Moderately	I know	Slightly	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Upper	Yes	No
127	Combined	15	10	80	6	40	Female	25-44	Yes	Other	Yes	No	Moderately	I know	Moderately	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Slightly	Yes	Upper	No	No
128	Combined	50	15	30	5	40	Male	18-24	No	Edward Str	Yes	Yes	Very Much	I know	Somewhat	Moderately	Very Much	Moderately	Somewhat	Useful	Very helpful	Slightly	Maybe	Main	No	No
129	Combined	15	10	20	3	50	Male	18-24	Yes	Other	Yes	Yes	Very Much	I live there	Somewhat	Moderately	Somewhat	Moderately	Somewhat	Useful	Helpful	Slightly	Yes	Upper	Yes	Yes
130	Combined	21	50	100	10	40	Male	18-24	Yes	Aspect	Yes	Yes	Very Much	I know	Moderately	Very Much	Very Much	Very Much	Somewhat	Crucial	Helpful	Moderately	Maybe	Café	Yes	No
131	Combined	13	10	10	7	20	Male	18-24	No	Edward Str	Yes	Yes	Moderately	I know	Moderately	Very Much	Very Much	Very Much	Very Much	Useful	Helpful	Slightly	Yes	Main	Yes	No
132	Combined	15	20	35	9	8	Female	18-24	No	Other	Yes	No	Moderately	I live there	Somewhat	Very Much	Very Much	Very Much	Very Much	Crucial	Very helpful	Not at all	Yes	Tramlines+Café	Yes	No
133	Combined	15	30	45	5	20	Male	25-44	Yes	Other	Yes	No	Slightly	I know	Not at all	Moderately	Very Much	Very Much	Moderately	Useful	Helpful	Slightly	Yes	Stairs	No	Yes
134	Combined	10	17	150	4.5	56	Male	18-24	No	Edward Str	Yes	No	Somewhat	I know	Moderately	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Café	No	No
135	Combined	20	17	150	6	20	Male	18-24	Yes	Other	Yes	No	Moderately	I know	Moderately	Very Much	Very Much	Somewhat	Very Much	Useful	Very helpful	Slightly	No	Café	No	No
136	Combined	10	10	50	4	25	Male	25-44	No	Edward Str	Yes	Yes	Moderately	I know	Not at all	Very Much	Very Much	Very Much	Very Much	Useful	Very helpful	Not at all	Yes	Main	Yes	No
137	Combined	13	10	20	10	30	Female	25-44	Yes	Omnia Spa	Yes	No	Moderately	I know	Somewhat	Very Much	Moderately	Somewhat	Somewhat	Useful	Helpful	Somewhat	Maybe	Stairs	Yes	No
138	Combined	16	7	30	4	10	Male	18-24	Yes	Omnia Spa	Yes	Yes	Very Much	I know	Moderately	Very Much	Very Much	Very Much	Somewhat	Useful	Very helpful	Slightly	Maybe	Café	No	No
139	Combined	18	6	50	3.5	20	Female	18-24	Yes	IQ	Yes	No	Very Much	I live there	Moderately	Slightly	Somewhat	Somewhat	Somewhat	Useful	Helpful	Slightly	Maybe	Café	No	No