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INCLUSIVE BUILT FACILITIES: A CASE STUDY OF A HIGHER EDUCATION INSTITUTION

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Abstract

Building an inclusive society has been a goal with universal appeal. In respect of sustainable design and construction, due consideration in disability inclusion is necessary for it has social, economic, legal and environmental implications. It is not a new subject; however, there is still a long way for our built environment to be inclusive. In this paper, a practicable means to appraise the inclusiveness of built facilities quantitatively, the Building Inclusiveness Assessment Score (BIAS), is proposed. Literature, guides and standards of barrier-free access and universal design are reviewed so as to construct a hierarchy of relevant inclusion attributes. A multiple-criteria analysis technique, the Non-structural Fuzzy Decision Support System (NSFDSS), is then applied to analyse the weightings of attributes. On-site assessments are undertaken to collect data for grading individual inclusion attributes. The inclusiveness of built facilities in the University of Hong Kong is studied.

In BIAS, a hierarchy of inclusion attributes is appraised. The outcomes are integrated in form of a score. Notwithstanding the research project is still ongoing, preliminary findings from on-site assessments are presented. A novel insight is provided to sustainable design and construction which should not only regard environmental and economic sustainability but also social sustainability. Compare with earlier attempts to quantify the accessibility of buildings, BIAS further reduced the subjective elements. The framework of BIAS can also be modified to assess built facilities of other uses.

Keywords: Barrier-Free Access, Disability Inclusion, Non-structural Fuzzy Decision Support System, Performance Measurement, Universal Design

INTRODUCTION

Building a society for all has been a goal with universal appeal. A society as such is known as an inclusive society that rises above differences of race, gender, class, generation and geography to ensure equality of opportunity regardless of origin, and one that subordinates military and economic power to civil authority (Atkinson, 2010). In architecture, the persuasion of Richard Rogers, the architect of the world renowned Centre Pompidou in Paris, France, probably depicted the ideal of inclusion in broad sense (Cole and Rogers, 1985; pp11):

"It is my belief that exciting things happen when a variety of overlapping activities designed for all people – the old and the young, the blue and white collar, the local inhabitant and the visitor, different activities for different occasions – meet in a flexible environment, opening up the possibility of interaction outside the confines of institutional limits. When this takes place, deprived areas welcome dynamic places for those who live, work and visit; places where all can participate, rather than less or more beautiful ghettos."

Inclusion in architecture is, however, often synonymous to disability inclusion. Disability nowadays is considered as a social rather than a medical issue (Goldsmith, 1997; Holmes-Siedle, 1996), for it is seen as the outcome of interaction between persons with impairments and a non-inclusive society (United Nations, 2006). Under the United Nations Convention on the Rights of Persons with Disability, obstacles and barriers to accessibility in buildings and other physical environment shall be identified and eliminated. 147 countries and regions have already signed this convention since 2007. In the meantime, access for persons with disability to buildings has increasingly become a right under laws (e.g. the Americans with Disabilities Act in the US and the Disability Discrimination Act in the UK). Failure to observe these laws may result in legal proceedings. Universal design is a means to make inclusion in built facilities possible. It is the design of products, environments, programmes and services to be usable by all people to the greatest extent possible, without the need for adaption or specialised design, and it shall not exclude assistive devices for particular groups of persons with disabilities where this is need (Mace, Hardie and Plaice, 1991; United Nations, 2006). This idea is more specifically exemplified by 7 underlying principles (Table 1).

Though there has been gradual progress to promote disability inclusion in buildings, the subject is not free from challenges. A particular challenge is the assessment of accessibility for built facilities. This is done through access audit which is user oriented and access appraisal which is desktop survey dominated (Sawyer and Bright, 2004). The shortcomings of access audit and access appraisal are later highlighted in Wu, Lee, Tah and Aouad (2007). It is thought that the assessment processes are quire complex that involve a lengthy checklist. Meanwhile, they heavily depend on the experience of the assessor for a large number of subjective judgements are included.

The main purpose of this research is to review design guidelines and manuals for disability inclusion in built facilities, to develop a quantitative assessment scheme to appraise the inclusiveness of built facilities and to investigate the inclusiveness of built facilities of a higher education institution, the Hong Kong University. By conducting on-site assessments, both inclusive features and problems leading to exclusion are identified. The sample consists of 28 buildings which are built between the 1910s and the 2000s. Since this research is still ongoing, only preliminary findings are reported at this stage.

The 7 Principles of Universal Design
Principle 1 Equitable Design The design is useful and marketable to people with diverse abilities
Principle 2 Flexibility in Use The design accommodates a wide range of individual preferences and abilities
Principle 3 Simple and Intuitive Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level
Principle 4 Perceptible Information The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities
Principle 5 Tolerance for Error The design minimises hazards and the adverse consequences of accidental or unintended actions
Principle 6 Low Physical Effort The design can be used efficiently and comfortably and with a minimum of fatigue
Principle 7 Size and Space for Approach and Use Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility

Table 1: *The 7 principles of universal design (source: The Center for Universal Design, 2006)*

INCLUSION AND SUSTAINABLE DESIGN AND CONSTRUCTION

Very often sustainable design and construction is solely regarded as design and construction that is eco-friendly. Sustainability is, however, much more than merely environmental protection. It includes not only environmental sustainability but also social and economic sustainability. Social sustainability is seen as "the ability to maintain desired social values, traditions, institutions, cultures or other social characteristics" (Barbier, 1987), whilst the central idea of economic sustainability is "maintenance of capital or keeping capital intact" that follows Hick's well-known definition of income – "the amount one can consume during a period and still be as well off the end of the period" (Goodland, 2002). Sustainability in short centres on the maintenance of capital in environmental, social and economic aspects, and of course, the environmental facet is of particular concern. Further to the three aspects of sustainability, two paradigms of sustainability are developed. While capitals are assumed to be substitutable in weak sustainability, natural capitals are assumed to be non-substitutable to other forms of capital in strong sustainability (Neumayer, 2010). To qualify as sustainable design and construction, social sustainability which is manifested in equity and accessibility should be represented, for everyone should have equal rights and freedoms. Whereas for economic sustainability, non-inclusion ends in loss of an enormous opportunity given the estimated rate of disability is 10-12% worldwide (The World Bank, 2009).

THE CASE OF THE HONG KONG UNIVERSITY

As the oldest tertiary institution in Hong Kong, the coming year marks the centenary of the University of Hong Kong (HKU) which was established in 1912. With 22,139 students and 6,010 academic staffs in 2009/2010, HKU comprises ten faculties which are mainly located in the Main Campus. The exceptionally hilly terrain of the Main Campus has been a great challenge to fostering disability inclusion despite the Universities' initiative to promote equal opportunities. The Universities' Equal Opportunity Committee (EOC) and then the Disability Action Sub-committee were set up to oversee and expedite disability inclusion affairs. The units are very dedicated in promoting equal opportunities for all and to make HKU a truly accessible campus is on the agenda (The University of Hong Kong, 2011; pp10). Upgrading of buildings to introduce more lifts and wheelchair ramps to ensure wheelchair access has been undergoing bit by bit and tactile guide paths are provided. Other than the endeavours to ameliorate the inclusiveness of built facilities, the Centre of Development and Resources for Students (CEDARS) offers supportive services to students with disability. They include assistance related to basic necessities, commuting and study, and coordination of buddies and volunteers to help the students (ibid; pp11). All in all, inclusion is seen as important cornerstone of a good employer and a good university in HKU: "…the socially inclusive environment, and the respect for individuals that we are promoting, are values that are of utmost importance in the holistic education of the University." (ibid; pp10)

RESEARCH METHODOLOGY

As the main purpose of this research is to develop a quantitative assessment scheme to appraise the inclusiveness of built facilities in higher education institutions, literature, guides and standards in connection with disability inclusion in built facilities are reviewed in the first instance. It plays a crucial role in the subsequent development of the assessment framework which is one of the cruxes in this research. Another crux is to determine the weighting of attributes towards disability inclusion in built facilities. In the following, the assessment framework, the weighting methods and data collection will be discussed separately.

THE ASSESSMENT FRAMEWORK

Designing for persons with disabilities is a movement emerged after the World War II, with the issue of American Standard A117.1 American Standard Specifications for Making Buildings and Facilities Accessible to, and Usable by, the Handicapped by Tim Nugent that earmarks such a move. This standard was later set as the model for corresponding code of practice in the British Standard issued in 1967 and subsequent legislations against exclusion of persons with disabilities in buildings (Goldsmith, 1997). Apart from guides and standards, there have been interests to evaluate whether a built facility is inclusive or not. It can be done qualitatively by access audit or access appraisal. Access audit was used to study the access provisions in public housing estates in Hong Kong in Chan, Lee and Chan (2009), however, it involves a great deal of subjective judgments and the overall level of inclusiveness cannot be determined. On the contrary, rating scales for individual accessibility criteria are not explained in Wu et al. (2007) who seek to develop a quantitative building accessibility model using the Analytical Hierarchy Process (AHP) to prioritise the underlying accessibility criteria.

For the purpose of filling the research gap, a quantitative assessment scheme which is workable and practical is needed. In the course of developing the assessment framework, reference has been made to Design Manual: Barrier Free Access 2008 in Hong Kong and BS8300: Design of Buildings and Their Approaches to Meet the Needs of Disabled People to determine attributes or factors that contribute to the inclusiveness of built facilities (Buildings Department, 2008; British Standard Institute, 2009). Other guides and standards in Canada, Singapore, the US and the UK are also considered (BCA, 2007a; 2007b; International Code Council, 2009; NRC-IRC, 2010; Peloquin, 1994; Sawyer and Bright, 2007). As the problem is disability inclusion in built facilities in higher education institutions, it is decomposed into elements of different levels from the general to the more specific at the lower levels (Tam, Tong, Chiu and Fung, 2002). The decision hierarchy is then formed when the attributes have been grouped under corresponding criteria. The hierarchy developed for the time being is shown in Figure 1. During the making of this hierarchy a dilemma is posed. On the one hand, it has been underlined in literature that many criteria at multiple levels will make subsequent pair-wise comparison difficult (Tam and Tummala, 2001). On the other hand, items on the checklist should be assorted and incorporated into the hierarchy for pair-wise comparison accordingly. In such a case, the assessment scheme developed will be more objective and it fills the research gap in Wu et al. (2007). On account of disability inclusion which is concerned with physical, visual and speech disabilities, and hearing impairments, the current hierarchy may be amended by further decomposing into separate hierarchies. Example of an improved hierarchy is shown in Figure 2.

There are four levels in the decision hierarchy developed for the time being. Similar to Wu et al. (2007), the top level is the objective which is to provide an index of inclusiveness of built facilities in higher education institutions. The succeeding level is divided into design and management that represent the hardware and the software in disability inclusion respectively. The idea of design here is actually similar to the physical features demarcated in Sawyer and Bright (2007; pp68), while management refers to the acts taken to build and maintain an inclusive environment. Under design attributes are structured under individual areas and facilities. The items in level II to level IV under design are tabulated in Table 2.

Next is the computation of rating for quantitative attributes in the assessment scheme. Individual attributes are rated using a continuous scale from 0 (for exclusive practice, i.e. the worst practice in disability inclusion to 2 (for the best practice in disability inclusion). Contrary to earlier studies which set the starting point for benchmarking the worst practice to the standards prescribed by laws or codes (Ho et al., 2004; Then, 1996), the rating for meeting legal minimum requirements here is 1. Whether an attribute is qualified as the best practice or not is referred to relevant guides and standards. As the actual condition often lies between complete exclusion and the best practice, linear interpolation is used to calculate the rating. If attributes are qualitative in nature, either dichotomous or multinomial classification is adopted to assign a rating (Ho, 2000).

THE BUILDING INCLUSIVENESS ASSESSMENT SCORE (BIAS)

For simplicity's sake, it would be more convenient to present the overall inclusiveness in form of a score or an index. It is called the Building Inclusiveness Assessment Score, or BIAS in short, which is essentially an aggregated figure of the ratings (F) and weightings (w) of all attributes that affect the inclusiveness of built facilities in higher education facilities (Ho et al., 2004):

$$\text{BIAS} = g(w_1, w_2, \ldots, w_n; F_1, F_2, \ldots, F_n) \quad (1)$$

where BIAS is the Building Inclusiveness Assessment Score;
w_1 (i = 1, 2, … , n) denotes the non-negative weighting of the *i*th inclusive attribute and all w_i's sum to unity;
F_i denotes the (standardised) rating of the *i*th inclusion attribute;
n is the total number of inclusion attributes; and
$g(.)$ is a continuous or discrete function that combines all w_i's and F_i's through the weighted arithmetic mean:

$$\text{BIAS} = \sum_{i=1}^{n} w_i F_i \quad (2)$$

As can be seen in equation (2), it implies a positive relationship between the BIAS and each F_i, given the weightings are positive. In other words, the higher the F_i, ceteris paribus, the higher the score is achieved in the BIAS. Because the computation of rating for quantitative attributes, F_i, has been explained in the last section, the approach to ascertain the weighting of the inclusion attributes, w_i, will be discussed.

THE WEIGHTING METHOD

Irrespective of the approach used to ascertain the weighting of the inclusion attributes, w_i, the outcome should reflect the relative importance of an attribute towards disability inclusion objectively. Owing to the large number of attributes involved, Multiple-Criteria Decision Analysis (MCDA) technique is applied to provide consistent and least biased solution. Among MCDA techniques, the Non-structural Fuzzy Decision Support System (NSFDSS), rather than the commonly used Analytical Hierarchy Process (AHP), is chosen to prioritise the inclusion attributes. Compare with other MCDA techniques, AHP is simple to operate and it enables pair-wise comparison between factors (Ho et al., 2004). When the hierarchy of criteria has been constructed, pair-wise comparison is undertaken and then the consistency level and relative weighting of each criterion are computed (Wu et al., 2007; see Saaty, 1980 for AHP and Chen, 1998 for NSFDSS; also see Ho et al., 2004; pp66 who have explained the procedures of the AHP workshop). An alternative to AHP is NSFDSS which is indeed very similar to AHP. In principle, both AHP and NSFDSS involve three steps namely decomposition, comparative judgement and synthesis of priorities (Tam et al., 2002). NSFDSS is, however, superior to AHP for a simplified scale of importance is used in NSFDSS that enables automatic consistency correction. Besides, NSFDSS can assign more precise priority to the decision criteria for the number of semantic operators used in NSFDSS to measure difference in the magnitude of the first ordered decision and others is greater than that used in AHP (Tam, Tong and Chiu, 2006; Yau and Chan, 2008). It is apparent that

NSFDSS is more desirable and therefore it is chosen to analyse the weightings of inclusion attributes. It is expected that the result of NSFDSS can be delivered by mid July.

DATA COLLECTION

This section describes data collection for assessing the inclusiveness of built facilities in the Main Campus of HKU using BIAS. As one of the purposes of this research sets out to investigate the inclusiveness of built facilities there, on-site assessments of 28 buildings are conducted. The assessments are split into two stages that look into common areas and particular facilities in buildings respectively. At all events they are conducted by at least two assessors who are required to follow the assessment procedures. With intent to minimise the subjective elements, BIAS is created in a way such that the assessors need not to be experienced or professional in the subject. What they need is to be briefed and trained before they conduct actual assessment on-site. Numerical data or yes/no items are the principal data to be solicited, and pictures are taken as record for future reference. In this regard, simple equipment including measuring tape, metal ruler, spring scale and digital camera will be sufficient for the purpose of assessment. The first stage of assessment has been finished in March 2011 and the second stage will begin by May 2011. Preliminary findings from the first stage of assessment will be discussed next.

PRELIMINARY FINDINGS

With regard to the buildings surveyed they are of diverse design and built form. Through the use of BIAS suggested above, their inclusiveness is appraised. Because this research is still ongoing, preliminary findings for the first stage of assessment (i.e. which is confined to the common areas) are presented below.

Lift is not available in a multi-storey building. It means that this building is exclusive to persons with physical or ambulant disabilities. Similar exclusion is caused by the presence of a step(s) in front of entrances that are not bevelled.

Tactile guide path is provided along external access route; however, it is seldom connected to lift zones. Besides, the tactile guide path is usually chopped when it overlaps with channel covers and gratings. In many staircases, tactile warning strips are not provided at landings.

In respect of ease of navigation, room numbers are assigned in an inconsistent manner. Though the layout of buildings is relatively simple, navigation is made difficult as different methods are used to number rooms of the same building.

Handrails fixed at height other than the recommended range are not uncommon (i.e. between 850mm and 950mm). On handrails Braille and tactile information and horizontal extension (of not less than 300mm) at each end are sometimes missing. In some short stairs, handrails are not installed.

Indication and notification for lifts is beyond sufficient. Very often there is no audible signal to indicate arrival of lift, its direction of travel and closing of the doors. Moreover, some lifts do not have visual indication to show acknowledgement message in case of emergency.

Wheelchair users may find it difficult to move out of lift cars for interiors finishes at appropriate height is non-reflective.

No provision of accessible toilet in some buildings is noticed. Where accessible toilets are provided, some of them are cramped with space insufficient for manoeuvring, whilst some are not provided with emergency call bell and alarm.

Accessible car parking spaces are often provided, nonetheless, requirements in dimensions and marking are not often met. Usually the accessible car parking spaces are narrower and the markings are smaller than required.

CONCLUSION

The argument that disability inclusion is an issue in sustainable design and construction is not false as increasingly more built facilities are obliged to be inclusive under law. In existing buildings, for example, alteration may become necessary. In this regard, disability inclusion is concerned with environmental and economic sustainability rather than merely a social issue. Among accessibility assessment methods that are currently available, they largely rely on assessors' subjectively judgements and are principally qualitative in nature. There have been attempts to improve the process by developing a quantitative assessment model, however, still considerable amount of subjective elements are present in the model. BIAS proposed here prevails for the inclusion criteria of individual areas and facilities are introduced into the hierarchy and subsequently weighted. It gives not only an inclusiveness score but also unearths the perceived weightings of the inclusion criteria. As can be seen in guides and standards, barrier-free design requirements in Hong Kong are relatively less strict. The Multiple-Criteria Decision Analysis technique to be used to analyse the priority of the inclusion attributes was discussed. NSFDSS rather than AHP is chosen for it is less time-consuming and yields more precise result.

The inclusiveness of built facilities in the Main Campus of the University of Hong Kong has been studied. As point out in the preliminary findings there are rooms to make the built facilities more inclusive. More imminent issues are to provide lifts and accessible toilets with emergency call bell and alarm. Other minor improvements such as provision of tactile warning strips at landings and Braille and tactile information on handrails are recommended. Last but not least, the philosophy of disability inclusion in built facilities should be building for all rather than persons with disabilities only. Contrary to that misbelief is inclusion in built facilities benefits everyone. It should be promoted in all societies no matter they are young or aged – a young society also calls for inclusion as parents with infants inside pushchairs want barrier-free passages.

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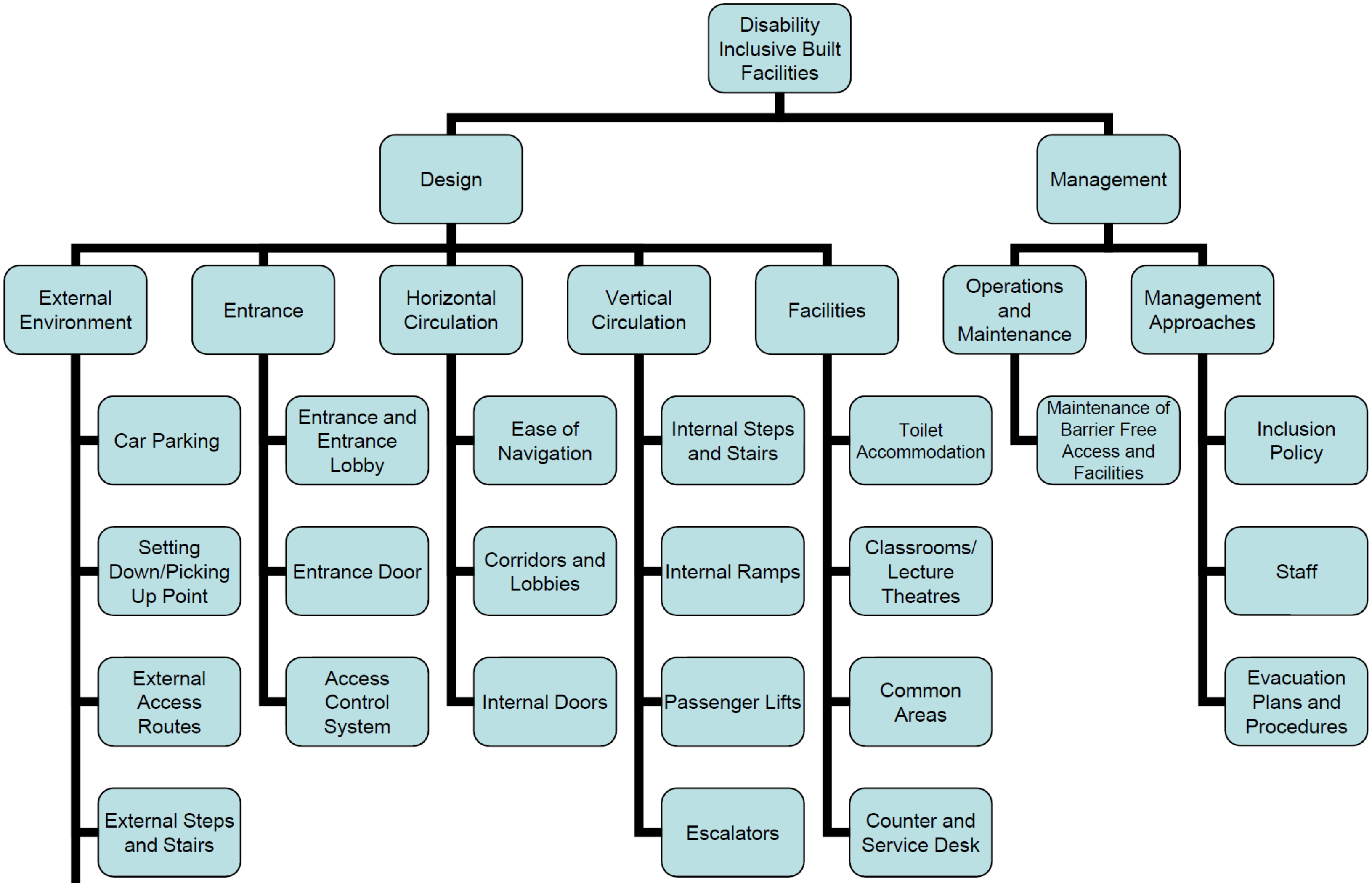

Figure 1: *Hierarchy of attributes that affect the inclusiveness of built facilities in higher education institutions*

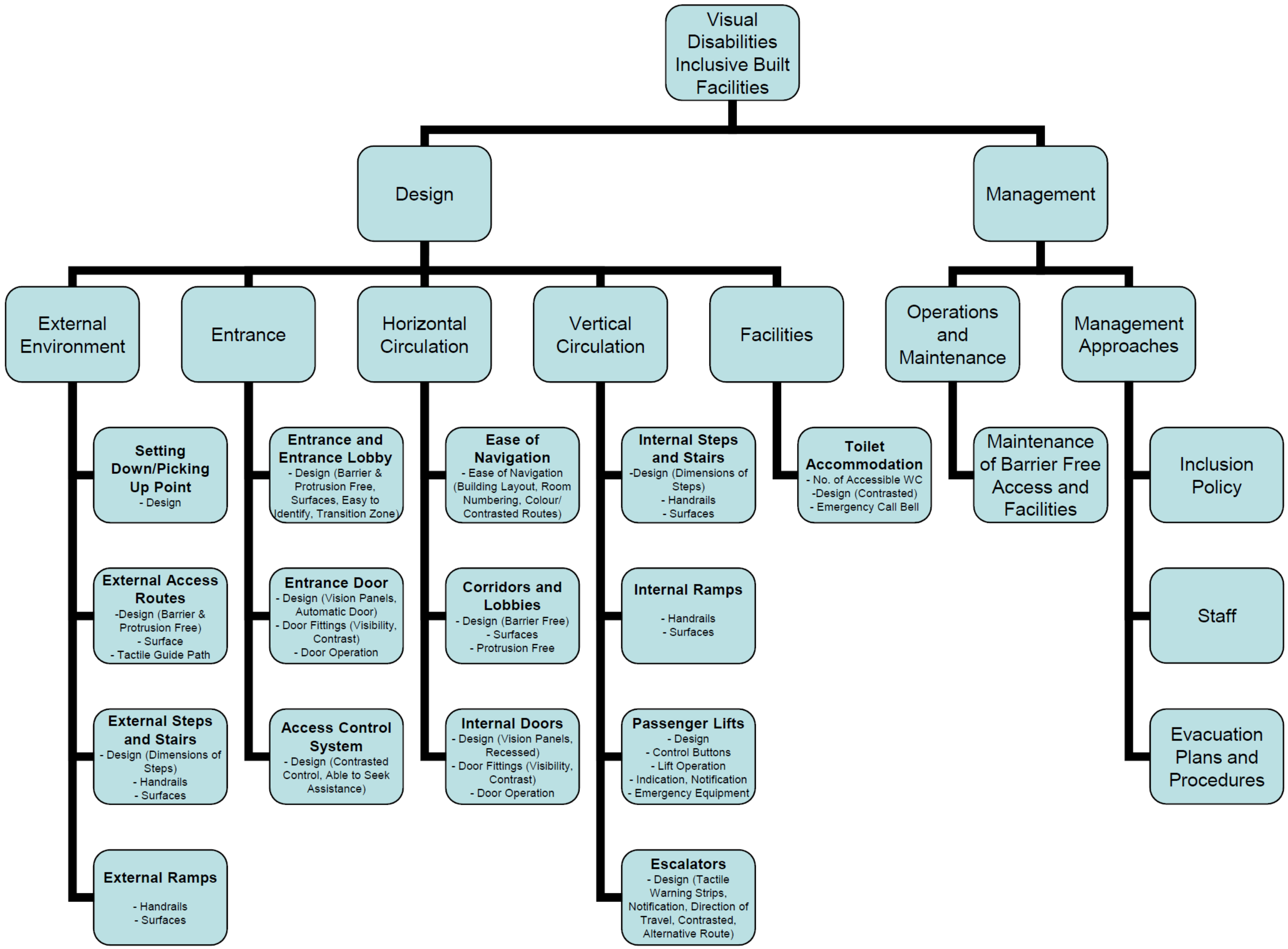

Figure 2: *Improved hierarchy of attributes that affect the inclusiveness of persons with visual disabilities in higher education built facilities*

Level II	Level III	Level IV
External Environment	Car Parking	• No. of Accessible Parking Space • Design of Accessible Parking Space
	Setting Down/ Picking Up Point	• Design of Setting Down/ Picking Up Point
	External Access Routes	• Design of External Access Routes • Surface of External Access Routes • Provision of Tactile Guide Path
	External Steps and Stairs	• Design of External Steps and Stairs • Handrails of External Steps and Stairs • Surfaces of External Steps and Stairs
	External Ramps	• Design of External Ramps • Handrails of External Ramps • Surfaces of External Ramps
Entrance	Entrance and Entrance Lobby	• Design of Entrance and Entrance Lobby
	Entrance Door	• Design of Entrance Door • Door Fittings • Door Operations
	Access Control System	• Design of Access Control System
Horizontal Circulation	Ease of Navigation	• Ease of Navigation
	Corridors and Lobbies	• Design of Corridors and Lobbies • Surfaces of Corridors and Lobbies • Protrusion Hazard
	Internal Doors	• Design of Internal Doors • Door Fittings • Door Operations
Vertical Circulation	Internal Steps and Stairs	• Design of Internal Steps and Stairs • Handrails of Internal Steps and Stairs • Surfaces of Internal Steps and Stairs
	Internal Ramps	• Design of Internal Ramps • Handrails of Internal Ramps • Surfaces of Internal Ramps
	Passenger Lifts	• No. of Accessible Passenger

		Lifts • Design of Passenger Lifts • Control Buttons of Passenger Lifts • Lift Operation • Indications and Notifications • Emergency Equipment
	Escalators	• Design of Escalators
Facilities	Toilet Accommodation	• No. of Accessible WC Cubicles/Accessible Unisex Toilet • Design of Accessible WC Cubicles/Accessible Unisex Toilet • Emergency Call Bell in Accessible WC Cubicles/Accessible Unisex Toilet
	Classrooms/ Lecture Theatres	• Design of Classrooms/ Lecture Theatres • Building Services and Relevant Facilities • Assistive Technology
	(Student) Common Areas	• Design of Common Areas and Fittings • Building Services
	Counter and Service Desk	• Design of Counter and Service Desk
N.B. 1. Design in general is concerned with dimensions and layout of individual areas and facilities. 2. Surfaces are referred to the firmness, the slip resistance, the pattern and the luminous contrast of finishes. Provision of tactile warning strips is also under surfaces. 3. Handrails have to meet requirements in dimensions and shape, fixing position and luminous contrast. It is also necessary to provide Braille and tactile information on handrails. 4. Door: door design is about the dimensions of doors; door fittings are about the furnishings or fixtures on door leaves; door operation is about the opening and the closing of doors.		

Table 2: *Level II to Level IV attributes under Design in the decision hierarchy*

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