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ACCESSIBILITY OF WASHROOMS IN BUS TERMINALS IN WESTERN KENYA TO LEARNERS WITH PHYSICAL DISABILITY

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Abstract: Learners with physical disability in the western part of Kenya frequently make use of bus terminals during in the trip to and from school. Special schools attended by learners with a physical disability are few in number and far removed from the residences of most students thereby necessitating travel. Bus terminals located herein become obligatory points of passage for almost half of learners with physical disability in Kenya since seven out of thirteen special schools are located herein. This study, therefore sought to establish the accessibility of washrooms to learners with a physical disability whenever they made use of bus terminals. A cross-sectional survey design targeting 317 respondents who were sampled from a population of 1,525 was used. Data was collected through the use of questionnaires, technical measurements and observation schedules. It was established that washrooms in the study area enhanced spatial exclusion due to the presence of barriers at doorways and constricted washroom stalls.

Keywords: Universal design, spatial inclusion, physical disability.

Introduction

Children with disabilities (CwD) have universally suffered discrimination, violence and exclusion (International Save the Children Alliance, 2001). To counteract this discrimination, the rights of children were advocated for through legislations (Munro, 2001). In 2007, when Kenya signed the International Convention on the Rights of Persons with Disabilities, she stated her commitment to protect the rights of persons with disability by promoting access to facilities open to the public (Kiai, Onsando & Mwaura, 2007). Prior to this, the Government of Kenya enacted the Persons with Disabilities Act (PDA) in 2004 (GoK, 2004). The PDA addresses the provision of accessible terminals under the area covering rights of People with Disabilities (PwD) and equalization of opportunities.

The design and layout of washrooms have a direct bearing on the independence of learners with physical disability (LwPD) during instances when they use terminals. The concept of accessibility brings the idea of ‘everybody’s possibility to access’ (Duarte & Cohen, 2007). The basis of Universal Design (UD) principles is the provision of environments which are usable by all people (Lafferty, 2007). In the context of washrooms, the intent of UD is to simplify life for all users by making the facilities usable to all members of the populace, without locking out any segment.

A study by Ochieng, Onyango and Oracha (2010) investigated the accessibility of buildings in Kisumu Central Business District to people with physical disability. This study confirmed that numerous design barriers in and around buildings hampered mobility of people with physical disability. Another study which also investigated the accessibility of the pavements to people with physical disability was conducted by Ochieng, Onyango and Wagah (2014). This study noted that the pavements in the western part of Kenya did not enhance the independence of people with physical disability due to the presence of barriers in the pedestrian environment. Other than the pedestrian environment, the design of washrooms also has a direct bearing on the overall accessibility of a bus terminal. This study, therefore evaluated the design of washrooms in Western Kenya so as to establish the extent to which the spaces enhanced spatial inclusion of LwPD. The focus of the study was on LwPD enrolled in special schools since bus terminals were obligatory points of passage in the trip to school.

Methodology

The study was conducted through a cross-sectional survey design which was ideal since it enabled the researcher to collect data rapidly in the study area on the design of washrooms located in bus terminals at a given point in time (Oso & Onen, 2005). For the purpose of this study, the western part of Kenya was considered to be Kisumu County, Bungoma County, Homa Bay County and Kakamega County. These four counties have the highest prevalence of physical disability when compared with the rest of the Republic (GoK, 2008). The western part of Kenya comprises of the former Nyanza Province and the former Western Province. The study area cut across the major bus terminals in Kisumu County, Kakamega County, Homabay County and Bungoma County. Figure 1 shows the location of the study area.

Figure 1. Map of Kenya Showing Position of Western Kenya

The population of LwPD who made use of the terminals in the study area (1,525 from which 317 respondents) was sampled. Since the study focused on the major terminals at which respondents terminated their trip, the distribution of the interviewees was such that 14% evaluated the design of Kakamega terminal, 34% evaluated Bungoma terminal, 26% evaluated the design of Kendu Bay terminal, while 26% evaluated the design of Kisumu terminal. The distribution of respondents in the study area has been presented in Table 1.

Table 1. Distribution of Respondents. Field Data, 2016. Source: author.

Bus Terminal Evaluated	No. of Special Schools around	Population of LwPD using	No. of Respondents	% of Total
Kakamega	1	209	43	**14%**
Bungoma	3	515	107	**34%**
Kendu Bay	1	400	83	**26%**
Kisumu	2	401	84	**26%**
Total	**7**	**1,525**	**317**	**100%**

Respondents were required to evaluate the design of the major bus terminal at which they terminated the trip to school. The distribution of respondents was such that: 14% evaluated Kakamega bus terminal, 34% evaluated Bungoma bus terminal, 26% evaluated Kendu Bay bus terminal, while an additional 26% evaluated Kisumu bus terminal. Respondents were proportionately distributed.

Data was collected through the use of questionnaires, technical measurements and observation schedules. Respondents were required to evaluate the design of washrooms based on the following parameters: washroom door size, threshold design, washroom stall size, presence of grab bars and whether washroom floors were slippery. The observation schedule was used to verify the following: the dimensions of washrooms, the presence of at least one washroom accessible to a person with a disability, the state of washroom floors- whether they were slippery or they enhanced mobility, and the design of washroom doors.

Results and Discussion

Socio-demographic Profile of Respondents

Gender and Age of Respondents

The target population for the study was 1,525 LwPD from which 317 respondents were sampled. The ages of the respondents varied between 11 years and 17 years. A presentation of the gender and age of respondents has been presented in Table 2.

Table 2. Gender and Age of Respondents.Field Data, 2016. Source: author.

Gender	11-13 Yrs.	14-16 Yrs.	17-19 Yrs.	Total
Female	18.9%	28.4%	3.5%	50.8%
Male	16.7%	25.6%	6.9%	49.2%
Total	**35.6%**	**53.9%**	**10.4%**	**100%**

In the trip to school, all the respondents aged 11-13 years travelled with an escort to school (18.9%), while some of the respondents aged 14-16 years (28.4%) travelled with an escort. None of the interviewees aged 17 -19 years (10.4%) travelled with an escort. Across the ages, it became clear that the percentage of LwPD attending the special schools who were 11-13 years (35.6%) were less than those who were 14-16 years (53.9%). There was, however a drastic drop in the percentage of respondents who were 17-19 years (10.4%).

The disparity of ages across the study area can be attributed to the fact that respondents were drawn from both primary and secondary schools. In the study area, there is a critical drop of respondents aged 17-19 attending formal educational institutions since they only constituted 10.4%, yet respondents aged 14-16 were 53.8%. It seems therefore that as learners get older, they tend to quit formal learning institutions. This finding is in line with an observation made by Mugo, Oranga and Singal (2010) who revealed that youth with disabilities usually “fall through the cracks”.

Assistive Devices Used by Respondents

Respondents in the study area used assistive devices to substitute- to some extent- the missing or disabled limb. These devices also helped the learners to be independent since they enhanced movement from one place to another. Table 3 presents the distribution of assistive devices in the study area.

Table 3. Assistive Devices used by Respondents.Field Data, 2016. Source: author.

Assistive Device	Bungoma	Kisumu	Kendu Bay	Kakamega	Total
None	2.2%	15.5%	16.1%	7.6%	**41.3%**
Wheelchair	26.5%	4.7%	1.9%	0.3%	**33.4%**
Walking Stick	0.3%	0.6%	0.6%	0.6%	**2.2%**
Crutches	3.5%	5.4%	5.4%	3.2%	**17.4%**
Special Boots	1.3%	0.0%	2.5%	1.9%	**5.7%**
Total	**33.8%**	**26.2%**	**26.5%**	**13.6%**	**100%**

Across the study area, level of disability differed amongst the respondents who could either be classified as wheelchair users or ambulant disabled. Both the wheelchair users and ambulant disabled made use of the four bus terminals in the study area. These findings further reveal that ambulant disabled were more than wheelchair users. Ambulant disabled include those using special boots, walkers, crutches and walking sticks. The respondents who did not use any assistive device in the study area had neurological disorders which greatly reduced their strength. By extension, the dexterity with which this group manouvered within bus terminals was significantly reduced. This group of respondents was also classified as ambulant disabled.

Barriers at Washroom Entrance

Respondents in the study area were required to evaluate washroom entrances. The parameters used for the evaluation included: the presence of high thresholds, the presence of stairs, and the presence of ramps. Equitable access at washroom entrances was guaranteed when thresholds were no higher than 13 mm and when stairs and ramps were provided next to entrances. These provisions would ensure that entrances were accessible to all. A breakdown on the state of washroom doors has been presented in Table 4.

Table 4. Barriers Present at Washroom Entrance.Field Data, 2016. Source: author.

Bus Terminal	No Barrier	High Thresholds	Ramped access with no stairs	Total
Bungoma	2.2%	31.5%	0.0%	**33.8%**
Kisumu	5.7%	20.5%	0.0%	**26.2%**
Kendu Bay	25.6%	0.0%	0.0%	**25.6%**
Kakamega	1.6%	0.0%	12.9%	**14.5%**
Total	**35.0%**	**52.1%**	**12.9%**	**100%**

Across the study area, the barriers respondents came across were either high thresholds or ramped access with no stairs. More specifically, half of the respondents encountered high thresholds at washroom entrances (52.1%), while 12.9% encountered ramped access with no stairs. A third of respondents in the study area, however, experienced no barrier at the washroom entrance (35%). The most common barrier in the study area was high thresholds as highlighted by more than half of the respondents (52.1%). These results show that more than three-quarters of respondents experienced difficulty while making use of the entrances in the study area. Table 5 outlines further whether difficulty experienced was dependent upon assistive device used.

Table 5. Obstacles at Washroom Entrance. Field Data, 2016. Source: author.

Assistive Device	No Barrier	High Thresholds	Ramped access with no stairs	Total
None **(Neurological disorders)**	24.0%	9.8%	7.6%	**41.3%**
Wheelchair	1.9%	31.2%	0.3%	**33.4%**
Walking Stick	0.9%	0.9%	0.3%	**2.2%**
Crutches	5.7%	8.8%	2.8%	**17.4%**
Special Boots	2.5%	1.3%	1.9%	**5.7%**
Total	**35.0%**	**52.1%**	**12.9%**	**100%**

Respondents who did not use assistive devices were 41.3% of which more than half (24%) experienced no barrier at the entrances, less than a quarter (9.8%) highlighted the presence of thresholds as a barrier, while 7.6% confirmed that ramped access with no stairs was a barrier. The greatest barrier experienced by respondents who had neurological disorders was the presence of high thresholds (9.8%). Wheelchair users were 33.4% of which almost all experienced barriers due to high thresholds (31.2%), while a significant portion experienced barriers at the ramps (0.3%). This highlights the fact that the slope of the ramp was too steep for 0.3% of the respondents. High thresholds presented a barrier to slightly less than half of the walking stick users (0.9%), half of crutch users (8.8%) and slightly less than half of special boot users (2.5%).

The distribution of responses amongst respondents who experienced difficult due to the presence of ramped access with no provision of stairs along aide was such that respondents with neurological disorders reported the highest occurrence (7.9%), when compared to crutch users (2.8%), special boot users (1.9%), wheelchair users (0.3%) and walking stick users (0.3%)

The variation in responses can be attributed to the fact that entrances of washrooms in the study area were designed differently- with some washroom doors having thresholds while others had ramps. Some respondents pointed out that one barrier arose due to the provision of ramps at washroom entrances, while an entrance having steps was lacking. This phenomenon was present in Kakamega terminal as is evidenced in Figure 2.

Figure 2. Ramped Access with no stairs (Kakamega Terminal). Field Data, 2016. Source: author.

The main barrier in Kakamega bus terminal was that a ramped access had been provided at the main entrance of washrooms. Such a provision would benefit those on wheelchair while other disabled persons would experience difficulty traversing over the ramped surface. The researcher noted that thresholds were absent in entrances to washrooms in Kakamega. Other than ramped access with no stairs, respondents also pointed out that the presence of high thresholds was a barrier as has been highlighted in Table 6.

Table 6. Threshold Heights at Washroom Entrances.Field Data, 2016. Source: author.

Bus Terminal	Threshold Height in mm
Bungoma	160
Kisumu	150
Kendu Bay	155
Kakamega	0
Mean Height	**116.3**

Threshold heights varied between 150 mm and 160 mm as has been illustrated in Table 4.26. In Bungoma, respondents making use of washrooms encountered thresholds of 160 mm, in Kisumu the thresholds were 150 mm, in Kendu Bay the thresholds were 155 mm, while in Kakamega there were no thresholds at washroom entrances. The mean threshold height in the study area was therefore 116.3 mm. In order to establish if there was a significant difference between threshold height in the study area and the recommended threshold height, the study employed a t test. The study adopted a 95% confidence level, an α of 0.05 and a test value of 13 mm.

$$\overline{X_1} = 116.3\ mm$$

$$\mathrm{X} = 13\ \mathrm{mm}$$

$$t_{0.05} = 2.641$$

$$t_{e0.05} = 1.96$$

The presence of a computed t value which was significantly larger than 1.96, confirmed that there was a significant difference between threshold heights in the study area and the recommended threshold height. Threshold heights in the study area were much higher than the recommended height, given that in the study area the mean height of thresholds was 116.3mm, while the recommended height is 13 mm. The mobility of the learners was hampered during instances when they made use of the washroom entrances due to the presence of thresholds higher than 13mm.

On the presence of thresholds, Solidere (2004) confirms that high thresholds present a barrier to potential users. Joines (2009) explains further that most environments are designed for the average individual, a myth which only exists in anthropometric tables and ergonomics classrooms. Application of such ergonomic principles was seen clearly in the assumption that all members of society could be able to use thresholds which ranged in heights of between 150 mm to 160 mm. The presence of high thresholds confirmed further that the assumption of the designers of the bus terminals is that the "average" individual would use these thresholds.

To ensure equitable access over thresholds, Diversity Management and Community Engagement (2004) confirm that thresholds should not exceed 13 mm in height. Solidere (2004) clarifies further that thresholds higher than 6 mm should be bevelled or have sloped edges to facilitate the passage of a wheelchair. In order to ensure safe access over thresholds in the study area, there is a need for provision of bevelled thresholds no higher than 13 mm in the study area.

To cater for people who have non-ambulatory disabilities, Solidere (2004) proposes that ramps should be provided alongside any flight of steps. The design of these ramps should incorporate handrails having a smooth continuous surface from the top to bottom of the ramp, without breaking the handhold (Diversity Management and Community Engagement, 2004). Within the study area, it is commendable that a ramp had been provided at the entrance of washrooms in Kakamega bus terminal. The only point of departure is that there were no stairs next to the ramp. Such a scenario locked out ambulant disabled. This category encompassed those using special boots, crutches, walking sticks and those having neurological disorders.

Provision of ramps next to staircases would help ensure that the ambulant, ambulant – disabled and wheelchair users were able to use the same spaces. In this way, spatial inclusion would be enhanced. Provision of ramps next to stairways would also be in line with the UD principle which advocates for flexibility in use. This principle provides for adaptability to users pace, while providing choice in methods of use. Within the study area, provision of ramps next to stair cases would ensure that the washroom entrances are accessible to all, regardless of physical status.

Lid (2013) explains further that UD is not planning and designing for people with disabilities but acknowledging diversity in abilities among citizens. UD involves values, knowledge and practice. The values are dignity, equality and equal possibilities. Due to the condition of plurality, designers should plan for diversity physically, socially and spatially. Design of public places and institutions can be a manifest expression of respect for all individuals as equal citizens. Within the study area, provision of accessible doorways adhering to UD standards would help ensure that doorways were accessible.

Narrow Doorways

Another barrier highlighted by respondents was the presence of narrow washroom doors which impeded access. The researcher verified the washroom door sizes in the study area. Table 7 presents a breakdown of washroom door sizes in the study area.

Table 7. Washroom Door Widths. Field Data, 2016. Source: author.

Bus Terminal	Door Size in mm
Bungoma	790
Kisumu	790
Kendu Bay	700
Kakamega	670
Total	**737.5**

Door widths ranged between 670 mm, 700 mm and 790 mm. Washroom doors in Bungoma and Kisumu were 790 mm, doors in Kendu Bay terminal were 700 mm, while doors in Kakamega were 670 mm. The mean doorway width in the study area was 737.5 mm. In order to establish if there is a significant difference between washroom door size in the study area and the recommended washroom door size, the study employed a t test. The study adopted a 95% confidence level, an α of 0.05 and a test value of 900 mm.

$$\overline{X_1} = 737.5 \ mm$$

$$\mathrm{X} = 900 \ \mathrm{mm}$$

$$t_{0.05} = -5.255$$

$$t_{e0.05} = 1.96$$

The presence of a t value which is significantly less than 1.96, confirms that there is a significant difference between washroom door size in the study area and the recommended washroom door size. Washroom door sizes in the study area were narrower than the recommended door size, given that in the study area the mean height of washroom doors was 737.5 mm, while the recommended washroom door size 900 mm.

In the provision of accessible doorways, Douglas (2002) notes that a clear minimum width of 900 mm should be provided so that potential users can manoeuvre within the doorway without any difficulty. Presence of narrow doorways, in essence locks out potential users of washrooms who use assistive devices which require additional space. Since the normate template keeps a walking and fleshy body at the centre of thinking about design, buildings often fail to consider space requirements for bodies that use technologies to navigate space. In order to sustain itself, the normate template relies upon the impression that normates are normal, average, and majority bodies (Hamraie, 2013). A normate template is one held to operate between the 5th and 95th percentiles in ergonomics and anthropometrics. Within the study area, both wheelchair users and ambulant disabled experienced difficulty manoeuvring through narrow doorways.

A universally designed space can reduce dependence, ease burdens on strained relationships and empower multiple members of the social sphere. Individuals need not struggle to enter through entrances (Joines, 2009). The existence of narrow doorways in the study area confirmed that these doorways excluded some people from making use of the washrooms. The presence of narrow doorways passed out non-verbal cues to the wheelchair users and ambulant disabled that these doorways were designed solely for those who could “fit” in the given doorways. In this way, spatial exclusion was enhanced.

Narrow Wash Room Stall

Respondents in the study area pointed out that washroom stalls were narrow and this posed a barrier. The size of washroom stalls in the study area was defined by the washroom lengths and widths. The trend of responses has been presented in Table 8.

Table 8. Narrow Washroom Stall.Field Data, 2016. Source: author.

Bus Terminal	Washroom Stall Not Narrow	Washroom Stall Narrow	Total
Bungoma	6.9%	26.8%	**33.8%**
Kisumu	13.2%	12.9%	**26.2%**
Kendu Bay	6.9%	19.6%	**25.6%**
Kakamega	7.3%	6.3%	**14.5%**
Total	**34.4%**	**65.6%**	**100%**

The highest percentage of respondents who highlighted the presence of narrow doors used Bungoma bus terminal (26.8%). This percentage represented slightly more than a quarter of the respondents who made use of the study area. A further distribution of responses is such that a fifth of the respondents from Kendu Bay (19.6%), while slightly less than a fifth made use of Kisumu bus terminus (12.9%). Within Bungoma terminal, about three-quarters of the (26.8%) indicated that washroom stalls were narrow, while responses from Kisumu terminal was such that slightly less than half stated that washroom stalls were narrow (12.9%).

The trend of responses in Kendu Bay was such that almost two-thirds of the respondents (19.6%) indicated that washroom stalls were narrow while in Kakamega, slightly less than half indicated that washroom stalls were narrow (6.3%). Table 9 presents results for narrow washroom stalls based on assistive devices of respondents.

Table 9. Washroom Size.Field Data, 2016. Source: author.

Assistive Device	Stall Size Adequate	Narrow Washroom Stall	Total
None (Neurological Disorders)	18.9%	22.4%	41.3%
Wheelchair	1.9%	31.5%	33.4%
Walking Stick	0.3%	1.9%	2.2%
Crutches	10.1%	7.3%	17.4%
Special Boots	3.2%	2.5%	5.7%
Total	**34.1%**	**65.9%**	**100%**

Respondents who did not use assistive devices were 41.3% of which slightly more than half (22.4%) indicated that washroom stalls were narrow. Almost all the wheelchair users (31.5%) indicated that washroom stalls were narrow. Amongst walking stick users, more than three-quarters (1.9%) stated that washroom stalls were narrow. Crutch users were 17.4% of which slightly less than half (7.3%) confirmed that washroom stalls were narrow. Slightly less than half of special boot users (2.5%) stated that washroom stalls were narrow. The trend of responses reveals that more than three-quarters of the respondents experienced spatial exclusion due to narrow washroom stalls in the study area. The specific parameters used to evaluate the contributing variables to narrow washroom stalls were: washroom width, washroom length and washroom door opens into the cubicle.

Washroom Widths in the Study Area

Across the study area, washroom stalls had various widths as has been outlined in Table 10.

Table 10. Washroom Widths.Field Data, 2016. Source: author.

Terminal	Washroom Width (mm)
Bungoma	830
Kisumu	850
Kendu Bay	820
Kakamega	820
Total	830

Within the study area, the mean washroom stall widths was 830 mm. In Bungoma terminal, the washrooms had a width of 830 mm, in Kisumu the width was 850 mm, Kendu Bay 820 mm and Kakamega 820 mm. In order to establish if there was a significant difference between washroom widths in the study area and the recommended washroom width, the study employed a t test. The study adopted a 95% confidence level, an α of 0.05 and a test value of 1675 mm.

$$\overline{X_1} = 830\ mm$$

$$\mathrm{X} = 1675\ \mathrm{mm}$$

$$t_{0.05} = -119.5$$

$$t_{e0.05} = 1.96$$

The presence of a t value which was significantly less than 1.96, confirmed that there was a significant difference between washroom widths in the study area and the recommended washroom width. Washroom widths in the study area were significantly narrower than the recommended width, given that in the study area the mean washroom width was 830 mm, while the recommended washroom width was 1675 mm.

Washroom Lengths

Presented in Table 11 is a breakdown of washroom lengths in the study area.

Table 11. Washroom Length.Field Data, 2016. Source: author.

Bus Terminal	Washroom Length in mm
Bungoma	1580
Kisumu	1600
Kendu Bay	1480
Kakamega	1590
Total	**1562.5**

Within the study area, washroom lengths varied between 1480 mm and 1560 mm. Washroom length in Bungoma bus terminal was 1560mm, in Kisumu the length was 1540 mm, in Kendu Bay washroom length was 1480 mm, while in Kakamega bus terminal the washroom length was 1520 mm. The recommended washroom length as per UD standards is 1500 mm minimum by a recommended width of 1675 mm for use by persons with mobility aids or others requiring personal assistance (Diversity Management and Community Engagement, 2004). Within the study area, washroom lengths fell within the required lengths in Bungoma bus terminal, Kisumu and Kakamega. Washrooms in Kendu Bay fell short of this requirement by 20 mm.

The presence of narrow washroom stalls in the study area was a barrier to LwPD, especially the ones who used assistive devices. McLaren, Philpott and

Hlophe (1996) suggest that assistive devices enable people with disabilities to be independent so that they can function as active members of society. While these devices do not cure or eliminate challenges, they take advantage of the strengths of the disabled person; and then circumvent areas of difficulty (Mcguire, 2011). Once this compensation has been done then people with disability are able to achieve their individual lifestyle goals and ambitions (McLaren, Philpott and Hlophe, 1996).

Solidere (2004) identifies insufficient space in washrooms as a barrier to access. Lacey (2004) suggests that suitable and easily identifiable sanitary accommodation should be provided for all building users. This will involve combinations of general provision of accommodation for ambulant people with disabilities, those who need more space and wheelchair users. Sanitary facilities should be designed to meet the needs of all building users regardless of age, size, ability or disability. Adopting a UD approach will ensure that facilities can be accessed and used by a diverse population with an equitable level of convenience, understanding, choice, safety and comfort (Center for Universal Design, n.d.).

The presence of washroom widths which were significantly narrower than the recommended in enhanced spatial exclusion of individuals who could not operate within the widths set forth across the study area. Learners who had assistive device experienced spatial exclusion since these devices required additional space. The presence of narrow washroom in the study area therefore, meant that some LwPD were completely locked out of washrooms.

Doors Open into Washroom Cubicle

Another barrier highlighted by all the respondents was that usable space in the WC was compromised since doors opened into the toilet stalls. This phenomenon also contributed to constricted washroom lengths. Lacey (2004) suggests that doors to WC cubicles and wheelchair-accessible unisex compartments should open outwards. It is important however to ensure that the WC door does not open onto a circulation path to ensure the privacy of users (Pagel and Harris, 2002). During instances when they open into the cubicle, they should not encroach unduly on usable space. Where doors swing outward, an additional pull handle should be mounted horizontally close to the hinge side of the door (Diversity Management and Community Engagement, 2004). Where cubicle doors are outward opening, particular care should be taken in planning the layout of the toilet to minimize the risk of a person colliding with the door. Wherever possible, outward opening doors should open against an adjacent wall (Center for Excellence in Universal Design n.d.).

From the perspective of disability, UD is not planning and designing for people with disabilities but acknowledging diversity in abilities among citizens. UD involves values, knowledge and practice. The values are dignity, equality and equal possibilities. Due to the condition of plurality, there is need to plan for diversity physically, socially and spatially. Design of public places and institutions can be a manifest expression of respect for all individuals as equal citizens. Further, experiencing access contributes to giving individuals a social basis for self-respect as equal citizens. Usability is a subjective term. If design is to be usable by all people to the greatest extent possible, there is a need for knowledge from a vast number of different individual perspectives (Lid, 2013).

Conclusion

Inappropriate design of washrooms located in bus terminals of Western Kenya enhanced spatial exclusion of LwPD. This study also revealed that there were instances when respondents with neurological disorders experienced difficulty just as much as wheelchair users, crutch users, walking stick users and special boot users. A possible point of intervention in the provision of accessible washrooms would be the involvement of persons with disabilities in the design process. This segment of society can be able to guide designers on the components of accessible built environments. This scenario arises since they possess the experiential knowledge of spatial exclusion and can thereby suggest solutions for circumventing the design barriers.

Further, there is a disconnect between what the Country (Kenya) pledges to do as far as UD is concerned and what actually exists on the ground. On one hand, the government has enacted legislations, while ratifying international conventions which uphold UD. On the other hand, the washroom designs in the western part of Kenya confirm that designers of these public spaces did not consider UD requirements despite the existence of these legislations. Incorporation of UD parameters in the built environment, therefore requires more than just legislations.

In addition to this, the study revealed that UD is more than codes and dimensions since there were instances when the lengths of washrooms were within the recommended dimensions, yet some members of the populace stated that they experienced difficulty using the designed spaces. During this particular instance, washroom doors opened into the cubicle thereby constricting the space available in the toilet. This reveals that UD also encompasses intricate details of washroom design such as layout and door swing.

In conclusion, Universal Design places an onus on designers of the built environment to factor in cause-effect relationships of their design actions on the final consumers of living spaces.

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Appendices

APPENDIX I.STUDENT QUESTIONNAIRE

Dear Respondent,

This study intends to establish the design barriers in bus terminals which deter safety, independence and free mobility of students with physical disability in the trip to and from school. Please note that participation in responding to questions contained herein is voluntary. The information you provide will be kept confidential within the limits of the law. Your name will not appear in any report or publication of the research. The contents of this questionnaire will be safely stored in a place that is locked and will be destroyed at the end of the study.

Please answer the questions contained herein truthfully.

SECTION ONE: DEMOGRAPHIC QUESTIONS

Given below are questions on your demographic profile. Please answer them truthfully.

What is your age? _________

What is your sex?

Male

Female

Specify the town in which you live. ___________________

Type of assistive device used

__Wheel Chair __Crutches __Special Boots __Walking Stick __None (Neurological Disorders) Other (Specify)____________________

Name of School attended ____

Do you travel alone to school ____

Are there times you require assistance in using terminals? Please explain

List the major terminals you use in the trip to school

SECTION II: EVALUATION OF WASHROOM

Is your independence in washrooms hampered due to its design while maneuvering through the doorway due to its width?

__Yes __No

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Tick the statements which describe the characteristics of the washrooms

Washroom doors are narrow and difficulty is experienced going through the doors.	Washroom doors are wide and difficulty is not experienced going through the doors
The threshold is high and difficulty is experienced using it.	The threshold is low and difficulty is not experienced maneuvering over it.
The wash room stall is narrow and difficulty is experienced turning inside the washroom.	The wash room stall is wide and difficulty is not experienced turning inside
Grab bars are absent	At least two grab bars have been provided around the sinks and WC
The washroom floor is slippery	The washroom floor is not slippery.

Please outline any other barriers that you encounter in using washrooms

APPENDIX II OBSERVATION SCHEDULE FOR BUS TERMINALS.

Name of Terminal____

1. County

   ____

2. **COMPARTMENTS**
   a. Is at least one compartment for each sex accessible to a physically disabled person?
   b. Is the accessible washrooms marked with the international symbol of accessibility?
   c. What are the dimensions of the washrooms?
3. **Washroom Floor**
   a. Describe the state of the washroom floor (Is it wet or dry)

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b. Is the wash room floor on skid or does it present a slipping hazard.

4. REST ROOM DOOR

a. Do the doors open outward unless sufficient space is provided within the toilet stall?

b. Are the doors lockable from the inside and releasable from outside under emergency situations?

c. Has a handle been placed on the door from the inside to facilitate closing?

d. Has another handle been provided on the outside

ACCESSIBILITY OF TOURIST SITES TO PEOPLE WITH DISABILITIES: THE CASE OF CAPE COAST AND ELMINA CASTLES IN GHANA

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Abstract: The term accessibility is used in the context of providing equal opportunity to enter into an environment. Much is not known about the accessibility of tourist sites such as castles and forts to people with disabilities. This study sought to examine the accessibility of the Cape Coast and Elmina Castles to people with disabilities through a qualitative approach which involved in-depth interviews and photovoice to collect data. The study revealed that the castles are inaccessible. Though ramps, spacious pathways and hand rails in washrooms existed, there was however, no mutual relation between the design of the castles and the concept of accessibility as defined by the Disability Act. The creation of awareness on the rights of the disabled to participate in the tour of castles can perhaps draw the attention of local government authorities and other relevant stakeholders to effect the necessary changes.

Keywords: accessibility, people with disabilities, tourist sites, Ghana.

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Introduction and background

According to the World Health Organization (2011), more than a billion people or about 15% of the world's population are estimated to live with a disability. The number continues to increase due to several factors among which are advances in science and technology (WHO, 2011). In spite of the fact that they constitute a significant proportion of the world's population, issues affecting people with disabilities continue to receive little attention leading to their marginalization in all spheres of life.

Accessibility is an essential part of the inclusion of people with disabilities. An accessible barrier-free environment is the first step towards fulfilling the right of people with disabilities to participate in all areas of life. Accessibility is a very broad term covering all aspects of assuring that persons with disabilities can participate and have the same choices as persons without disabilities (World Bank, 2010).

Many environments, spaces, products, etc. are developed without a consideration of people with impairments (including the elderly), and it is often assumed that such groups are either unimportant or irrelevant for mainstream design to consider. This often results in these environments and products becoming inaccessible to special populations (and sometimes to mainstream population as well).

Today, tourists seek authentic experiences from places they visit. For countries where the historic environment is a crucial component of tourism, the concept of maintaining authenticity is vital to encourage potential visitors. Historic buildings, such as castles, were built in a time when accessibility for people with disabilities was not a major concern. Today, the number of people living with disabilities is increasing and is expected to continue to grow as a result of the ageing population, sickness and longer life expectancy. While all people may have a desire to participate in tourism, and a similar growing interest in an authentic experience, a historic site is enjoyed by all interested visitors only when it is accessible to all (Heather, 2013).

Accessibility issues are perhaps most readily identified with the needs and capabilities of people with disabilities. This group has received relatively little attention in the literature when it comes to their particular needs and capabilities as consumers (Kaufman-Scarborough, 2001).

The major challenge confronting most historical facilities are their inaccessible nature. In an attempt to make them accessible, there is always the assumption that making the built environment accessible is expensive and may put a financial burden on authorities concerned. Accessible infrastructure creates value for owners, as a building that meets accessibility requirements will be able to adapt easily to changing needs, including the ageing or emerging disabilities of its occupants. But, it can also be agreed on the point that, because many people do not consider disability issues as important, it will be quite difficult to solicit for financial help with such attitude from the society. Also to support this, Imrie and Hall (2001) have identified some assumptions within the construction industry that, currently, prevent the built-environment from being designed in such a way as to reduce architectural disability. One of these assumptions is that it is unreasonably costly to provide environments that are fully accessible. This assumption is half-truth and can be disproved. In terms of cost, one could argue that inclusive design can be financially beneficial, in that, in most cases, universal design elements can be added to a product's design for little or no cost. It must, however, be admitted that, in some situations, designing for everyone may include features that cost more than traditional designs.

According to Imrie (2002), the built environment of many countries has remained largely inaccessible which can be attributed to the common reason that statutory and legal provisions underpinning the construction of barrier-free environments are feeble or absent in most countries. In many of the developed countries such as UK, US and even the developing countries such as Ghana, there are international and national laws that mandate its citizens to ensure accessibility to places, especially public places including tourist sites

Accessible Tourism and Legal Regimes

Accessible tourism is a form of tourism that involves collaborative processes between stakeholders that enable people with access requirements, including mobility, vision, hearing and cognitive dimensions of access, to function independently and with equity and dignity through the delivery of universally designed tourism products, services and environments (Buhalis & Darcy, 2010). Accessible tourism can be implemented if more details are allowed for understanding of the needs of PwD (Darcy and Pegg, 2011). Tourism for PwD is not only removing physical barriers (Yau, McKercher and Packer., 2004), it should provide a meaningful experience to ensure their quality of life. Accessible tourism promotes human rights and equal opportunity, by paying more attention to the needs and requests of tourists with disabilities and recognizing that people with disabilities have the same needs and desires for tourism as others, thus leads to the concept of accessible tourism (Yau et al., 2004). Involving people with disabilities in tourism activities does not only create revenue but it is also a legal obligation (Takeda & Card, 2002)

At the sixteenth session of the General Assembly of the World Tourism Organization (WTO) at Dakar in Senegal (2005), a general resolution was made to ensure that member countries take steps to make tourism sites accessible to all. In section V subsection D of the resolution, which focuses on museums and other buildings of tourists interest, facility owners are required to resolve problems that may be encountered by visitors with reduced mobility in their horizontal or vertical movement, by providing ramps or elevators as the case may be as well as taking into account the needs of people with visual or hearing impairment. To this end, all information shall be provided in both written and acoustic form.

The UN Convention on the Rights of Persons with Disabilities (2006) states in articles 8 and 30 that, state parties should ensure access for persons with disabilities as everyone else, ‘to the physical environment, to transportation, to information and communications, including information and communications technologies and systems, and to other facilities and services open or provided to the public, both in urban and in rural areas` and that participation in cultural life, recreation, leisure and sport are crucial for the full enjoyment of life by people with disabilities.

According to section 6 of Persons with Disability Act, 2006 of Ghana, the owner or occupier of a place to which the public has access shall provide appropriate facilities that make the place accessible to and available for use by people with disabilities. It further states in section 7 that a person who provides service to the public shall put in place the necessary facilities that make the service available and accessible to people with disabilities. In ensuring compliance, the act spells out sanctions for non-compliance in section 8 which states that among other sections, a person who contravenes sections 6 and 7 commits an offence and is liable on summary conviction to a fine not exceeding fifty penalty units or to a term of imprisonment not exceeding three months or both.

However, despite the passage of the Persons with Disability Act by the Parliament of Ghana and several years after the country had ratified the United Nations Convention on the Rights of Persons with Disability, little has been done on the provision of access for people with disabilities in public buildings in Ghana.

The study, therefore, sought to find out the views of authorities of the Cape Coast and the Elmina Castles on accessibility of their facilities to people with disabilities as against the reality of the facilities.

Methods

A descriptive case study design was chosen to investigate the extent to which the Cape Coast and Elmina Castles are accessible to people with disabilities. The study adopted a qualitative approach which involved in-depth interviews with 7 participants purposively recruited. The respondent's recruitment was based on the following criteria (a) should be a policy maker and (b) should have direct control over or management of the institutions. In addition, field workers at the castles were recruited purposively. The participants comprised of 2 managers and 4 field workers therein referred to as tour guides at the selected castles and 1 tourist board representative. Interviews were tape-recorded and subsequently transcribed. To derive a more objective form of assessment, an observation was done on the two castles. Interview and observation guides were used to collect data as well as photovoice. The observation was done to ascertain the existence and accessibility of facilities such as Parking area, Door size (entry and exit), Hallways, Signs and symbols, and Washrooms

Thematic analysis was employed for analyzing self-reported data. Initially, researchers studied the field notes, reduced the tapes into transcripts and carefully read through them. This was done to look for themes and similar ideas or responses to the questions posed to the respondents of which the respondents' information or speech were translated into specific categories for the purposes of analysis based on the interview guide which was prepared. In the case of the observation, photo voice was used in which pictures taken from the two facilities were compared and identified similarities and differences in relation to the observation guide that was used.

Ethical Consideration

Ethical clearance was sought from the Committee on Human Research, Publication and Ethics at Kwame Nkrumah University of Science and Technology. Further clearance was sought from the central regional tourist board. Informed consent was sought from respondents. Also, respondents were assured of confidentiality and anonymity.

Limitation of the study

The study did not make use of a large sample size which could potentially reduce the transferability of its findings.

Results

Demographic characteristics of participants

Table 1. Demographic characteristics of participants. Field Data, 2015. Source: authors.

Respondents	Place of work	Experience at work (yrs)	Position at work
1	Cape Coast Castle	5	Manager
2	Elmina Castle	15	Manager
3	Tourist Board	3	Manager
4	Cape Coast Castle	1	Volunteer
5	Cape Coast Castle	3	Field worker
6	Elmina Castle	5	Field worker
7	Elmina castle	4	Field worker
N= 7		X= 5	

N- Total number of respondents X- mean years of experience

Support Systems

The study found several support systems which in the view of the participants aided their work. However, these support systems could not be directly linked to aiding people with disabilities who visit these tourist sites.

System of communication

Table 2.Support Systems on communication. Field data, 2015. Source: authors.

Respondent	Response to question: What system of communication exists to aid tourist with disability in relation to A- Advertisement B- Clarity of information C- Signage?
1	A. “Well there are other informal ways of advertising the castle and included fairs organized annually such as PANAFEST in the central region, just that these are for the general public and not directed towards specific groups like the people with disabilities.” B. “No please...” C. “Well, the map at the reception can serve as a guide to tourist with hearing impairment…”
2	A. “For advertisement to be honest with you, we don’t have anything in place for the disabled tourist, we sometimes advertise our facility through music videos, movies but we don’t really target people with disability”. B. “No please” C. “As for the signs, you can consider the danger sign on one of our spoilt door and this is large enough to be seen even by the visually impaired”

Respondent	Response to question: What system of communication exists to aid tourist with disability in relation to A- Advertisement B- Clarity of information C- Signage?
3	A. "Well, there may be a form of advertisement in the 2 castles but I'm not sure whether it is specific for people with disabilities" B. "People do not get to know about the detailed information and accessible state of the castles, thus the location, activities of the castle…." C. "Well, I think you will find some signs there….I'm not sure they are entirely convenient for the disabled tourist"
4	A. "Mm, I don't know about any adverts about this place ever since I started my volunteer work" B. "No, I don't think we have clear information with regards to the disabled tourist" C. "Oh yes, you can see a number of signs around…..I don't think they were designed with the disabled tourist in mind"
5	A. "Brochures and journals which were sent to hotels also served as another informal way of telling people about the castles". B. "No Idea " C. "As you can see, there are not many signs, you can see the parking lot sign, the map at the reception….."

Respondent	Response to question: What system of communication exists to aid tourist with disability in relation to A- Advertisement B- Clarity of information C- Signage?
6	A. "No please" B. "No…" C. "Yes, you can see the sign of the skull on top of one of the entrances to the dungeon which represent danger"
7	A. "...No we don't" B. B. "No idea" C. "you can see one of the skeleton signs that communicates danger to people with hearing problem"
N=7	

Table 2 shows the findings on the system of communication that exist to facilitate the people with disabilities. Three main areas were presented, the existence of a form of advertisement specific for the people with disabilities, clarity of information made available to the people with disabilities even before they embark on their journey to these tourist sites and then the existence of signage system. It is quite apparent that a form of advertisement existed in both the Elmina and Cape Coast Castle. The media of advertisement include organized fairs, music videos, movies, brochures and journals. None of these advertisements, however, was intended for people with disabilities as described by all the respondents. The fact that no system of advertisement existed for the people with disabilities automatically implied that the variable clarity of information with regards to the accessibility of the castle to the people with disabilities elicited "No" as a common response. In relation to the signage, a number of signs and symbols were captured by researchers, and this includes signs of danger, gender and a map in both castles. Whereas the map of the Cape Coast Castle was well located on a map (at the reception) to help tourists with hearing disabilities to know the exact locations without finding difficulty in identifying some rooms, one can argue that the font size, colour and background would not be convenient for the visually impaired. Analysis of the picture illustrated by Figure 5 communicated a form of danger in relation to a condemned door to tourists with hearing impairment and this was not only large enough to be perceived by the visually impaired, but the sign is also internationally recognized. Although some signs existed, they were meant for the general public and not for the tourist with disability. Some facilities had no signs of the "people with disability" at the parking lot and also the lavatories to communicate the places are reserved for the disabled but this was not seen.

Infrastructural system of support

Table 3. Support Systems on Infrastructure. Field Data, 2015. Source: authors.

Respondents	Responses to question: Does the infrastructure of the castles aid people with disabilities? A- Floors/surfaces/pavements /space B-lavatories
1	A. "You can find 2 ramps in the castle and this was designed to make it easy for tourist with difficulty in walking, the doors are wide enough to facilitate easy entry and exit, the fact that the "door of no return" is located at the extreme south of the castle makes it difficult to be accessible by tourist with mobility impairment should there be an emergency, the floor surfaces are also rough…" B. "As for the lavatories, they are always unlocked and accessible, the toilets seats are low and we have horizontal hand grails that help tourist who use crutches and other mobility impairments"
2	A. "There is a long series of stair case that have no ramps and this is a problem for those with mobility impairment, but the parking space, courtyard and other places are wide enough. The doors are however large enough to accommodate wheel chairs though" B. "The entrance to the lavatories are restricted because there is no ramp that links the ground floor to the lavatories but rather, there is one stair present"
3	A. "Well, the surfaces of the floors are rough because of the rocks and stones which were used in building of the two castles; this

Respondents	Responses to question: Does the infrastructure of the castles aid people with disabilities? A- Floors/surfaces/pavements /space B-lavatories
	sometimes makes it difficult for those with walking impairments. Some of the castles have ramps and this is helpful” B. “The doors to the lavatories are always opened and there is a wide space for movement when one access the lavatories, hand grails have also been provided to facilitate”.
4	A. “The ramp beside the stairs that leads to the communication channel enables people with disabilities to move freely without a guide” B. “ as for the lavatories, they are always open to all”
5	A. “Though the surfaces are rough I think they help prevent the visually impaired from slipping, two ramps present and the sloping entrances to the dungeons, as for parking lot we don’t have one specific for the disabled tourist, we also have a parking space” B. “the lavatories are accessible to people with disabilities due to the presence of the horizontal grails and the low-leveled of the toilet system”
6	A. “ The doors are wide enough to accommodate even wheel chairs, just that we don’t have ramps by the stair case and this is bad” B. “ the lavatories are spacious enough but just that a staircase

Respondents	Responses to question: Does the infrastructure of the castles aid people with disabilities? A- Floors/surfaces/pavements /space B-lavatories
	leads to this place and there is no ramp”
7	A. “There is no special parking lot for the disabled…” B. “the lavatories are always open to all”
N= 7	

Table 3 shows clearly the findings of the system of support that exists in both the Cape Coast and Elmina Castles. The doors, floors, horizontal and vertical movements, lavatories and the parking lots were all assessed. It is apparent that the surfaces of the floor of both castles are rough as illustrated by Figures 2 and 4. The rough surface of parts of the floors was perceived as posing a challenge to the tourist with impaired mobility, but this was not the case for some of the participants who thought the rough surfaces rather facilitate free movement. Whereas ramps were identified along some of the staircase found in the Cape Coast Castle, none was reported to be present at the Elmina Castle. The existence of these ramps that aid in vertical movement is confirmed in Figure 3. The doors to the various rooms and spaces of both castles were wide enough and this makes the entry of wheelchair free and easy. The same could however not be said about one of the doors of the toilet showed in Figure 10. Although a parking space existed in both castles as confirmed by Figure 1, they were not areas that were specifically reserved for the disabled tourist. Washrooms were present in both castles and they were spacious enough to allow for free movement of tourist with mobility impairment (Figure 9); the fact that these washrooms had handrails showed, to support the mobility impaired.

Support systems in relation to staffing

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Table 4. Support system in terms of staff training. Field Data, 2015. Source: authors.

Respondents	Response to question: Do the staff receive special training in areas like A. handling of special equipment B. Dealing with stigmatization?
1	A. "The staff has not acquired any special skill in assisting the people with disabilities in touring the facility and despite this claim, we do not discriminate people with disabilities when assisting them" B. "There is always a fair treatment with our clients and there is nothing like discrimination".
2	A. "The staffs have no formal training on assistive devices for visual and hearing impairments…" B. "our customer service policy requires that all tourist be treated with respect and that we do"
3	A. "Well, it almost impossible to employ skilled personnel when it comes to managing the disabled tourist..." B. "The staff take care of all tourists equally and there is nothing like discrimination"
4	A. "We have no special training in the management of people with disabilities who visit our facility". B. "Mm, we only treat people with disabilities equally as the tourist without disabilities. We can say that our services are not discriminatory"
5	A. "Someone skilled in the repair of prosthesis? No there is no such personnel, you know they usually are accompanied by a guide"

Respondents	Response to question: Do the staff receive special training in areas like A. handling of special equipment B. Dealing with stigmatization?
	B. "the thing is that you don't get many people with disabilities but if we get, we give them due respect"
6	A. "We manage them without any special skill because we do not have knowledge in how to handle people with disabilities" B. "...never do we discriminate people with disabilities in the course of rendering our services but we rather give them special attention when touring the castle".
7	A. "From time to time, we help in any way possible eg. Helping move the wheel chair, just that we don't have any skill" B. " As for discrimination, it doesn't exist in this setting because we try to entertain out visitors and not to make them feel bad"
N= 7	

It was quite clear from the responses provided by table 4 that no formal training on the management of tourist with disability existed. This can be explained by the fact that the turnout of people with disabilities is not that frequent and they are usually accompanied by a guide. The guides are the ones who are equipped with specific skills that aid the people with disabilities. Researchers could not take a picture of any unit that was delegated to repair and replacement of prosthesis commonly used by the people with disabilities. It is clear that a system of customer service clearly exists to prevent discrimination, the staff were however not aware of special needs of the people with disabilities in relation to stigmatization.

Vertical circulation: staircases and ramps

Vertical circulation refers to the vertical movement of people from one floor to another within or between buildings and facilities. Building components that are usually employed to scale these heights include staircases, ramps and lifts. Most of the rooms or dungeons in the castles are accessed by stairs. A staircase in Cape Coast Castle is complemented by a ramp as shown in Figure 1**.** In Elmina Castle, the case is different, there is series of long steep stairs with handrails without attachment of ramps and is located just beside the main entrance door shown in Figure 2**.**

The question is, how do people with disabilities efficiently tour around in the Elmina Castle? These are not just any steps. At the top of these stairs sits a room for one of the prominent governors who used to reside in the Castle at time of the slave trade. Aside from the room, the design of the stairs attracts tourists to climb and take photographs on the stairs. And here again, people with disabilities are neglected. However, the ramp beside the stairs in the Cape Coast Castle which leads to the communication channel serves as another pathway for tourists who access the upper floors. Both people with disabilities and people without disabilities can freely use that channel without any stress of climbing the stairs. Even though the ramp was not constructed intentionally, it makes Cape Coast Castle have an advantage over the Elmina Castle. Another accessible ramp can be found in Figure 3 where the stairs are accessible to people with disabilities because of the attachment of the ramp. The ramp which is located beside the stairs that leads to the communication channel on the second floor at the Cape Coast castle enables people with disabilities to move freely even without the help of a guide. It also serves as universal design, thus anybody who feels uneasy with the stairs can freely access the top floor with the aid of the ramp and moreover, the aged can also use this support service present at the Cape Coast Castle and feel satisfied.

The long series of stairs at the Elmina Castle prevents people with disabilities from fully utilizing their bill (money paid to the institution before the tourist guide takes the tourist on the tour).

Horizontal circulation: entrances, floor surfaces

The untiled surface of the floor and the presence of ramp in Cape Coast Castle facilitate the circulation of people with disabilities and the aged who find it difficult to walk. Despite the rough surface which may cause difficulty in walking or moving the wheelchair at times, it prevents people from slipping on the floor which might cause harm to the individual and also have a ramp attached. There are large spaces around the castle with yards which can be used for any recreational activity in the castle**.** See Figure 3. The wide space and ramp also present facilitate movement. The castle is also lucky to have their second ramp at the courtyard. The presence of the two ramps can also be said to be one of the factors of high patronage of the Cape Coast Castle as compared to Elmina Castle.

The floor surface can cause difficulty in the movement of wheelchair and canes. The narrow entrance and the poor lighting system do not encourage touring by people with disabilities. This is shown in Figure 4.

Signage and information

About 100% of the signage in both castles are not internationally recognized, but in these cases, the signs and inscriptions are visible, clear, simple, and easy to read and understand Contrasting colours were also employed to differentiate letters from their backgrounds (embossment on a wooden material for the signage). The map of Cape Coast Castle gives directions to tourists who tour in the castle. The map of the castle, therefore, describes where one can locate one room or a dungeon when he/she is in search of a room and also facilitate the communication between the management of Elmina Castle and tourists with difficulty in hearing. The signage is clear and easy to understand by any tourists. Even though the sign on top of the female slave dungeon in Elmina Castle is not internationally recognized, it communicates to tourists who the residents of the dungeon were. The map of the Cape Coast Castle at the reception of the Cape coast Castle communicates to tourists the architectural view of the castles and where each room is located in the castle. This helps tourists with hearing disabilities to know the exact locations without finding difficulty in identifying some rooms. Despite the symbol (the skull with two cutlasses) on top of the condemned door at the Elmina Castle which communicates "danger or killing" to tourists with hearing impairments, it is not internationally recognized. The symbol on the door communicates better what used to happen in that cell to the tourists. See Figures 5, 6 and 7.

General lightening

The lightening system in Cape Coast Castle as shown in Figure 8 will pose a challenge to tourists with low vision. Movement of tourists in the castle becomes more difficult due to the presence of two barriers at the same time, the rough nature of the floor surface and the poor lightening system. The lightening system in the castle is poor causing difficulty in movement in the dungeons. Most of their source of light is through the natural means. The lightening system in the dungeons at the Cape Coast Castle does not favour tourists with low vision.

Tourists without low vision will find it difficult moving in and around the dungeons. Aside from the lightening system, the floor surfaces are rough, making gaiting very difficult.

Sanitary accommodation

The result revealed that the unlocked accessible washroom had less restriction for people with disabilities because there were supportive services present such as low level toilet system **as** shown in Figure 9, horizontal hand rails and wide cubicle found in Figure 10. They also have ample space for maneuvering by wheelchairs. Wheelchair maneuvering space is very critical in allowing people with disabilities to use toilet accommodation either independently or with assistance from others, when necessary. Aside from the space and the horizontal hand grails and the location of the toilet seat, the washroom is always opened making the facility accessible to all.

The ample space at the washroom of the Cape Coast Castle helps in circulation by people with disabilities especially the tourists with physical disabilities. The horizontal grab rails help people with disabilities to stand and move on their own.

Emergency exit

The existence of a building is equally important as the entrance into a building and exit from the building. In the case of Cape Coast Castle, the emergency exit is not accessible to people with disabilities who tour in the institution. The exit door is located at the extreme south of the castle and the path leading to the door is rough making people with disabilities unable to find their way out of the castle in case of any emergency. The door also leads to the shore of the beach with stairs as shown in Figures 11 and 12.

Though the management of the two castles want to maintain the originality of the purpose of which the castles are serving, they can make one or two changes to the institutions to make it accessible to all. Despite the large door of the “door of no return” in Cape Coast Castle, the location of the door makes it inaccessible. The door is located at the extreme end (south of the castle) with rough surface so in case of an emergency, tourists with physical impairments will not be able to escape easily.

Discussion

The study sought to explore support systems that exist in the Cape Coast and Elmina Castle in areas of communication, infrastructure and staff training. Of all the support systems in the two castles, the strongest was the infrastructure. Both castles were found to provide some level of support to the tourists with disabilities although a lot can still be done. The readily accessible washrooms, large doors and pathways, the presence of ramps can all be found on the accessibility of facilities. The infrastructural design of the two castles was however reported to have existed way before the passing of the Ghana Disability Act and this makes it impossible to relate infrastructure with the implementation of the Act.

The findings of the study also revealed that both castles had inferior systems of communication that were specific to the tourists with disabilities. Clarity of information with regard to the level of infrastructural accessibility has been proven to be one of the factors that motivate the tourists with disabilities to embark on such a journey. Inaccurate or vague information could lead to inadequate preparation which has the potential to make the tour of a castle frustrating to the people with disabilities. The availability of well-trained staff in relation to the management of people with disabilities was the weakest of all the support systems. The fact that the staff working in these castles had not received any formal training on handling people with disabilities and sensitivity training on psychological management of the people with disabilities introduce a big challenge. One prominent problem people with disabilities face is stigmatization. Stigmatization arises naturally because the society is built on the system of “survival of the fittest” forcing people with disabilities to be sidelined.

Conclusion

Barriers to physical activity by people with disabilities persist in spite of legislative requirements and existing accommodations. The study tried to assert the accessibility of the Cape Coast and Elmina Castles to people with disabilities. The main aim of this study, as stated earlier, was to examine the accessibility level of Cape Coast and Elmina Castles to people with disabilities.

The findings showed that some of the respondents had knowledge in the Ghana Disability Act. Some supportive services such as ramps, wide doors and entrances, directional signs were also identified in the castles. But major renovation has not been made to the castles despite the legislation because the management wanted to keep the originality of the castles. Findings based on the study revealed however indicated the workers had no special skill or training in managing people with disabilities who visit their facilities. The experience that is felt in the course of tourism is less felt among people with disabilities. Increased government support could help to increase compliance of the Ghana Disability Law (Act 715).

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Appendix 1. Using photovoice to identify barriers and facilitators to persons with disabilities who access Cape Coast and Elmina castles.

PART A: Vertical Circulation: Stairs and Ramps

Figure 1. The entrance of Cape Coast. Source: Field Photovoice (2015).

Figure 2. The entrance of Elimina Castle. Source: Field Photovoice (2015).

PART B: Horizontal circulation: Entrance, floors and surfaces

Figure 3. Floor surfaces at Cape Coast Castle. Source:Field Photovoice (2015)

Figure 4. Pathways in Elimina Castle.

PART C: Signage and Information

Figure 5. Label at the entrance of rooms and dungeons in the Elmina Castle.
Source: Field photovoice (2015)

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Figure 6. Map of Cape Coast Castle. Source:Field photovoice (2015)

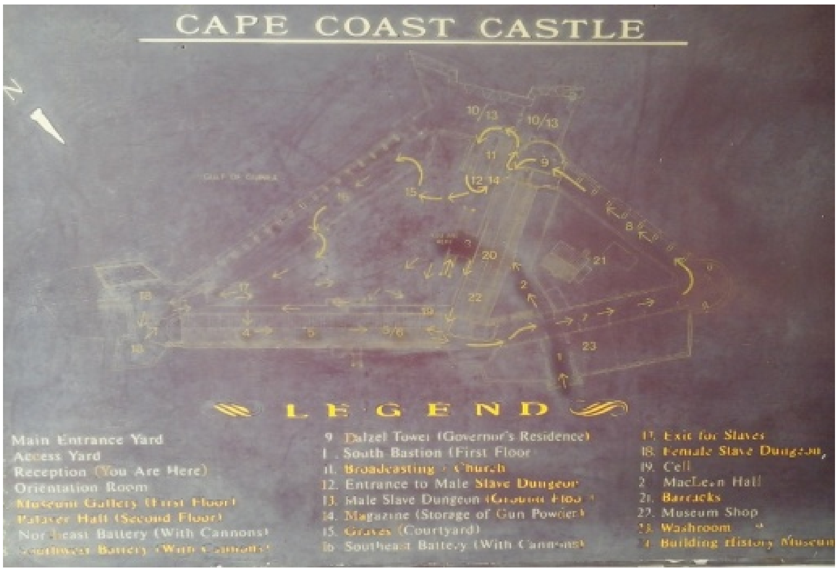

Figure 7. The symbol (the skull with two cutlass) on top of the condemned door at the Elmina Castle which communicates "danger or killing" to tourists with hearing impairments. Source: Field photovoice (2015)

PART D: General Lighting

Figure 8. Lighting system in the Cape Coast Castle Dungeons. Source: Field photovoice (2015).

PART E: Sanitary facilities

Figure 9. Washroom of Cape Coast Castle. Source: Field photovoice (2015).

Figure 10. Toilet seat at Cape Coast Castle. Source: Field photovoice (2015).

PART F: Emergency Exit

Figure 11. Emergency exit of Cape Coast Castle. Source: Field Photovoice (2015).

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Figure 12. Way to the outside of Cape Coast Castle. Source: Field Photovoice (2015).

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AN INVENTORY TO ASSESS EMPATHIC CONCERN FOR DISABILITY AND ACCESSIBILITY: DEVELOPMENT AND PRELIMINARY PSYCHOMETRIC INVESTIGATION

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Abstract: Cultivating empathy and prosocial attitude towards disability is a first step for university students to become the leaders of society and professions to create accessible environments and inclusive society. Gauging levels of empathy and prosocial attitude towards disability among the students is important for evaluating the adequacy of disability training and education. We developed and conducted an initial psychometric validation of a novel inventory in Japanese and English languages to assess Empathic Concern for Disability and Accessibility (ECDA) in Japan and New Zealand. Preliminary psychometric evaluation indicates strong internal consistency in the Japanese sample ($\alpha = .96$) and the New Zealand sample ($\alpha = .93$). Exploratory factor analysis demonstrated a four-factor solution for both samples. The present study has resulted in the development of the ECDA that demonstrated initial support for internal consistency and construct validity. The ECDA may be used for the cross-cultural comparisons of disability training and education.

Keywords: empathy; prosocial attitude; reliability; validity

Introduction

Accessibility is a significant factor in the success of public spaces (Pasaogullari & Doratli, 2004), which in turn contribute to health and quality of life (Rogers, 2003). Although broad accessibility is mandatory in most developed nations' public spaces (United Nations, 2013), many citizens, such as people with impairments of mobility and vision, are still impeded as a result of disabling environments (Mulligan, Miyahara, & Nichols-Dunsmuir, 2017). Accessibility features, such as ramps and audible signals, are essential; but sometimes human assistance can also be vital. Noticing a person being impeded by an inaccessible public environment, many onlookers would empathise with the person and try to help. Whether or not they will actually take action, however, depends on a variety of factors. One important factor for predicting helping behaviour is empathic concern that "is aroused when someone experiences a close bond with another, and it motivates altruistic behaviour, which is directed primarily at improving the other person's welfare" (Twenge, Baumeister, DeWall, Ciarocco, & Bartels, 2007, p. 62), or to be more specific, the ability to empathise with the victims of circumstance and the attitude or readiness to engage in prosocial behaviour by assisting them in the inaccessible environment. Here, we seek to develop a prosocial attitude scale, namely empathic concern for disability and accessibility (ECDA), to measure such specific empathic concern for people with impairments who are disabled by inaccessible environments. The developed scale can be used for future cross-cultural evaluation of disability training and education.

The prosocial attitude of support providers towards people with disability has been investigated not so much from the perspective of promoting prosocial behaviours as the perspective of preventing the support providers' burnout and maintaining their well-being. If support providers or helpers have true altruistic motivation, or empathic concern (Batson et al., 1991), the helpers will empathise with support recipients, imagining how the recipients would be feeling. In contrast, if helpers' motivation involves egoistic considerations, such as a desire to reduce their own discomfort of facing individuals who experience disability, the helpers' imagination is focused on how the helpers themselves would be feeling and thus taking the risk of personal distress (Batson, Early, & Salvarani, 1997). Increased mindfulness of emotional separation from support recipients is critical as a preventative measure for service providers' burnout and as a maintenance factor of their well-being (Bazzano et al., 2010; Thomas & Otis, 2010). However, it is necessary to find ways to promote prosocial behaviours for interdependent humanity (Burke, 2011) because disability is a social feature which is highly transient and unpredictable in nature throughout our life (Siebers, 2008). We all can be disabled at any point of our life: Unless we create a disability-friendly societal environment, we have to eventually pay the consequences.

Empathy and prosocial attitude towards people with disability should be cultivated in disability training and education as a key feature to creating an accessible society and environment, and disability training and education are paramount for university students who are expected to become the leaders of society and professions (Mulligan et al., 2016; Myers, 2009; Stachura & Garven, 2007). Among other disciplines of university education, physical education and sport sciences have unique roles to play in accessibility issues because sports and exercise involve not only the cognitive and psychosocial domains, but also emphasise the physical domain of human faculties. The vision of the Paralympic Movement, as an example, includes the component to "touch the heart of all people for a more equitable society" (International Paralympic Committee, 2016), which should be an integral part of the curriculum of physical education and sport sciences. The authors of the present study were particularly interested in gauging the current status of and to monitor the change of prosocial attitude towards disability as a result of intervention, such as a Paralympic education, for physical education and sport science major students. In the absence of such a specific scale to assess prosocial attitude and its change as a result of intervention, a new measurement tool needs to be developed.

Two recent reviews of available instruments to measure general attitudes towards disability have confirmed that there is a lack of a scale which specifically measures empathic concern for disabled people. A systematic review (Lam et al., 2010) identified seven instruments to measure attitudes of general adult populations, healthcare students and professionals towards patients with physical disability. The most recent scoping review (Palad et al., 2016) also identified several instruments, with some overlaps with the ones included in the systematic review (Lam et al., 2010), which measure attitudes towards disability. The available instruments measured the attitudes of the general population, persons with disabilities, adults, children, health professionals, and students toward intellectual disability, communication disability, or disability in general. The scoping review (Palad et al., 2016) pointed out the limited psychometric properties of the measurement tools, as well as the lack of data on responsiveness to change and on cross-cultural validity. To address these limitations, we aimed to develop a series of visual stimuli to represent persons with impairments in accessible (i.e., non-disabling) and inaccessible (i.e., disabling) environments and to pilot test a scale to measure helping intention towards them for future use in intervention research to detect changes in the prosocial attitude of university students in Japan and New Zealand. These two nations were considered as good candidates for comparison because they differ considerably on Hoftede's (2001) key cultural dimensions.

Methodology

The multi-centre, cross-cultural study had four phases: Phase 1. Constructing vignettes and generating an item pool; Phase 2. Reviewing the item pool and determining the format for measurement; Phase 3. Administering items to pilot samples, evaluating and finalizing items; Phase 4: Evaluating items. We will describe the procedures and the outcomes of Phase 1-3, and the procedure of Phase 4 in this section.

Phase 1: Constructing vignettes and generating an item pool

The first step in developing a stimulus pool involved building approximately 100 vignettes representing 50 examples of persons with impairments in accessible (i.e., non-disabling) and 50 in inaccessible (i.e., disabling) environments. This collection was assembled by four research staff members searching, collecting, and taking photographs of such situations, and by consulting with five stakeholders. Three experts in adapted physical activity and a former teacher and tour conductor who had worked with people with disabilities searched on internet websites for suitable photographs and written descriptions with English or Japanese search terms, such as a combination of disability and inaccessible. While searching, they consulted with three persons with physical or visual impairment, and two disability workers (an occupational therapist and a volunteer worker) for ideas on disabling environments and the content validity of identified photographs. If suitable photographs were unavailable, two of the four research staff members took appropriate photographs, either by themselves or accompanied by a person with disability. A master list of 473 photos and verbal descriptions was compiled in a spreadsheet and uploaded to cloud storage serving as a shared virtual computer drive accessible from each research staff member's computer.

Phase 2: Reviewing the item pool and determining the format for measurement

Content validity, meaningfulness to university student viewers in both New Zealand and Japan, and insights into common themes of the 473 photos were generated from qualitative inquiry into disability and accessibility by a panel of the three research staff members in New Zealand and three members in Japan. The first author either met face to face, or communicated by e-mail with the five research staff members, and asked about the content adequacy of accessible and inaccessible situations, and the nature of impairment. As a result, the panel members reached a consensus that (1) impairments should be limited to impairment in mobility and vision, so that an average university student could understand and imagine the situations easily; (2) a person with impairment should not appear in the photographs, to avoid the confoundings inherent in gender, age, ethnic group, etc.; (3) a person with impairment in mobility or vision should be described in written words as “a wheelchair user”, “a person using a white cane”, etc.; (4) the format of measurement would be a four-point Likert scale with response anchors of 1: Not at all, 2: A little, 3: Moderately and 4: Very much, to the question: “Please watch a series of slides on the screen and circle a number to describe the extent you would like to help the person right after watching each slide”; (5) 50 pairs of accessible and inaccessible conditions in similar places (e.g., a pathway with and without an obstacle), with each slide being displayed for a period of six seconds, would be appropriate to answer the question about helping intention with a four-point Likert scale.

Phase 3: Administering items to pilot samples, evaluating and finalizing items

Members of a focus group, consisting of three university students in Japan and three university students in New Zealand, individually went through all 100 items. The Japanese participants informed the second author (YS) and the New Zealand participants informed the fourth author (RW) of any confusion or ambiguity in the photographs and verbal descriptions, and how quickly and accurately they were able to rate each slide. The participants reported that it took too long and was too tiring to view 100 items. Consequently, the number of items was reduced to 60 (30 pairs of accessible and inaccessible conditions) by excluding 40 items that the participants found ambiguous, repetitive, or culturally irrelevant.

Phase 4: Evaluating items

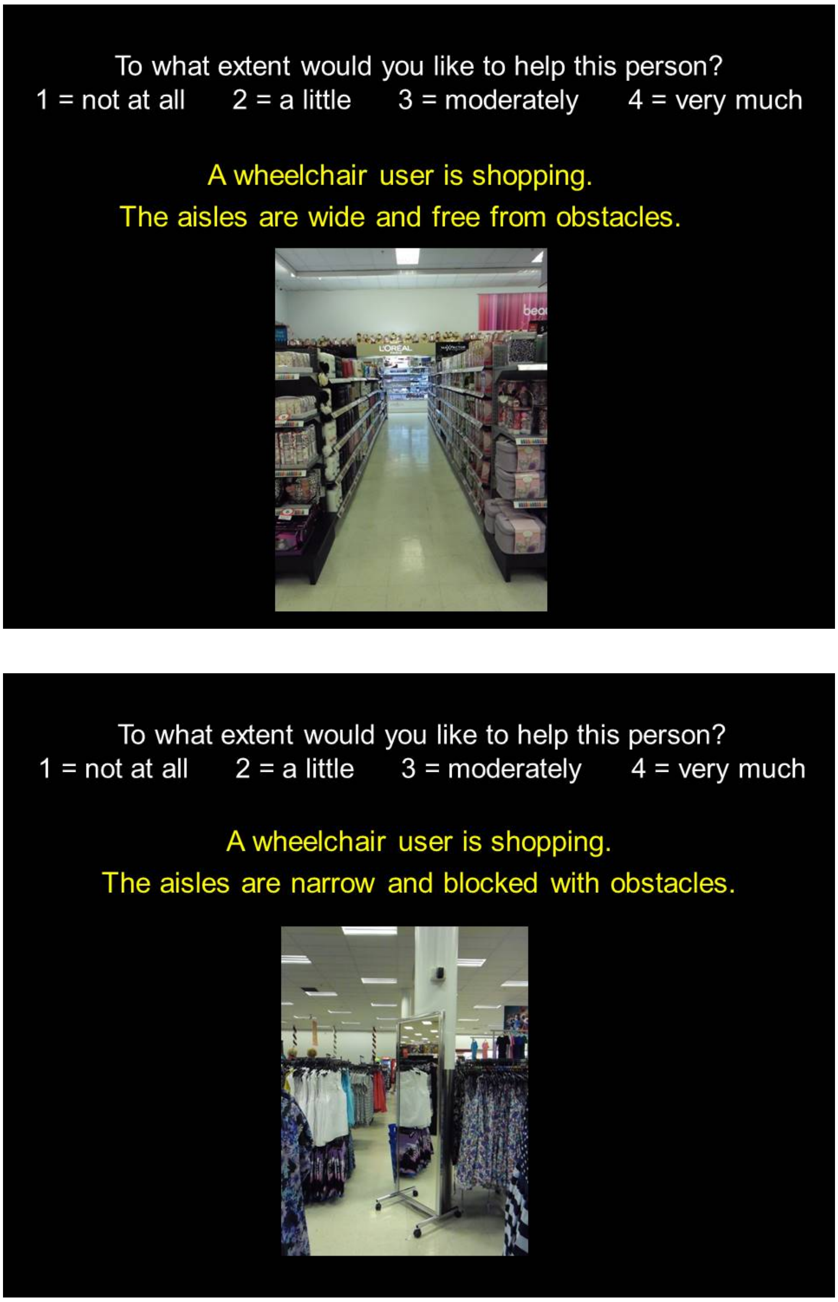
Participants

We used convenience samples of 127 (76 males, 51 females) Japanese, and 104 (48 males, 56 females) New Zealand physical education major undergraduate students of the second and the first authors respectively. Although the scale was not specifically developed for physical education and sport science major students, but for university students in general, we thought our samples were adequate for examining the internal consistency and construct validity for pilot validation. The Japanese participants were all native Japanese, including a student with a long-term physical disability. The New Zealand sample consisted of one Australian, five Europeans, 95 New Zealanders, two Pacific Islanders, and one South African. In terms of ethnic background, 87 participants identified themselves as New Zealand Europeans, and 11 participants as Maori, and one participant as a Pacific Islander. Obviously, some New Zealand participants had multiple citizenship and multicultural backgrounds. With respect to disability, four New Zealand students had long-term disabilities, encompassing the following domain areas of the New Zealand Census: seeing, walking, hand use, learning, and communication. None of the ethnicity and disability minority students in either Japan or New Zealand was an outlier on the measures described below. Hence, the minority students were grouped together as part of their respective cultural groups of Japan and New Zealand, and the participants were grouped only with respect to culture.

Measures of helping intention

The final set of 60 items, derived as explained in Phase 3, were used in both Japan and New Zealand. The verbal descriptions were written in Japanese and English in Japan and New Zealand respectively. A written description displayed on each photograph slide stated the type of impairment to be considered (either mobility or visual impairment) and why the person was disabled or not due to an environment (see Figure 1). After viewing each photo slide with its verbal description, participants were asked how much they wished to help the person described on the slide on the scale of 1 (not at all), 2 (a little), 3 (moderately) and 4 (very much).

Figure 1. Exemplary items of Empathic Concern for Disability and Accessibility for accessible (above) and inaccessible (below) conditions.



Procedure

Data were collected during a lecture, entitled "Disability and Assessment," in both Japan and New Zealand. After a brief lecture on the topic of disability sports, which was not directly related to the nature of the current study, the study was introduced with an explanation of the ethical approval procedure and the right not to participate. Then we distributed a survey form to individual students. As part of the learning activity in the lecture, students were asked to view the 60 slides of the ECDA on the screen and to respond on a survey form on which the four-point Likert scale was printed.

Data analysis

To determine the internal consistency of the scale Cronbach's alphas were computed for both the New Zealand and the Japanese samples. An acceptable criterion for Cronbach's alpha was set at .70 or higher (Nunnally & Bernstein, 1994).

To assess construct validity, we performed exploratory factor analyses (EFA) with IBM SPSS Statistics Version. 22.0, following a guideline (Pasaogullari & Doratli, 2004). First, our sampling adequacy and the confirmation of the non-identity matrix were assessed with the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity respectively. Because we assumed that all items and emerging factors, which were designed to measure the helping intention of participants to aid people with impairments, would be highly correlated, a promax (oblique) rotation was used with a principal axis factoring method of extraction. Only factors with a minimum Eigenvalue of 1.0 or more were considered. To find the optimal number of factors, we followed the Minimum Average Partial test method (Velicer, 1976). Discriminant validity was investigated by inspecting factor correlations. A correlation between factors that exceeded .70 (49% shared variance) was considered to be too high because it lacked sufficient discriminant validity between the factors.

To assess the validity of the factor structures suggested by EFA, we planned to perform confirmatory factor analyses (CFA), using IBM SPSS AMOS 24. We assessed normality for CFA by paying attention to kurtosis and skewness of the datasets from Japan and New Zealand as recommended by Byrne (2010).

Results

Reliability

Internal consistency

Reliability estimation indicated the ECDA measure as a whole was sufficiently reliable in the Japanese sample (α = .955) and the New Zealand sample (α = .925). Likewise, split-half reliability for accessible items (n = 30) and inaccessible items (n = 30) demonstrated similarly high reliability in the New Zealand sample (α = .875; .918) and in the Japanese sample (α = .935; .948).

Validity

Exploratory factor analysis of 60 items

The sufficiency of our sample size was confirmed by the KMO, which yielded .67 for the New Zealand sample, and .85 for the Japanese sample. Both samples' statistics exceeded the minimum standard of .50 - .60 (Netemeyer, Bearden, & Sharma, 2003). Further, Bartlett's test of sphericity provided significant chi-square values of 3,625 (p < .001) for the New Zealand sample, and 5,107 (p < .001) for the Japanese sample. Thus, our samples met the two prerequisites for exploratory factor analysis (EFA).

We performed EFA using principal axis factoring with a promax rotation with the New Zealand and the Japanese data sets independently. Our a priori assumption was that the 60 items would generate a two-factor solution of 30 accessible items and 30 inaccessible items. Solutions for two, three, four, and five factors were individually examined in the factor loading matrix. The four-factor solution was preferred in both the New Zealand and the Japanese datasets because of (1) its previous theoretical support; (2) the 'leveling off' after four factors on the scree plots; and (3) the insufficient number of primary loadings and difficulty of interpreting the fifth and subsequent factors. The four-factor solution accounted for 49.46 % of the total variance in the Japanese sample and 39.53 % of the total variance in the New Zealand sample. The factor loading matrix and factor correlation matrix for the Japanese and the New Zealand samples are listed in

Appendix 1 and Appendix 2 respectively. Of the 60 items, 32 items were loaded on the same four factors in the Japanese and New Zealand samples, and 25 items were loaded on the same first two factors. The factor correlations were low ($r < .70$), indicating adequate discriminant validity for the four factors in both samples.

Exploratory factor analysis of 32 items common to all four factors

With the assumption that the 32 items would load on the same four factors in both samples, we performed EFA using principal axis factoring with a promax rotation with both nations' data sets independently. Solutions for two, three, four, and five factors were individually examined in the factor loading matrix. None of the factor solutions provided a strong fit.

Exploratory factor analysis of the 25 items common to both samples

We selected only the common items from Factor 1 and Factor 2 with the assumption that the 25 items would load on the same two factors in both samples, and performed EFA using principal axis factoring with a promax rotation with both nations' data sets independently. We examined solutions for two, three, and four factors in the factor loading matrix, and the two-factor solution demonstrated the fit, as shown in Appendix 3 and 4. The two-factor solution accounted for 48.76 % of the total variance in the Japanese sample and 41.46 % of the total variance in the New Zealand sample. The factor correlation was low ($r < .70$), indicating adequate discriminant validity for the two factors in both samples. Note that Item 26 in the New Zealand sample loads on both Factor 1 and Factor 2. Therefore, this item should be excluded in confirmatory factor analysis.

Confirmatory factor analyses

Although we wanted to perform confirmatory factor analysis for a two-factor model of the 24 items without Item 26, the tests for normality and outliers in IBM SPSS AMOS 24 indicated that our datasets from Japan and New Zealand violated the normality assumption in terms of a multivariate normal distribution (Critical Ratio > 5.00) (Byrne, 2010). Therefore, it was inappropriate to perform confirmatory factor analysis based on usual Maximum Likelihood (ML) estimation.

Because the sample sizes were less than 1,000, we were unable to base our analyses on asymptotic distribution-free (ADF) estimation (Byrne, 2010).

Discussion and conclusion

Existing tools for measuring attitude towards disability have not examined responsiveness to change and cross-cultural validity (Palad et al., 2016). To assess intervention effect in future research, we have developed a 60-item inventory named the Empathic Concern for Disability and Accessibility (ECDA) in Japanese and English languages to specifically assess prosocial attitude towards people with mobility and visual impairments who are either disabled or not disabled in inaccessible and accessible environments respectively. Initial ECDA pilot testing provided preliminary support for the instrument's reliability, construct and discriminant validity in Japan and New Zealand.

The ECDA evidenced a high internal consistency in both New Zealand and Japanese samples. Exploratory factor analyses (EFA) of both samples revealed four-factor solutions. The four extracted factors for both samples were characterised as Factor 1: obvious inaccessible situations; Factor 2: obvious accessible situations; Factor 3: complex inaccessible situations; Factor 4: complex accessible situations. The items included in each factor showed some difference between the two samples. Thus, items loaded with greater explanatory power on four factors rather than the hypothesised two factors. Lee J. Cronbach and Paul E. Meehl, the pioneers who introduced content validity stated that "Construct validation is involved whenever a test is to be interpreted as a measure of some attribute or quality which is not operationally defined. The problem faced by the investigator is, 'What constructs account for variance in test performance?'" (Cronbach & Meehl, 1955). The EFA of the 60 items revealed additional factors related to the complex quality of situations, and we labelled them as complex accessible and inaccessible situations. All factor correlations were low ($r < .70$) in both samples, demonstrating good discriminant validity and different qualities of helping intentions for accessible vs. inaccessible, and obvious vs. complex situations. Because the items contained in each of the four factors partially differed between the samples, the 60-item ECDA as a whole is not cross-culturally valid in its construct. However, the 25 items common to Factor 1 and Factor 2 in both samples demonstrated cross-cultural construct validity. In fact, Item 26 loaded on both factors in the New Zealand sample. Therefore, the 24 items, excluding Item 26, have the best cross-cultural construct validity. The two factor correlation was low ($r < .70$) in both samples, demonstrating good discriminant validity and different qualities of helping intentions between accessible and inaccessible situations.

Just because the 24 items seem to have the best cross-cultural construct validity, it does not necessarily mean that it would suffice to administer only those 24 items. It is noteworthy that the 24 items were not administered independently, but as part of the 60 items in our study. Because of the likely impact of presentation order (Schwarz & Hippler, 2004), the response from our pilot samples could have differed if only the 24 items had been administered to participants. A follow-up study needs to examine the usefulness of the 24 items alone as compared to the full 60-item version of the ECDA.

In a further application, the ECDA may be used to identify neuronal networks involved in prosocial attitude towards disability. In block design functional magnetic resonance imaging (fMRI) studies, an equal number of stimuli for contrasting conditions, such as accessible vs. inaccessible conditions, are required (Maus, van Breukelen, Goebel, & Berger, 2010). If the 60-item ECDA is used for such a purpose, the categorization of each item must be determined not from our initial categories of accessible and inaccessible situations, but from the accessible and inaccessible factors from the four-factor solution which demonstrated the perceptions of the ECDA slides in each sample.

Despite these preliminary findings that the ECDA has high internal consistency and adequate construct validity, the present study has limitations to be addressed. First, the distribution of data for individual items deviated from normality of skewness and kurtosis. The distributions of the accessible items were theoretically expected to be positively skewed, the distributions of the inaccessible items negatively skewed, and all items were theoretically expected to be leptokurtic. Whereas all distributions of the 60 items were within the acceptable range of skewness < 3 and kurtosis < 10 (Kline, 2011) for the Japanese data, several of the 60 items were outside the acceptable range for the New Zealand data. Although we attempted to apply various mathematical transformations to normalise those items, our attempts were unsuccessful. We were also unable to perform confirmatory factor analysis because our datasets violated the assumption of multivariate normal distributions (Byrne, 2010). Thus, the construct validity of the ECDA is limited to our verification by exploratory factor analyses conducted, with a violation of the assumption of normality in the New Zealand sample.

Our study is also limited to two groups of undergraduate students in the largest physical education and sport science departments of universities in each country. In that sense, they may be regarded as “representative” physical education and sport science students, but our findings may not be generalised to all university students in each country because students studying other majors could be different in their prosocial attitude towards disability. The fact that the data collection took place during the lectures of the first two authors also poses a potential acquiescence response bias (Lavrakas, 2008).

To further examine the psychometric properties of the ECDA, future studies should examine criterion-referenced validity and sensitivity to change with a representative sample of university students who are not taught by the researchers. To establish convergent validity this inventory needs to demonstrate significant correlations with the existing measurement tools of attitude towards disability, such as those identified by recent systematic (Lam et al., 2010) and scoping reviews (Palad et al., 2016), and also with more extensive, already established empathy and altruism scales, such as the Interpersonal Reactivity Index (Davis, 1983) and the Self-Report Altruism Scale (Rushton, Chrisjohn, & Fekken, 1981). Sensitivity to change as a result of intervention, such as empathy priming, (Barlińska, Szuster, & Winiewski, 2015) meditation on compassion (Salzberg, 1995), disability training and education (Mulligan et al., 2016; Myers, 2009; Stachura & Garven, 2007) may be investigated by administering the ECDA to university students in Japan and New Zealand before and after intervention. After the disability training and education, the students should be less empathic and willing to help in accessible conditions, and more so in inaccessible condition by learning when to help and when not to, respecting independency. A context-specific scale like the ECDA could be useful for developing evidence-based strategies to educate university students.

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Appendices

Appendix 1. Factor loadings from exploratory factor analysis of Japanese sample (N = 129)

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
26	A wheelchair user is trying to wash their hands. There is no space under the basin for the wheelchair.	**.858**	.046	.184	-.198
34	A child in a wheelchair wants to play in the park not designed for wheelchair users.	**.814**	-.180	.066	-.176
16	A wheelchair user is trying to use a library computer. All computers are too high to access from wheelchairs.	**.774**	-.028	.005	-.031
31	A wheelchair user cannot use the escalator.	**.700**	.123	.030	-.254
58	A blind person is walking down the footpath. The overhanging branches are in the way.	**.697**	.029	.125	-.111
56	A person with visual impairment has a difficulty recognising low contrast objects in the room.	**.690**	.014	.098	-.040

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
52	A blind person is walking. The long cane misses the barriers.	**.690**	.033	.084	-.135
54	A blind person is walking, and unaware of the car parked across the footpath.	**.666**	.237	-.295	-.045
47	A wheelchair user is trying to enter the bathroom. There are steps.	**.656**	-.001	-.201	.110
20	A wheelchair user is trying to drink water. The standing fountain is too high and inaccessible.	**.645**	.075	-.030	.097
60	A partially sighted person is walking down the stairs. The tactile paving is broken, and the stairs are low contrast.	**.627**	.186	-.053	.036
43	A wheelchair user is wheeling up a steep slope.	**.606**	-.046	-.060	.089
36	A wheelchair user is shopping. The aisles are narrow and blocked with obstacles.	**.605**	.018	-.037	.186
40	A wheelchair user is trying to climb up to the upper floor.	**.578**	-.240	.113	.075

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
30	A wheelchair user is trying to enter the shop. The entrance is blocked by a clothing rack.	**.569**	.105	-.110	.058
50	A wheelchair user is on the nature walk. The path is muddy.	**.560**	.031	.033	.033
38	A wheelchair user is trying to climb up the stairs. There is no ramp.	**.548**	.020	-.117	.092
28	"A wheelchair user is trying to enter the shop. The entrance has steps.	**.508**	-.126	-.038	.262
41	A wheelchair user is trying to enter the building. There are stairs in front of the door.	**.473**	-.052	-.150	.406
46	A wheelchair user is trying to enter the apartment house. There is no ramp.	**.400**	.231	-.095	.247
23	A wheelchair user would like to eat at a café. There are wide spaces to get between the tables.	**.391**	.378	.270	-.309
8	A blind person is walking with a cane. The tactile paving is blocked by bikes.	**.374**	-.180	.012	.374

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
13	A wheelchair user is trying to move through the doorway. The door opens automatically.	-.194	**.885**	-.213	.075
15	A wheelchair user is trying to use a library computer. There is a lowered table accessible for wheelchair users.	.033	**.794**	-.069	-.219
9	A blind person is standing at the railway crossing. There is tactile paving on the crossing.	.115	**.750**	-.159	.149
7	A blind person is walking on the footpath with unobstructed tactile paving.	.197	**.683**	-.030	-.174
11	A wheelchair user is using a ramp to get to the building.	.002	**.649**	-.139	.271
29	A wheelchair user is trying to enter the shop. The automatic door is wide and free from obstacles.	-.211	**.575**	.347	-.016
19	A wheelchair user is trying to drink water. There is an accessible low fountain.	.188	**.518**	.253	-.285
27	A wheelchair user is trying to enter the shop. The entrance is wide and flat.	-.055	**.496**	.202	.087

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
21	A wheelchair user is trying to climb this gentle slope.	.230	**.443**	.114	-.019
18	A blind person is walking towards the exit following the tactile paving and there are no obstacles.	.034	**.435**	.252	.152
35	A wheelchair user is shopping. The aisles are wide and free from obstacles.	-.004	**.402**	.335	.113
25	A wheelchair user is trying to wash their hands. There is space under the basin for the wheelchair.	.141	**.386**	.362	-.117
32	A wheelchair user can use the lift.	.056	**.302**	.264	.164
57	A blind person is walking down the footpath. The branches from the tree are high and clear.	.022	-.161	**.866**	-.098
51	A blind person is walking. The pathway is clear from obstacles.	.013	-.203	**.768**	-.082
55	A person with visual impairment can recognise high contrast objects in the room.	-.023	-.078	**.732**	.046

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
49	A wheelchair user is on the nature walk. The pathway is flat and smooth.	-.166	.227	**.709**	-.080
59	A partially sighted person is walking down the stairs, assisted by tactile paving and the high contrast stairs.	-.030	-.008	**.648**	.040
53	A blind person is walking on the clear footpath.	.184	-.135	**.622**	.107
44	A wheelchair user is wheeling along a flat path.	-.296	.277	**.465**	.239
48	A wheelchair user is trying to enter the bathroom. There are no steps.	.030	.142	**.459**	.080
39	A wheelchair user is trying to climb up to the upper floor with the wheelchair lift.	-.221	.305	**.442**	.126
45	A wheelchair user is trying to enter the apartment house. There is a ramp leading to the deck.	-.009	.278	**.352**	.131
33	A child on a wheelchair is playing in the park designed for wheelchair users.	-.006	.287	**.334**	.177
1	A wheelchair user is trying to get a book from the high shelf.	-.119	-.069	.015	**.642**

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
22	A wheelchair user is trying to climb this fairly steep slope.	.254	-.217	.196	**.578**
14	A wheelchair user is trying to move through the doorway. The door is heavy to open.	.162	-.407	.128	**.572**
4	A blind person is selecting a destination floor. There is no Braille on the buttons	.013	.061	-.034	**.548**
5	A blind person is trying to walk across the pedestrian crossing. There is a car on the crossing.	.201	.148	-.112	**.543**
10	A blind person is trying to walk across the railway crossing. There is no tactile paving on the crossing.	.322	.114	-.147	**.515**
12	A wheelchair user is trying to climb up the stairs.	.329	-.241	.108	**.506**
2	A wheelchair user is trying to get a book from the top of the low shelves on the side.	-.246	.103	.102	**.498**

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
17	A blind person is walking on the footpath with tactile paving where a car is parked right next to it.	.275	.001	.137	**.476**
3	A blind person is selecting a destination floor by reading Braille.	-.042	.225	-.062	**.423**
6	A blind person is trying to walk across the pedestrian crossing. There is no tactile paving on the crossing.	.272	.156	.119	**.401**
37	A wheelchair user is trying to climb up the ramp. The ramp is between the stairs.	.215	.134	.215	**.322**

Factor correlations	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1				
Factor 2	.29			
Factor 3	.37	.57		
Factor 4	.56	.15	.35	

Appendix 2. Factor loadings from exploratory factor analysis of New Zealand sample (N = 104)

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
46	A wheelchair user is trying to enter the apartment house. There is no ramp.	**.790**	-.217	-.025	-.085
28	A wheelchair user is trying to enter the shop. The entrance has steps.	**.779**	-.133	-.019	-.074
40	A wheelchair user is trying to climb up to the upper floor.	**.760**	.135	-.291	-.162
38	A wheelchair user is trying to climb up the stairs. There is no ramp.	**.686**	.103	-.174	-.186
30	A wheelchair user is trying to enter the shop. The entrance is blocked by a clothing rack.	**.679**	-.031	.034	.014
41	A wheelchair user is trying to enter the building. There are stairs in front of the door.	**.679**	-.091	-.021	.005
34	A child in a wheelchair wants to play in the park not designed for wheelchair users.	**.679**	-.062	-.023	.129

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
24	A wheelchair user would like to eat at a café. There are narrow spaces to get between the tables.	**.647**	-.008	-.046	.027
43	A wheelchair user is wheeling up a steep slope.	**.586**	-.165	-.052	.146
47	A wheelchair user is trying to enter the bathroom. There are steps.	**.571**	.057	-.001	.043
54	A blind person is walking, and unaware of the car parked across the footpath.	**.561**	.125	-.003	.012
36	A wheelchair user is shopping. The aisles are narrow and blocked with obstacles.	**.544**	-.001	.033	.120
20	A wheelchair user is trying to drink water. The standing fountain is too high and inaccessible.	**.542**	.041	.289	-.004
31	A wheelchair user cannot use the escalator.	**.517**	.067	.040	-.029
58	A blind person is walking down the footpath. The overhanging branches are in the way.	**.476**	.124	.263	-.106

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
21	A wheelchair user is trying to climb this gentle slope.	**.445**	-.043	.063	.316
52	A blind person is walking. The long cane misses the barriers.	**.431**	-.112	-.017	.031
56	A person with visual impairment has a difficulty recognising low contrast objects in the room.	**.406**	-.030	.109	-.033
45	A wheelchair user is trying to enter the apartment house. There is a ramp leading to the deck.	**.397**	.306	-.106	-.023
22	A wheelchair user is trying to climb this fairly steep slope.	**.386**	-.151	.252	.142
50	A wheelchair user is on the nature walk. The path is muddy.	**.371**	-.040	.095	.311
26	A wheelchair user is trying to wash their hands. There is no space under the basin for the wheelchair.	**.362**	.272	.181	.108
60	A partially sighted person is walking down the stairs. The tactile paving is broken, and the stairs are low contrast.	**.335**	-.022	.285	-.050

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Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
37	A wheelchair user is trying to climb up the ramp. The ramp is between the stairs.	**.215**	.085	.002	.160
32	A wheelchair user can use the lift.	-.044	**.760**	-.098	-.123
35	A wheelchair user is shopping. The aisles are wide and free from obstacles.	-.077	**.685**	-.105	.046
51	A blind person is walking. The pathway is clear from obstacles.	-.019	**.638**	.072	-.136
44	A wheelchair user is wheeling along a flat path.	.002	**.631**	.042	-.035
39	A wheelchair user is trying to climb up to the upper floor with the wheelchair lift.	-.027	**.629**	-.007	.176
29	A wheelchair user is trying to enter the shop. The automatic door is wide and free from obstacles.	-.083	**.589**	-.025	.143

Miyahara, M., Sawae, Y., Briggs, H., Wilson, R., Doihata, K., & Sugiyama, A. (2017). An inventory to assess empathic concern for disability and accessibility: development and preliminary psychometric investigation. *Journal of Accessibility and Design for All, 7*(2), 159-197. doi: 10.17411/jacces.v7i2.132

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
42	A wheelchair user is trying to enter the building. There is a ramp beside the stairs.	.181	**.575**	-.247	.169
49	A wheelchair user is on the nature walk. The pathway is flat and smooth.	-.057	**.536**	.101	-.147
48	A wheelchair user is trying to enter the bathroom. There are no steps.	-.085	**.518**	.080	.026
27	A wheelchair user is trying to enter the shop. The entrance is wide and flat.	-.103	**.487**	.057	.096
33	A child on a wheelchair is playing in the park designed for wheelchair users.	.108	**.439**	-.170	-.075
53	A blind person is walking on the clear footpath.	.020	**.411**	.384	-.110
55	A person with visual impairment can recognise high contrast objects in the room.	-.150	**.401**	.324	.150
59	A partially sighted person is walking down the stairs, assisted by tactile paving and the high contrast stairs.	-.016	**.385**	.230	.129

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
23	A wheelchair user would like to eat at a café. There are wide spaces to get between the tables.	.035	**.380**	-.098	.249
25	A wheelchair user is trying to wash their hands. There is space under the basin for the wheelchair.	-.067	**.301**	.298	.075
18	A blind person is walking towards the exit following the tactile paving and there are no obstacles.	.141	**.237**	.118	.202
6	A blind person is trying to walk across the pedestrian crossing. There is no tactile paving on the crossing.	-.062	-.093	**.745**	.026
8	A blind person is walking with a cane. The tactile paving is blocked by bikes.	-.141	-.012	**.584**	.162
10	A blind person is trying to walk across the railway crossing. There is no tactile paving on the crossing.	.146	.020	**.551**	-.301

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Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
14	A wheelchair user is trying to move through the doorway. The door is heavy to open.	-.079	-.029	**.525**	-.119
5	A blind person is trying to walk across the pedestrian crossing. There is a car on the crossing.	.144	-.008	**.493**	.013
17	A blind person is walking on the footpath with tactile paving where a car is parked right next to it.	.358	-.115	**.468**	.036
9	A blind person is standing at the railway crossing. There is tactile paving on the crossing.	-.042	.085	**.455**	.376
16	A wheelchair user is trying to use a library computer. All computers are too high to access from wheelchairs.	.237	.243	**.435**	-.099

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
1	A wheelchair user is trying to get a book from the high shelf.	.163	-.073	**.286**	.090
57	A blind person is walking down the footpath. The branches from the tree are high and clear.	-.036	.268	**.279**	-.013
13	A wheelchair user is trying to move through the doorway. The door opens automatically.	.077	.137	-.224	**.692**
7	A blind person is walking on the footpath with unobstructed tactile paving.	-.039	-.143	.328	**.552**
3	A wheelchair user is trying to move through the doorway. The door opens automatically.	.077	.137	-.224	**.692**
12	A blind person is walking on the footpath with unobstructed tactile paving.	-.039	-.143	.328	**.552**

Item number	Item description	Factor 1	Factor 2	Factor 3	Factor 4
11	A blind person is selecting a destination floor by reading Braille.	-.162	-.032	.076	**.538**
15	A wheelchair user is trying to climb up the stairs.	.174	.159	.383	**-.521**
19	A wheelchair user is using a ramp to get to the building.	.292	.065	-.020	**.424**
2	A wheelchair user is trying to use a library computer. There is a lowered table accessible for wheelchair users.	.145	.175	-.286	**.412**
7	A wheelchair user is trying to drink water. There is an accessible low fountain.	-.073	.277	-.057	**.386**

Factor correlations	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1				
Factor 2	.13			
Factor 3	.48	.28		
Factor 4	.24	.28	.34	

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Appendix 3. Two factor solutions for the 25 items common to the Japanese sample (N = 129)

Item number	Factor 1	Factor 2
34	**.761**	-.133
47	**.758**	-.169
36	**.738**	-.002
41	**.732**	-.163
28	**.717**	-.181
26	**.711**	**.230**
43	**.688**	-.123
56	**.685**	.136
40	**.685**	-.168
20	**.637**	.168
60	**.632**	.200
58	**.628**	.196
54	**.622**	-.008

Item number	Factor 1	Factor 2
38	**.622**	-.064
30	**.620**	.011
52	**.614**	.107
50	**.578**	.090
46	**.568**	.130
31	**.535**	.199
29	-.300	**.941**
27	-.087	**.769**
35	.019	**.765**
25	.033	**.724**
18	.075	**.670**
32	.144	**.523**

Note. Loading larger than .300 is marked in **bold**.

Factor correlations	Factor 1	Factor 2
Factor 1		
Factor 2	.36	

Appendix 4. Two factor solutions for the 25 items common to the New Zealand sample sample (N = 104)

Item number	Factor 1	Factor 2
46	**.789**	-.291
28	**.733**	-.203
34	**.727**	.035
30	**.726**	-.055
20	**.709**	.225
41	**.698**	-.192
40	**.617**	-.069
47	**.610**	.081
58	**.607**	.174
38	**.605**	-.112
36	**.602**	.102

Item number	Factor 1	Factor 2
43	**.601**	-.183
54	**.594**	.182
31	**.569**	.149
60	**.528**	.054
50	**.516**	.112
56	**.512**	.004
26	**.462**	.424
52	**.459**	-.097
29	-.078	**.711**
32	-.121	**.656**
35	-.144	**.653**
27	-.056	**.651**
25	.112	**.567**
18	.279	**.473**

Note. Loading larger than .300 is marked in **bold**.

Factor correlations	Factor 1	Factor 2
Factor 1		
Factor 2	.12	

DESIGN AND REALIZATION OF A SWIVELLING SEAT FOR A PARALYMPIC RACING BOAT

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Abstract: In past few decades, an increased interest in physical disability studies has developed. However, there is a lack of devices and innovations that allow disabled athletes to participate in Paralympic sports properly. In this work, a new, ergonomic swiveling seat used for Paralympic sailing boats has been developed and is compared to the traditional seating system. To increase the performance of the improved seat during a regatta race, a variety of innovative modifications have been introduced; the structural seat design has been developed through 3D simulation; a FEM (finite element method) analysis has also been presented to calculate the real stress and deformation ranges on the structure. Results show significant reduction in the weight of the seating structure, as well as an increase in the seat's movement accuracy, in relation to the design and selection of the actuator. Furthermore, structural modifications make the swiveling system more ergonomic for most disabled users during sailing.

Keywords: Ship engineering, disability, 3d simulation, swiveling seat, finite element analysis.

Introduction

Paralympic sports have seen an exponential increase in participation in the last few decades. More than 4,000 athletes participated in the most recent Paralympic Games, held in London in 2012; few sporting events have seen such a rapid evolution in recent years. This rapid growth has also contributed to challenges in understanding the injury risks associated with participation a variety of sports, as well as with the evolution of technical equipment. The last decade has presented an important increase of additional impairment types in new sports and specialities.(Webborn, Uk, & Emery, 2014) In order to provide opportunities for disabled individuals who practice sports, it is necessary to use special devices, such as specialized chairs.(Hettinga et al., 2010)

Disabled people show high rates of chronic disease as well as sedentary lifestyles. Fortunately, access to physical activity and sports opportunities allows for a decrease in the discomfort that a person with a disability may experience. The Paralympic Movement (or International Paralympic Committee) provides an opportunity to transform the stigma surrounding physical disability, and also serves as a catalyst for public health education and program development.(Blauwet & Iezzoni, 2014) In this regard, Paralympic sports aim to promote participation in sports by people with disabilities by controlling the impact of impairment on the outcome of competition.(Tweedy, Beckman, & Connick, 2014)

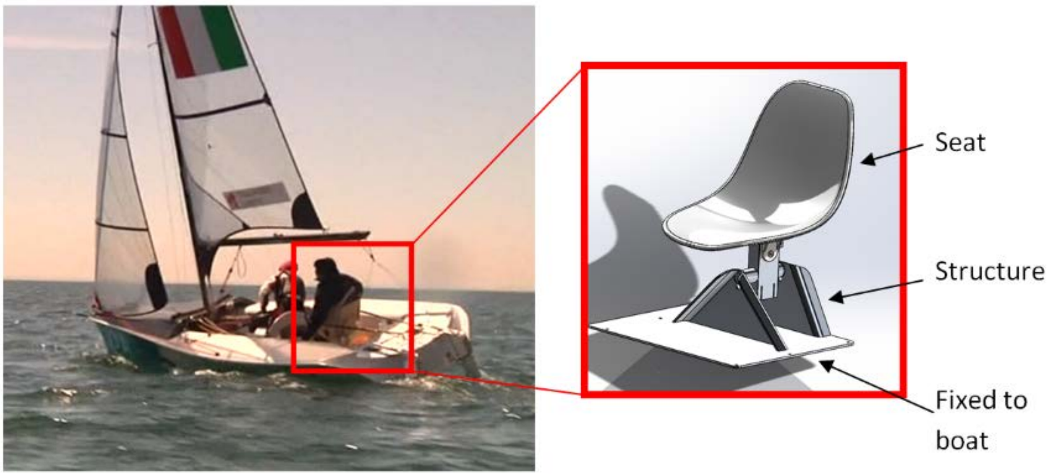
In 1996, sailing was first introduced to the Paralympic Games. The SKUD 18 is a specialized high-performance class of sailing boat used in racing. It is a lead-assisted skiff with a tube-launched asymmetrical and a modern high performance fixed rig; active able-bodied and disabled sailors alike have enjoyed the two-person version since 2006. The debut for the SKUD 18 class was in Qingdao, China during the 2008 Summer Paralympic Games, in which eleven nations competed on the 2-person.(Morton, 2008).

With its 140 kg bulb and 1.7m draft, the 2-person SKUD 18, even with both crew on the centerline, the structure has exceptional stability and is fail-safe.

Further studies led to new developments such as a version of the SKUD 18 that may also be adapted as a three-person boat. In its open configuration, one crew member uses the centerline seat and one uses the trapeze. A wide range of additional equipment can also be added to compensate for any functional disability and to enable the crew to maximize their collective potential.(Hansa Sailing, 2016)

No technical studies have presented any innovation related to this kind of sailing device thus far. For this reason, this study discusses the design of a new swiveling seat located on the sailing boat, to improve upon and provide a comparison to the old seat. The aim of this study is the reduction of the weight of the structure, and increase the precision of the structure's movement. For this reason, a lower weight allows having a lower inertia of the boat and therefore greater reactivity (better handling during the regatta race). Secondly, a better positioning of the seat allows to hence the precision of the centre of gravity in order to compensate the force on the sails. Moreover, the analysis and the introduction of ergonomics solutions optimize the athlete's posture during the regatta race. Maintaining a reasonable price for the structure is also essential for this kind of device. Figure 1 shows the boat with the disabled athlete on board and the current seat under study.

Figure 1. Disabled athlete on Skud 18 and current seat. Source: Authors.



Weight reduction of an object can be achieved in various ways; one solution is the adoption of a material with higher structural performance. For example, in the transport sector, the adoption of high-resistant steels or aluminium alloys in place of traditional steels leads to significant weight reductions.(L Solazzi, 2012; Luigi Solazzi, 2010) The use of composite materials with carbon fibers and natural fibers leads to a further significant weight reduction because they present a more powerful Ashby index,(Ashby, 2005) and also because these materials can be designed ad hoc for a specific use.(Collotta et al., 2016; L. Solazzi & Scalmana, 2013)

The first point of development in this research is to change the material and shape of the supports. To further reduce weight, the oversized components in the original seat structure have been identified and changed. Precision in the movement of the swiveling seat is achieved by adopting a new irreversible mechanical actuator, which has been chosen to prevent upsetting the structure's original configuration.

This study was further extended by examining the structure's mechanical stresses using FEM software, with the purpose of verifying analytical elaborations. In conclusion, the new swiveling seat shows a reduction in weight by using a new material (aluminum alloy instead alloy) of 50%, while still maintaining an equivalent safety factor. The optimization of the structure is done by uniformizing as much as possible the stress value on the component. This is possible removing or reducing parts that have less stress. Furthermore, this process happened iteratively to bound the maximum value of stresses in order to have at least the same safety coefficient.

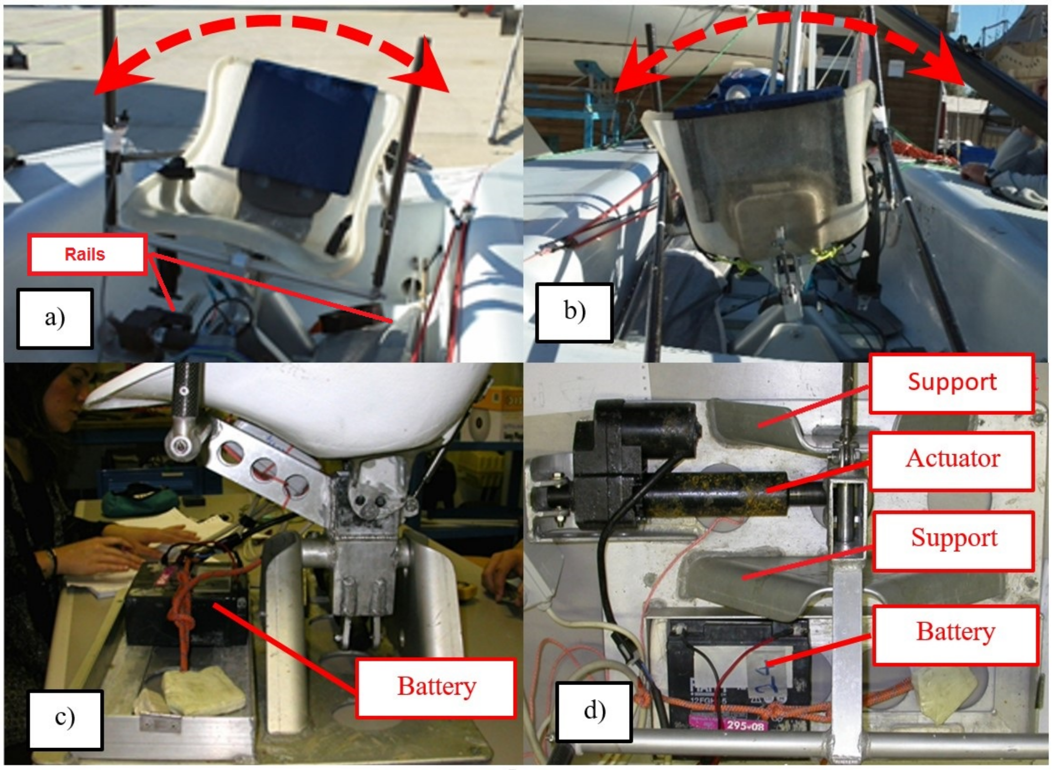
Methodology

This project is primarily focused on a technical analysis of the seat in order to follow a scientific and rigorous approach. Initially, the original seat was measured and weighted; 3D drawings of all details and a model of the existing seating system were then completed. Following this, loads and constraints were developed, taking into account hypothetical load configurations. During this first analysis, different proposals were introduced in order to solve a variety of technical issues. At this point, new prototypes were identified, studied and analyzed through the information coming from the initial model. A comparison between the two models was performed with the recalculation of safety factors, while part of the initial analysis was focused on the correct precision of the seat movements. Thus new types of actuators have been considered based on the required specifications. Technical drawings of the new swiveling seat were also made to provide a schematic of the final structure.

Current seating system

Figure 1 and Figure 2 shows the current seat, which has been subject to analysis in this work. The existing seat is fixed to the hull; the helmsman sailor can set their position when the boat is in a stationary position by shifting themselves back and forth along two rails. The sailor can also set the position of the seat by changing the angle settings (lurch and roll angles). Lurch angle (referred to the boat) is allowed by a rear screw (this adjustment takes place when the boat is stationary), while roll angle (referred to the boat) is allowed by an actuator positioned on the base of the seating system; this kind of actuator is also controlled by the athlete during sailing activity.

Figure 2. Pictures and mechanism of the current seating system: side, front and plan views. Source: Authors.



The original structure is primarily composed of a bottom plate, with two supports that are welded (which contain the locations of the pin that allows the roll rotation) together above it. The movement of the original seat was made by a linear actuator (Warner K2xG10 - 12v_0.4), which was powered with a direct current. This Warner K2xG10-12v-04 B-Track(L Solazzi, 2012) linear actuator has a 4" stroke and a 10:1 gear ratio for use in rugged duty applications, such as scissor and dump box lifts. This K2x series unit is capable of moving loads of up to 1200 pounds at a rate of 1 inch per second. Moreover, its maximum speed is 38 mm/s, which makes it possible to tread the stoke in 4 s as the athlete requires to be competitive.

The weight of the current structure is an issue of the swiveling seat, which results in bending deformations on the bottom plate. For this reason, a bottom and lighter plate is introduced in order to spread the stress on a wider surface on the hull. Another disadvantage of the seat is related to its reversibility wherein the absence of a power supply the seat is not capable of maintaining its position with an applied load. The reversibility is dictated by the efficiency of transmission. The higher the efficiency of transmission, the greater the possibility that the actuator cannot maintain its position. If the actuator is not irreversible, it cannot maintain its exact position (it may have a low accuracy) and cause a reduction in the performance of the athlete. In addition, the current structure involves play in mechanical connections, which decreases the accuracy of positioning.

Preliminary analysis

Initially, the two parts of the assembly were studied with analytical models. Particularly, the central hollow pin and supports (bigger and smaller).

For both parts, it was important to find loads and define constraints. In particular, the load of the measured seat is P_s=29 N(≅3 kg) and the hypothesized load of the human is P_u=903 N (≅92 kg).

The load used in the analysis must be calculated as the load of the human added to the load of the seat: both loads are increased by a multiplier, which accounts for dynamic effects:

$$P=(P_s+P_u)\cdot k \quad \text{with} \quad k=1.8$$

k is defined as a constant parameter used to consider a real situation with accelerations generated by the external environment (dynamic effect). It is estimated that the maximum accelerations on the sail may be comparable to the accelerations on the vehicle system. For this reason, the dynamic factor k has been chosen as 1.8.(L Solazzi, 2012)

One of the most stressed parts of the seat is its support. In fact, the section of greatest stress (critical section) parallel to the bottom plate of the seat is the section where the pin is positioned. This is a typical “C” section, with a central linear component that decreases linearly away from the bottom plate. The material of the existing seat is an aluminum alloy (Al 6063-T6).(European Standard Organization, n.d.)

All details about the chemical composition and mechanical properties are reported in Table 1 and Table 2.

Table 1. *Chemical composition of aluminum*

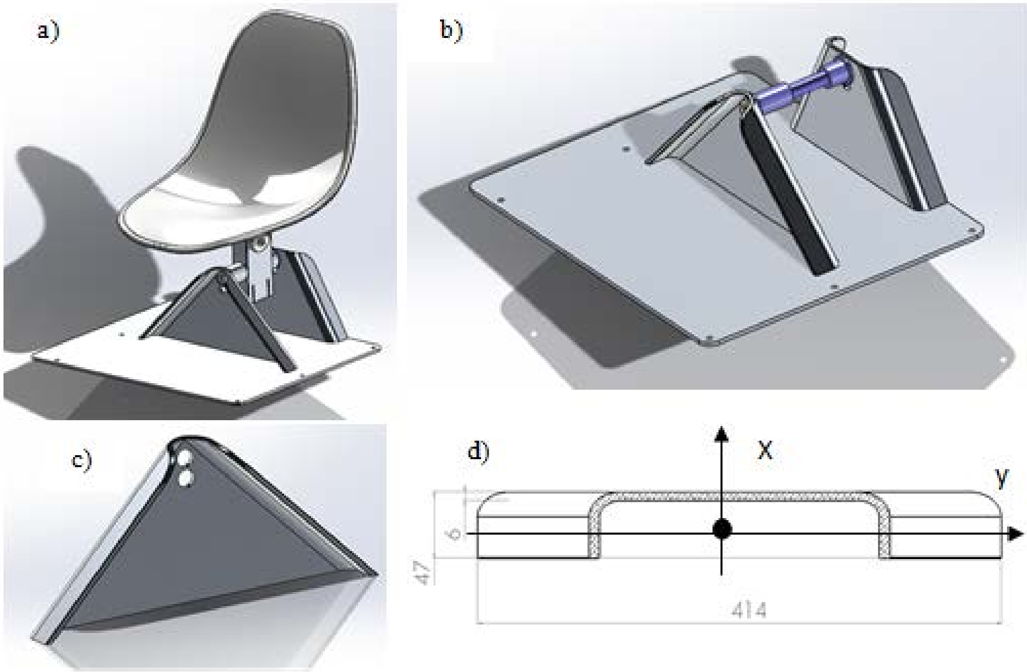
Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
0.2-0.6	<0.35	<0.1	>0.1	0.45-0.9	<0.1	<0.1	<0.1

Table 2. *Mechanical properties of aluminum*

		Ultimate tensile strength σu[MPa]	Tensile yield strength σy[MPa]	Elongation at break [%]
Al 6063 T6	**Thickness <10 mm**	215	170	8

The solid model of swiveling seat in the original geometrical configuration is reported in Figure 3. Moreover, the strength on the support is calculated with consideration of two different loads: the first is vertical due to the P load (it acts on the pin seat), while the second one is horizontal due to inertial effects.

Figure 3. 3D model of swiveling seat. (b) 3D model of swiveling seat without chair. (c) 3D model of the bigger support. (d) "C" section of the bigger support. Source: Authors.



This first analysis shows an initial, technical overview of the system; in which the most critical section has also been outlined. After this initial test, the support safety factors were analyzed and calculated following a standard procedure. In order to obtain a lighter structure, the safety factor has been made more uniform along all the supports; to modify this factor, the geometric configuration was changed (Figure 3 (c)). Another critical element of the structure is the pin that allows the swiveling of the seat. The external diameter of the hollow pin is 20 mm and the internal diameter is 18 mm; this is also made of 39 Ni Cr Mo3 steel. (Ente Nazionale di Normazione, n.d.) The chemical composition and mechanical properties of the hollow pin are reported in Table 3 and Table 4.

Table 3. Chemical composition of hollow pin steel

C	Mn	Si	Cr	Ni	Mo	P	S
0.35-0.43	0.5-0.8	0.15-0.40	0.6-1.00	0.7-1.00	0.15-0.25	<0.35	<0.35

Table 4. Mechanical properties of hollow pin steel

		Ultimate tensile strength σu[MPa]	Tensile yield strength σy[MPa]	Elongation at break [%]
39 Ni Cr MO 3 (hardened and tempered)	**ϕ>16 mm**	930-1130	735	11

The ability of this material to resist corrosion is high, and necessary due to is frequent contact with sea water. The effect of corrosion on any component, even in static loading conditions, also significantly decreases the mechanical performance of the component.(L. Solazzi, Scalmana, Gelfi, & La Vecchia, 2012)

The hollow pin is primarily subject to shear strength; furthermore, the previous consideration about the reaction forces is used to provide a further check analysis. The aim of this dimensioning is to consider the worst load situation. In this case, the worst load example exists when all of the P load acts on only one of the supports. The hollow pin is safety dimensioned with a very high safety factor, and for this reason, 39 Ni Cr Mo 3 steel has been used to increase stiffness.(Ente Nazionale di Normazione, n.d.)

FEM analysis

In order to determine the strength and deformation ranges on the structure, a 3D model and FEM (finite element method) of the existing sitting system have been carried out.

FEM analyses are usually used for nonlinear structures and allow the study of a complex and bound geometry that would otherwise be difficult to treat as a simple model. FEM analysis subdivides a large problem into smaller, simpler, parts. This subdivision into finite elements achieves not only an accurate representation of complex geometry, but also an inclusion of dissimilar material properties, an easy representation of the total solution, and captures the local effects.

The structure has been analyzed in configurations with one, two and three loads. In all simulations, some parameters have been defined, such as the kind of analysis (static strength with linear model material), materials of the components (pins: 39 Ni Cr Mo 3; (Ente Nazionale di Normazione, n.d.) central bushings: Nylon 101; other components: Al 6063-T3 (European Standard Organization, n.d.)) and constraints (the bottom plate is fixed while the lower part of the base of the seat is hinged).

An important aspect to consider is the displacement of the center of gravity (CG) of the athlete.

Figure 4 shows the displacement of the center of gravity as a result of the rotation of the seat (maximum rotation $\alpha= \pm 25$ °). Strengths on the structure are induced by the weight (including dynamic effects) and by the actuator, whose is dependent on the position of the seat. For example, when the seat is upright (α = 0 °), the actuator does not generate any force. Also, the force of the actuator was determined by balancing the rotation around the pin. In particular, it was assumed that the distance of the athlete's center of gravity from the pin is equal to 480 mm (a), while the distance between the actuator point and pin is 90 mm (b).

The analysis is separated into three cases to give values to the different contribution of loads on the distribution and magnitudes of the stresses. Although, each load is distributed and has a value equal to P.

The first load case consists solely of a vertically distributed load, representative of an inertial load. In the second case, there is a vertical and horizontal load. Finally, the third load case consists of a vertical load and two horizontal loads.

Table 5. Applied forces of the FEM analysis for the current seating system in the studied three different load configurations.

Load case	Forces in Z direction [N]	Forces in Y direction [N]	Forces in X direction [N]
First case	1680	0	0
Second case	1680	1680	0
Third case	1680	1680	1680

Figure 4. Representation of load conditions (i) on the three axes (ii) on the two axes (iii) angle of inclination. Source: Authors.

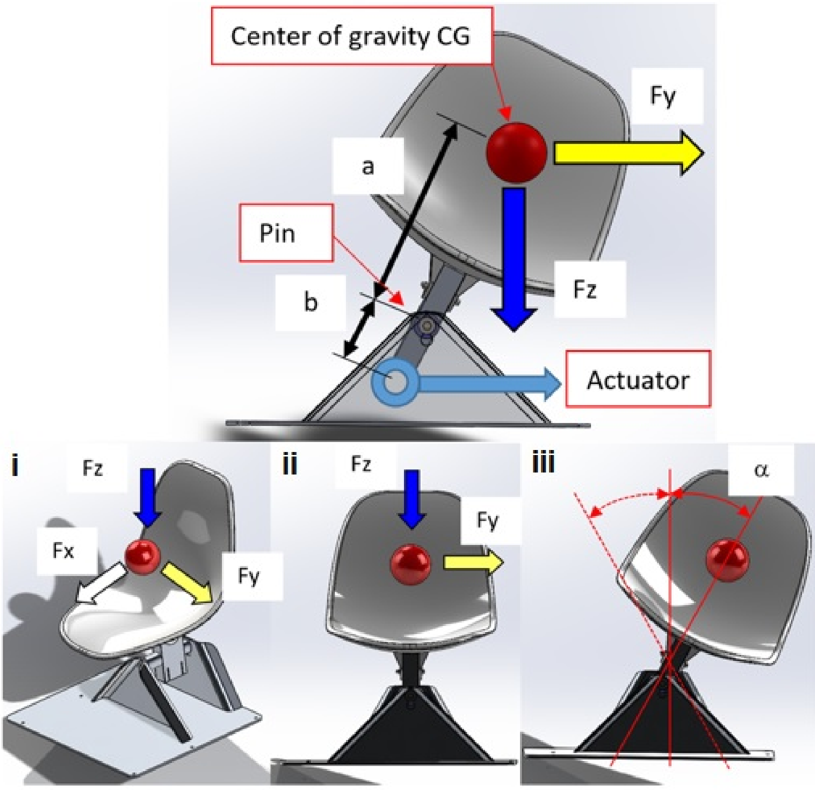


Figure 5. Results of the FEM analysis of the current structure. (a), (b) displacement and stress of first loading condition (c), (d) displacement and stress of third loading condition. Source: Authors.

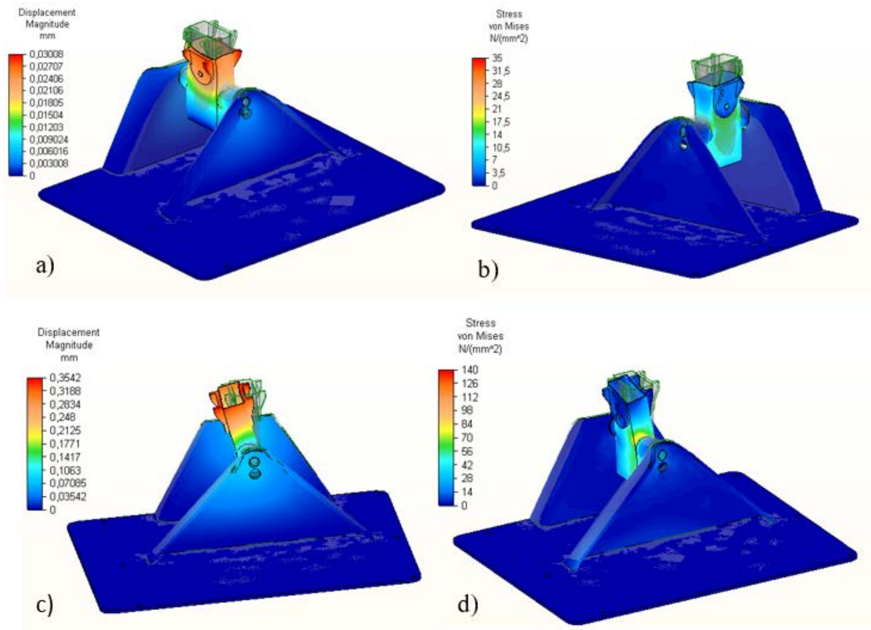


Table 6. Results of the FEM analysis for the current seating system in the studied three different load configurations.

Load case	**Maximum stress [MPa]**	**Maximum displacement [mm]**
First case	**32**.5	0.030
Second case	85	0.252
Third case	145	0.354

This analysis also shows that supports and the bottom plate are not critical. In fact, stress and displacement values are very low for the first and second load case. In the third load condition, which considers all force components, the stresses are much higher. However, the maximum value of stress is lower than the yield limit of the material.

Improved seat

In the new structural seat proposal, the extra material has been removed according to the previous analysis, to decrease the weight of the structure. A series of preliminary studies were carried out by adopting composite materials. However, the increased cost made this choice unviable regardless of the significant weight reduction. An aluminum alloy with high mechanical properties compared to the original seat has been used for the structure. Otherwise, the same material has been maintained for the hollow pin. The alloy adopted for the realization of the structure is the aluminum Al 7075 (Ente Nazionale di Normazione, n.d.) which is used in the aeronautical sector; the characteristics are reported in Table 7 and Table 8.

Table 7. Chemical composition of aluminum

Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
0.4	0.5	1.2-2.0	0.3	2.1-2.9	0.18-0.28	5.1-6.1	0.2

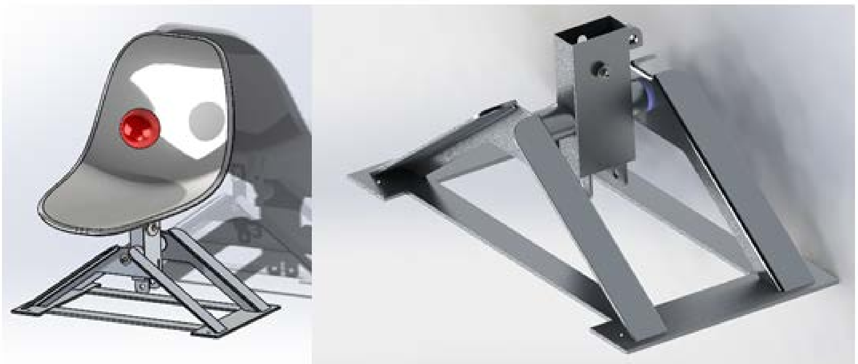
Table 8. . Mechanical properties of aluminum

		Ultimate tensile strength σu[MPa]	Tensile yield strength σy[MPa]	Elongation at break [%]
Al 7075 T6	**Thickness <10 mm**	510	430	5

In the original structure there were two different supports: one large and one small. They were oversized, for this reason the type of material has been maintained, but the shape has been changed (Figure 6). In order to keep the same safety factor of the actual structure, the critical area has remained constant along the vertical direction of the support. A new support shape has been created in order to exhaust the load directly on the drivings.

The original bottom plate has been replaced with four welded plates in order to recover the oversizing of the existing seat. All these modifications are presented in Figure 6 in which the new structural proposal is shown.

Figure 6. New sitting system. Source: Authors.



The improvements in this new seat include better load distribution and a reduction in weight; this innovative structure's weight is decreased by about 50% from the original structure. The price of the supports and bottom plates are also estimated at about 150 €, that is lower than the price of original structure. The stress tension is also approximately equal to the current model.

FEM analysis

The structure has been analyzed with a FEM analysis using the same load conditions as the original structure with one, two and three loads (Figure 7).

Figure 7. Results of the FEM analysis of the improved model. (a), (b) displacement and stress of first loading condition (c), (d) displacement and stress of third loading condition. Source: Authors.

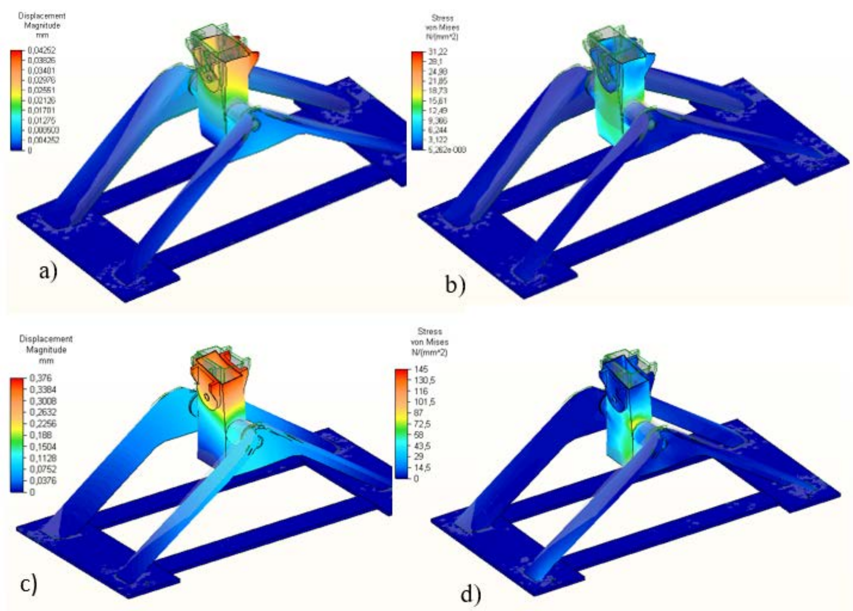


Table 9. Results of the FEM analysis for the new seating system in the studied three different load configurations.

Load case	Maximum stress [MPa]	Maximum displacement [mm]
First case	30	0.04
Second case	60	0.230
Third case	140	0.370

Figure 7 also shows that the areas of highest stress are similar to the previous structure. Moreover, the FEM analysis shows that maximum displacement values are very close to the values of the existing structure.

Table 10. Safety factors and displacement comparison between the existing seat and new proposals.

a) First load case

	Current	Proposal
η (safety factor)	11.3	14.3
CG Horizontal displacement [mm]		

b) Second load case

	Current	Proposal
η (safety factor)	4.2	6.3
CG Horizontal displacement [mm]	0.252	0.230

c) Third load case

	Current	**Proposal**
η (safety factor)	2.5	2.5
CG Horizontal displacement [mm]	0.354	0.370

The safety factor is calculated with respect to the improved structure. The hollow pin does not create any safety issues, and it has also been observed that the new proposal is the safest out of all three cases. Compared to the actual structure, the first and in the second load cases present a higher safety factor (η), while the third case η remains the same as in the existing seat. In comparison with the second proposal, η remains the same in the first and in the third cases and higher for the second case. The structure of the first proposal allows for lower distribution of stresses, so that the seat base is relieved by them.

In the second case, the new proposal presents the most rigid; the CG displacement is also lowest of all of the other models. In the third case, the new proposal is more rigid than the second but with a higher level of deformity than the current structure. It may therefore be concluded that the new supports are more deformable (than the actual ones) if they are loaded by a force in the pin axis direction.

Movement system

The required movement of the swiveling seat presents a roll rotation of ± 25° with respect to the vertical axis through the centroid of the seat itself. This angular movement is translated into a linear translation of the actuator piston of 76 mm.

To maintain the dimensional specifications of the current structure, the required force from the actuator is equal to 13140 N. In this case, the sizing is used to choose the optimum drive. The required power for moving the load is 0.2 kW so the power actuator must be higher than the calculated power. The original linear actuator, Warner K2xG10 - 12v_0.4 (Warner linear, 2016),powered by direct current (DC) - is the first movement device, which has been chosen for its speed and compatibility with the required speed. The price is also affordable and presents an average cost of 500€.

It was verified that the power needed to overcome the forces is equal to 0.2 kW, but the actuator chosen must have the necessary parameters to achieve the desired stroke with the speed required, if the size characteristics of the structure are to remain unchanged.

This drive is reversible and movement is more accurate and in the absence of a power supply it will not be able to maintain its position with an applied load. This irreversibility gives more stability to the athlete, (i.e. it avoids additional forces applied to the structure as well as ensures greater precision to the movements).

In addition, the type of engine is also maintained and is powered by direct current (DC) in order to maintain the battery already supplied, and remove the possibility of the requirement for additional components such as a transformer. When selecting the drive, the service of the drive must also be considered, which is characterized by the duty cycle. As required by the actuator operation, this parameter is not restrictive because the movement does not require a continuous service or an immediate reaction to the load.

The possibility of connecting a linear actuator drive without a motor, and with a gear-motor, is evaluated to keep the dimensional characteristics of the structure unchanged, and to introduce the irreversibility properties.

The actuator and related gear-motor chosen are Thomson Electrack FA14 10B65 (Thomson Linear Motion, 2016a) and Thomson AKM24C respectively (Thomson Linear Motion, 2016b.) All adjustments and lubrication are made at a factory level, and it is not required or recommended that further maintenance be completed throughout its duration, as the actuator ensures consistent performance and is reproducible. The component Electrack FA14 10B65 has a flange for mounting of the gear-motor, and is durable and robust. This is optimal because the actuator is used in an open atmosphere in contact with water and salt. The stem is made of stainless steel and has a cover tube of corrosion resistant aluminum.

Furthermore, this actuator allows attaining a maximum speed of 19 mm/s; its speed is compatible with the required speed of 17 mm/s in order to have the stroke time equal 4 s.

This model has been chosen despite being driven ball screw and is reversible because this will be compensated by the gear-motor with a transmission ratio of 1:50. The gear-motor, AKM24C, which drives the actuator, offers the precision and performance required by the most demanding motion control environments and fits perfectly for this elaboration. This actuator is the best option for several reasons, such as its irreversibility, the possibility of maintaining the dimensional features, and the price.

Conclusion and result application

This research work is focused on the analysis of the structure of a swiveling seating system for the SKUD 18 boat by evaluating different values of tensile strength of materials. In this way, it was possible to study and present a suitable improved proposal for this Paralympic boat seating system. The aim of this work has been to improve the performance and ergonomics of the swiveling seat for athletes using the SKUD 18.

The support section has been changed, and it allows both a reduction of about 50% material weight, as well as better stress distribution. This is possible thanks to a reduction in the base of the seat (the top of the structure), and the safety factor of the whole structure, which has been increased.

The new structure has the load directed downwards on the drivings of the seat so deformation is reduced on the bottom plates. The disadvantage of the current seating system driving is its reversibility, and the driving chosen for the new swiveling seat achieves irreversibility without a change in the price. The actuator, Thomson Electrack FA14 10B65, and relative gear-motor, Thomson

AKM24C, are irreversible and there is a possibility of maintaining the same dimensional features as the previous actuator.

The system can also be developed further, and changes in the structure have been produced without distorting that of the original. In this way, the material used can be changed as well, in order to decrease the total weight, but maintain the same tensile strength.

The driving has been chosen to maintain the same type of engine, and is powered bywith direct current. This is necessary to maintain the battery charge and remove the requirement for additional components, such as a transformer, for the system. In future developments, a new movement concept could be investigated in order to optimize not only the rotation of the system, but also ergonomics. In conclusion, this structure is being built and it will be settled in the SKUD 18 of the Italian national team that will compete at Rio 2016 Paralympic games.

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RETHINKING THE BATHROOM FOR ADOLESCENTS WITH CEREBRAL PALSY: AN EXPLORATORY PILOT STUDY ADDRESSING PRIVACY AND INDEPENDENCE

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Abstract: Caring for a child with cerebral palsy (CP) at home represents a major challenge and can have a significant impact on the caregiver's physical and psychological well-being. Caregivers and professionals often feel uncomfortable with adolescents' emerging behaviours. Adolescents' need for privacy requires a certain level of independence to be achieved. However, the physical environment may cause problems in achieving the required degree of privacy. The main objective of this study was to explore and identify realistic, evidence-based solutions to promote independence and privacy in the bathroom for

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teenagers with CP. The authors used a two-stage co-design process: the conception of the design solution, followed by validation. The results of this project demonstrate the need to combine original technical aids and environmental settings to create a safe, hygienic environment for the user. The results can guide therapists in their clinical approach to designing washing facilities that meet the hygiene and psychological needs of other adolescents, adults and seniors with mobility impairments.

Keywords: Cerebral palsy, adolescents, design solution, bathroom, independence, privacy.

Introduction

When children are young, caregiving is an important parental role. This role is often much greater when the child has permanent functional limitations that lead to long-term dependence. This can be the case when the child has cerebral palsy (CP), a non-progressive, permanent disorder resulting from damage to the developing brain (Ingram, 1964; Scoles, 1982) that occurs in 1.5 to 2.5 children per 1,000 live births (Murphy, Yedgin-Allsopp, Decoufle, & Drews, 1993; Oxford Register of Early Childhood Impairment, 1998). Along with motor impairments, many children with CP also have communication and cognitive impairments. Together, these can lead to complex limitations and restrictions on self-care activities. The task of caring for a child with CP with complex disabilities at home, therefore represents a major challenge and can have a significant impact on the caregiver's physical and psychological well-being. Although both the child and caregiver may show increased mastery of their respective skills and roles over time, the burden of care may also increase over time as both parties age.

Caring for a growing child with CP is an important consideration since 90% of children with CP survive into adulthood (Evans, Evans, & Alberman, 1990). Activities taking place in the bathroom are probably among the most physically demanding for children with CP with complex needs and their caregivers. Furthermore, contemporary society has rigorous hygiene standards, reinforced by the media. It is commonly understood that a daily shower or bath and twice daily tooth brushing are required (Kira, 1976; Morales, 2007). Moreover, for many able-bodied individuals, their bathroom represents a private place for relaxation and self-indulgence (Morales, 2007). For people with disabilities, however, this same space, is often the scene of difficult and stressful experiences (Mullick, Preiser, & Ostroff, 2001), possibly due to a lack of accessibility and privacy. Thus, this qualitative pilot study had two main objectives:

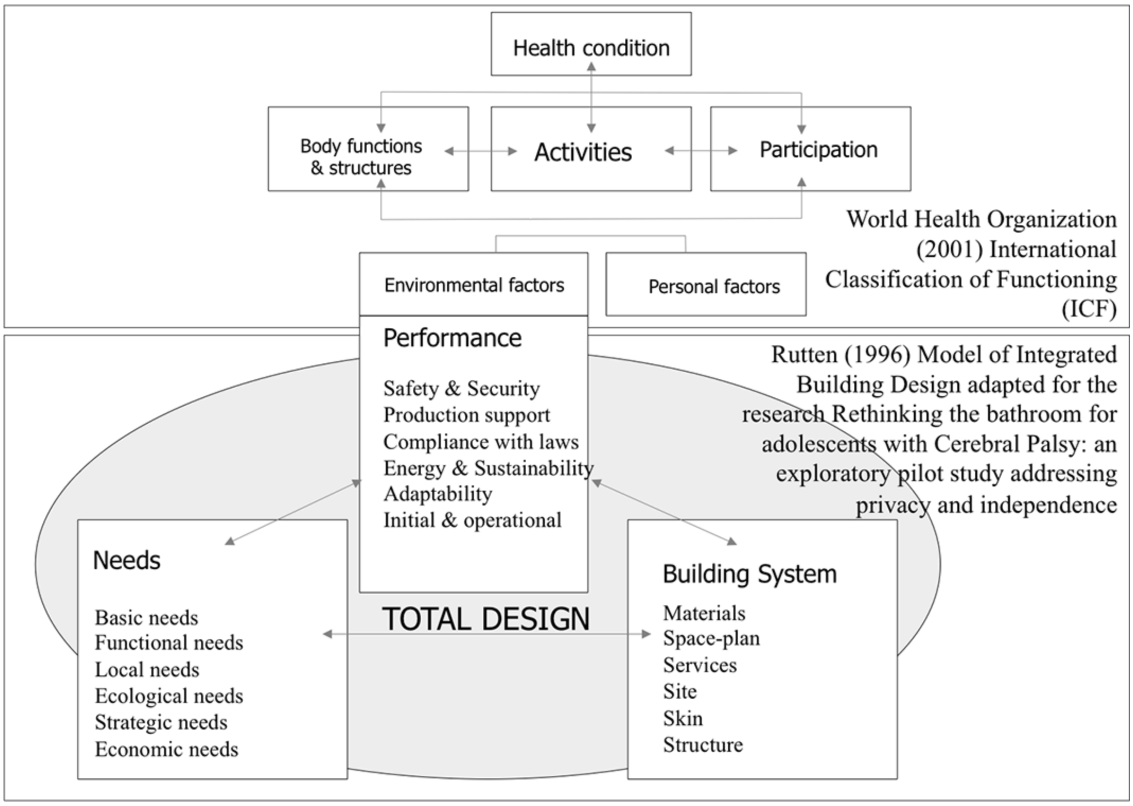
1. To provide a sensitive portrait of the everyday struggles with basic hygiene activities faced by adolescents with CP.
    a. To understand the solutions and procedures used by adolescents with CP and their caregivers when taking a shower.
    b. To determine the independence and privacy needs of adolescents with CP when taking a shower.
    c. To determine caregivers' needs in terms of assistance to the adolescent with CP in the shower.
2. To explore and suggest some potential solutions addressing the needs of this population.

To address privacy and accessibility issues from a design perspective, the Model of Integrated Building Design (MIBD, see figure 1) (Rutten, 1996; Van Hoof, 2010) was particularly helpful. With this model, the relationship with accessible environments is viewed from different perspectives and is seen as a triangular relationship between (1) the needs, (2) the performan**ce and (3) the design solution.**

The usefulness of a design solution is related to its fit with the requirements of the stakeholders (in this case, adolescents with CP and their caregivers). For adolescents with CP who have complex needs, two bathroom requirements are likely: independence and privacy. Along with architectural barriers, dependence on caregivers for personal care is one of the main impediments preventing adolescents with physical disabilities from developing independent social lives (Blum, Resnick, Nelson, & St. Germaine, 1991; Greydanus, Rimsza, & Newhouse, 2002; Nosek & Hughes, 2001). Although individualization and separation from one's caregivers are among the main goals of adolescence, caregivers may feel anxiety about allowing children with complex needs to take responsibility for themselves (Murphy & Young, 2005; Kewman, Warschausky, Engel, & Warzak, 1997). Privacy in the bathroom is particularly important to adolescents because physical growth and sexual maturation are prominent features of this developmental stage, and modesty is a natural response to these changes. For children with CP, adolescence begins earlier and ends later than in able-bodied children (Worley et al., 2002).

As for the other two factors in the MIBD, performance is the ability of the design solution to meet stakeholder expectations and needs. The design solution includes all elements relevant to the design process.

Figure 1. IFC/MIBD Model. Source: Rutten (1996); Van Hoof (2010)



Methodology

The study used a qualitative co-design methodology (Ivey & Sanders, 2006; Sanders & Stappers, 2008; Sleeswijk Visser, et al., 2005), where the user or stakeholder is an "expert in his own experience" and contributes to the design of the solution. This study was divided into two main phases: the exploration of the current situation along with the conception of the design solution; and the validation of the design solution in consultation with experts.

Study participants

Three adolescents, three family members, and ten service providers (five occupational therapists and technician orthosis-prosthesis specialists, and five bathroom product specialists) participated. The inclusion criteria for the adolescents were: (1) having a diagnosis of CP; (2) being 13 to 21 years old; (3) using a wheelchair at all times for mobility; (4) being classified as level IV or V on the Gross Motor Function Classification System (GMFCS) (Palisano, Rosenbaum, Bartlett, & Livingston, 2008); (5) having sufficient cognitive and communication skills to permit active collaboration in the two study phases; and (6) using a standard or telephone shower at home. Family members had to be the primary caregiver at home of one of the adolescents, and service providers had to be experienced with the shower needs of young people with GMFCS level IV or V CP. All participants were clients, families or employees of Centre Intégré Universitaire de Santé et de Services Sociaux (CIUSSS) de la Capitale-Nationale, Institut de Réadaptation en Déficience Physique de Québec (IRDPQ), with the exception of the bathroom product specialists, who were employed in private businesses in the community. The study was approved by the local institutional review board. With the exception of minors, written informed consent was given by all participants. For minors, this consent was provided by caregivers and the child consented to participate.

Protocol

Phase 1: Needs analysis and user-generated design solutions. The adolescents and their caregivers were visited in their homes twice. Meeting 1 was divided into two parts. Part 1 was a semi-structured interview with the adolescent and the caregiver to identify problems experienced in the shower. Sociodemographic and home adaptation information was also collected, including age; date of birth; number of people living in the house; number of bathrooms in the house; diagnosis; services received (what kind, from whom and specialty); and home adaptation (type, if there is one). To identify the difficulties, a series of questions were asked, such as:

- What experiences do you dislike most when you take a shower?
- What feelings and sensations are associated with taking a shower?
- How relevant to you is privacy in the shower?
- Do you think some bathroom activities require more privacy than others?
- If so, what are they?

The interview was digitally recorded. Part 2 involved making a video-recording of the adolescent having a shower in his/her own bathroom, wearing a bathing suit. This was done to provide the researchers and the service providers with (1) information on the procedures, needs, difficulties and possible solutions related to the shower; and (2) a visual and verbal description of the showering procedure from the adolescent's and the caregiver's perspective. At the end of the first visit, the adolescents and their caregivers were given a notebook, pencil and eraser. During the following week, they were to think about and record possible design solutions without regard to cost or development expense that would better allow the adolescent to take a shower independently, in private.

One week later, the second visit took place. The adolescents and their caregivers described their design solutions, while one of the researchers sketched the solution on a large piece of paper so everyone could see the idea. This was particularly important since the drawing allowed all participants to provide relevant input. Following Phase 1, the research team finalized the preliminary design solutions based on the information from the two visits.

Phase 2: Validation (consultation with experts). Design proposals were criticized, enriched and validated by the participants during three focus groups. What is called "validation," in this case, becomes a filter, a research strategy to "purify" and enhance the design and set some parameters for the unlimited process of creation in order to achieve more realistic, viable and sensible solutions. The main objective of this session was to assess and improve the design proposal from an adaptive and clinical point of view.

The three sessions followed the same co-design and brainstorming format: the two researchers (E.M. and D.M.) and the two clinicians (M-C. B. and C. P) explained the project in a PowerPoint presentation to the participants. A question period was allowed, and then the printed versions of the different design proposals on 60 x 90 cm sheets of paper were displayed so participants could suggest their ideas (modifications), These ideas were discussed to try to reach a consensus and then the main researcher drew them in on the printed diagram. Finally, the design solutions were modified according to the comments of the different focus groups: Group 1: adolescents (three individuals) and their caregivers (three individuals); Group 2: occupational therapists (five individuals); Group 3: bathroom product specialists (five individuals). Following Morgan's (1988) recommendation, there were an odd number of participants in each group. All group sessions were digitally recorded.

Data analysis

The data were analyzed using content analysis (Mucchielli, 2009; Ryan & Bernard, 2000). Three of the co-authors independently identified the main concepts from Phase 1, Visit 1 that were directly related to design solutions. Concepts were then discussed and any differences were resolved through consensus. The graphic results from Phase 1, Visit 2 (drawn by E.M. and data from the participant notebooks) were then compared with the concept data (Ivey & Sanders, 2006). This process enabled the design proposals to be checked and filtered for validity.

Results

Needs of adolescents with CP

Need for independence

The teenage participants unanimously answered that genital hygiene is the task where they are most dependent on others, but where they would most like to be independent. Other tasks requiring assistance were washing their hair, back and feet.

"I can wash my face and upper body by myself but not my lower body."

Problems for the caregivers included inappropriate positioning (need to kneel on the floor next to the bathtub/shower to help with washing; need to transfer their child, etc.) that caused long-term back problems. Other elements such as splashing were also mentioned as being unpleasant.

"I have to be on my hands and knees to wash her… There is no curtain. We use the shower to rinse off, so both of us get wet."

Need for privacy

The adolescents unanimously mentioned that they would prefer to shower by themselves. However, they were used to having a caregiver perform this task, and it did not bother them. For example, one participant said that respect for privacy is desirable but not always realistic in this context. Another mentioned that the energy needed to be independent would likely result in fatigue. The third noted that having a non-family member caregiver is uncomfortable because that person will not perform tasks the same way a family member would. For example, the mother of one participant shaves her daughter's pubic area once a month.

“I could do it myself but I am used to always having someone there. It doesn’t bother me.”

“I have not had privacy for a long time. When it’s my mother, it’s better. When it’s someone else, I have to get used to them.”

Feelings regarding showering

What the adolescent participants valued most in taking a shower was an efficient way of getting clean and the feeling of warmth. Two of the participants preferred taking a shower instead of a bath for these reasons. One of the participants, however, especially enjoyed taking a bath, as it was warm and relaxing. Her caregiver agreed and added that she [OK?] could also take a break while her daughter was in the bathtub.

“What do you like most about taking a shower?” “It’s quick. She likes relaxing in the bathtub, but there’s never enough [hot] water. Since we installed the shower [with adaptations] it’s quick; she’s done in 15 minutes.”

One participant used a ceiling-mounted mechanical lift from the bed to the bathroom. The rail stopped at the toilet so she could urinate before getting into the hot water. Keeping the room warm was a priority as the participant was sensitive to cold. After 20 to 30 minutes in the hot water, the water was drained to start the washing. Washing was done by the caregiver with a sponge, kneeling at the edge of the bathtub. The participant was rinsed with a telephone-type shower spout, dried, put back in the lift, and transferred back to her room where she was dressed in her bed. The main obstacles were a low bathtub and postural problems affecting the caregiver’s back while soaping and rinsing.

“I like the older, lower tubs better because I have back problems. But our [modern] bathtub allows me to put more water in. The best thing to do is to be on my knees so I can be close. However, now I have help. You have the right to receive help, no matter how much money you make.”

Another participant used a manual wheelchair to go from his bedroom to the bathroom. He then transferred from the wheelchair to the toilet to a wheeled shower chair. The caregiver washed the participant from outside the shower and provided a towel for drying. Opening the shower curtain was minimized to keep the shower stall warm. The transfer process was then reversed after the shower. The main obstacles were the shower sill, the restricted space in the shower stall, the lack of a fixed temperature control and a soap holder that was inaccessible to the participant.

"The shower is relatively large, but still too small…because he has grown and his feet touch the bottom of the shower…it's not easy to get the shower chair in. The shower has a little lip, you have to go over a little bump. We have no choice because of how the bathroom is built."

The third participant was taken into the bathroom in her manual wheelchair. She performed a "sit-to-stand transfer" from the wheelchair to an adjustable-height (hydraulic) seat that was then used to transfer her into the bathtub. The main obstacles were a small space between the bathtub and the sink, the accessibility of the soap and the height of the bathtub.

"We made adaptions when we built [the house]. As she's grown older, her needs have changed because of her condition…We added a lift…Sure, theoretically the bathroom could be a foot larger…we've realized that the counter is two inches too wide."

Design proposals

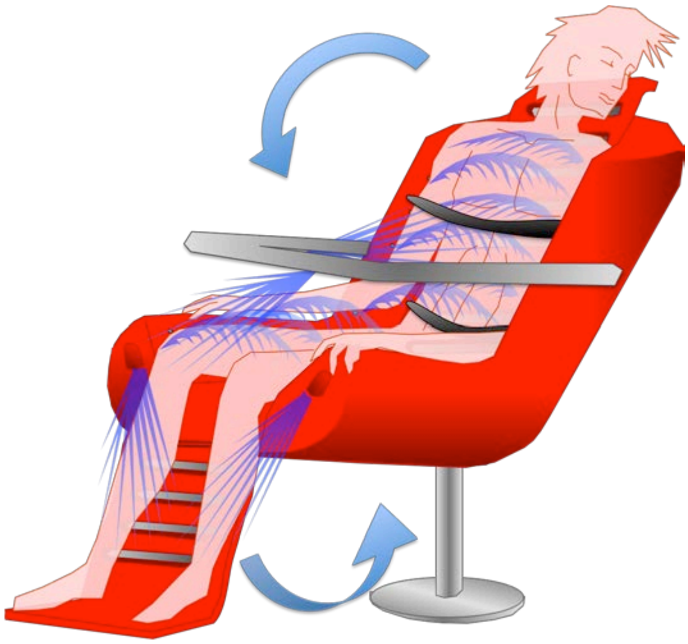
Of the main problems identified, the lack of space was one of the most important. Regarding fixtures, the idea of a "car wash" shower with multiple shower heads was unanimously suggested. It was considered important to have a telephone-type shower head and another fixed shower head that could be directed at the adolescent, to provide a continuous flow of warm water, as well as other shower heads at specific locations that could spray water or soap. Control of water intensity and temperature by a button-type "interface" or a joystick was also suggested.

During Phase 1, Visit 2, each adolescent and caregiver provided ideas related to design solutions. These solutions were then presented to the three focus groups (Phase 2). The three design solutions judged the most relevant by the research team and the experts are presented here.

Shower chair

The shower chair should have a toilet seat-type opening and bidet-type fixtures. There should also be water jets in the back and legs of the chair (see figure 2).

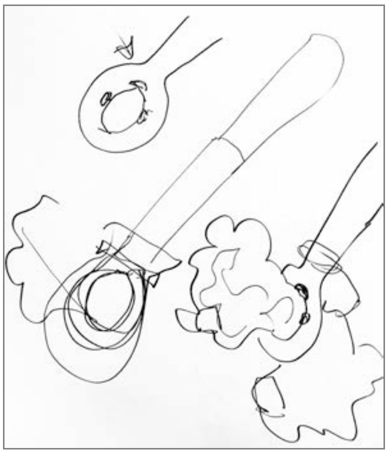
Figure 2. Shower chair. Source: Authors.



Extensions

Extensions that attach to water or water/soap jet with a soft sponge-like material at the end would be desirable, especially if operated with an infrared system (see figure 3).

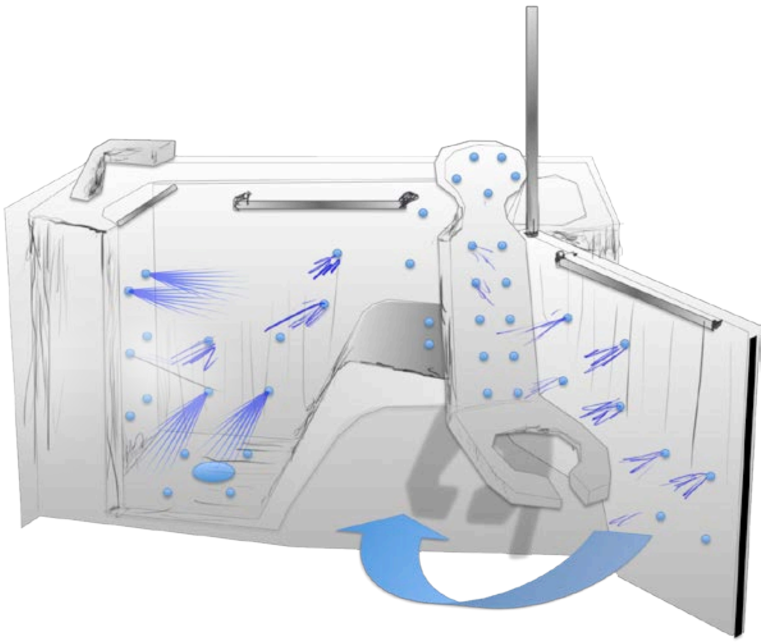
Figure 3. Sketch of extensions.



Shower-bath

A walk-in bathtub with a bath chair on wheels that could be anchored to the bathtub door would facilitate transfers. The bathtub should have water jets in its walls and base so it could be used for a bath or shower. The jets could also facilitate rinsing the perianal area through the above-mentioned opening in the bath chair. This jet system would also allow the person to stay warm while in the tub (see figure 4).

Figure 4. Shower-Bath.



Discussion

Need for independence

The adolescents and caregivers in this study were aware of each teenager's abilities and limits in the shower and bathtub and of the considerable amount of energy that would be required by both the adolescent and the caregiver to support full independence. Independence in the shower or bathtub was therefore not a priority for either group. Furthermore, the participants recognized that they were never likely to be able to wash their hair or genitals without help. However, the results also showed that the amount of caregiver assistance provided was sometimes more than was required, which constituted a barrier preventing the teens from becoming more independent, even if full independence was not realistic. The provision of more assistance than was needed may have been related to time constraints and hygiene standards (Kira, 1976).

Need for privacy

All three adolescent participants said they would prefer to be able to manage their hygiene without personal assistance. However, they also agreed that this was unrealistic given their limitations. While they reported being used to receiving the help of a caregiver, they preferred someone they were familiar with, whom they could trust, whether this was a family member or not. All of them also expressed a greater need for privacy when they had many caregivers or a new caregiver.

Performance

Although the three adolescents' homes had been evaluated and adapted under the supervision of an occupational therapist specializing in home adaptation, some areas of need still remained. For example, the teenage participants and the caregivers suggested larger bathrooms and shower spaces and more accessible shower and bathtub fixtures.

Design solutions

Given the diversity of limitations and environmental contexts, one design solution cannot meet all needs. However, the adolescent participants and their caregivers agreed that a combination of design solutions would likely increase their independence in dealing with personal hygiene even though some assistance would always be required. For example, it was unanimously felt that the heat provided by water jets would have a relaxing effect. This was considered beneficial, as spasticity and related discomfort or difficulty with positioning can temporarily increase during bathing or showering if the person feels cold. An opening in the shower seat that would allow access to the perianal area and use of the toilet before showering or bathing was also suggested as a solution. However, it was recognized that this type of chair would be technically complex to design. Another unanimously accepted design solution to increase independence was extensions. Given the upper limb motor limitations of the participants with CP, however, additional work is required to develop a handle that would allow them to control the extensions. The extensions would need to be made from a material that was safe, washable and hygienic.

The shower-bath solution would meet the need for relaxation, maintain a warm temperature and prevent caregivers from getting soaked. However, since the shower-bath should be level with the floor so the chair can get in, the caregiver's position could be problematic. Participants liked this solution because it would allow the adolescent to stay warm and because of the additional water jets for the perianal area. This design solution could be used by any member of the family; it would help seniors with their hygiene practices, and it would occupy the same area as a regular bathtub.

The combination of the extensions with the shower chair or the shower-bath might give adolescents with CP greater autonomy.

Study limitations

The results of this study are limited to adolescents with CP who use a wheelchair for mobility and their caregivers. It is likely, however, that at least some of these results will apply to other populations with similar needs, such as adolescents with a neuromuscular condition or adults with CP at GMFCS levels IV and V. Another limitation was the small sample size (3 adolescents and their caregivers). A small sample size was chosen because of the co-design methodology, which requires one to go "deeper" rather than wider with data collection. Greater breadth of results came from the service providers in Phase 2 of the study.

Conclusion

Using the MIBD, this qualitative study aimed to explore problems and solutions affecting bathroom design for adolescents with CP with complex care needs. The results highlight the need to explore new and existing technical aids in the bathroom environment to facilitate showering. While all adolescent participants expressed a desire to be more autonomous in achieving their personal care, motor disabilities limit their independence. Therefore, human assistance remains necessary, which affects their privacy. This seems, however, to be tolerated by the teenage participants. Caregiver involvement is necessary, but the level of aid provided is sometimes greater than required, increasing the burden of care.

It is suggested that needs for independence and privacy should be evaluated as part of clinicians' intervention process in the bathroom area. This would allow a better match between needs and proposed solutions in order to optimize the performance of the tasks. In addition, it is recommended that occupational therapists educate caregivers about the risk of injuries related to showering, so they can design a bathroom while their children are young that will accommodate their future growth. This would contribute to allowing teenagers with CP to stay at home and avoid institutionalization. In this regard, it would be interesting to document the impact on caregivers of the introduction of design solutions meant to promote independence for a child with CP at the early stages of life.

Considering the data collected and the concrete identification of design solutions, future research will focus on testing the prototypes. If the prototypes prove to be effective, the training of occupational therapists in the use of this equipment will be essential so adolescents with CP can gain more independence and privacy.

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DEVELOPING A TAXONOMY OF THE BUILT ENVIRONMENT FOR DISABILITY STUDIES. METHODOLOGICAL INSIGHTS

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Abstract: For a city to be inclusive, its physical environment must be identified, characterized and assessed prior carrying out any transformations or improvements. Indeed, such identification is a necessary first step to enhance the impact of appropriate policies for citizens with impairments and functional limitations. The objective of this research was to develop a comprehensive and applicable vocabulary set, for the description of the physical environment in support of the implementation of the United Nations Convention on the rights of persons with disabilities to Quebec City's context, which can, in turn, be applied to other cities and environments. We developed a taxonomy based on the Human Development Model – Disability Creation Process (HDM-DCP). We reviewed documents containing nomenclatures with respect to the specific case of Quebec

City's physical environment in order to develop a comprehensive taxonomy that could be replicated in other contexts with other datasets. We organized the information under the original taxa of the HDM-DCP; this was carried out via an iterative process where elements of similar type were organized into a common level within one hierarchical branch under more general categories. When categories linking objects to broader subcategories were not already identified, we expanded the structure by creating new sub-categories or hybrids. The applicability of the developed taxonomy was tested through field analyses (photos of street sections) to determine whether all relevant objects and infrastructures in the city were included. The resulting taxonomy was found to be useful in identifying/mapping elements of the physical environment. Both at the individual and collective level, it allows the identification of the elements that play a role in mobility, resulting in enhanced social participation and the reduction of disabling situations for people with disabilities.

Keywords: Taxonomy, politics, disability, mobility, physical environment.

Introduction

The United Nations Convention on the rights of persons with disabilities (CRPD) has its foundation the principles of equality and non-discrimination. It informs signatory states, public and private actors of their responsibilities regarding aspects such as the implementation of policies, services, and infrastructures to ensure all people can access regardless of their disabilities (Fougeyrollas, 2010; Lang, 2009; Mégret, 2008; Shakespeare, 2015; United Nations, 2006). The Convention likewise frames disability in the language of human rights, marking a further move away from biomedical explanations, as the social model had done before, by placing the burden of disability on society and translating the phenomenon into a deficit of rights. Inversely, in an inclusive society respectful of the rights of its members, despite their differences and as defined in the supranational sphere, social and physical barriers within the national space are to be addressed and removed to facilitate social participation and the exercise of these rights. The implementation of the CRPD at the international level relies on the existence of guiding principles alongside existing and modified national legislative and normative frameworks. However, the CRPD does not offer a precise description or categorization of objects in support of these principles (Lang, Kett, Groce, & Trani, 2011; Quinn, 2008). For a city to be rendered inclusive, its physical environment needs to be identified, characterized and assessed prior to being transformed and improved. In addition, such identification is a necessary first step to ensure the development of policies dealing with what is acceptable or not for citizens with impairments and functional limitations.

The tools currently used to assess accessibility focus on various environmental components as well as descriptors and norms or recommendations (Americans with disabilities act [ADA], 1995; Brownson et al., 2004; Kentucky Cabinet for Education and Workforce Development, 2012; McClain, Lutz, Salmans, & Wright, 1999; Measuring up program-2010 Legacies Now- Accessible Tourism Strategy, 2008; Rimmer, Riley, Wang, & Rauworth, 2004; Rivano-Fischer, 2004; Saelens, Sallis, Black, & Chen, 2003). The absence of taxonomical uniformity renders the identification of factors of the physical environment, their analysis as well as the way bodies interact with them very complex. Most existing tools are based on norms and not on a comprehensive conceptual model providing a specific vocabulary to describe environmental elements. An exhaustive taxonomy of the physical environment is required to implement, in a structured and efficient way, the provision and evaluation of accessible built infrastructures for all professionals and individuals who might be concerned with the improvement of accessibility of the built environment. Many persons with disabilities experience disabling situations (Fougeyrollas, Cloutier, et al., 1999) in their community due to obstacles found in the physical environment (Clifton, Smith, & Rodriguez, 2007; Gray, Hollingsworth, Stark, & Morgan, 2008; Hoehner, Ivy, Ramirez, Handy, & Brownson, 2007; Kirchner, Gerber, & Smith, 2008; Lee, Tudor-Locke, & Burns, 2008; Millington et al., 2009; Spivock, Gauvin, & Brodeur, 2007). This then entails important social and societal costs (Cooper, Cohen, & Hasselkus, 1991; Deliot-Lefevre, 2006; Law, 1991; McClain, Medrano, Marcum, & Schukar, 2000;

Shumway-Cook et al., 2005; Tranter, Slater, & Vaughan, 1991). Thus, to implement the guiding principles of the CRPD and limit the occurrences of such disabling situations, there is a need for the identification as well as the assessment of the diverse components of the built environments, such as objects or infrastructures, as well as their transformations in accordance with the CRPD.

The Centre interdisciplinaire de recherche en réadaptation et intégration sociale (CIRRIS)' research program *Right to equality and Inclusive Cities*, which we are a part of, grounds itself in Henry Lefebvre's (Lefebvre, 1968) radical notion of right to the city which entails the right of people, regardless of their capacities, to inhabit and enjoy the materiality of the city and to participate in its public affairs so as to reshape the processes of urbanization (Harvey, 2008). The CIRRIS program seeks ways through which public actors, community groups, and researchers can come together to improve quality and measurement of access (Fougeyrollas, Boucher, & Charrier, 2017) in order to eliminate environmental obstacles and make cities more inclusive for people with disabilities. In support to these activities, our team sought initially to develop a tool that could be used by all to identify the environmental components (physical and social) of the city and to qualify these as being either facilitators or obstacles to the social participation for people with disabilities. This research was built upon the research experiences of the co-authors as well as the experiences of various people with disabilities who acted as collaborators in the project. Indeed, people with disabilities are experts on what elements in an urban environment favor or hinder their mobility, and their concerns and knowledge need to be considered. For example, an ongoing research project aiming at developing design guidelines for accessible pedestrian infrastructures with municipalities consulted with individuals with motor, visual and hearing disabilities in order to better understand their needs in this regard (Gamache, Routhier, Morales, Vandersmissen, Boucher, et al., 2017; Gamache, Routhier, Morales, Vandersmissen, Leblond, et al., 2017). Many community partners are involved in the *Right to equality and Inclusive Cities* research team and helped generate ideas for this research.

A strong universal and systemic taxonomy of the physical environment built upon an interactionist perspective of disability ensures a common language usable by actors in different stages of the process of making cities more inclusive: from the identification of objects and infrastructures to their assessment and modification in order to improve access to the city.

The objective of this research was to develop a comprehensive and applicable set of information for the description of the physical environment in support of the CRPD. The methodology used for the development of the taxonomy could be adapted and expanded to any context of use. This paper offers insight into the methodological steps that our team underwent in the creation of a taxonomy of the physical environment that contains both particular objects and infrastructures and which is informed by the material reality of Quebec City. It could, however, be applied to other northern countries or other contexts. Furthermore, it should to be pointed that although this paper focuses on the physical environment, broader efforts must be undertaken to integrate the social dimension of the environment. In the ongoing works of our Inclusive Cities research team (Fougeyrollas, 2010; Fougeyrollas et al., 2017), such broader initiatives are also under development.

Scientific classifications and taxonomies

Taxonomies are the result of the process of classification of terms such as species, organisms, and economic activities (Gregg, 1954), and, in this case, physical elements of human dwelling spaces. A taxonomy is composed of taxa, categories, and elements, organized hierarchically as sub-groups or sets of elements going from the most general level of a classification to more specific ones (Gregg, 1954). Under a controlled vocabulary, each level of the taxonomy is created by grouping elements together in categories (Gregg, 1954). For example, a taxonomy of the physical environment of cities organizes elements (e.g. objects and infrastructures) into groups under headings such as “developed environment” which apply to a broad range of concepts (buildings, transportation infrastructure, technologies, etc.), or “natural environment” which refers to weather, rock formations, topography, etc. (Fougeyrollas, Cloutier, et al., 1999). As used in disability studies, a taxonomy of the physical environment provides a background index of objects and infrastructures that serve to identify and define the elements implicated in a disabling situation. A scientific classification is based upon a conceptual framework, meaning a model identifying concepts and their relations, conceptual definitions, and one or more taxonomies, as previously defined, which allow the identification (via descriptors) of elements as they occur in reality (Badley, 2008; Fougeyrollas, 2010). Qualifiers are then used to encapsulate qualitative and quantitative judgements of the characteristics and properties of an element, for the measurement and evaluation of what can be found in a taxonomy. Before identifying qualifiers; however, a taxonomy must be created to provide a common vocabulary for collaborative work and the application of corrective measures and interventions. In addition, the development of a taxonomy can be done in many different ways, and consequently these various results that might not all be global, holistic and functional for the context of outdoor mobility. Note that a taxonomy is limited in its application (Badley, 2008) as it does not allow for the description of relations between elements within the taxonomy. It is the role of conceptual models to identify and describe the relations between the body and the environment as well as between elements of the environment. Nonetheless, a taxonomy constitutes a fundamental part of any scientific classification aiming at explaining the ecology of a phenomenon (as a whole and via its part), whether this be related to the human development or to how disabling situations emerge.

Situational aspects of disability

The creation of a comprehensive taxonomy of factors of the physical environment leads to the identification of environmental elements such as objects and infrastructures that play a role in the disability creation process. Disability, indeed, is fundamentally situational “i.e., it is through the interaction of a person who has impairments and functional limitations, with elements of the physical environment that do not allow for the realization of socially defined activities, that disability is created" (Fougeyrollas, 1995; Fougeyrollas & Beauregard, 2001). For example, while a set of stairs could facilitate mobility for one person, it can prove to be difficult to use or become an absolute obstacle for others. This ecological understanding of human development (Bronfenbrenner, 1977, 1979; Fougeyrollas, 2010) requires the consideration of factors of the physical environment as agents in the disability creation process and how they intervene both at the individual and population level. This leads to the necessity of identifying the elements and relations at play within the "interlocked plurality of modes" (Whitehead, 1967, p. 70) of entities at a systemic level; where bodily, personal and environmental factors act upon one another simultaneously, creating possibilities or restrictions of social activity.

As of now, there is no comprehensive taxonomy of the physical components of the environment that is precise and exhaustive enough to be used as a general repertoire from which we could identify, document and report factors of the physical environment in specific contexts; nor does such a taxonomy exist to support the measurement and assessment of properties of the built environment so as to plan modifications that favor the social participation of people with disabilities. However, as previously mentioned, taxonomies are part of scientific classifications, and existing taxonomies should be considered either as a starting point for their expansion or at least as being complementary.

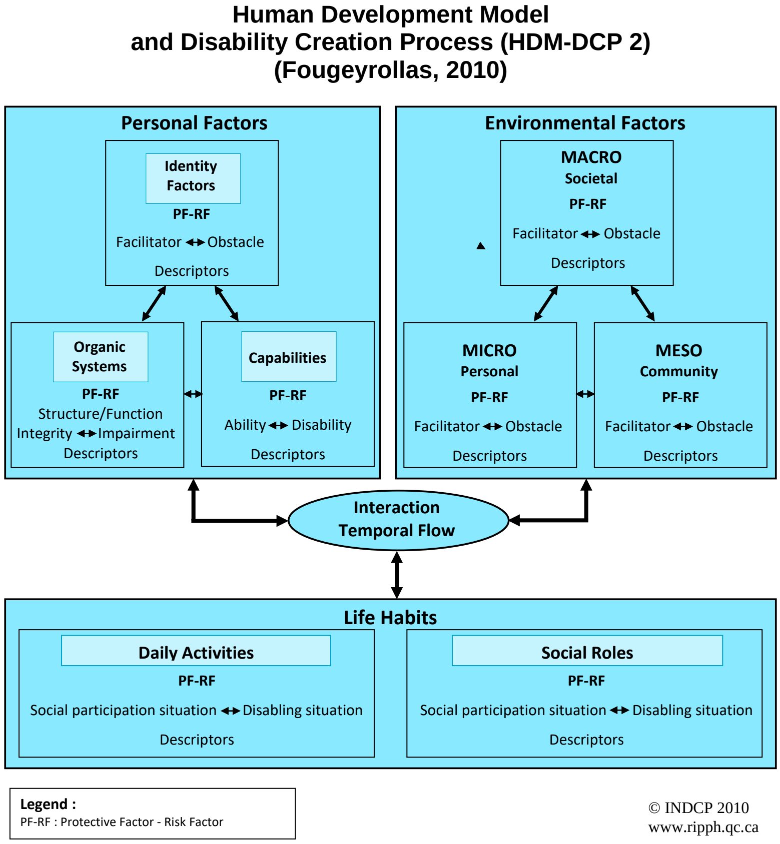
Disability models

As mentioned earlier, a taxonomy alone does not usually provide the links between different elements of the taxonomy. It should be the task of disability models to explain the links between individual and environmental dimensions as well as social activities in a structured and holistic manner as they occur in disabling situations (Fougeyrollas, Cloutier, et al., 1999). Moreover, the implementation of accessibility practices is an interdisciplinary task which could be applied easily under guidance from appropriate use of disability models.

Contemporary disability models emphasize the role of the environment in the disability creation process (Edwards et al., 2014; Masala & Petretto, 2008; Masala & Petretto, 2010; Shakespeare, 2015). The recognition of the environment as generating sets of factors that influence the development of disability has been enshrined in political models such as that used in the elaboration of the CRPD, the social model (Oliver, 1990; Shakespeare & Watson, 2001), but also in the International Classification of Functioning, Disability and Health (ICF) (Organisation mondiale de la Santé, 2000), and the Human Development Model – Disability Creation Process (HDM-DCP) (Badley, 2008; Fougeyrollas, Cloutier, et al., 1999). Both the ICF and the HDM-DCP have defined taxonomies with broad environmental categories, but none of them have yet been detailed enough to include infrastructures and objects. They are limited in their scope, and their environmental taxonomies have not more than a few hierarchical levels, leaving the specific reality of the world "i.e., its objects and infrastructures, unclassified". However, the ICF and the HDM-DCP are composed of conceptual domains which are used to detail taxonomies regarding the person, his/her environment as well as the life habits he/she performs. This allows a better understanding of disability through the identification of the elements at play in disabling situations. The recognition of the importance of the environment in the process of disability creation in both the ICF and the HDM-DCP has had an substantial impact in the manner we understand disability (Barnes, 2011; Schneidert, Hurst, Miller, & Üstün, 2003; Tøssebro, 2004) and elaborate disability measurements (Palmer & Harley, 2012; Üstün, Chatterji, Bickenbach, Kostanjsek, & Schneider, 2003).

Both classifications provide a strong basis for the development of a more detailed and exhaustive taxonomy of the built environment in order to implement the CRPD and inclusive policies in urban contexts as well as to accommodate the new Sustainable Development Goal encapsulating disability issues (United Nations, 2015). Indeed, initial attempts to address this latter issue for the HDM-DCP have already been begun (Edwards, 2017). The specificities of the HDM-DCP in the province of Quebec where our research team works are more relevant for the task at hand. The HDM-DCP conceptual model was adopted as the reference framework for the development of the province of Quebec's governmental disability policies (Office des personnes handicapées [OPHQ], 2009) and has served to create new laws that aim to promote the exercise of equality of rights since the end of the 1990's. Municipalities of 15,000 citizens or more, as well as public organizations employing more than 50 people, must prepare each year an action plan that identifies obstacles to the integration of people with disabilities as well as actions undertaken concerning the content of the previous action plan (Governement of Quebec, 2004). Across 25 years of development and use, the HDM-DCP model finds part of its robustness and usefulness in its recognition of environmental elements which are distributed across both social and physical factors. This model is furthermore widely used in clinical practice within the province (Ministère de la santé et des services sociaux, 2003) and has been utilized for the development of tools that help enhance social participation and of the access to the environment (Fougeyrollas, Cloutier, et al., 1999), such as the Measurement tool of the Quality of Environmental Factors (MQE) (Fougeyrollas, Noreau, St-Michel, & Boschen, 1999; Gray et al., 2008; Levasseur, Desrosiers, & St-Cyr, 2008; Noreau, Fougeyrollas, & Boschen, 2002; Whiteneck & Dijkers, 2009) and the Assessment of Life Habits Scale (LIFE-H) (Desrosiers et al., 2004; Fougeyrollas et al., 1998). The HDM-DCP is particularly useful in operationalizing social participation as an outcome, as it considers the temporal dimension in which the interaction between personal and environmental factors takes place. It provides mutually exclusive conceptual domains and dimensions regarding the realm of personal factors including organic systems, capabilities and identity factors that are associated with daily life activities and social roles (see Figure 1). The issue of mutual exclusivity between activities and participation is presently not resolved in the ICF (Badley, 2008; Imrie, 2004; Levasseur, Desrosiers, & St-Cyr, 2007; Whiteneck & Dijkers, 2009). Even though the HDM-DCP's taxonomy of environmental factors is currently limited in terms of content, it possesses a great potential for expansion. This model is directly applicable to Quebec's context to begin with, but could easily be applied to other cities and environments.

Figure 1. . Human Development Model – Disability Creation Process (HDM-DCP). Source: (Fougeyrollas, 2010)



Reference : FOUGEYROLLAS, Patrick (2010). *La funambule, le fil et la toile. Transformations réciproques du sens du handicap.* Quebec : Les Presses de l'Université Laval, 315 p.

The HDM-DCP defines environmental factors as follows: "An environmental factor is a physical or social dimension that determines a society's organisation and context" (Fougeyrollas, Cloutier, et al., 1999, p. 111). As presented in Table 1, in the HDM-DCP's taxonomy, there are four taxa or broad conceptual categories. The first level of categorization divides the model into *Physical factors*, which are: "the artificial and natural elements of the environment" (Fougeyrollas, Cloutier, et al., 1999, p. 119) and social factors, which are "elements of the environment's political, economic, social and cultural systems" (Fougeyrollas, Cloutier, et al., 1999, p. 113). A second level within the category of physical factors subdivides it into a *Nature* taxon, "the biotic and abiotic elements that surround and act upon human beings and who are acted upon in interaction (sic)." (Fougeyrollas, Cloutier, et al., 1999, p. 119) and a Development taxon, "the elements created, transformed or organised by human beings that influence their environment." (Fougeyrollas, Cloutier, et al., 1999, p. 120). The Development taxon then divides into an Architecture, National and Regional Development taxon and a Technology taxon (see Table 1 for the definition of each term). In this research, we focused our attention on the category Development. The label 2.2.2.1 Urban Development at the lowest level of the original taxonomy is the one we wanted to develop further.

Table 1. HDM-DCP physical factors – development. Source: Fougeyrollas, P., Cloutier, R., Bergeron, H., St-Michel, G., Côté, J., Côté, M., Rémillard, M.-B. (1999). The Quebec classification: Disability creation process: Québec RIPPH/SCCIDIH.

Item	Description
2	**Physical factors: The artificial and natural elements of the environment**
2.2	Development: The elements created, transformed or organized by human beings that influence their environment
2.2.1	Architecture: "Buildings and their components erected by human beings (excluding technology)"
2.2.1.1	Residential Buildings
2.2.1.2	Public Buildings
2.2.1.3	Industrial Buildings

Item	Description
2.2.2	National and Regional Development: “The elements and their components resulting from the transformation and adaptation of geographically limited space according to the needs of human beings. (excluding architecture)”
2.2.2.1	Urban Development: The elements and their components resulting from the transformation and adaptation of space occupied by cities and their suburbs, such as public places, urban parks, urban road networks, etc.
2.2.2.2	Rural Development
2.2.2.3	Reservations and National Parks
2.2.2.4	Circulation Routes
2.2.2.5	Other Land Developments
2.2.3	Technology: “The products of the transformation of matter (excluding architecture)”

It should be noted that the expanded taxonomy could also be integrated into other classifications of factors of the physical environment, such as the ICF, taking into consideration the different conceptual segmentations that such alternative schema would entail. This classificatory process remains a collaborative, gradual and ongoing effort due to the ever-changing contexts of human development, including both the knowledge and the cultural understandings of the world we are trying to describe. The global approach of the HDM-DCP and the ICF and their compatibility with the CRDP and disability studies make them compatible with the taxonomy we developed.

Methodology and Results

Expansion of the taxonomy

Starting from the original taxonomy of the HDM-DCP, which considers the elements of the environment as factors which can be either qualified as obstacles and facilitators, we developed the taxa to include both objects and infrastructures. We expanded the 2.2.2.1 Urban Development category, allowing us to organize elements in a hierarchical tree to identify environmental components of urban areas with regard to disability. In order to develop an overview of relevant terminology, we examined several existing documents. We began by reviewing documents containing nomenclatures concerning Quebec City's physical environment, including open data from the municipality of Quebec City (database - http://donnees.ville.quebec.qc.ca/donne_details.aspx?jdid=18), the GeoIndex (database - http://geoindex-plus.bibl.ulaval.ca/), the Guide pratique d'accessibilité universelle de la Ville de Québec (Service de l'aménagement du territoire de la Ville de Québec, 2010) (design guidelines to ensure accessibility of urban infrastructures for all), and the Measure of accessibility of urban infrastructures for adults with physical disabilities (MAUAP) (Gamache, Vincent, Routhier, McFadyen, Beauregard, et al., 2016; Gamache, Vincent, Routhier, McFadyen, Routhier, et al., 2016) (tool to assess the level of accessibility of urban infrastructures for adults with physical disabilities) (see the Appendix which describes the constitutive information of these documents). For example, in the Guide pratique d'accessibilité universelle de la Ville de Québec (Service de l'aménagement du territoire de la Ville de Québec, 2010), we found terms such as ramps, signage, stairs, sidewalks, pedestrian paths, crosswalks, paths. We then proceeded to combine the content of these documents into a common repertoire which acts as a general pool containing all of the information from existing nomenclatures of both objects and infrastructures of the city. We organized the information under the original taxa of the HDM-DCP. This step allowed for the identification of duplicates and synonyms, which were eliminated. The remaining elements were merged into simplified conceptual categories. During this process, objects and infrastructures were grouped under newly created intermediate categories. Elements have been grouped and organized in relation to the properties of the taxa. For example, to classify the object curb cut, two higher-ranking categories were identified, Urban Road Networks and Pedestrian Network and were used to complete the link between the broader categories and the object. The same procedure was followed with the object sidewalk which was classified into the same category since it shared several of the same characteristics as the higher level taxa. The integration of each element was carried out via an iterative process where elements of similar type were organized into a common level of one hierarchical branch (example: sidewalk, curb cut) under general categories (Pedestrian Networks). Likewise, when categories linking objects to broader subcategories were not already identified or were missing, we expanded the structure of the HDM-DCP by creating new sub-categories or hybrids such as Urban Road Networks. In this particular case, the category Urban Road Network was not part of the original taxonomy but was readily found under the definition of Urban Development. The sub-category Pedestrian Network then had to be generated under Urban Road Network to organize elements such as the curb cut and the sidewalk. This allowed for a first expansion and then the linking of the different levels from the pre-existing macro categories to the objects.

In order to classify each element, we answered the following questions: 1- What are the characteristics that are specific to each category and each subcategory? 2- What makes categories mutually exclusive? 3- Does the element share enough characteristics to fit under a category? The validation process allowed us to organize the elements and create subcategories. This is where we differentiated objects, viewed as single elements, from infrastructures, which are structured groups of objects, in order to correctly hierarchize the different taxonomical levels of the physical environment. For an example of the developed taxonomy, see Table 2. The validation process also provided us with the opportunity to differentiate objects from their properties, the latter being related either to design choices or materials entering into the composition of objects. Even though properties are not part of the taxonomy of the physical environment since the latter only includes objects, some properties can be found in the taxonomy of technology, for example, materials. This issue will be clarified in the discussion section.

Table 2. Example of the developed taxonomy for 2.2- Development, 2.2.2- National and Regional Development, 2.2.2.1- Urban Development, 2.2.2.1.1.3- Urban Road Networks

Level 1	Level 2	Level 3	Level 4
Roads	Street		
	Alley		
	Highway		
	Boulevard		
Physical transportation infrastructure	Juction		
	Section		
	Median		
	Crossing		
	Intersection	Intersection with an angle different from 90°	
		Roundabout	
		T or unaligned crossroad	
		Junction branch block	
		Crossroad with median	
		Crossroad with large radius	
		Crossroad with special traffic patterns	
	Upper passages		
	Bridge		
	Covered bridge		
	Rotating bridge		
	Ford		
	Culvert		
	Tunnel		
	Overpass		
Pedestrian network	Footbridge		
	Sidewalk	Raised sidewalk	
		Lowered sidewalk	
	Pedestrian path		
	Curb cut		

Level 1	Level 2	Level 3	Level 4
	Crosswalk		
	Path	Multi-purpose path	
		Natural path	
	Pedestrian network equipment	Gate	
		Bollard	
		Line	
		Radius	
	Projection		
	Covered walkway		
Cycling network	Cycling path/circuit		
	Cycling trail		
	Cycling segment		
	Cycling track		
	Cycling network equipment	Post	
		Retarder (délai)	
Transportation stops	Bus stop		
	Station		
	Metro station		
	Landing stage		
	Parking	Parking lot	
		Onstreet	
		Interior	
	Reserved parking space		
	Parking equipment	Parking meter	Button
			Slot
			Signage
		Ticket machine	
		Terminal	
		Toll station	
		Guard	
		Parking sticker	
	Signage	Pannel	
		Painting on the ground	
Road signage equipment	Road sign - speed	Epigraph	
	Lit signage	Commemorative plaque	
	Road marking		
Civic address	Postal address		

Level 1	Level 2	Level 3	Level 4
	Street name		
	Generic address		
	Link address		
	Building number		
	Civic number		
Traffic control device	Traffic light		
Pedestrian signage equipment	Optic/call button		
	Time count		
	Post		
	Audible signal		
	Tactile paving		
Surface	Pavement		
	Coating		
	Slab		
	Brick		
Public lighting	Lighting		
	Street light		
	Post		
Urban furniture	Bench		
	Trashcan		
	Bike rack		
	Piknik table		
	Water fountain		
	Anti-noise barrier		
	Retaining wall		

Evaluation of the extracted knowledge

The second phase of this research aimed to evaluate the applicability of the developed taxonomy. This phase consisted of field analyses and testing to determine whether the developed taxonomy included all objects and infrastructures observed in the city. To achieve this, street sections in Quebec City were studied (for an example see Figure 2). Photos of the physical elements were obtained for each road section. For each photo, the path was described using the taxonomy, and we identified missing elements. We found that all permanent public elements were included, but those private elements such as houses, flower pots, or temporary objects such as a chain fence blocking the entrance to a park or garbage cans would need to be added to complete the taxonomy.

During field tests, concerns were raised regarding the manner in which objects act together in reality. It became apparent that properties of single objects taken alone were not sufficient to understand how these reacted within a disabling situation. Indeed, assemblages of objects can have different properties than those of individual objects. For example, a curb cut is never free-standing. It always exists in relation to its surrounding objects - it is integrated within the sidewalk and is adjusted to fit the contours of the street. The characteristics of each element affect the characteristics of surrounding elements, and their assemblage also acts on the characteristics of each individual element. When we try to assess either use or access to the physical environment, each object must be taken into account in relation to other objects in its surroundings. For example, the steepness of the road or the presence of a drainage grate in relation to the incline and the location of the curb cut might render the curb cut inaccessible due to the important energy expense required to overcome these combined obstacles and the inadequate angle of attack for wheelchair users to manoeuver safely. However, the curb cut in itself might not be inaccessible.

Figure 2. Example of a street section observed in Quebec City

DISCUSSION

The objective of this research was to develop a comprehensive and applicable information set for the description of the physical environment in support of the application of the CRPD and further the UN SGO's in relation to disability and urbanism (United Nations, 2015), but for which the methodology used for the development could be adapted to any context of use. We thus developed a taxonomy based on the HDM-DCP which is applicable in Quebec's context, but could also be applied elsewhere in northern climates. Furthermore, the methodology used to develop the taxonomy adopted a "disability studies" perspective aiming at the ensuring the respect of the CRDP and monitoring of its implementation so as to ensure equal rights for any citizen with disabilities. The resulting taxonomy was found to be useful in identifying/mapping elements of the physical environment. Both at the individual and collective level, it allows the identification of items that interact with individuals, resulting in enhanced social participation or the reduction of disabling situations for people with disabilities. Some questions remain open, however. First, how should we address composite objects (i.e., objects composed of other objects, such as regular curb cuts vs. curb cuts with tactile paving)? For example, should the taxon Curb Cut be expanded into several subcategories identifying all types of curb cuts including curb cuts with tactile paving or should Tactile paving be placed in Technology as a separate object?

Secondly, the same question can be asked regarding materials entering the composition of objects. Should the object be subdivided into a typology reflecting the materials used or should materials have their own taxonomic section? Materials exist on their own, without necessarily being specific objects. For example, concrete can enter the composition of different objects: it can take the shape of a slab, which can then be a constituent of a sidewalk. Concrete, along with its subcategory concrete slab, was located in the taxonomical branch Technology. However, concrete slab can also be integrated within the taxonomical branch Built environment as a subcategory of Sidewalk, since it enters the composition of the object. When describing an object's materials and design characteristics, these could be regarded as the object's properties. Therefore, the definition of each element could contain an enumeration of its possible properties (materials and design characteristics) to make the taxonomy more operational and coherent without doubling the information content. Properties were a main concern in building the taxonomy since they allow for the identification of qualifiers of objects. For example, to fully describe a sidewalk, its properties need to be identified (i.e., slope) as well as qualifiers derived from observations, such as assessments from measurement scales (i.e., the slope's percentage). It is only through such qualifiers that the object can be judged as a function of its conformity to the functional requirements found in norms or assessment tools. It is by measuring these qualifiers that one can propose a universal design or corrective intervention.

Another interesting question that arises is how the taxonomy would be used in an ontology of disability in the city – this is to say in the description of the relations between people with disabilities and objects as they happen in real life (Gharebaghi et al., 2017; Riddle, 2013; Vehmas & Makela, 2008). The taxonomy, when used as a background reference for an ontology of the city, leads to a knowledge base of objects, relations and processes of the city that have an effect on participatory or disabling situations. However, other branches of the taxonomy such as Technology, Architecture and the Social dimension, which include laws, policies, governmental agencies, private and public organizations, etc., remain to be developed to describe how the city really works. Since the taxonomy we are working on is a first attempt to structure the information about objects and infrastructure found in a city, these concerns should orient its development in order to answer the needs of actors, groups, stakeholders and governmental agencies with regard to disability and the development of inclusive cities. Additionally, taxonomies of individual and collective functional capabilities should be taken into consideration in the construction/description of an ontology. Scales could also be developed so as to evaluate objects and infrastructures from the perspectives of these different actors as a function of their own levels of expertise and intervention. For example, the scale of analysis at a population level requires the identification of a different set of objects, infrastructures, and relations than an intervention taking place at the individual level (Fougeyrollas, 2010).

The contribution of this study is anchored in the strategy used. More than one way of developing a taxonomy can be adopted, but the most appropriate way to develop a global, holistic and comprehensive taxonomy of the built environment focused on the task of outdoor mobility is not easily found. We proposed here a taxonomy applicable in northern countries, similar to the Quebec context in which this study was performed, but potentially expandable along similar rules to any urban context. The methodology used to develop the taxonomy can be adapted to different contexts, according to the cultural data of the environment. It allows a contextual approach for the development of such a taxonomy to better analyze the necessary components for safe and efficient outside mobility that provides insight on the juxtaposition of assemblages and individual objects.

Limits

At the moment, the taxonomy of the physical environment developed here only represents the entities identified in the documents we consulted; it identifies only the objects found in Quebec City. Furthermore, the taxonomy only includes objects that were identified as being pertinent for the developers of these documents. To reach a higher degree of universality, documents from other cities and other sources should be considered. It is only through the compilation of data from a diversity of contexts that we can expect to reach a point of information saturation. Indeed, the taxonomy developed here has not yet been validated via different communities of practice (e.g. urbanists, engineers, occupational therapists) to ensure that it reflects different types of formal knowledge. Also, the testing phase led us to recognize that work needs to be done on other branches of the taxonomy, in particular on the technological taxonomy, and, more generally, on the social aspects. Only then would the taxonomy be sufficiently developed to ensure integration within appropriate ontologies allowing for the full identification of interactions between taxa. The taxonomy could also be completed with appropriate qualifiers, scales and assessment tools for tangible urban field applications.

Conclusions

This research involved the development of a comprehensive and applicable information set for the description of the physical environment in support of the application of the CRPD. The development of the taxonomical arborescence allowed further development of the HDM-DCP. Starting from pre-existing documents and taxonomies of the physical environment, we used an iterative approach to classify objects and infrastructures to create intermediate categories which served to complete the taxonomic structure of the HDM-DCP. The results of this study are of two kinds, methodological and taxonomical. The methodological results consist of the organized integration of elements from documents into a structured taxonomy, the identification of concepts relative to objects and infrastructures at play in the disability creation process or in support of greater social participation, the differentiation of elements and their properties, and the recognition of other dimensions of the environment (such as social components and technology) that need to be developed to complete a realistic description of the urban space. Moreover, to ensure the universal character of the taxonomy, a further methodological step would involve the integration of documents from different geographical and cultural contexts. The taxonomical results consist of a full taxonomy of the physical environment, the identification of missing categories and subcategories of the HDM-DCP, the development of categories linking the general categories already found in the HDM-DCP with the objects and infrastructures found in diverse documents, and the finding that the taxonomy needs to be periodically updated to reflect the changes taking place in the real world.

From our perspective, organizing a city's environmental elements into a single taxonomy considerably increases the potential knowledge available to city actors (such as persons with disabilities, activists, stakeholders, and governments) and users of their own environment. Future studies should allow for the development of tools that are sensitive to cultural and legal contexts as well as normative goals and structural capacities. The latter would provide a common ground for academics and researchers to create national, regional or localized accessibility assessments based upon the developed taxonomy of factors of the physical environment. As stated previously, these tools should be universal enough to be used in different contexts but specific enough to engage the lived reality of persons with disabilities minimizing distortion from representations or interpretations.

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