An Inclusive Design Study of Wheelchair Users in the Built Environment

Tom Page [1] & Gisli Thorsteinsson [2]

Abstract

The aim of this study is to determine the problems wheelchair users face in the built environment and why these problems have not been resolved. The study considered the role of the designer in creating an inclusively designed built environment. The literature review finds that there are many designers that support inclusive design, but also some that do not. The government has enforced many directives and legislation, but this is often met by designers using the bare minimum required and does not solve the issues that wheelchair users face. The empirical research then moves on to finding answers to research questions that were not found during the literature review. Two online questionnaires were used in order to gain qualitative and quantitative results from 45 wheelchair users and 54 designers. The results are analysed through the use of charts, and then the results are discussed. The designers are found to be in support of designing for wheelchair users, but often feel that if they do the revenue potential of their design will be affected. The study concludes that wheelchair users' problems are a combination of the poorly designed built environment and the wheelchair they use.

Keywords: Wheelchair Users, Task Analysis, Design, Built Environment.

1. Introduction

Today the world is full of a variety of gadgets and technology designed to make the simplest tasks easier and even just for fun. But are we living in a world where able-bodied people fill their lives with un-necessities whilst those in wheelchairs struggle to complete basic everyday tasks? Many researchers have conducted studies investigating this area to determine why wheelchair users are less catered for and who is responsible. In this study, the researcher questions whether it is the role of the designer in enabling those in wheelchairs or is there an underlying source.

1.1. Aim

To investigate the difficulties wheelchair users have in the built environment and where the origins of their problems lie.

1.2. Objectives

- To investigate the opinions of both wheelchair users and designers on designing for inclusivity in the built environment, using reports and studies.
- Use studies, reports and articles to understand the current state of UK cities and environments for wheelchair users.
- To use questionnaires to further explore the views and opinions of wheelchair users and designers.
- To decide whether the design of a wheelchair impacts on the user's capabilities and self-esteem, using questionnaires.

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[1] Associate Professor in Product Design, School of Architecture, Design and the Built Environment, Nottingham Trent University, 50 Shakespeare Street, Nottingham, NG1 4FQ. Email: tom.page@ntu.ac.uk

[2] Professor in Design, Department of Design and Craft, School of Education University of Iceland, V / Stakkahlid, 105 Reykjavik, Email: cdt@hi.is

1.3. Research Questions

1. What problems or obstacles do wheelchair users face in the built environment?
2. Are there any particular environments where wheelchair users are less catered for?
3. Is there enough support for those in wheelchairs and for inclusive design?
4. Are there any existing government schemes or directives to ensure the built environment is adequate for wheelchair users? Are they being met?
5. Who is responsible for accommodating and supporting wheelchair users within the built environment? Is it the designer or another organisation?
6. Are wheelchair users a minority that should or should not be catered for?
7. Are difficulties in the built environment more prominent for those who are very dependent on their wheelchair than those who are not?
8. Are designers ignorant to the need of designing for wheelchair users or are there other reasons?
9. Is the source of wheelchair users' problems the built environment or their wheelchair?

2. Literature Review

2.1. The Built Environment

In the UK, wheelchair users face many barriers in their day-to-day lives which prevent ease of mobility and access. 90% of our day is spent inside artificially constructed surroundings (Russel, 1999). However, most of these environments are built with little or no consideration for the less able (Holmes-Sielde, 1996). In May 1997, 75% of UK polling stations were inaccessible for wheelchair users (Imrie and Hall, 2001). Those in support of inclusive design believe all users of the built environment should have the ability to take control of their environments (Hatch, 1984) but many users are faced with a variety of barriers including societal attitudes (Imrie and Hall, 2001) and the absence of strong regulatory control (Gleeson, 1999). As all users are totally immersed in the effect of the built environment, the design of it is important to every one (Giddens, 1993). Walker (1996) was quoted as saying 'I don't want respect… I don't want to have to ask to get in and out of buildings and buses… what would it be like if black people, pram pushers or homosexuals couldn't use public buildings? (Walker cited in Imrie 1996).

The UK built environment is largely seen to have 'been constructed without reference to the physical needs of disabled people' (Barnes, 1991). When commuting, wheelchair users come across many obstacles, which to an able-bodied person would not be seen as a problem. In Cambridge, there is no dedicated fund for disabled access, currently the budget is £30,000 for general accessibility which is only 1/1000th of the County Council's budget of £848 million (Bourke, 2018). However, in recent years disabled people's access issues to public buildings and environments has become an important part of the political agenda with many local authorities implementing strategies for accessible built environments (Imrie and Kumar, 1998). The 2004 Strategic Planning Guidance Implementation for Greater London states that 'the mayor will, and boroughs, should, endeavour to ensure that in meeting the principles of inclusive design the spatial needs of London's diverse communities are also addressed' (Greater London Authority cited in Adams, 2006).

In 2018, the UK hosted the Paralympic Games; therefore it was important that the Olympic Park was accessible for the disabled athletes and spectators. The Olympic Park was praised for its overall accessibility and the facilities created to accommodate wheelchair users. It showed the UK's potential for an inclusive and accessible city (British Broadcasting Corporation, 2018). Even after the success of the Paralympics in promoting accessible environments, the modern built environment is still not sympathetic to the needs and access requirements of people with disabilities. It can be said that Frampton's (1992) belief that 'postmodernism is actually more de-humanising than modernism as its promises can never be delivered,' is still true today (Frampton, 1992). The Disability Rights Commission has set itself a goal to create a society where all disabled people can participate fully as equal citizens (Massie cited in Adams, 2006). Their chairman, Massie concludes that the goal of inclusive design is to create an environment that can be used by a diverse range of users, therefore, the design process should constantly expand to accommodate the requirements of the people designed to assist (ibid).

2.2. The Designer

Attitudes to wheelchair users are generally negative and people are often ignorant to the difficulties wheelchair users face in their daily lives. The European Commission argue that everyone, of any age, with or without a disability must be able to access and use any part of the built environment as independently as possible (European Commission, 1996).

There are many regulations and directives that mean designers should consider access, such as the Disability Discrimination Act 1995 which states disabled people should not be discriminated against when completing tasks for their daily lives (Lacey, 2004). Legislation and building regulations compiled to assist the disabled population have to be adhered to, but the recognition that the built environment can, and does, create disabling environments has to be accepted by the individuals that implement them (Steinfield and Danford, 1999). Unfortunately, the directives are limited and many designers will 'dumb-down' the standards of access by rarely providing more than what is required by law (Imrie and Hall, 2001). However, understanding what disabled people want rather than perceiving what they need, cannot be written into legislation and is an essential principle to providing adequate solutions to accessibility issues (Imrie and Hall, 2001).

In 1997, architect Selwyn Goldsmith observed that buildings have always been, and always will be, geared to suit two-legged able-bodied people and not people propped on sticks or rolling about in chairs on wheels (Goldsmith, 1997). This stems from designers opinions that disabled users are the minority. In the UK 10% of people are registered disabled, of these 4% are dependent on a wheelchair, therefore it could be argued that there are not enough people to make designing for wheelchair users economically viable (Imrie and Hall, 2001). On the other hand, it can be argued that designers must consider changes that manufacturers, distributors and end users will have to make, or adapt to, in order to benefit from a new design (Jones, 1992). It can be said that to be a designer is to be conscious of, and accept, some responsibility for the physical form of our world (Blake, 1983). A postal survey carried out by the Economic and Social Research Council (ESRC) found that 90% (108 practices) of UK surveyors believe the property market should provide more accessible buildings as it was morally right to design for all (ESRC, 1999 cited in Imrie and Hall, 2001).

The biggest concern for property developers is that designing for wheelchair access will reduce profits. During the ESRC surveys, an interviewee claimed that developers are only 'interested in initial capital costs and… will only provide what the law requires' (ibid). Other interviewees agreed that designing for wheelchair access, such as wider corridors, meant loss of commercial space, therefore fewer profits. However, these concerns mainly appear with designers of commercial buildings who need to make a profit from selling or letting space, rather than those designing for retail and leisure facilities who understand wheelchair users are potential customers (Partington, 1999). Designers of buildings for the general public, have a greater awareness of the need for access and are more willing to design accessible features as it is more marketable (Imrie and Hall, 2001). An interviewee during the ESRC surveys said, "If we are developing a new building it needs to be marketable and the market now expects accessibility for disabled people." (ESRC, 1999 cited in Imrie and Hall, 2001). Public developers are also subject to public opinion and scrutiny and after the 2018 Paralympic Games; the awareness of the need for disabled access has increased.

The ESRC also carried out a study with thirty disabled participants from the Weymouth and Gateshead areas (ESRC, 1996 cited in Adams, S.K., 1996). The study illustrated the oppression felt by disabled users in the built environment and many commented on the discrimination they felt from their able bodied peers. Participants complained that although some of them had been in discussions with planners and designers, when the project was finalised advice given by disabled participants was disregarded. This is reiterated by Marks (1999) who believes that barriers experienced by wheelchair users within the physical environment are looked at from the viewpoint that 'design aesthetics reflect certain idealised assumptions about the inhabitants and users of the built environment' (Marks, 1999).

Many designers are concerned that designing for access reduces the aesthetic of a building. During the planned extension of the Building Regulations 1995, the Housing Builders Federation (HBF) claimed that providing ramped access to homes 'will in itself be ugly' and that handrails would give 'an institutional feel' (HBF, 1995 cited in Imrie and Hall, 2001). However, it can be argued that it is the role of the designer to make accessible features, such as ramps and handrails, more aesthetically pleasing whilst still providing successful function (Nussbaumer, 2018). Brookwell, an access surveyor for Bournemouth Borough Council believes access 'isn't just ramps and toilets, nor is it rocket science; it is a common-sensible approach to making your building accessible to all'.

User involvement in the design process is seen by many as a hindrance rather than assisting (Towers, 1995). Whereas, disability groups argue that if advice is sought during the design stage, expensive re-adaptations would not be necessary later on (Jolley, 1996). Direct involvement by end users in the design and decision making process has proved to be successful, not only in the design of products, but also with the development of buildings (Luck cited in Adams, 2006).

The use of an 'inclusive design methodology', where the end user is incorporated into the design process, would allow the production of inclusively designed products. However, encouraging designers to employ inclusive design methods will only be successful when the impact of new inclusive design methodology is seen through the usability of products and designs (Clarkson and Keates, 2003). The differing values and attitudes in designing for inclusivity and for non-inclusivity are summarised in Table 1.

Table 1: (Adapted from Sommer, 1983)

Inclusive Design	Non-inclusive Design
Concern with meaning and context	Concern with style and ornament
Participative	Non-participative
Human orientated	Corporate or institution orientated
Client re-defined to include users	Owner as exclusive client
Low cost	High cost
Grassroots design approaches	Top-down design approach
Democratic	Authoritarian
Seeking to change design attitudes	Acceptance of prevailing design attitudes
Use of appropriate technology	Use of high technology
Use of alternate models of development process	Development process controlled by corporate interests
Heterogeneity	Homogeneity

Jordan claims that designers fail to design inclusively as they do not consider that the product may be used by someone with a disability (Jordan, 2003). Designers focus on providing solutions that match their own physical and skill capabilities (Cooper, 1999), and by adhering to the given brief, automatically exclude the disabled user by default (Jordan, 2003). The use of design texts, such as ergonomic data further reinforces designers' believes that a wheelchair user is reduced to a universal size characterised by fixed parts, limiting the research surrounding the wheelchair user (Neufert and Neufert, 2000).

Designers have the potential to influence and help change attitudes towards wheelchair users through their work (Adams, 2006). The principles of inclusive design look towards restoring disabled peoples' self-esteem, dignity and independence through user friendly design (Imrie and Hall, 2001). But designers' current beliefs that there are too many different impairments to cater for (Goldsmith, 1997), that it is too costly, only relevant to a minority of the population and only adhered to on the extent of the law (Connell and Sanford, 1999), means that an inclusively designed built environment will remain an idealisation. Once designers understand the difficulties faced by wheelchair users then they can begin to design the products and environments they require (Jordan, 2003).

From the literature review it can be said that there is much support for inclusive design and designing for those in wheelchairs. There are many government and local schemes set out to improve the built environment for wheelchair users such as the Disability Rights Commission and the Economic and Social Research Council. From this, research question 3 and 4, of the introduction, have been successfully answered. Research question 6 can also be answered and concluded that wheelchair users are a minority that should be catered for and a physical disability should not prevent wheelchair users accessing and manoeuvring their built environment. However, more research needs to be carried out to answer research questions 1, 2 and 7 in finding what obstacles and environments wheelchair users have particular difficulties and whether the users' dependency affects them.

The literature review allowed an extensive review on designers' opinions when designing for wheelchair users, both positive and negative. However, much of this information is outdated. Therefore, the empirical research will be used to further explore research questions 5 and 8 to understand designers' responsibilities and opinions towards designing for the wheelchair users.

3. Empirical Research

3.1. Existing Research Methodologies

A good example of research surrounding inclusive design is the Economic and Social Research Council's which was carried out between 1997 and 1999 (Imrie and Hall, 2001). Their research aimed to find the opinions of property professionals and developers in designing for the disabled.

The ESRC used a postal questionnaire which was sent to 10% of architectural practices and 5% of chartered surveying practices in the UK. An advantage of using postal and written questionnaires is that they provide first-hand responses to specific questions and allow for open-ended questions. The initial questionnaire was posted, four weeks later a reminder and additional questionnaire were sent to non-respondents, and then a telephone-reminder occurred a following two weeks later. Even after this there was a poor response, with only 120 questionnaires returned (ibid). Therefore, a disadvantage of postal questionnaires is the poor response rates and that they do not allow for verbal follow up questions to the users responses (Nussbaumer, 2018).

In 2004, researchers from the Department of Applied Social Science at Lancaster University carried out research into the social implications of increases in wheelchair use. The research was primarily gathered from an extensive postal questionnaire. The questionnaire consisted of 136 questions all of which consisted of ranking questions, tick box questions and yes or no questions. The ranking questions required the user to rank from 1 (very good) to 5 (very bad) on a variety of questions (Figure 1). The questionnaire also used ranking questions where the user would comment strongly agree to strongly disagree on statements given (Figure 2). Even though the questionnaire was extensive, the simple method to answer the questions encouraged wheelchair users to respond to the questionnaire and the researchers gained encouraging results (Sapey et al, 2004). Therefore, using a 'tick-box' style question with ranking exercises is advantageous for gaining extensive results in a questionnaire.

How would you rate the following aspects of this wheelchair? *(Please tick one box for each aspect)*				
17. Weight Very good $\square_1$	Good $\square_2$	Satisfactory $\square_3$	Bad $\square_4$	Very bad $\square_5$
18. Manoeuvrability Very good $\square_1$	Good $\square_2$	Satisfactory $\square_3$	Bad $\square_4$	Very bad $\square_5$
19. Ease of propelling Very good $\square_1$	Good $\square_2$	Satisfactory $\square_3$	Bad $\square_4$	Very bad $\square_5$
20. Balance Very good $\square_1$	Good $\square_2$	Satisfactory $\square_3$	Bad $\square_4$	Very bad $\square_5$
21. Transportability Very good $\square_1$	Good $\square_2$	Satisfactory $\square_3$	Bad $\square_4$	Very bad $\square_5$

Figure 1. (Taken from Sapey et al, 2004)

	Does not apply to me	Strongly agree				Strongly disagree
		1	2	3	4	5
48. Discrimination against wheelchair users should be dealt with strongly under the law.	$\square_0$	1	2	3	4	5
49. Wheelchair users should take responsibility for solving their own access problems.	$\square_0$	1	2	3	4	5
50. The Disability Discrimination Act will help to change attitudes towards wheelchair users.	$\square_0$	1	2	3	4	5
51. *Comments:*						

Figure 2.   (ibid)

Many previous researchers have also used focus groups with disabled users. Adams (2006) used a focus group method to gather research for a PhD. Focus groups can be advantageous to research as they enable group interaction and peer support to facilitate the participants to speak openly about access issues (Adams, 2006).

One of the disadvantages found from focus groups was that the naïve researcher is open to constant danger of 'information overload' (ibid). The data provided from the focus group was extensive and Adams (2006) found it necessary to amend the original project concept to reduce the overload of information and to obtain richer, more structured responses.

Adams also found when interviewing a wheelchair user, judging their emotions from body language was more difficult.   A person with limited mobility would not gesticulate with their arms like an able bodied person, but would rather swear profusely during the interview (Adams, 2006).

3.2. Methodologies Used

3.2.1. Method: Online Questionnaire

A questionnaire will be carried out with wheelchair users and designers to gain responses towards the built environment and designing for wheelchair users. After looking at the focus group method used by Adams (2006), it was found too much information could be provided from respondents during an unstructured interview, which could not be properly analysed during the restricted word limitation. Therefore, a structured questionnaire will be used, rather than an interview method, as it allows for more structured responses and constructive analysis. During an interview, the interviewee's feelings can be further expressed through body language; however, Adams (2006) found that wheelchair users tended to express their feelings through swearing, rather than body language due to their restricted movement. Therefore, the same responses will be gained from a questionnaire as would be gained from an interview.

After looking at existing methodologies, an online questionnaire will be used. Postal questionnaires require a lot of effort by users, as the questionnaire needs to be taken to a post-box or office to be returned to the researcher. For wheelchair users this can be difficult and they may be put many off responding. However, online questionnaires will allow the respondent to answer the questions easily and quickly in their own home, with no extra effort required once the questionnaire is completed. In 2018, 80% of UK homes had internet access, making an online questionnaire a more logical method of communication with the wheelchair users (Office for National Statistics, 2018). An online questionnaire also saves time and money, as the responses are instantly sent to the researcher and the questionnaire can be created for free on many questionnaire creation websites such as 'surveymonkey.com'. The questionnaire will use tick-box and ranking questions, in which the results will provide numbered results that can be analysed, this is quantitative data. The questionnaire will also allow respondents to freely comment on questions, this information can be observed but not measured, this is qualitative data.

3.2.2. Questions to be asked – Wheelchair Users

The questionnaire for wheelchair users aims to answer key questions that have not been answered during the literature review. The questionnaire was created online using 'surveymonkey.com'. The questionnaire will be passed onto various social network groups for those who use wheelchairs, including the GB Wheelchair Basketball Association. A sample size of 20 - 30 is required to gain sufficient results for analysis, it is hoped with much promotion of the questionnaire this can be achieved. The questionnaire will be live for 4 weeks from the 7th March to the 4th April for respondents.

Question 1 – How dependant are you on your wheelchair? This question will be used as a basis for analysis to see whether those more dependent on wheelchairs have more problems in the built environment than those who are less dependent and how their opinions may differ or be similar through the answers of the other questions. This question will provide quantitative results.

Question 2 - On a scale of 1 to 5, how do you feel being a wheelchair user impacts on daily tasks? This quantitative question uses a ranking scale similar to the one used by the researchers of Lancaster University, where 1 is a serious barrier to 5 being a serious benefit. A ranking scale of 1 to 5 still allows a wide range to rank across whilst still making the question easy to answer.

Question 3 - Please explain any tasks that you find difficult when using your wheelchair. This question allows the respondent to comment freely on any personal difficulties they have, therefore will give qualitative results. During the analysis similarities can be observed or any extreme responses can be reviewed.

Question 4 - How satisfied are you with your experiences as a wheelchair user in the following environments? In this question the respondent is required to tick the boxes and rate the environments from 'very dissatisfied' to 'very satisfied', similar to questions asked in the Lancaster University questionnaire. From this question the researcher is looking to find what particular environment wheelchair users have the most problems and to see if there is a particular environment that stands out from the rest. The results will be quantitative.

Question 5 - If you have felt dissatisfied with any of the above environments, please comment on your experiences. This qualitative question allows the respondent to comment freely and give more detail about the environments they have particular problems with.

Question 6 - How far do you feel the following support inclusive design for wheelchair users? Again, this question requires respondents to tick boxes rating the different areas like that of question 4, so is quantitative. Here the respondents will rate from 'very un-supportive' to 'very supportive'. Here the researcher is looking to see where wheelchair users feel they are not being supported through their built environment, particularly whether they feel designers need to do more.

Question 7 - If you feel any of the above organisations have been un-supportive, please comment why. Like question 5, this question allows the respondent to further comment and give more detail on their response to question 6. The researcher hopes to gain some interesting views, and to observe any similarities. This question provides qualitative results.

Question 8 - Please tick to rank the following statements. This question follows the same 'tick and rate' answering method as questions 4 and 6, so is also quantitative. Here the respondents are rating 'strongly disagree' to 'strongly agree' on a variety of statements surrounding their wheelchair. From this question it is hoped a better understanding will be gained on whether the users' problems is with the built environment or in fact their wheelchair.

3.2.3. Questions to be Asked – Designers

The questionnaire for designers aims to further understand the opinions of designers from what was found in the literature review. The questionnaire was created online using 'surveymonkey.com'. The questionnaire was passed onto fellow designers at the Loughborough Design School and again, a sample size of 30 is required to gain sufficient results for analysis. The questionnaire will be live for 4 weeks from the 7th March to the 4th April for respondents.

Question 1 - How important do you feel it is to design for wheelchair users? With this question it is hoped to find designer's opinions on designing for wheelchair users. The question uses a simple ranking scale of 1 'not important' to 5 'very important'. This question will provide quantitative results.

Question 2 - Please comment on why or why you don't feel designing for wheelchair users is important. This question allows the designer to expand on why they selected the answer they did for question 1, the qualitative results will allow for detailed analysis as to why respondents gave their answers.

Question 3 - When designing, how often do you refer to ergonomics? This quantitative question is answered again with a ranking scale from 1 'never' to 5 'always'. By asking if designers look at ergonomics gives a basic analysis into whether the designer considers human data at all. This question is further expanded in question 4.

Question 4 - How often does this ergonomic data relate to wheelchair users? This question uses the same ranking scale as question 3, so is quantitative. From this question the researcher wants to understand if the designer considers ergonomics for wheelchair users within their designs or just uses ergonomics for able-bodied users only.

Question 5 - Please rank the order of the following areas of design from 1 through to 6, on the order you consider them when designing. (1 = least important, 6 = most important) From this questionnaire it is hoped the researcher will be able to see if designers factor appearance and revenue over inclusive design and the use of ergonomics as expected. The respondent is required to rank the areas of design in the order they consider them, as stated in the question. As this question provides quantitative results, it will be much easier to analyse.

3.3. Ethical Procedures

The questionnaire will have to meet the ethical guidelines set out by the University's ethics committee. To be approved to carry out the questionnaire, completion of the ethical checklist is required,. Participants of the questionnaire will also be asked to read the 'Participants Information Sheet' which outlines what is involved in the questionnaire and any other information they may require. Each participant will also be asked to give their consent.

For those filling out the questionnaire on paper they will be asked to sign their consent at the start. For those doing the online questionnaire, a consent question is added to the start which does not allow them to move onto the questions until they have given consent.

## 4. Analysis and Discussion

4.1. Analysis of empirical research

4.1.1. Wheelchair Users Responses

During the 4 weeks the questionnaire was live there were 24 respondents, which has allowed for plentiful results and comments to analyse. 8 of these respondents'. The first question was to determine how dependant the respondents are on their wheelchair. The results showed that most users were not fully dependant on their wheelchair but used it often (figure 3).
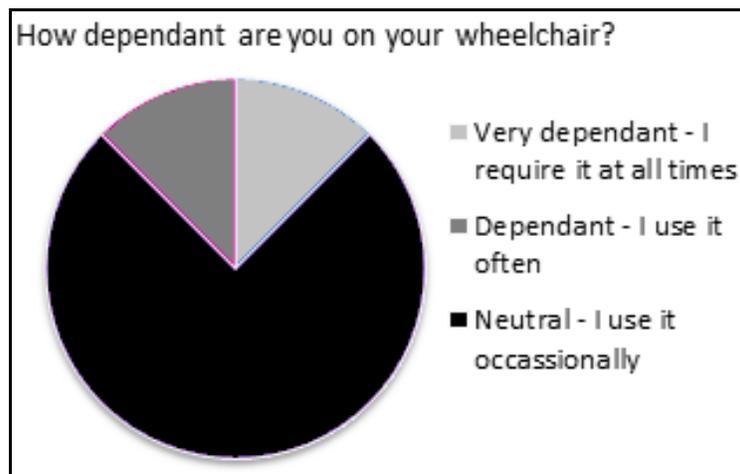
Figure 3. Wheelchair Dependency

In question 2, the majority of the respondents felt that being a wheelchair user was a barrier in completing daily tasks (figure 4). This was roughly split into being a minor or serious barrier. Interestingly, respondent 1 felt that being a wheelchair user was actually a significant benefit. This respondent answered 'neutral – I use it occasionally' to question 1, therefore an opposite answer to the majority of users who are mostly dependant on a wheelchair could be expected.
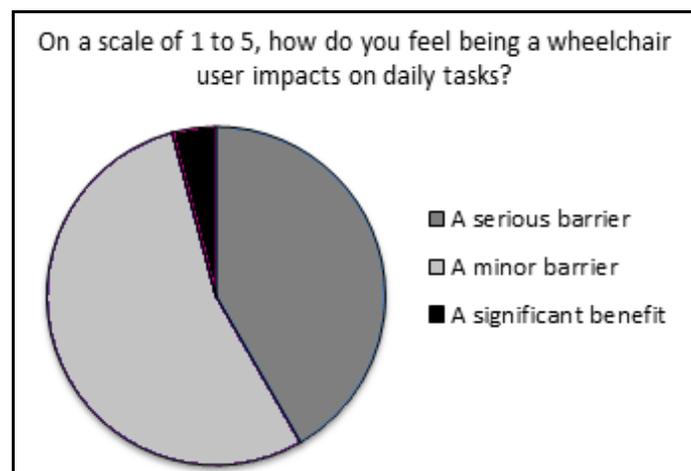
Figure 4. Opinions of Wheelchair Users and Daily Tasks

Question 3 asked respondents to comment on tasks they find difficult when using their wheelchair. The majority of respondents discussed issues when shopping, particularly the gap between rails not being sufficiently wide enough for their wheelchair to fit through (respondent 6).

Many respondents also commented on access issues due to the lack of dropped curbs, and those curbs that are dropped being blocked by motorists (respondent 2), and due to uneven surfaces meaning parts of buildings are inaccessible (respondent 1).

Question 4 asked respondents to rank particular environments on how satisfied they were with them (figure 5).

Question 5 then follows on by asking the respondents to comment on why they may have been dissatisfied. At supermarkets, respondents were generally split between neutral and dissatisfied. In the comments most found that supermarkets tended to put everyday products on high shelves and left boxes, carts or displays in the way of aisles, making it more difficult to manoeuvre around (respondents 4, 5 and 7).

With clothing/fashion retailers the majority of respondents were dissatisfied or very dissatisfied. Many commented on clothing rails being too close together allowing for little or no access for their wheelchair (respondents 1, 2, 4 and 7). Respondent 8 also commented that in the stores they feel 'on edge' as they don't want to accidently catch something. The majority of respondents also felt very dissatisfied with public transport. Respondent 1 comments that accessing public transport independently is difficult but possible with the help from staff.

Generally respondents are satisfied or have neutral feelings about entertainment areas and outdoor areas with no specific comments made towards them, other than a few respondents commenting on high curbs and no ramped access in outdoor areas (respondents 2 and 4). The responses for health services appear to be split three ways with users satisfied, neutral or dissatisfied. Many commented that they find health services too cramped in waiting rooms with no specific places for wheelchair users to wait (respondent 5). At sport provisions respondents were mostly dissatisfied or had neutral feelings. Many of the comments were aimed at swimming pools, with a few respondents commenting on their local pools not having lifts to get in or out of the pool
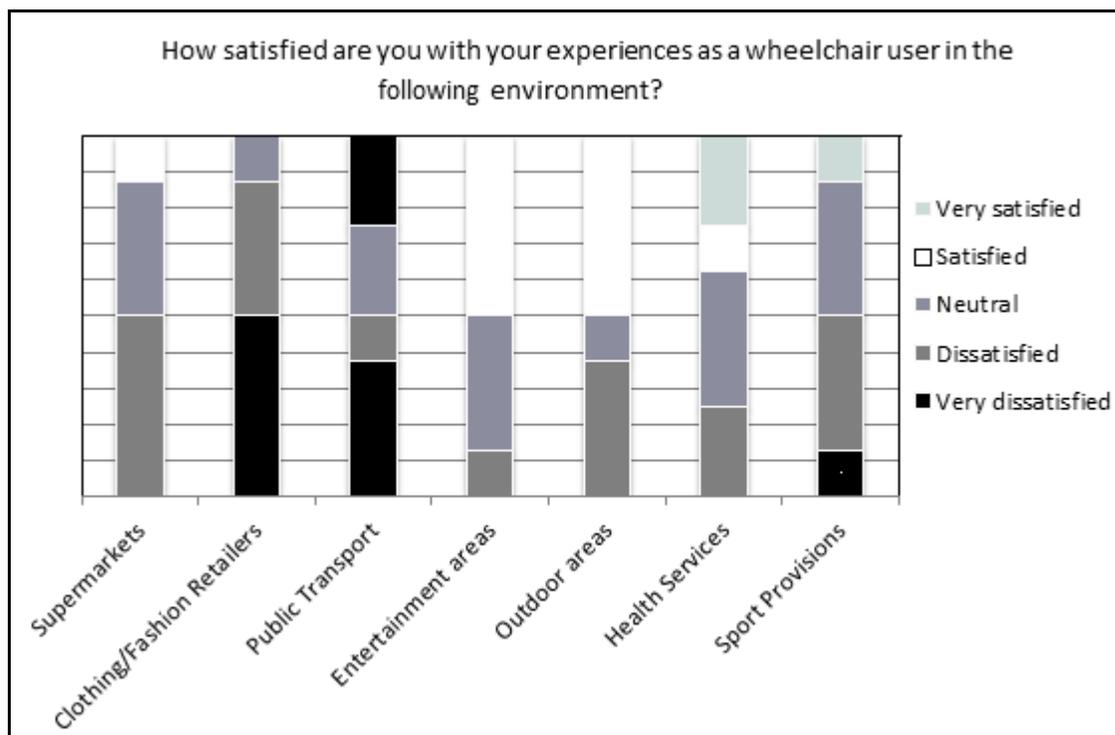
Figure 5. Opinions of Wheelchair User Experiences

The most interesting point to make from the results of question 6 is that none of the respondents feel that any of the groups listed are 'very supportive' of inclusive design (figure 6). With residential associations respondents mostly rated their support as neutral, with a few saying supportive. Respondents rated retailers generally as very un-supportive and un-supportive. Public transport was rated mostly as supportive by respondents, with many also saying neutral. With regards to the government, respondents were split; 50% feel the government is un-supportive and the other 50% feel neutrally with some rating the government as supportive. Respondents rated the general public and designers equally, with the majority saying un-supportive and the rest rating neutrally with a few rating supportive.
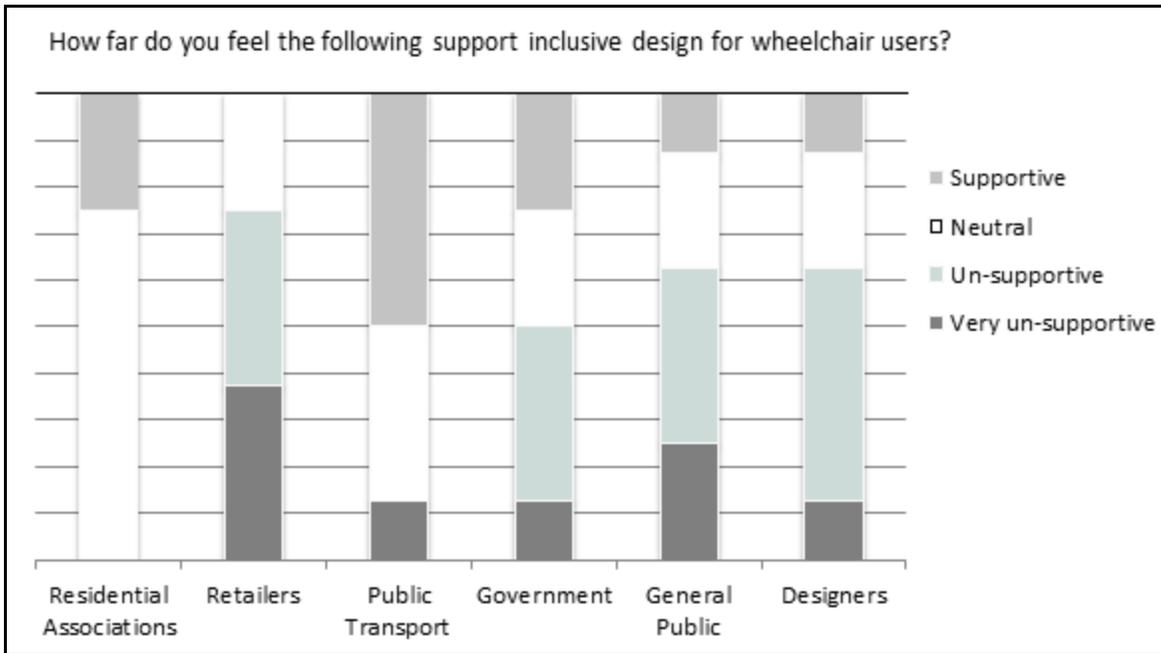
Figure 6. Opinions on Inclusive Design of Wheelchairs

Question 7 consisted of respondents rating 5 statements. For the first statement 50% of the respondents said they disagree with the statement and would not be more comfortable in their wheelchair if it looked better (figure 7). However, a quarter agreed with the statement and the last quarter felt neutrally.

Figure 7. Opinions Design for Appearance and Comfort of Wheelchair

The second statement had very varied results (figure 8). The majority agree or strongly agree that there is not enough choice in the design of wheelchairs whereas, a quarter of users agree with the statement. With the third statement directly asking users if designers should do more to improve the styling of wheelchairs, 75% agreed or strongly agreed with the statement. Only 3 of the 24 respondents disagreed with the statement. When given the statement that wheelchair uses should not have to pay for their wheelchairs, the majority agreed. The rest of the respondents rated neutral.
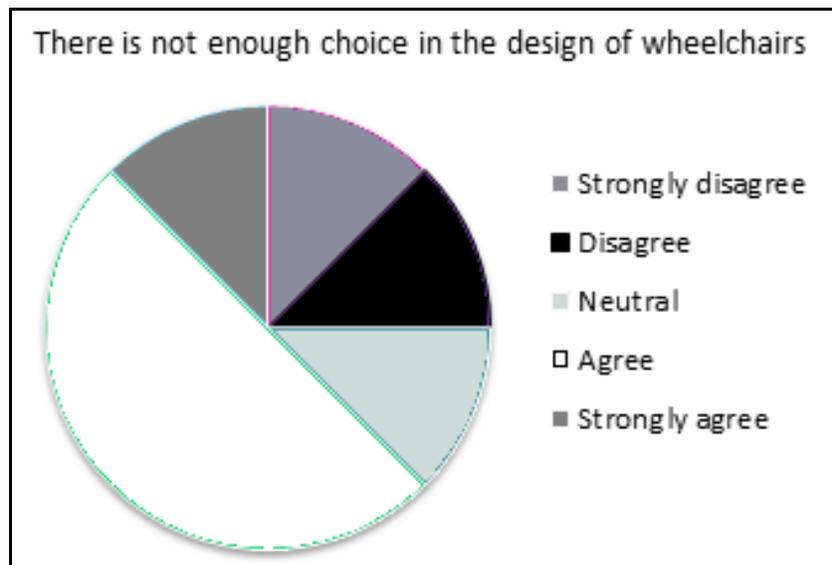
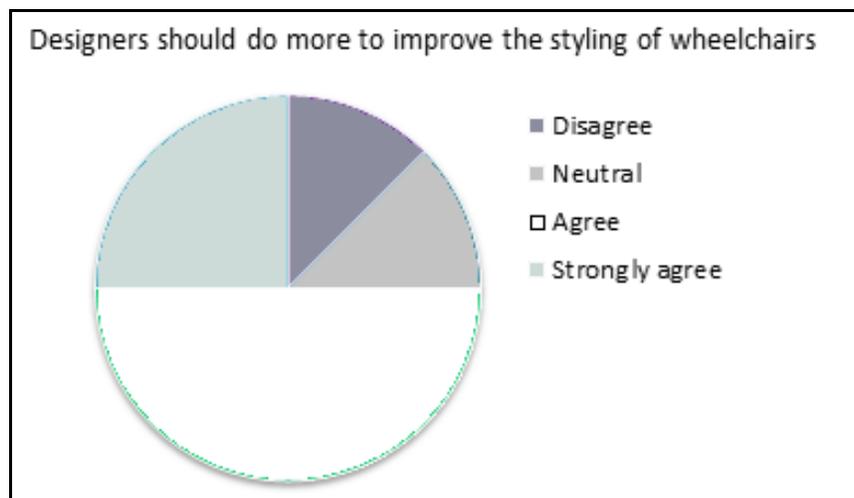**Figure 8. limitations on choice of wheelchair designs**

Figure 9. Opinions on Designers and styling of Wheelchairs
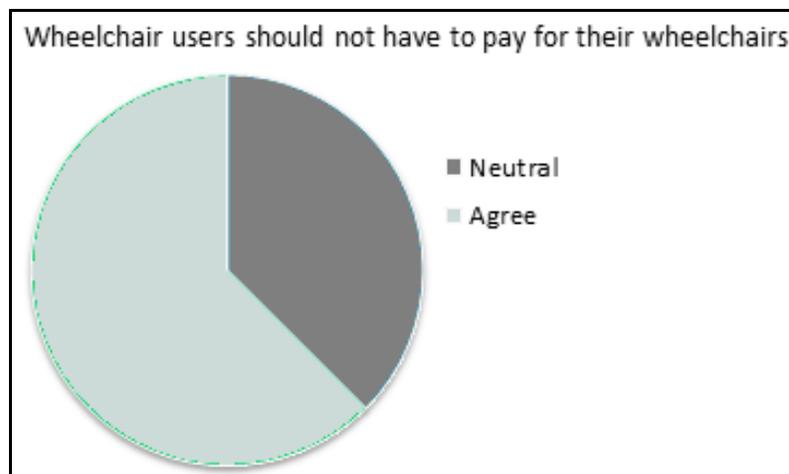

Figure 10. Opinions of paying for wheelchairs

The final statement found that respondents mostly agree that the design of their wheelchair prevents them from carrying out certain tasks (figure 11). 25% disagreed with this statement.
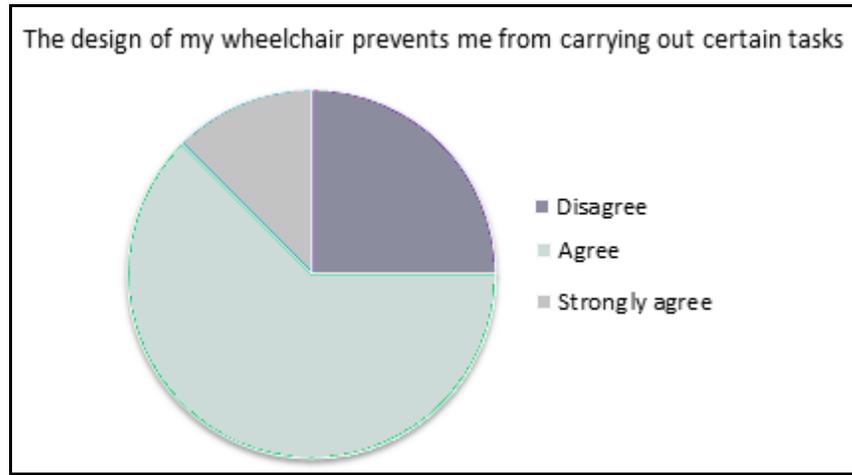

Figure 11. Design & Task Analysis of Wheelchair

4.1.2. Designers Responses

During the 4 weeks the questionnaire was live there were 36 respondents, which was much more than expected. Question 1 asked the respondents how important they felt it was to design for wheelchair users, and the majority felt it was very important and should be considered. Only 2 of the 36 respondents felt it was not a major issue. The following question asked users to comment on why or why they don't feel designing for wheelchair users is important. Both respondents that previously said it was not a major issue to design for wheelchair users commented that from a business sense designing for wheelchair users would affect the cost and the design (respondent 1). The majority of the respondents all commented that it was only fair to design for wheelchair users as they are also people and should be catered for and not limited by their disability (respondents 2 – 5).
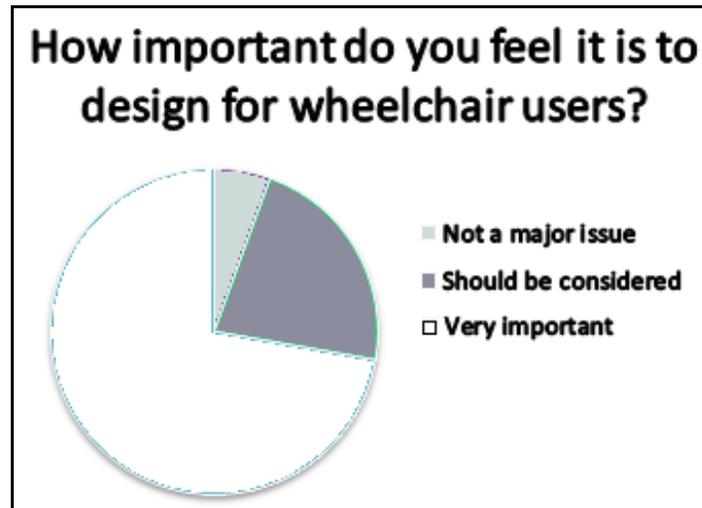

Figure 12. Design for Wheelchair Users

Question 3 shows that's just over half of the respondents often use ergonomic data. The other respondents either occasionally or always use ergonomic data (figure 13). In question 4 the respondents were then asked how often this data relates to wheelchair users, the results are quite different. Half of the respondents never or rarely use wheelchair ergonomic data when designing (figure 14). None of the respondents always use the wheelchair data.
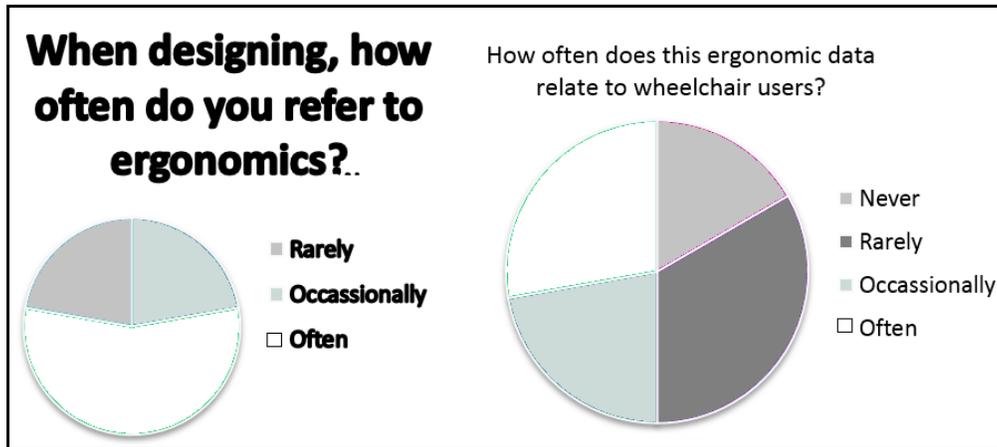
Figure 13. Ergonomics   **Figure 14. Ergonomics wheelchairs**

For the final question, respondents were asked to rank in order areas of design they consider first (figure 15). The results show a random spread with no clear common order throughout all respondents. For first, the majority was revenue potential. Looking at ergonomics it is mostly considered at rank 4, with a few respondents placing it at other rankings. Inclusive design is equally spread across the rankings, with either 8 or 6 respondents ranking at each position, other than 4, where it was not ranked at all.
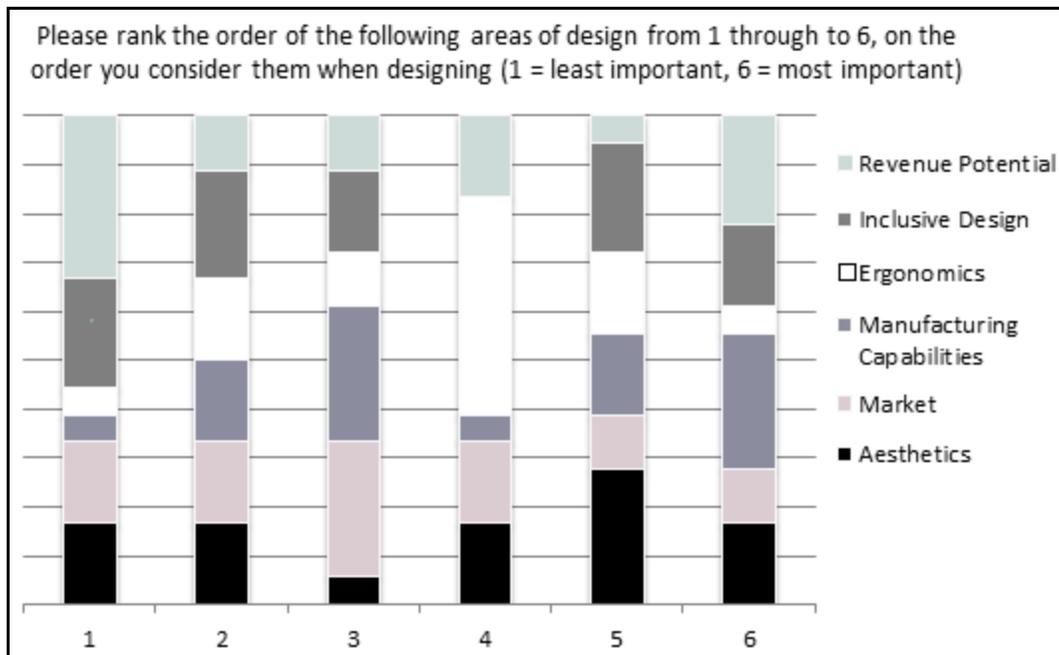

Figure 15. Order of Importance of Design Constraints

4.2. Discussion of empirical research

The wheelchair user questionnaire was completed by 24 respondents. Even though this was in the range to be expected, it would have limitations on whether the respondents' opinions were a true reflection of all wheelchair users. The first question asked users how dependent they felt they are on their wheelchair. Of the 24 respondents, 83% said they were 'dependent' on their wheelchair, meaning they used it often. Only 2 respondents claimed to be 'very dependent', requiring it at all times, and a further 2 respondents claimed to be 'neutral', only requiring their chair occasionally. Even though this result shows a reflection on the numbers of wheelchair users who are dependent on their wheelchair, it also adds limitations.

The respondents were not an equal spread of capabilities, meaning that the research could be limited and bias to the views of those who are 'dependent' on their wheelchair, over those who are fully dependent or not so dependent.

However, looking at the results gathered, there are clear links between the dependency of the wheelchair user and the answers they gave. All the respondents who were 'very dependant' on their wheelchair in question 1 felt that being a wheelchair user was a serious barrier on daily tasks in question 2. In question 4, these respondents mostly answered 'dissatisfied' or 'very dissatisfied' to their experiences in different environments and then commented on many negative experiences in all the environments listed in question

5. They were also the biggest contributor to 'un-supportive' or 'very un-supportive' responses when asked about the supportiveness of different social groups in question 6. Those who described themselves as being 'dependent' on their wheelchair gave a variety of answers across the range available, showing no particular pattern between the respondents. Those who responded as 'neutral' to their dependency on their wheelchair often answered 'satisfied' or 'very satisfied' with their experiences in different environments. These respondents then gave very little information about negative experiences they had had in question 5. They also responded that some of the social groups listed were 'supportive', with a few respondents answering neutrally. From this, the results of this study find the statement given as research question 7 to be true, and that difficulties in the built environment are more prominent for those who are very dependent on their wheelchair than those who are not as they answered more negatively to questions 4, 6 and 7, and commented on many more poor experiences in question 5.

One respondent who answered 'neutral' then answered that being a wheelchair user was a significant benefit in question 2; this was a stark contrast to the answers of the other respondents. However, this respondent never explained why they felt it was a significant benefit in question 3. This was a limitation of using an anonymous questionnaire as the respondent could not be asked why they felt this way, or to question whether the respondent had made a mistake when completing the online questionnaire. In a further study it would be better to have this questionnaire followed up with an interview, where the respondent could be questioned further about their response.

Question 3 allowed respondents to comment on particular tasks they find difficult in their wheelchair. 75% of the respondents commented on access issues including building doorways, space between rails/stock in shops and ground surfaces. Many respondents also commented on issues with daily tasks that for able bodied are simple but they find difficult, such as carrying, reaching, cleaning and cooking. All these are quite simple tasks, which could easily be made easier with simple aiding designs. From this part of the study, research question 1 can be answered as the obstacles and problems wheelchair users face in the built environment are discussed. This part of the study can also offer an answer to research question 9, as it determines that the source of wheelchair users' problems is not only the built environment, but also the limitations of their wheelchair. Question 4 allows research question 2 to be answered as there are clearly environments the respondents are less satisfied with compared to others. Respondents were found to be mostly dissatisfied with clothing and fashion retailers. Many of these respondents then commented further in question 5 by discussing problems reaching things on high racks, fitting through the clothing rails and manoeuvring around the busy layout of the store. Most of these problems are access issues, which reflect the answers given in question 3. Respondents were also mostly dissatisfied with public transport, which again was highlighted as difficult to access. All these access problems are caused by the design of the store or transport. And so, it could be argued in this case, that the designer is responsible for the access issues the wheelchair users have, as stated in research question 5.

However, from question 6 it was found that wheelchair users do not feel it is solely designers that are unsupportive, but also equally the general public, retailers and the government. Therefore, for research question 5, it can be said that it is not just the role of the designer in supporting and accommodating wheelchair users in the built environment, but also the other groups that wheelchair users have felt unsupported by. From this further areas of research were found to be possible. The study could be more thorough by exploring the opinions of other social groups towards wheelchair users, such as retail managers, governing bodies and the general public, to determine fully whether these groups are purposefully unsupportive to wheelchair users, or if in fact they only appear unsupportive to the wheelchair users.

In question 7, the majority of respondents agreed that there is not enough choice in the design of wheelchairs. This then linked to the next statement where the majority of respondents agreed that designers should do more to improve the styling of their wheelchairs.

This seems to suggest that most wheelchair users feel that the designer is responsible for the design of their wheelchair. However, further discussion with the wheelchair users could determine what aspects of the design they would want to be improved and whether these requests are plausible by designers or whether wheelchair users' expectations are unrealistic.

Question 7 also asked respondents whether they agree that wheelchair users should not have to pay for their wheelchair. The majority of the respondents agreed that they should not have to cover the costs of their wheelchair, a few respondents answered neutrally and none of the respondents disagreed. However, this brings forward a lot of questions about disability and who should cover the costs. The wheelchair users feel they should not have to pay for the wheelchair that aids their disability, however, those who require corrective glasses for their vision have to pay for their glasses, so begs the question, where do you draw the line on what the NHS should pay for? This again could be further discussed with the wheelchair users, and their responses recorded when asked how much the NHS should pay towards a disability or impairment.

The research then moved on to question the designers, to see if the unsupportive attitude that the wheelchair users considered them to have, was true. The first question found that 94% of the designers questioned agreed that designing for wheelchair users was important and should be considered. When commenting further the majority of respondents believed that wheelchair users should be treated equally to able-bodied users and that design should be enabling for them. From this it is clear, that designers do have good intentions for wheelchair users and do understand the need to design for them. This supports the research found during the literature survey in answering research question 8, that designers are not ignorant to the need of designing for wheelchair users. However, inevitably in design, wheelchair users are often not accommodated, therefore, if designers appreciate the need to design for wheelchair users, there must be further reasons in the design process that means the wheelchair users are then designed out.

The designers questioned all claimed that they do consider ergonomics when designing, with 85% saying they consider ergonomics often or always. However, when asked if this ergonomic data related to wheelchair users, 50% of the designers answered rarely or never. From this, it could suggest that designers don't think to further their ergonomic research by looking at data available for wheelchair users. There is much ergonomic data related to wheelchairs that is readily available, and often included in many data references, such as AdultData. The literature review suggested that designers see wheelchair users as a set of measurements determined by their wheelchair. Consequently, those designers who do consider wheelchair users could be looking at a set of predefined wheelchair measurements rather than considering for example, how a user's size and stature may consequently affect their reach in their wheelchair. During the wheelchair users' questionnaire, question 7 asked users whether they agree that the design of their wheelchair prevents them from carrying out certain tasks. More than half of the wheelchair respondents agreed, which suggests that the lack of ergonomic research surrounding the design of the wheelchair and the users' statures could have contributed to the wheelchair users' problems. This study could have been improved by asking the designers further about the type of data they use, and to determine if the ergonomic research they carry out is actually relevant to a design project they could be working on.

During the questionnaire, the designers ranked six areas of design in order of what they would consider them in the design process (question 5). The results provided no clear pattern with each area of design being placed at each ranking among the respondents. However, there was a clear area that was ranked to be considered first among most of the respondents, and this was revenue potential. Many of the designers commented on how designing for wheelchair users could increase the retail price of the design, meaning it would be less marketable to able bodied and would therefore have an effect on the profits made from revenue. Consequently, the results of this part of the study suggest that designers are more concerned with revenue potential, which then suggests this is the reason wheelchair users are not considered during the final design. This supports the information found during the literature review. This then further answers research question 8, in which it can be said that there are other reasons that lead to designers not accommodating wheelchair users in their designs. Interestingly, inclusive design was the second design area to be ranked first. From this, it could suggest there are two types of designer, those who actively design for wheelchair users, and those who are driven by profits and revenue. However, the results from this study are limited in proving whether this is true, and could be further investigated in a future study. In relation to this, aesthetics was also commonly ranked first by the design respondents for question 5. Many of the designers commented on how designing for those in wheelchairs could have a negative impact on the aesthetics.

From this, it is clear designers feel strongly about the aesthetics of their designs, and that they consider aesthetics to be one of the most important design issues. However, looking back at the wheelchair users' questionnaire, during question 7, the wheelchair users were asked to rate whether they would be more comfortable in their wheelchair if it looked better. Half of the respondents disagreed, which proposes that for the majority of wheelchair users they are less concerned about the aesthetics of a design and would prefer a better functioning wheelchair, over a more aesthetically pleasing one. We can presume that designers concentrate on the aesthetics so that their designs are more appealing to able bodied users.

However, the results from the designers questioned are limited. Only 36 designers responded to the questionnaire, many of which are students of Loughborough Design School. Even though these students are excellent designers, they lack the experience gained by those who have worked in design consultancies and are likely to be unaware of the pressure felt from clients to gain high profits. Therefore, student respondents may feel more positively towards designing for those in wheelchairs than experienced designers. Again, this area would have to be further researched to give fully conclusive results.

5. Conclusions

After carrying out the literature review and empirical research, the research questions from the introduction have all been answered, some more thoroughly than others. The results have been both expected and a surprise, and has led to the discovery of opportunities for further studies.

The results for research question 1 have found that there are a variety of obstacles and problems that wheelchair users face. The research has found these obstacles are often simple design problems that could easily be resolved if the design was considered more, such as wider spaces, lower shelves etc. Research question 2 was also answered during the empirical research and revealed that an overwhelming majority of wheelchair users are dissatisfied with most of the environments they use and consequently face challenges and obstacles with the built environment every day. The environments such as retail stores and public areas need their designers to consider their disabled cliental to achieve inclusively designed environments. Challenges and obstacles have also been found to be considerably more prominent for those who are more dependent on their wheelchair than those who are less dependent, thus answering research question 7. After gathering results to answer research question 9, the study has established that wheelchair users' problems do not stem solely from the poor environments they try to access, but also from the poor design of their wheelchair. The study has found that a lot of design development needs to be considered for both the built environment and wheelchairs. As most of the problems are design related, we can conclude that designers have a key role in improving the access and ease of manoeuvrability for wheelchair users. Without designers actively designing solutions for the wheelchair users, their problems and difficulties will continue.

The results from the wheelchair users are limited due to the lack of distribution of the respondents. The respondents were not asked which area of the UK they were from therefore the results of the study may not be a reflection of the whole of the UK. A future study could find that some UK cities are better than others at accommodating wheelchair users in the built environment. This could be done with case studies of particular cities in which a selection of respondents are questioned from each city. A future study could also investigate the condition of the built environment outside of the UK and whether in fact, compared to other countries, the UK is better or worse.

The study has found that designers support the need for inclusive design considerably more than was expected. Research questions 3 and 6 have found the majority of designers agree that even though wheelchair users are in fact a minority, it was morally right to design inclusively for them. However, in answering research question 8, the study also found there are other factors that consequently mean in reality, wheelchair users are not considered in the final stages of the design process. The study has found that the biggest factor masking the need for inclusive design is the apparent pressure to fulfil maximum profits and revenue. The empirical research found that only a small minority of designers feel that designing inclusively can increase the retail price of a product and then reducing its sales, but then, the majority of designers ranked revenue potential as one of the most important factors to consider when designing. This could suggest that, as the designers were questioned through a questionnaire, they gave more thought out answers that were considered to be a more moral answer to give than their true thoughts. Consequently, a future study would involve face to face interviews where respondents are asked questions on the spot, and with less time to consider answers, they are more likely to be honest.

The study has found that wheelchair users do not believe designers are solely responsible for accommodating them in an inclusively designed built environment. From the results of research question 5, it is clear that there needs to be further support from the government and general public in accommodating those in wheelchairs. When investigating research question 4, the literature review found that there are many existing directives enforced by the government that mean designers have to meet certain regulations to create an environment that is inclusively designed. Nevertheless, this study has found that designers find it easy to work around these regulations, and often provide the bare minimum that evidently means they do not make access and manoeuvrability any easier for the wheelchair user. The study has found that the government needs to do more to ensure inclusively designed environments are created. This can start with stricter enforcement of existing regulations. However, this study cannot say for certain whether the general public are supportive or not of wheelchair users. The opinions gained are only those of the wheelchair users; for that reason to gain more grounded results, a future study should include interviews and questioning of the general public. This would allow differing perspectives around including wheelchair users in the design of the built environment.

The study has led to many interesting insights surrounding the need for an inclusively designed built environment. The aim has been met as the problems the wheelchair users' face has been found and it is clear the origins of their problems are with both the built environment and their wheelchair. The objectives have also been met; there is much awareness surrounding the difficulties wheelchair users face and how it is very important to design for them. However, without further support and encouragement, designers will be less likely to design for wheelchair users. Unfortunately, there is a negative stigma towards designing for those in wheelchair users, and until this is resolved, it is expected that the problems wheelchair users face will continue for many years to come.

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