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EDITORS' LETTER

This volume 4, number1 includes a set of peer reviewed articles from different areas corresponding to health and education, society and informatics engineering, and architecture.

The first article presents the development of a game designed for the evaluation of intellectual capabilities of teenagers with Down syndrome.

The second article presents a case study that evaluates the costs and benefits of web accessibility in Ireland.

The third study presents sidewalk design solutions for preventing falls in public spaces due to winter conditions

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DEVELOPMENT OF A GAME FOR THE EVALUATION OF OPERATIVE STRUCTURE IN TEENAGERS WITH DOWN SYNDROME

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Abstract: When an individual presents some type of intellectual disability, there is a tendency to expose him to innumerable evaluations, repeating them several times in a short period so as to verify his development. In some cases, the evaluation is tiring and could lead to the desistance of the person evaluated and to the exhaustion of the appraiser. In this article a computational game was developed in *Flash* for teenagers with the Down Syndrome that demonstrate light or moderate intellectual disability to evaluate cognitive seriation functions and classes inclusion based on the Jean Piaget theory. The game is set up in a kitchen where the individual to be evaluated helps the principal character in achieving tasks. After the termination of the activities a report is made with the analysis of the operative structures demonstrated. To evaluate the efficiency of the game, the subjects went through the evaluation of the operative tests and then played the game. Two pilot tests were made and applied to 13 teenagers with the Down Syndrome. The analysis showed that the method minimizes subjectivity and manipulation of the material needing less time making the report as the game is produced immediately. There was a bigger interest because the game contextualizes the tests even when the individual had verbal difficulty the evaluation access was possible through the game which didn't occur when applied in the real tests.

Keywords: Down syndrome, Games experimental, Disability evaluation.

Introduction

The Down Syndrome (DS) is related to the chromosome trisomy 21 which [1] can occur in the sperm, in the ovule, or cellular division after fertilization. DS individuals present some classical characteristics such as : hypotonia , cardiac pathology, thyroid dysfunction, intellectual disability, among others.

People with intellectual disabilities are defined as individuals that have global development retarded classified as light, moderate, severe and profound starting from level [2] and [3].

People with disabilities are generally exposed to innumerable repeating evaluations so as to verify the evolution, which is sometimes tiring causing desistance and exhaustion, where in some cases, a type of mobility access to the game would be possible if there was a hardware adaptable to the disability.

To make a good psychodiagnostic, is necessary to observe many facets to the integration of personality, cognition and neurological aspects. Therefore, the individual should go through a battery of different traditional tests to learn the functions of the brain and a complete neuropsychological assessment [4] and [5]. The battery neuropsychological for example, the LNNB is based, on Luria's Neuropsychological Investigation, a measure developed by Christensen in 1975. This battery consists of 269 items in the following 11 clinical scales: reading, writing, arithmetic, visual, memory, expressive language receptive language, motor function, rhythm, tactile and intellectual [6].

"Almost all batteries of neuropsychological exploitation of children and adults include classical psychodiagnostic tests. These are generally used in part by the need not to overburden the evaluation itself is long. " (author's translation) [5]

[7] The author comments the goal of the evolutionary neurological examination is to propose a series of tests that is obtained by examining the neurological profile. This result is confronted with chronological age, in order to establish a 'developmental quotient'.

The computational game "O trapalhão" is based on the operative tests seriation and classes inclusion based on the Jean Piaget theory which proposes to evaluate the operative structures that these tests analyze, aiming the facility of the application. For Piaget, it is necessary to know something of the subject performing the action on the object and these actions can be internalized, reversible and are coordinated this is called operative structures. The operative structures are the ratings, seriations, correspondence, matrices, series of numbers, spatial metrics, projective transformations, etc. [8].

It is through action on the objects, organized and directed, the child alters both the medium as their internal structures. The real-world knowledge is taken from the understanding of the similarities and differences between objects [9].

From the seriation and classes inclusion, the child puts in his order cognitive universe, therefore these operational tests were chosen.

From these notions, it is possible the formation of mathematical concepts, and the construction of numerical concepts. The exploration is done in order to build the concept of series, such as the notion of before and after, the notion of higher and lower, union, intersection, subtraction etc., as required in the development of logical-mathematical reasoning.

The computational games are of great value in the psychological, psycho pedagogical, speech, medical diagnosis, among others because they don't need a big space ,and are attractive to the new generations, demanding less time of application and interpretation. Furthermore, according to literature, the application of the tests needs a "very advanced theoretical and experimental formation by the experiences. Parallel to the experimentation and child interrogation, one has to make an interpretive analysis of

conduct“[10], meaning that there is subjectivity by the applier, influencing the final evaluation.

Computer games can contribute to an appreciable extent for the imaginative ability of children presenting gains in thinking skills. According to the same author, the imagination can be seen as fundamental to human cognition and information processing [11].

The Swiss biologist Jean Piaget looked to understand the way the individual knows what he knows, using as a base the biology and structure of what we call biological and epistemology [12]. “If the biological and epistemology problems are really solidary, it is the knowledge that prolongs effectively the proper life”.

Through operative tests it is possible to determine the degree of acquisition of some principal notions of cognitive development, and through them detect the levels of cognitive structures the individual evaluated is capable to operate.[10]

The present work shows a new evaluation method of operative structures using a virtual game for DS teenagers presenting light or moderate disability.

Methodology

Volunteers

The research was divided in two phases. In the first one two pilot tests were made to check flaws in the game.

The first application of the pilot that was made with a child (9 years old) who did not have any apparent mental disability, as well as the pilot two which was made with a teenager (14 years old) with DS, were performed in a doctor's office and after application, arose the need to make some changes to the adaptation of the interface.

There have been several changes as the size of the bottles to ensure the credibility of the evaluation, the possibility of returning the movement

with the bottles when they were on the shelf and a few speaks of the main character.

The second phase evaluations were made in 13 (13-18 years old, 5 female and 8 male) DS teenagers the evaluations, with mild-moderate intellectual disability; were made in the music room of a special school.

The Information on the degree of disability of each volunteer (mild, moderate or severe), were provided by the special school where the teenagers studied.

To minimize stimulus interference, the table used was placed next to the wall so that both applier and participant were with their backs against the door, closed during the application.

Development of the game

The game was developed through the *Flash* which permits the creation of games with more attractive animation than other traditional technologies [13], the files being relatively small, making its usability simpler.

The game presents the final result in a report with the analysis of the operative notions used by the player through the behavior shown during execution. The report was obtained using PHP language and a Mysql data bank available through WAMP application, integrating the web server Apache, Mysql and PHP.

Evaluation

Each operative test was represented by at least three correlating tasks, which when integrated, indicated the level of cognitive notions that the subject operated at the moment of the game.

To facilitate the identification of the game, the "O Trapalhão" has a familiar scenario, a kitchen, for those who play. These characteristics aim to facilitate the identification of the individual, approaching to the attitudes in his day to day.

The evaluation application was divided in two stages. The first was realized by a psychologist for the evaluation of the operative tests seriations and the class inclusion as described in the literature after which the application of the virtual game was made for other psychologist previous trained.

Following that, the psychologist emitted a report of each application which was compared with the virtual one and the results analyzed, and all application in the room, there was another educator observing how everything was done.

Results analyzed

Was made a comparative table with the data collected in reports with general information such as age, gender and the others data as: Reaction time of the test virtual x non-virtual (measured from the time the material or the computer was placed in front of the participant, until the moment it start to move to assess the interest in evaluation), Outcomes of class inclusion and seriation of the test non-virtual X virtual, applications Interest in non-virtual objects in the evaluation, easy handling hardware and difficult to play the game, Impossibility evaluation and the comments made by applicators.

Game description

At the opening of the game, the character enters the kitchen Figure 1. The player has to remove a bottle from the shelf and they all drop. The teenager has to put them in order for the seriation evaluation.

Figure 1. Evaluation seriation phase. The character finds the bottles in disorder and has to organize them.



After arranging them they drop again and have to be reorganized but the final order on the shelf is not seen by the player. In the last seriation stage, the player finds a bottle on the floor and has to insert it in order as seen in figure 2.

Figure 2. Last stage of seriation evaluation



Figure 3 shows on the screen if the player can conceptualize the term "clothes". He has to drag them to the box separating them from other objects. If he can't, the evaluation is stopped due to the impossibility of inclusion of classes through this game.

Figura 3. Inclusion of classes evaluation phase.



After the initial stage, the player has to answer series of questions to verify if he possesses a notion of class's inclusion. Figure 4 shows one of the questions for evaluation.

Figura 4. Classes Inclusion evaluation phase



Results and discussion

After the application with 13 DS teenagers, a comparison was made by the psychologist evaluation report and game report, besides the observation reports made by the researcher and the psychologist. Some data were taken from the interpretation made by observation reports generated by both. The

psychologist, who applied not virtual evaluation, as the psychologist who applied virtual evaluation, both observed the difficulties handling the material and the interest of the tool used.

The graph in figure 5 shows that the participants were not able to be evaluated regarding seriation though they hadn't the notion, it was possible to do so in the virtual evaluation, where around 15% the participants wouldn't have benefited from the non virtual application; however they could benefit with the game and therefore make it possible the access to this type of evaluation to individuals who couldn't be evaluated by the conventional form. Figure 6 shows the possibility to use the game as an evaluation instrument, as the results between the reports are equivalent.

Figure 5. Comparison of application of seriation evaluation

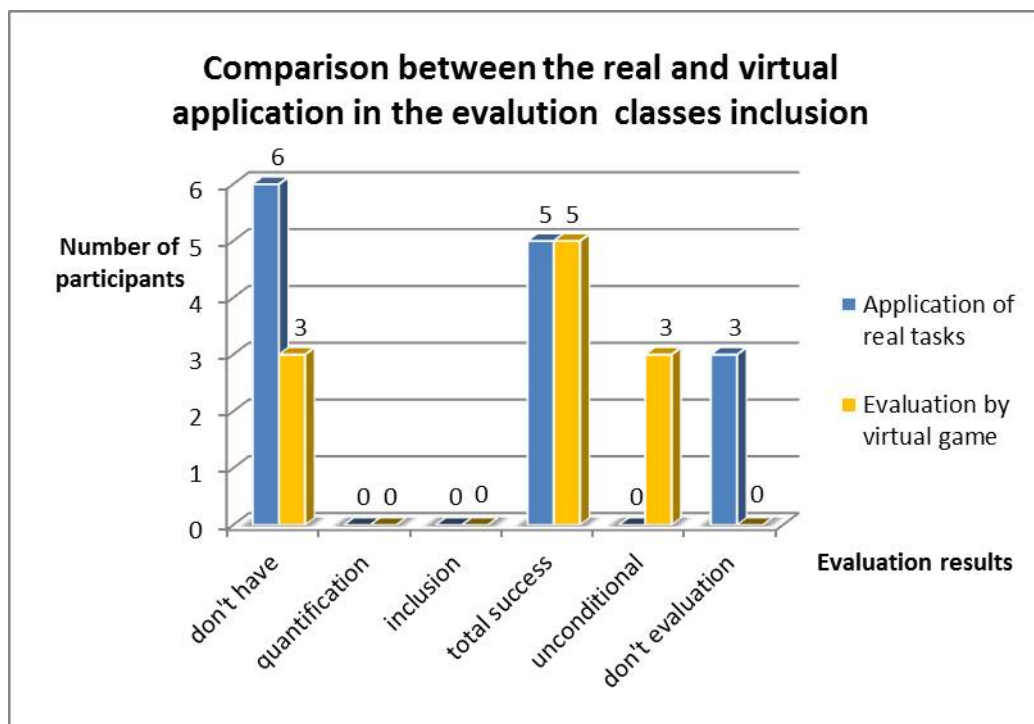
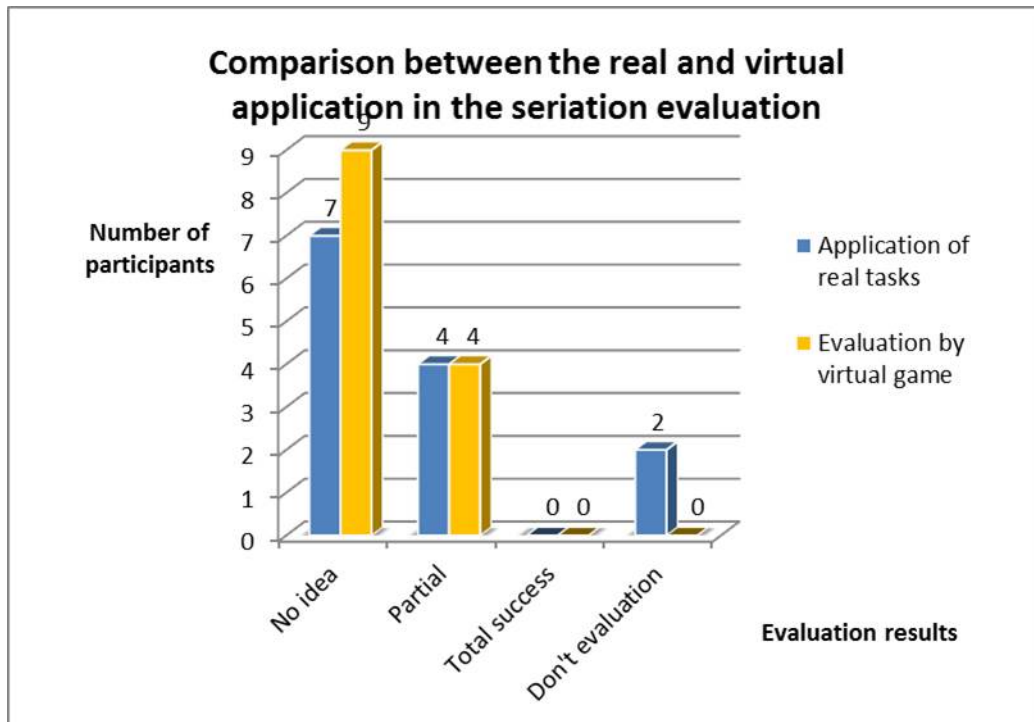
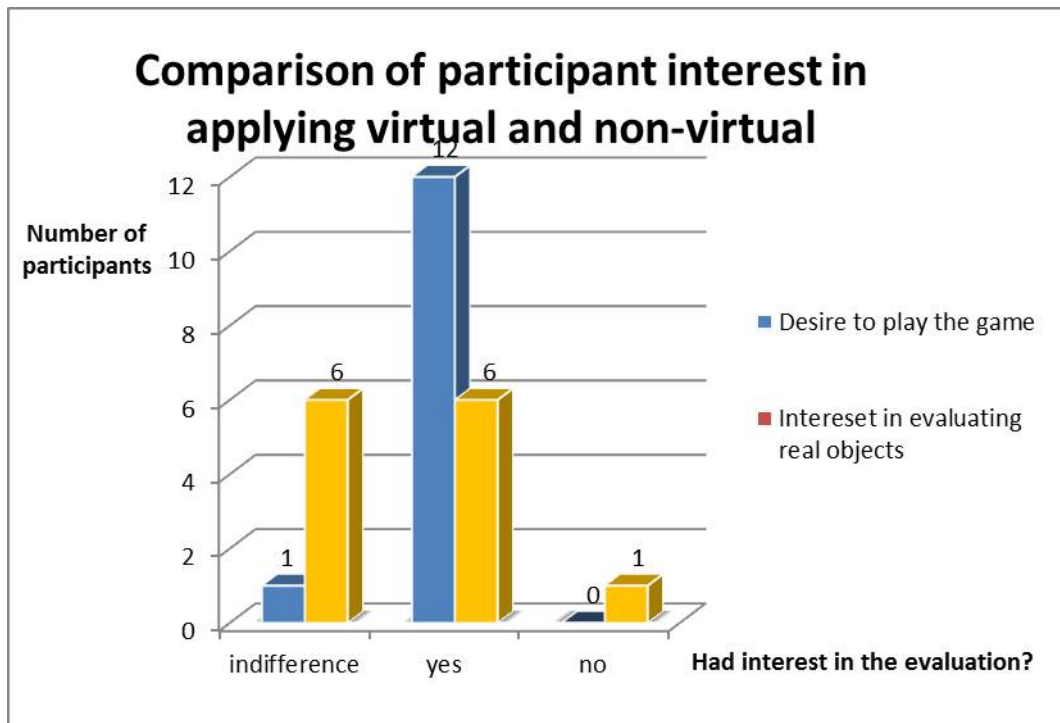


Figure 6. Comparison of application of evaluation classes inclusion.



From the observation report done by applicators, through the behavior demonstrated by the participants, as seen in Figure 7, it was possible to compare the difference between interest in the virtual application and the not virtual.

Figure 7. Comparison between participants' interests

Conclusion and future works

After evaluation application, reports and graphs data, it was possible to point out that during the application, those who were evaluated didn't feel themselves being tested, were very interested by the game, minimized material interference manipulation, facilitated game contextualization identification and the identification with the character, besides using less time for the preparation of the report that is produced immediately after the game, other than the non-virtual assessment should be done after application requiring a great time.

It is important to point out that this game doesn't have the objective to discriminate any individual nor demonstrating mental age; not even a diagnosis instrument but be an instrument to assist a complete diagnosis.

This evaluation interface was well accepted and showed the possibility to be used as an evaluation objective; however there is a need to standardize it for the population wishing to be evaluated.

Besides, this game can be used in adaptable computers for several disability, evaluating operative notions of an individual who for some reason for example has partial or total loss of superior members and would have great difficulty or even the impossibility to be evaluated by conventional Piaget tests.

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DETERMINING COSTS AND BENEFITS OF WEBSITE ACCESSIBILITY IN IRELAND: RESULTS FROM AN EMPIRICAL APPROACH

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Abstract: This study explores the market potential for the ICT sector to expand its reach when websites are accessible to people with disabilities. Twelve Dublin-based organisations were surveyed and interviewed over four months to analyse organisations' benefits in having accessible websites and to explore returns of investment. The questionnaire used in this study was treated as a litmus test to see the status of web accessibility implementation in Ireland. Although the respondents were unable to answer the hard-hitting questions illuminating the ratio of costs vs. benefits, the results from the questionnaire illustrate how these organisations incorporate accessibility into their websites and gauge the tangible and non-tangible benefits of implementing web accessibility. The study supplies suggestions of the areas that need to be brought to light when putting into practice web accessible solutions.

Keywords: Web Accessibility, Cost Benefit Analysis, Case Study, Ireland

Introduction

Despite the advancements of technology and public policy and the efforts of many advocates, ensuring accessibility for people with disabilities is often not a priority for organisations that provide ICT goods and services. When the World Wide Web Conference launched the Web Accessibility Initiative (WAI) in 1997, founder Tim Berners-Lee stated that worldwide, there are more than 750 million people with disabilities (Paciello, 2000).

The United Nations estimates that there are one billion people in the world living with a disability (UN, 2011) and in Ireland, 10-20% of the adult population has some form of disability (NDA, 2002). The Irish National Disability Authority estimates that 85% of people with disabilities acquire their disability during their working life (NDA, 2012). Seeing as the world is becoming more dependent on technology for everyday tasks; it is inherent that people who use the web should have the same amount of access as everyone else, regardless of individual capabilities and functions. Businesses who do not consider accessibility in their ICT goods and services are currently excluding a large part of the market, and are missing a big opportunity for tapping into new ventures.

By examining the benefits that organisations have already introduced accessibility in their web sites, this study aims to build the business case for accessibility and further promote the spirit that accessibility is not just good corporate social responsibility but it is also beneficial for the organisations' bottom line. eAccessibility is a concept which ensures that all people of all levels of ability have the same access to information on the internet as everybody else. This includes people with disabilities and elderly people with reduced functional capabilities (Technosite, Tech4i2, et al. 2012).

This study asks the following questions:

- What are the main accessibility and usability issues in eAccessibility?
- What are the existing good practice models?
- Where are the benefits, savings or expenditures of firms investing in accessible websites?

Complying with legislation and corporate social responsibility are important issues when dealing with ensuring eAccessibility, however excluding people with disabilities also excludes a large share of the market where organisations are missing out in potential profits. Developers who create inaccessible websites involuntarily exclude millions of users from their potential audience. A Forrester Research survey commissioned by Microsoft shows that 57 per cent of adult users of Windows in the United States

benefit from its accessibility features from simple zooming to text-to-speech functions (Microsoft, 2012).

Related Work

With the aim to quantify the costs and benefits of web accessibility in Ireland, the following studies were found as exemplary background documents with similarities and differences within the scope of the present study.

Technosite, ONCE Foundation

Technosite, ONCE Foundation led a study for the European Commission, along with Tech4i2 (UK), AbilityNet (UK), and Norwegian Social Research (Norway) in cooperation with the Blanck Group (USA) in 2011 called “Study on Economic Assessment for Improving eAccessibility Services and Products”. This report is the most relevant report when creating the state of the art for the methodology due to the fact that the current study will essentially emulate and expand from. This study explored the cost benefit analysis of eAccessibility goods and services, and interviewed organisations to gather raw data, same as the current study. Most relevantly, this report has developed its own Business Case Tool which helps an organisation problem-solve over the issue of investing in web accessibility and 24 in-depth case studies from organisations throughout the EU that have already implemented web accessibility (Technosite, Tech4i2, et al. 2012).

Kanchi

Kanchi is a private organisation that uses business and media leadership to create an inclusive world for people with disabilities (Kanchi, 2013). Kanchi published a study “The Business Case for Disability” (2011) where they had seven case studies around the four themes of what they consider to be the business case for disability. Unfortunately, their case studies were mostly tied around the issue of employment and thus outside the scope of the present research on ICT accessibility. Their findings and methodology are useful for the guidance of the current study.

The Kanchi study emphasizes that the business case for disability is centered around return on investment (ROI). All businesses have an ROI when they attempt to measure the financial return against the capital spent by the business. Access to markets, reputation management, and retention of staff are the key factors that increase the return on investment when investing on accessibility (Kanchi, 2011).

G3ICT

The advocacy wing of the UN Global Alliance for ICT, called G3ICT, commissioned a white paper in 2012 titled “Web Accessibility for Better Business Results” which highlights the benefits of adhering to eAccessibility for a business, and includes two case studies on accessible eBanking in Australia and a case on accessible content management systems.

Although their methodology is not spelled out in their report, interviewing methods must have been used for their 2 case studies in order to extract quotes and qualitative data regarding eAccessibility. Like the previous Kanchi report studied, G3ICT concludes that accessibility is important for expanding markets, ensuring customer loyalty, and promoting a strong brand image (G3ICT, 2012). Expanding markets is the most important parallel of this report to the study in this paper, and will be analysed for benchmarking and reference use.

W3C

The Web Accessibility Initiative of the World Wide Web Commission (W3C) has created a white paper in 2005 and updated recently in 2012 called “Developing a Web Accessibility Business Case for Your Organization: Overview”. The difference between this paper and the studies currently examined so far is the fact that the W3C paper is a guide for businesses to specifically infuse accessibility into their eStrategies. Their study is divided into four parts: Social, technical, financial and legal/policy factors as to why a business should invest in eAccessibility. It gives perspective as to why different businesses may want to emphasize accessibility for different

reasons, whether it be in the private or public sector, a non-profit organization, a school, etc.

The W3C report is different from the Kanchi, and G3ICT reports because it specifies ongoing costs regarding website maintenance, direct cost savings, decreasing costs, and more information that is spelled out similarly to the Technosite report. This is key to building a business case and for this reason, the results from the W3C study will be very beneficial for this study.

Methodology

This study applies new empirical evidence to the theories behind business case methodology. The study used some of the pre-selected organisations provided by Kanchi, based in Dublin, and their previous collaboration with these organisations in the past. Due to this influence, most have experience to disability and accessibility related themes. With this help, and the dissemination of the questionnaire through online sources such as Survey Monkey, LinkedIn, Twitter, the Kanchi Network blog, etc., 12 participants responded to the study enquiry.

Central research questions

The themes behind the questionnaire are similar to that of the Technosite's questionnaire, in that they illuminate the costs and benefits obtained by the organisation investing in eAccessibility.

The first section of the questionnaire is general background information of the organisation such as their location, their sector, and information about the person answering the questionnaire. The second section is specifically on the development of their website, such as how much it cost to create it to begin with, whom their target audience is, who created the website, etc. The third section highlights the accessibility of their website and involves questions such as if it was created in an accessible manner from the beginning or not, to what extent it is accessible, how the testing and certification of the accessibility is assessed, and specific questions on the cost of the accessibility of the site (especially if it was introduced after the

launch of the website). The final section of the questionnaire involves the benefits seen from using accessibility on the website; such as if there were more sales, views, efficiency gains from interactions, etc. generated from the accessibility compliance.

Explanations related to sampling

According to Curtis et. al. (2000), samples are designed to make possible analytic generalisations (applied to wider theory on the basis of how selected cases with general constructs), but not statistical generalizations (applied to wider populations on the basis of representative statistical samples). Curtis argues that qualitative sampling can provide the opportunity to select and examine observations of generic processes (2000). The implications are that theory will drive the selection of these cases, and also that the careful examination of the cases may lead to elaboration or reformulation of theory. As Judith Okley explains, qualitative data analysis can refer to research using only a small sample of interviews, whether structured or unstructured (Bryman and Burgess, 1994).

The Kanchi network provided a list of organisations' contact information in order to ease the process of business sampling. Through assistance given via Kanchi, 40 companies were contacted, resulting in 8 interviews. Alternative methods were used to include more companies in the sample, as mentioned in previously, using LinkedIn, etc. These methods resulted in 4 more interviews. Therefore, the results presented in this report correspond to 12 interviews, total.

Methods of data collection

When the organisation was selected by the researcher, it was invited to participate in answering the questionnaire by an email introducing the interviewer, detailing the purpose of the questionnaire, and having a sample questionnaire included in the email to provide insight to the extent of the questionnaire. Structured interviews, whether face to face or over the telephone, lasted in duration between 30 minutes to an hour long.

Limitations

No matter how much preparation is put into a study, intentions and results always differ. From the beginning of the study, the number of participants to take part in the survey was originally imagined to be at least 20. However after investigating and contacting organisations for 4 months, the scope of the study had to be altered to 12 respondents. Reasons behind the lack of response can be examined can be seen as the following.

Firstly, the population of Ireland as of July 2013 is 4.8 million (CIA, 2013). The amount of eAccessibility practices is limited from the beginning by selecting a population of a small sized country.

Inviting public sector organisations into the study was also short-sighted. The reason to include them was to obtain a wider scope of organisations across different sectors. However, upon interviewing public sector organisations, the majority could not provide concrete data regarding the costs and benefits they experienced when making their websites accessible. If the website had to be accessible from the beginning for legislative purposes, the costs endured were not examined due to the mandatory nature of enforcing accessibility.

Another limitation includes the reflection of the low levels of policy and technology accessibility in Ireland as expressed through the Measuring eAccessiblilty in Europe (MeAC 2011) reports (Technosite, Tech412, et al., 2012). More information on this is found in the conclusion.

Results

The purpose of this field research was to examine the costs and benefits linked to eAccessibility. The sample size is a result of the lack of response attained throughout the course of the study; therefore the study has no statistical significance but offers a significant approach to understand the business case. In this context of sample size, quantitative and qualitative analysis of the data obtained has been performed.

Five out of the twelve responding organisations are in the ICT sector, while one is a sporting goods vendor, one is in the financial and insurance sector, one is an administrative service provider, one is a public administration (government) organisation, one is from the agriculture sector, one is a consulting organisation and one handles matters of human resources. Three of these twelve interviewed organisations are multinational. One of the responding organisations comes from the public sector, while the remaining eleven were from the private sector.

When examining the level of accessibility knowledge that the respondent knew before starting his/her current job, and how much he/she knows currently, 8 responded that they knew very little of accessibility beforehand, and only one responded that they still know very little of accessibility. Out of the 11 who responded how important it is having an accessible website for their organisation, 9 respondents found it very important and important that their website be accessible. Nine of 11 respondents had web teams that were knowledgeable of web accessibility. Six out of 11 stated that web accessibility was an important hiring factor in order to be included in the web team; however that leaves 5 stating it is not.

The majority, 7 out of 12, of the responding organisations have between one and 499 pages in their website. Three respondents stated that the initial development of their website cost between EUR 1,000 and EUR 10,000 while another three respondents stated that the initial cost of the website was from EUR 10,000 to EUR 40,000. A majority of respondents, 6 out of 9, update their websites in-house. Four respondents said they have a partnership between their web team and a third party consulting team, and one responded that they fully outsource their website updating to a third party consulting team.

When asked to respond to the significant factors in website development in terms of high, medium, low and no priority, the majority of respondents replied with high and medium across the board of web development elements. The cost of external consultants was not deemed a high significance where two thirds of respondents responding low to none in significance. The cost of training personnel was also ranked low and “none”

as the majority of the respondents had autonomy in their own website development either developing totally in-house or through a partnership with another organisation and their own in-house team. Web accessibility audit cost was not a high priority for any organisation, the majority saying medium, low and no importance.

The next part of the questionnaire aims to see how the websites are developed, in order to capture a snapshot of the situation the organisations experience before implementing website accessibility. As the results show, most websites discussed in the study are large and information-based that have been in existence for an average of 4 years and have rather large audiences. The costs in developing the website were incurred by their own staff and in partnership with an outside organisation, where these outside organisations did not mention web accessibility. The need for accessibility was seen from within the organisation and deemed important.

The third part of the questionnaire illuminates how the websites incorporate accessibility, and extrapolates a before and after assessment of accessibility implementation from the second part of the questionnaire. As the results from this section show, the respondents are unaware of how the levels of internationally certified accessibility standards are adhered, showing that there is no understanding of the role of how international organisations ensure web accessibility. Throughout each of the interviews, it is evident that the majority of the respondents did not know the level of accessibility of their website, how to monitor changes in accessibility requirements and standards, and have not participated in the certification of their websites to accessible standards.

Out of 11 responses, the overwhelming majority, 8, said their website does not accommodate for disabilities other than visual impairment. Of these 11 organisations, only 2 use subtitles for their videos on their website. Out of 7 responses, only 2 who used a third party to help develop their website actually raised the issue of accessibility.

Discussion

Overall the surveys and interviews conducted have shown some interesting points to take into consideration about the website accessibility situation in Ireland. Regarding the breakdown of organisations, it is important to note that public sector organisation websites in Ireland are mandated by law that they must be accessible to at least “Level Double-A Conformance to Web Content Accessibility Guidelines 1.0”, as described in the Disability Act of 2005 (NDA, 2005). This also means that private organisations, although not obliged by the law, seem very active on implementing accessibility in their websites. One of the outcomes of the survey is to identify the reasons why organisations choose to adhere to accessibility guidelines (and benefits of doing so) but if the organisation is legally obliged to be accessible, their responses to questions later on in the survey are quite limited, since they were mandated from the very beginning to be accessible.

During the current job position, many respondents learned about accessibility of websites during their employment which is a good sign of accessibility adherence. Although outside the scope of the questionnaire, some respondents did learn about accessibility through involvement within the Kanchi network, but some also learned from outside sources and learning modules.

Although only 11 respondents, 9 did say it was important to have an accessible website for their organisation. This suggests accessibility is overwhelmingly deemed important in the Irish market.

It is important to see the reasoning why the state of web accessibility is at the rate it is. Hiring staff knowledgeable of web accessibility is important to analyse because if people who know about accessibility are then replaced in the organisation by people who then do not understand the importance of accessibility, then the website in itself would then decrease in the accessibility level.

The majority of the purposes of the websites are to provide textual information to the public and the second most popular use of the site is to

provide an interactive interface with the public. From these findings there are three factors to point out:

- Websites that provide textual information to the public are deemed important to be accessible to an extent where people with disabilities can access information as every other individual.
- The lack of data representing transactional websites that involve eCommerce is an alarming factor that should be rectified. The rise of eCommerce accessibility is a field that requires more research.
- Textual based websites may be considered “easier” to render accessible, as the most difficult part of making an accessible website is the transactional part of it, followed by the interactive part (incorporating multimedia).

The majority of respondents update their websites in-house. This shows that the web teams in the organisation have more influence in what they wanted, as opposed to having externalities enforced by another private organization. Having the autonomy to develop their own website also indicates how the website can be perceived by its audience.

Seeing from the results of this study, organisations still need to understand the full scope of what achieving accessibility actually entails. However, out of 10 responses, only 3 have not incorporated plain or easy to read English in their website while the remaining 7 have, which is a promising sign.

It is important to understand what is not important to respondents in order for civil society to emphasise what other benefits can be achieved through web accessibility. Stakeholders in civil society can choose to expand their portfolio of perceived benefits of web accessibility and include what turns out to be not-so important to organisations, or they can conversely emphasize on what respondents already see as benefits, and do more studies on these benefits. From this study it is apparent that the top 3 benefits include more visitors, enhanced usability and attaining an improved social responsibility. The bottom three benefits include cost savings, efficiency gains and website retention. Understanding the reasoning behind these

results can illustrate where web developers are currently and where they potentially can be when it comes to their perception of web accessibility.

Conclusions

With the following results in mind, it is important to see what these conclusions hold and also to see how they compare to the MeAC 2011 scores for Ireland to see if there are correlations. Although two years have passed since the results of the MeAC 2011 study, all websites interviewed were in existence in 2011 and fall under the scope of the study.

When looking at the results from the MeAC study in 2011, Ireland scored lower than the EU average for website technology indicators for accessibility, both for public-sector and general web content technology status and that Ireland falls below the EU average for all policy indicators. This information coincides with what the study has shown that there is still much for Ireland to do when it comes to the level of accessibility for its websites.

Overall, the results of this study show the following:

- Accessibility is known in private sector organisations, and deemed important but not enforced.
- Accessibility is a topic that is currently being learnt in the respondent's jobs.
- More than half the respondents said that their web team consisted of people who knew about web accessibility.
- The main purposes of the websites examined are indeed informational.
- Many incorporate plain and easy-to-read English, however do not incorporate the use of subtitles for videos, do not know the level of web accessibility (WCAG rating), and mostly see accessibility as an issue for people with visual impairment as opposed to other types of disabilities.
- None of respondents are able to quantify the costs and benefits attained when implementing accessibility of their websites.

Pinpointing costs to accessibility was a difficult task for the few who could quantify the actual costs of the websites.

- MeAC scores for Ireland give a bigger picture of the overall situation of accessibility in Ireland, and coincide with the results of this study.

One recommendation to improve the situation of web accessibility is to include more awareness of the benefits of certifying the website (a demonstration of corporate social responsibility, joining a network of other certified websites, etc.) Staying up to date with the updates of website accessibility levels is important to stay consistent with the latest technology updates that occur all the time. Self-monitoring and self-training can be solutions to resolve this issue.

Seeing these results, the following suggestions can be made:

- Pinpointing the exact issues is necessary, but from what this study shows, a bigger emphasis on accessibility training and awareness is necessary due to the lack of knowledge shown from the results of this study. Some of these issue include:
 - o Accessibility beyond the visual realm: subtitled videos, easy to read English, the use of diagrams and other further measures in website accessibility need to be expanded.
 - o Expanding accessibility awareness is essential. More people need to know about its potential benefits for business. Voluntary certification and celebrating the “champions” of web accessibility is necessary for awareness, and hence, should be emphasised.
- Understanding the costs the organisations put into accessibility, and monitoring their benefits experienced are key factors missing from this study.
- Belonging to a network as unique as Kanchi also helps organisations raise awareness regarding the importance of accessibility and also informs the public on disability-related matters.

This study concludes that in order to further examine the costs related to website accessibility, web accessibility must be taken into consideration from the very beginning of creating a web project, whether based in the public or private sector. The different elements adding to costs of enduring web accessibility need to be studied further and while there is room for monitoring web accessibility awareness campaigns and training, it will be interesting to see what further analysis can bring in the future.

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WINTER: PUBLIC ENEMY #1 FOR ACCESSIBILITY EXPLORING NEW SOLUTIONS

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Abstract: Winter is expensive. For countries situated in the northern hemisphere, closer to the north pole, such as Canada, Russia and Scandinavia, winter requires the acquisition of special clothing, car tires, and sports equipment, snow removal or plowing from the streets, and is associated with the presence of ice patches, along with accidents and illnesses associated with cold weather. Fall-related injuries due to winter conditions have been estimated to cost the Canadian health care system \$ 2.8 billion a year. However, the greatest cost snow entails every year is the social isolation of seniors as well as wheelchair and walker users. This results from the lack of accessibility, as it is difficult to circulate on snow-covered streets even for the able-bodied. Social isolation has been associated with other negative consequences such as depression and even suicide. This exploratory pilot study aimed at finding possible and feasible design solutions for improving the accessibility of sidewalks during winter conditions. For this project we used a Co-Design methodology. Stakeholders (City of Quebec representatives, designers, urban planners, occupational therapists, and adults with motor, visual and aural disabilities) were invited to participate in the design process. In order to meet the objectives, two main steps were carried out: 1. Conception of the design solutions (through Co-design sessions in a Focus-group format with seniors, designers and researchers); and 2. Validation of the design solutions (consultation with experts and stakeholders). The results are a wide variety of possible and feasible solutions, including the reorganisation of the snow-removal procedure and the development of heated curb cuts. This project was funded by the City of Quebec in partnership with the Centre

interdisciplinaire de recherche en réadaptation et intégration sociale (CIRRIIS). Ultimately, the project sought to explore possible solutions to be implemented, if feasible, in the future by the municipal government.

Keywords: Winter, urban accessibility, co-design methodology, universal design

Introduction

Snow is a major problem for accessibility and current snow removal procedures are both expensive and inadequate to provide the accessibility required for people with disabilities. The low temperatures and snow precipitations experienced in countries situated in the northern hemisphere, such as Canada, Russia and Scandinavia greatly influence the everyday life of all individuals. For example, winter conditions imply acquiring special clothing, car tires, and sports equipment, as well as snow removal or plowing from the streets, and the existence of ice patches, along with accidents and illnesses associated with cold weather. Indeed, walking in winter conditions can be dangerous. Fall-related injuries due to ice or snow are an important and serious problem, especially in an aging society. They have been estimated to cost the Canadian health care system \$ 2.8 billion a year (Miller, Wightman, Rumbolt, McConnell, Berg, Devereaux, & Campbel, 2009). According to Environment Canada (2010), Quebec City is the third most important major Canadian city (metropolitan areas with over 150,000 inhabitants) to have received the greatest annual quantity of snow with 316 cm, behind St. Johns, Newfoundland, in 2nd place with 322 cm, and Saguenay, Quebec, in 1st place with 342 cm. It is estimated that Canada spends approximately \$ 1 billion on snow removal every year. The City of Quebec spent \$ 13.6 million in 2008 for this purpose.

However, the greatest cost snow entails every year in Quebec and in most northern countries is the social isolation of seniors as well as of wheelchair and walker users. These results from the lack of accessibility due to winter

conditions, as, for these individuals, it is almost impossible to circulate in snow-covered streets. Although there are several factors involved in the process of social isolation (Brennan, Moore, & Smith 1995; Edelbrock, Buys, Creasey, & Broe, 2001; Gardner, Brooke, Ozanne, & Kendig, 1999; Hall & Havens, 1999), adults with physical disabilities might prefer to stay home rather than go out, because of the challenges which will certainly be encountered. Social isolation, in turn, has been associated with other negative consequences such as depression (Gutzmann, 2000; Silveira & Allebeck, 2001) and even suicide (Conwell, 1997; Rapagnani, 2002).

Current efforts to make urban centers more accessible, such as the “Access City Awards” in Europe and the WHO’s “Age Friendly Communities” all over the world, do not take into consideration the impact of winter as a major accessibility problem. This particular subject has received little academic attention. Toronto Rehab is one of the few groups that has studied the impact of winter on seniors and individuals with motor disabilities. Its activities focus on the development of winter clothing and footwear along with walking patterns in cold weather. However, the problem is vast and the list of different aspects that require immediate attention is significantly long. **The aim of this project was to explore and to define some possible and feasible solutions to improve accessibility to urban centers in winter conditions.**

Current practices for snow removal and alternative strategies

In Canada, as in other northern countries, snow removal is most commonly done by mechanical means (snowplows, shovels, etc.), usually includes the use of chemicals (salt, sand, etc.) and generally involves three steps. The main actor of the first step is the salt spreader which removes snow and spreads salt. This chemical enhances snow melt and the granular nature of the salt contributes to providing better traction. Then, once the storm has subsided, the “front-end loaders” and “graders” push the snow to the edge of the road. Finally, the “snowplows” or “snow blowers” transfer the accumulated snow into a “dump truck”, which then takes the snow to a designated snow dump.

Despite the popularity of this technique, evidence suggests that there are many disadvantages associated with its use, namely the damage done to street furniture and the long term high maintenance costs for citizens as well as for public and private organizations. For example, salt damages the pavement, trees, and grass, as well as corroding automobiles and has severe effects on ground water, water bodies and roadside vegetation (Demers & Sage, 1990; Mayer et al., 1999; Remakrishna & Viraraghavan, 2005). These effects have led many scientists to believe that smaller amounts of chemicals could be used, which in turn would also be cheaper (Nixon, 1993). In addition, salt and sand spreading is generally performed once precipitations are finished. Thus, security measures are neglected since safety concerns are present before complete snow removal (Chen, 2011). Many hazardous accidents are associated with these conditions, as well as with the machinery used for snow removal. According to the Canadian Institute for Health Information (CIHI), the most serious injuries (excluding motor vehicles) are, by far, falls on ice. They led to 7138 hospital admissions in 2010-2011 within Canada, nearly 10 % more than in 2006-2007 (CIHI, 2011). Walking on icy and snowy surfaces is very dangerous. Finally, due to the fact that de-icing chemicals have negative impacts such as concrete corrosion and environmental pollution, it could be beneficial to diversify our methods for snow removal (Chen, 2011; Nixon, 1993; Wang, 2010). To address these problems, snow-melting alternative systems have been proposed in the past years such as hydronic and electrical asphalt-heating systems.

Hydronic systems

Hydronic heating systems use a circulating pump to deliver heated fluid (water and antifreeze) through pipes embedded near the upper surface of the pavement to melt snow and ice. Freeze protection is essential since most of these systems are operated intermittently in subfreezing weather. The pipe material in the deck is usually either cross-linked or high-density polyethylene. The pipe can be arranged so that it is simply clipped to the steel reinforcement before the concrete or the asphalt is poured. This type of system is warmed by kerosene, gas or a geothermal source (Chen, 2011:

3241-3242). The hydronic system technology requires special planning in the spacing and layout of the pipe. Despite the limited geographical environments where this technology can be used effectively as well as the amount of planning and work involved, several countries use hydronic systems, including Argentina, Finland, the United States, Japan and Iceland (Kinya & Shigeyuki, 2000; Lund, Rees, & Spitler, 2002).

Electrical systems

As an alternative strategy, electric snow-melting systems are more popular. They are composed of three basic components: a heating cable, a control unit and an activation device. The piping is buried in the pavement and is powered by electrical cables. The cables are inside the piping, and the heat output is determined by the resistance of the electric cables used and the imposed voltage. The power can be generated by a standard electrical system, wind turbine or solar system. The radiating heat from the electric cables warms up the entire surface of the material in which the piping is embedded. The same technology is used in underfloor heating systems. Several recent studies (Kinya & Shigeyuki 2000; Rees & Spitler, 2002) analyzed the pipe mappings and heat distribution needed to adapt this system for snow melt. Like the hydronic system, the electric snow-melting system needs careful organization of the pipes to avoid unnecessary heat loss and additional construction costs.

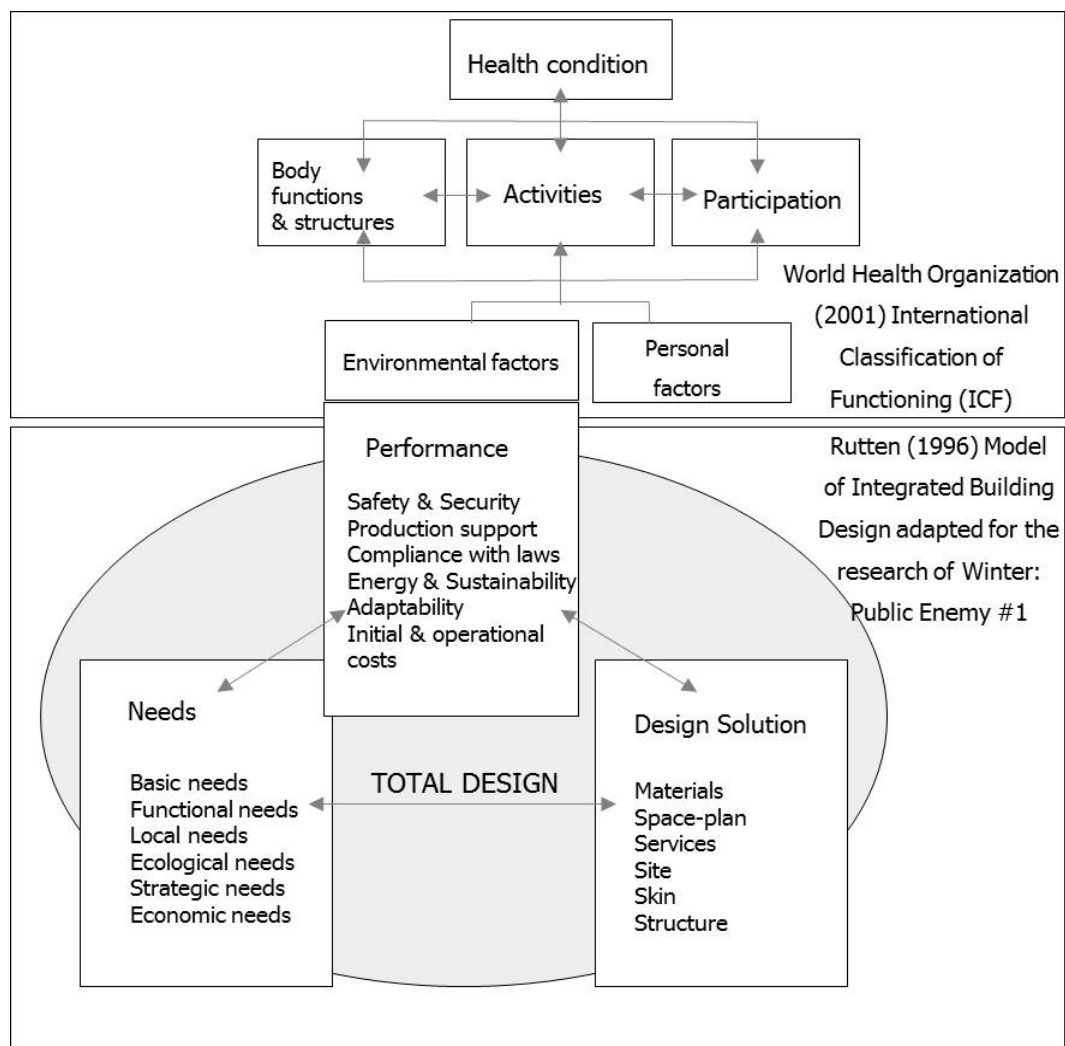
The combination of conventional and alternative methods for snow removal could lead to the creation of an innovative design solution which would match our climate and be in line with the Office des personnes handicapées du Québec (OPHQ)'s political initiative for access and social participation for all citizens (OPHQ, 2009).

Theoretical Framework

When looking for the most appropriate framework to describe the needs of the different actors relevant in the design process of an urban-accessible solution, we used a combination of two models, the International Classification of Functioning model (ICF) (WHO, 2001) and the Model of Integrated Building Design (MIBD) (Rutten, 1996), which were first combined

by Van Hoof and colleagues (2010). Despite the fact that Rutten did not elaborate much on his model, Van Hoof published several articles based on this model (ICF-MIBD-model). Moreover, we have successfully used this approach in the past (Huissman & Morales, 2012) and have adopted it here.

Figure 1. ICF/MIBD Model adapted to the research on Winter: Public Enemy #1



In Figure 1, in the ICF model, the built environment can be seen as an environmental factor influencing individuals in their everyday performances. The most important feature of this model is the clear and comprehensive structure which encompasses every aspect of the design process in a project. The needs of the different actors or stakeholders involved in a health or accessibility-related project are therefore taken into consideration in the design solution for individuals to have the best possible performance. In the

ICF-MIBD framework, the individuals' relationship with accessible environments is viewed from different perspectives and dynamically described in the MIBD model as a triangular interaction and co-dependant relationship between Needs, Performance and the Design Solution. The following paragraphs provide a general description of these three elements.

Needs

To respond to their needs, the different actors involved in the development of design solutions (stakeholders) define the importance and usefulness they attribute to these needs. There are six types of needs: Basic, Functional, Local, Ecological / Sustainable, Strategic and Economic. Each of these responds to the needs of different stakeholders participating in the creation of a design solution, such as the accessibility requirements for individuals with or without disabilities (basic need), the workers' needs for structured management of municipal activities to keep the city clean and functional (functional need), the city management staff's requirements (strategic need), the city leaders' needs (economic need), the community's requirements in terms of accessibility (local need), and the ecological impact of the design solution during construction and thereafter (ecological need).

Performance

Performance is the capacity of the design solution to meet the values or needs of the different stakeholders. It also includes the created expectations towards the design solution in relation to its contribution to improve the city's accessibility. Performance is divided into the following components: Safety & Security, Production support (infrastructure provided), Compliance with laws, Energy & Sustainability, Adaptability of the solution to different contexts, Initial and Operational costs.

Design Solution

The design solution is the group of components that forms and shapes the design itself. It includes all elements relevant to the design process of an urban-accessibility design solution. The building system is based on the 6 S's

(Brand, 1994): Stuff (Materials), Space Plan, Services (if it requires electricity, hydro-sanitary network, etc.), Skin (finishing), Structure of the design solution and Site (place where it will be built or implemented).

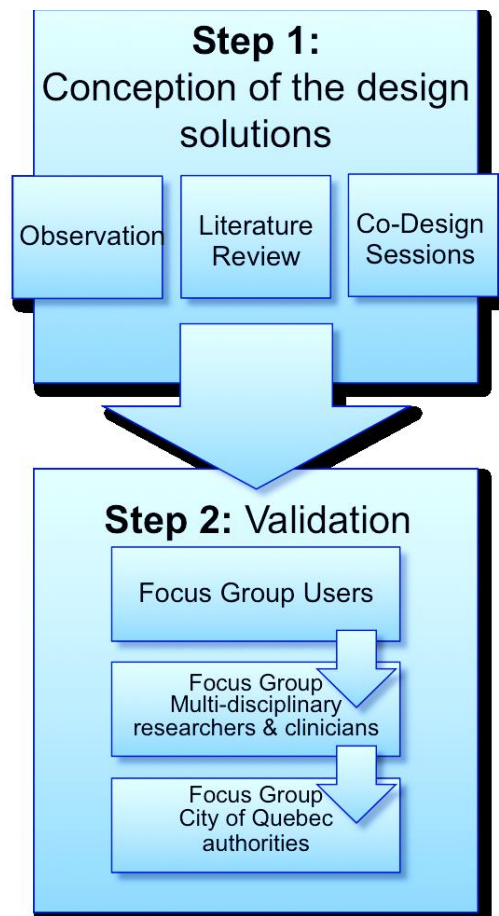
The different elements of this model, as presented in the previous paragraphs, provided a structural framework for the development of the Co-Design process we implemented. Particular emphasis was placed on the “Needs” and the “Design Solution” elements. For example, in the individual co-design sessions and group co-design sessions with users, the *basic needs* of people with motor, visual and aural disabilities were discussed in order to suggest new ideas or to improve earlier ones we presented. In the co-design group session with the Quebec City’s representatives, the ideas were discussed in terms of the *functional needs* of municipal activities and the action plan for snow ploughing, along with some local, strategic and economic needs. Moreover, the environmental implications (ecological needs) were also brought up as a very important element. All these elements influenced the development of design solutions with regard to their dimensions, materials, location, etc., in order to try to predict their performance in terms of safety, security, compliance with municipal laws, energy and sustainability.

Methodology

Co-Design methodology was used in which the stakeholders were invited to participate in the creation of design solutions and/or new strategies to improve accessibility in winter conditions. Recently, several authors (Ivey & Sanders, 2006; Sanders & Stappers, 2008; Sleeswijk, Visser, Stappers, Van der Lugt & Sanders, 2005) have redefined and extended the limits of participative design and promoted a new process known as co-design. Co-design refers to the act of collective creativity shared by two or more people, where the user is an “expert in his own experience” (Morales et al. 2012). In order to answer our questions and meet the objectives, this project was divided into two main steps:

1. Conception of a design solution or strategy
2. Validation via consultation with experts (See Figure 2).

Figure 2. Co-Design Methodology



The following paragraphs describe each step in detail:

Step one: Conception of the design solution or strategy.

The main objective of this step was to understand the needs (as described in the IFC/MIBD Model), along with the performance of existing technical aids in winter conditions. The design process was organized into three main phases: an observation activity, a literature review and the co-design sessions per se.

- **Observation:** Second-year students from the School of Architecture of Laval University in Quebec City took photographs and videos of accessibility restraints due to snow on sidewalks. In addition, these students were asked to use wheelchairs and walkers to test their performance and to increase their awareness of mobility limitations in winter conditions. Students had to choose a relevant location along with the nearest bus stop and street crossing; then, they analysed this

environment in terms of accessibility during the month of February 2013 in Quebec City. This phase provided data in terms of specific difficulties, related to the winter season, found in the urban context for wheelchair and walker users (i.e. snow accumulation in a street corner, among others).

- **Literature review:** A scoping review (Arksey & O'Malley, 2005; Levac et al. 2010) to understand the state of art of the problem and some potential needs was performed using keywords from two main themes:
 - o Snow removal: (snow ploughing OR plowing) AND (action plan for snow removal OR snow removal strategies) OR (processus de déneigement OR priorités de déneigement) AND (Scandinavian roads in winter OR snow ploughing in Scandinavia)
 - o Accessibility: (Winter accessibility OR accessibility with snow) AND (universal design for winter conditions OR inclusive design in winter) OR (Scandinavian design in winter OR accessibility in Scandinavian winter)

For the gray literature, websites on European accessibility measures were consulted such as:

- o <http://eo-guidage.com/>
 - o <http://www.universaldesign.ie/>; among others.
- **Co-Design sessions:** In order to respond to some of the needs identified as well as to address the poor performance of technical aids as revealed during the observation phase and the literature review, five co-design sessions with individuals were organized: two at the University of Montreal and three at Laval University in Quebec City. Based on the literature review and the observation activity, several important elements were identified as more problematic such as curb cuts, inclined streets, street crossings, bus stops and access to shops and restaurants. Each of these elements was discussed in all

sessions. The average duration of each session was 1.5 hours, with individual sessions organized for a subset of urban planners, architects, designers and experts in accessibility. All sessions were recorded and organized according to the same format. The research project was explained with the help of a PowerPoint presentation by the first author and then a period of questions helped clarify certain aspects of the project. Following this, the first author opened the session for suggestions or ideas to improve accessibility, with special focus on the previously identified elements (curb cuts, etc.). Other elements suggested by the participants were also welcomed and discussed. The first author then sketched the participants' ideas based on their description (graphic data). He then exchanged ideas with the participants until they reached at least three possible design solutions. For example, the first author asked open questions such as, how do you imagine we can increase the accessibility of curb cuts? Participants would then suggest something, such as "melting the snow". Then, the first author would ask, how would you materialize/conceptualize the snow melting idea? There followed exchanges with the participants until the idea had a more solid form and foundation. Particular emphasis was given to respecting the different elements of the IFC/MIBD Model (Van Hoof, 2010), addressing the needs within the proposed design solution as well as trying to imagine how to maximize performance. The analysis of the sessions' recordings allowed the first author to ensure full consideration of all the details and definition of the design solutions. The ideas collected during session one were presented at the end of session two; both the ideas gathered during sessions one and two were presented at the end of session three and so on. These ideas were presented only after the participants gave their own ideas. The objective of showing them to all the participants was to improve, combine or eliminate different ideas as appropriate. No individuals with disabilities participated in this first set of sessions as we aimed for a basic idea which could further be developed and expanded during step two of this study, through a focus group with users (adults

with motor, visual and aural disabilities) as the experts of their own experience.

Step two: Validation (consultation with experts).

The different ideas and design proposals resulting from the individual co-design sessions were presented to, enriched and validated by a variety of stakeholders. The key feature of this research project was precisely the gathering of different points of view regarding a common objective in order to better grasp all the elements that must be taken into consideration. What we call “validation”, in this case, is a filtering process, a research strategy to “purify” and enhance the design solutions and to set some parameters for the never-ending process of creation in order to achieve more realistic, viable and sensible solutions. A focus group is a methodological technique which allows “listening to people and learning from them” (Morgan, 1988, p.9). In order to meet our objectives in this study, it was pertinent to use this technique in order to learn from the “experts” in the process of creating design solutions. Three focus group sessions were organized.

The first focus group brought together an odd number (Morgan, 1988) of adults with motor, visual and hearing disabilities (n=5). Since, these individuals represent the main users of the proposed designs, they were the first ones whose opinion was sought. The participants were recruited through the Regroupement des organismes de personnes handicapées de la région 03 (ROP 03), a non-profit social organization representing people with disabilities. This focus group was particularly challenging and at the same time it was one of the most productive sessions. The ideas developed in the individual co-design sessions were represented via cardboard models for the blind participants so that they could grasp the architectural concepts discussed. For example, one idea proposed in the co-design session was to create a reservoir or trough underneath the sidewalks of a whole city block. The idea was to install these at strategic points throughout the city. This reservoir would be covered with a metallic grating for the snow to fall through. At the bottom there would be an electric source of heat for snow melting and the resulting water from the snow melt would be disposed of in the storm sewers. A cardboard model was fabricated to illustrate the

buildings, sidewalk, street and the reservoir covered with a “metallic-grating-like” surface. The reaction of the blind participants was very enthusiastic, as they clearly understood the idea when the first author guided their hands to each of the elements and explained the idea. This was repeated with most of the other ideas.

The second focus group brought together members of the Unis-vers-Cité research team (n=7). This multidisciplinary group includes researchers from many disciplines such as engineering, geomatics, occupational therapy, nursing, architecture, physiotherapy, and sociology working on accessibility issues. The main objective in this case was to assess and to improve the design proposals from a multidisciplinary perspective.

The third focus group gathered municipal representatives from the City of Quebec (n=7), such as employees from the departments of urban planning (Service de l'aménagement du territoire) and transportation and public services (Travaux publiques). The main objective of this group was to evaluate the feasibility and economic implications of implementing the “improved solutions” resulting from the first and second focus groups.

The reason for having three different focus groups was to differentiate distinct perspectives that can be used to examine each proposed solution, keeping in mind a holistic vision of the applicability of the design solutions. All three 3-hour sessions were based on a similar co-design and brainstorming format. All sessions were divided into two parts. The first consisted of the presentation and explanation of the project to the participants with a PowerPoint presentation. A question period took place after a break halfway during the session. Then, the different design proposals were presented and explained in a PowerPoint presentation. The proposals were discussed and suggestions to improve, combine or eliminate them were presented by the participants. The first author sketched the participants' suggestions according to the description they gave (graphic data). These suggestions were also discussed until unanimity was reached. Then another element was discussed (i.e. curb cuts, inclined streets, street crossings, bus stops, access to shops and restaurants), and so on. Other aspects were also openly discussed to find solutions.

Each co-design session and focus group session was recorded, and these recordings as well as the drawings resulting from the co-design sessions provided a backup description of the participants' suggestions. An evaluation and review of the recordings of each session (individual or group) along with the graphic data gathered during the session was performed after each session. This process allowed the first author to define and describe the different design solutions exhaustively.

Results & Discussion

As mentioned earlier, from the literature review and observation activity several important elements were identified as more problematic, such as curb cuts, inclined streets, street crossings, bus stops and access to shops and restaurants. Other discussions on different aspects or suggestions, besides the ones mentioned previously, were also welcomed. Conducting individual co-design and then group co-design sessions considerably improved the development and evaluation of the feasibility of the ideas. For example, in the first group session, an idea proposed in an individual co-design session to create a reservoir or trough underneath the sidewalks of a whole city block was taken up, but it was suggested to elaborate such a strategy only for curb cuts. The first group session gathered users only, people with motor, visual or hearing disabilities. It was argued that it was really this section of the sidewalk which required particular attention since snow always accumulates there. Therefore, in this session, a significant amount of time was invested to improve and solve technical problems for this particular suggestion. In addition, within the group session, new elements not discussed in the previous steps emerged, such as the inefficiency of the snow removal action plan by the City's authorities. This element was discussed in the two other session groups, particularly the one involving the City representatives.

Throughout the co-design and focus group sessions, themes and ideas were grouped and organized. Three main themes emerged:

1. Improve snow removal processes;
2. Incorporate new technology in the urban context to improve snow removal
3. Provide additional public transportation during winter months.

Due to the great number of elements discussed during the co-design and focus group sessions, not all suggested ideas are presented in this article. However, the most relevant ones, those which most drew our attention, are presented below.

1. Improve snow removal processes.

This necessarily includes rethinking the type of machinery and chemicals used in the snow removal process. As mentioned earlier, significant damage can be done to street furniture due to the machinery used for snowplowing. The use of new design solutions regarding the machinery needs to be considered in order to improve their performance and the efficiency of the snow removal procedures. Moreover, the de-icing chemicals currently used damage the pavement, trees and grass, corrode automobiles and pollute water supplies. New products should be developed to limit the adverse ecological impacts of the snow removal process. For example, on some highways in the province of Quebec, there have been scattered initiatives to use beetroot juice mixed with 50 % of the regular amount of salt used for de-icing. There are some limitations regarding the minimal temperature at which this product is efficient, since it freezes at -14°C without salt and at -28°C with salt (Proulx, 2012). However, this method reduces pollution by half and the stains induced by the beetroot juice are reported to be easily removed.

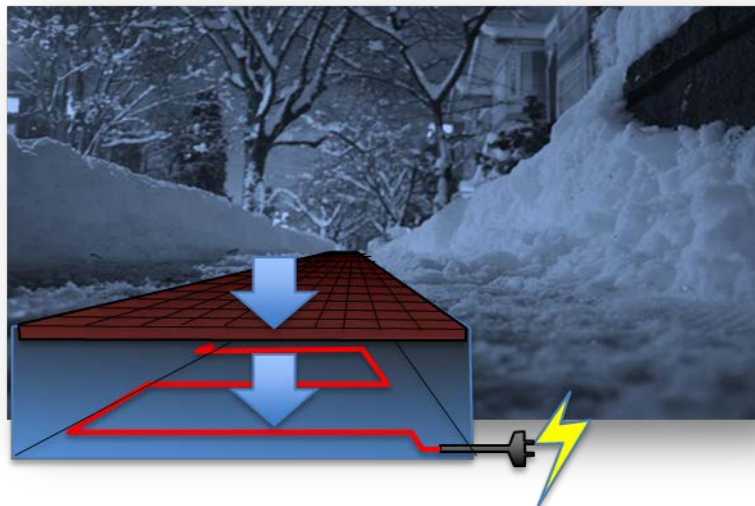
Other aspects of the procedure for snow removal also need to be reassessed. In the province of Quebec for example, the priority is given to vehicular circulation first, then to sidewalks and bus stops. Additional research needs to be done in order to consider having a better working understanding of the process, the priorities used to identify which infrastructures of the network should be cleared first, the users' needs and constraints, and the persons

responsible to carry out the city's snow removal procedure in order to demonstrate the benefits of modifications. Moreover, this procedure should be in agreement with an action plan on eco-friendly public transportation.

2. Incorporate new technology in the urban context to improve snow removal.

This point addresses sidewalks and curb cuts to melt snow and facilitate snow removal. This involves using an electrical system for snow-melting purposes. Particular attention was also given to curb cuts because most of them are inclined to facilitate wheelchair access. However, during winter months, this incline actually favors the accumulation of snow as well as water, rendering the snow removal process tedious. Due to the prioritization of snow removal for vehicular transportation, sidewalks remain often neglected, snow is plowed onto the sidewalk and accumulations are especially important at street corners, making walking very difficult for individuals without any disability and almost impossible for individuals with motor or visual disabilities (see Figure 3).

Figure 3. Solution for melting snow in sidewalks



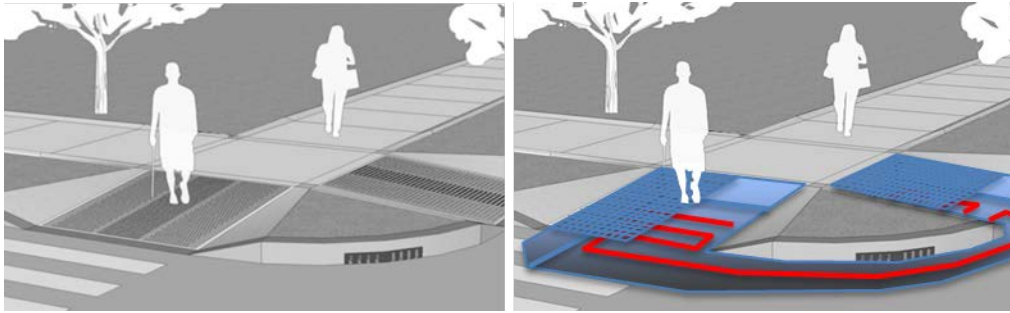
The implementation of a 30 cm-deep reservoir or through the width of the curb cuts' incline is proposed. This reservoir would be covered with a metallic grating for the snow to fall through. The proposed configuration for the metallic grating is a trellised section with 1,5 cm by 1,5 cm holes and a

20 cm solid strip in the center of the grating, allowing women wearing high heels to circulate safely. At the bottom there would be an electric source of heat for snow melting purposes. The resulting water from the snow melting process would be disposed of in the storm sewers (see Figure 4). Again, different possible sources for the energy could supply the resistor, including public lighting and solar panels.

Figure 4. Curb cut during winter months in Quebec City



For strategically selected sidewalks, the suggested design solution was to excavate a 30 cm-deep channel or trough, approximately 50 cm wide. As for the curb cuts, a 30 cm deep trough could be cut along the sidewalk, using a similar electric resistor heat source and also connected to the public storm sewers (see Figure 5). Again, different sources of energy to supply the resistor could be used. This solution will be evaluated in terms of cost/energy efficiency, in order to determine whether or not it will be implemented in Quebec City.

Figure 5. Solution to improve accessibility in street corners

3. Provide additional public transportation during winter months.

One of the main accessibility problems during winter months involves bus stops. This includes getting on and off the bus, the frequency at which the buses pass and the waiting time in cold weather. This could be improved if, during this period, additional routes could be used to take people with motor disabilities to strategic points, such as supermarkets, drug stores and community centers. The main financial problem of the City of Quebec's public transportation agency, as for many others in the world, would then lie in the additional bus drivers' salary. It was proposed to incorporate driver-free electric transportation systems, which have already been implemented in France (see CATS project – City Alternative Transportation System, www.parc-innovation-strasbourg.eu/CATS-project, and <http://induct-technology.com/produits/navia-2>). These vehicles follow a pre-programmed route and are equipped with sensors which identify obstacles and make the vehicle stop if any is present.

Another possibility is to develop a scooter rental program adapted to winter conditions, similar to the BIXI system, a public bicycle-rental system in Montreal. The BIXI system is an alternative means of urban transportation, with many bicycle-rental stations all over the city situated at key destinations. The stations are installed progressively in the spring, starting at the beginning of April, depending on weather conditions. Stations are kept in service until mid-November, before being removed from the streets for the winter months. The proposal was to replace the bicycles with scooters adapted to winter conditions in order to provide another transportation option. This idea has major repercussions in terms of investment and

political will, and its use could be out of the question for many countries. Nevertheless, these suggestions clearly exemplify the complexity of the problem and the diversity of solutions for improved accessibility during winter months.

Conclusions

Winter is expensive and the solutions given in this paper are not “cost-free”. However, walking in snow-covered streets during winter months is dangerous and fall-related injuries due to ice and snow are on the rise every year, proof that the way this problem is currently being addressed is far from optimal. This project provides some possible solutions to address this problem. Research grants will be sought in two areas: rethinking the snow-removal procedure to identify better snow-removal priorities for pedestrians and develop the curb cut prototype as outlined previously.

This project is clearly positioned under the umbrella of the global movement of “Age-Friendly Communities” and while winter is not a global problem, it does concern the northern countries of the world and the problems remain unsolved or badly addressed. The repercussions of being imprisoned for three or four months of the year for seniors and individuals with physical disabilities are very serious. This document is intended to be understood as a starting point for the development of additional studies seeking a better understanding of the person-environment interaction, with tangible results in the form of better design solutions.

Limitations of the study

This project could have had included seniors in its development. However, the focus of our recruitment was to gather adults with motor, visual and hearing disabilities; age was not considered a limitation. Moreover a cost/energy investment study of the solutions proposed has not been developed yet. Nevertheless, such a study will be carried out in the near future.

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