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Assessing the Disability Inclusiveness of University Buildings

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***Abstract*—With rights to access becoming basic human rights, a tool for building disability inclusiveness assessment is necessary to tell how far we have gone to include people with disabilities in buildings. This article proposes a Building Inclusiveness Assessment Score (BIAS) framework which is made up of two hierarchies of inclusion attributes, namely the Physical Disability Inclusion Sub-score (PDIS) and the Visual Impairment Inclusion Sub-score (VIIS). The tool allows simple, quantitative and more objective assessments of buildings. Using the tool, forty-eight university buildings from four universities in Hong Kong were assessed for illustrating its real-life application.**

***Keywords*—Barrier-free access; building performance assessment; disability inclusion; universal design**

I. Introduction

Not only as one of the essential values that represent civil societies, building an inclusive society has also become a goal with universal appeal. Irrespective of differences in race, gender, class, generation and geography, people should enjoy equal opportunities [1]. In architecture and facility management, inclusion has often been taken as “disability inclusion” which is synonymous with “accessibility” and “barrier-free design”. In spite of advocacies for fostering disability inclusion, our built environment is still far from inclusive. Among the barriers to a fully inclusive built environment, one relates to building inclusiveness assessment to establish how disability inclusive a building is. At present, the assessment is conducted by way of access audit or access appraisal [2]. These methods, however, have limitations. First, they involve complicated assessment processes against a long checklist. Second, they include many subjective elements that rely heavily on assessors’ experience to make judgment [3]. A research gap for a practical yet more objective mechanism to appraise the disability inclusiveness of buildings is therefore identified. Against this background, the primary aim of this research is to develop an assessment protocol that makes benchmarking of inclusiveness of buildings possible. The constructed assessment framework, the Building Inclusiveness Assessment Score (BIAS) is applied to evaluate and compare the disability inclusiveness of forty-eight buildings from four universities in Hong Kong.

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II. Assessing Disability Inclusiveness

To assess whether a building is disability inclusive or not, resort can be made to building performance measurement or building performance assessment. Performance measurement comprises tasks of information collection and data analysis for the actual values of predefined performance parameters of a building while a step forward is taken for performance assessment. The latter generally involves gauging a building’s performance against a single criterion or a set of criteria [4]. Despite the fact that building performance assessment has a long history since 1940s, its focus has been mostly placed on environmental sustainability, with a few on health, safety and building intelligence. Yet, little attention has been given to disability inclusion in the studies of building performance assessment so far. As confirmed in a comprehensive literature review, users’ experience or opinions to evaluate disability inclusiveness and accessibility of buildings is still being used by most researchers [5–7]. This measure of disability-friendliness of built environment is notoriously subjective and the evaluation results vary with evaluators’ past experience and expectations. This approach at the same time does not fulfil the objective of performance assessment, and most reports of performance measurement are too technical or complicated for non-experts. More preferable assessment results are quantifiable ones so that direct comparison or benchmarking of disability inclusiveness is possible. This in turn allows building owners and facilities managers to prioritize their resources for sensible adjustments or improvements to the existing building facilities [3].

Assessment of disability inclusiveness generally involves several criteria. Some kind of multi-attribute assessment model is therefore needed [8,9] What has been ignored in the literature is the fact that individual attributes may command different levels of significance to the overall inclusiveness of a building. In addition to that, most existing inclusiveness assessment models only address accessibility issues in design and construction stages of the whole life cycle of built environment. Building management and operations are often overlooked. In view of these shortfalls found in the existing approaches and disability inclusiveness assessment models, an appraisal model which is objective, quantitative and easy to use is required to fill the research gap. This study proposes a multi-attribute assessment model which aims to develop a practical and theoretically sound model to assess the disability inclusiveness of university buildings using quantifiable and objectively measurable building attributes related to both design and management of buildings.

III. Development of the Building Inclusiveness Assessment Score

For purpose of developing a quantitative appraisal model for assessing the disability inclusiveness of university buildings, this research began with a comprehensive review of literature, guides and standards relevant to the subject. The design guidelines and standards in Canada, Hong Kong, Singapore, the United States and the United Kingdom were studied to identify suitable building factors for incorporation into the model. In selecting attributes or factors for the assessment model, there are three guiding principles. First, the attributes to be evaluated have to be highly relevant in the determination of the disability inclusiveness of university buildings. Second, the attributes should be flexible enough to embrace most settings of university facilities around the world. Third, for practicality and objectivity, the attributes should be easily observable, measurable and verifiable.

In line with these principles, potential building attributes for inclusion in the assessment model are identified. These attributes are grouped under different categories and structured into two hierarchies of inclusiveness performance indicators as shown in Fig. 1 and 2. Underneath the attributes are various accompanying, operational parameters. One of the hierarchies is tailored for assessing the level of inclusion for the physically impaired in the university built environment, while the other is for the visually impaired. The two hierarchies consist of five levels. The top level, which accommodates the goals of the two hierarchies, is to indicate the overall inclusiveness of a university building. In the subordinate level, the general goals were decomposed into two branches, namely *Design* and *Management*. The *Design* branch represents hardware for disability inclusion and embraces attributes related to the physical features of buildings. These attributes are usually those outlined in the inclusive design guidelines and standards. The *Management* branch embodies software that enables a building to be inclusive and covers actions or initiatives taken to plan, monitor and maintain an inclusive environment. This division is sensible because it is not merely looking at the hardware of buildings in order to address inclusion issues. How the buildings are managed and maintained also matters in the inclusiveness assessment.

The third level of the hierarchies comprises seven categories, with five coming under *Design* and two under *Management*. The five design-related categories are *External Environment*, *Entrance*, *Horizontal Circulation*, *Vertical Circulation* and *Facilities*, and the two management-related categories are *Operations and Maintenance* and *Management Approaches*. The forth level is made up of the building attributes which are grouped under their respective categories. In all, there are twenty-three and twenty-two attributes in the hierarchies for inclusion of the physically impaired and the visually impaired respectively. To facilitate the objective assessment on how a building performs with regard to a particular attribute, the attribute may be broken down into different operational parameters where the fifth level is formed. A rating scale is adhered to each of these parameters for consistent evaluation. As an example, Table I illustrates how the parameter *Design of External Access Route* under the attribute *External Access Routes* is assessed in the two hierarchies using predetermined scoring table.

TABLE I. AN EXAMPLE OF RATING SCALE

Description	Score
External access routes have a clear width - of 1,500 mm or more. - of 1,050 mm but 1,500 mm.	 2 1
External access routes are from barriers including steps, curbs other than dropped curbs, steep ramps, doors or doorways impeding passage of wheelchairs, and inadequate maneuvering space for wheelchairs.	1
Indication signage for access route or entrance is provided.	1
Total:	___ /4

The scoring tables set out the rules to govern the rating of quantitative attributes in the assessment scheme. They are designed with reference to the legal requirements, relevant design guides and standards, best practices in the building industry and recommendations made by disability concern groups. A score is assigned to each parameter, depending on how many criteria the building under assessment fulfils. In the example illustrated in Table I, the score ranges from 0 to 4 for the parameter. A low score indicates the case of disability exclusion while a higher score means a higher level of disability inclusiveness. For more convenient applications, the complex assessment results with respect to the building attributes should be aggregated and transformed into some simple indices. In this light, a Building Inclusiveness Assessment Score (BIAS) is developed. The BIAS is taken as an arithmetic mean of two indices, namely the Physical Disability Inclusion Sub-score (PDIS) and the Visual Impairment Inclusion Sub-core (VIIS). The PDIS and the VIIS are weighted arithmetic means of the ratings of the attributes (and the parameters) that affect the disability inclusiveness of university buildings with respect to the physically impaired and the visually impaired respectively. Mathematically,

$$\text{PDISk} = \sum_{i=1}^{23} w_{ki} F_{ki} \quad (1)$$

$$\text{VIISk} = \sum_{j=1}^{22} v_{kj} G_{kj} \quad (2)$$

where $PDIS_a$ and $VIIS_a$ are the PDIS and the VIIS respectively of building k; w_{ki} (i = 1, 2, … , 23) denotes the non-negative weighting of the ith inclusion attribute of building k related to physical disability; v_{kj} (j = 1, 2, … , 22) denotes the non-negative weighting of the jth inclusion attribute of building k related to visual impairment; F_{ki} (i=1, 2,…,23) and G_{kj} (j=1, 2,…,22) denote the standardized ratings of the ith and jth inclusion attributes respectively of building k. All w_{ki} sum to unity and the same applies to v_{kj}. The scale for each F_{ki} and G_{kj} is standardized by taking the ratio of total score attained for the particular attribute to the maximum score attainable for that attribute so it ranges from 0 to 100%.

As can be seen from the above formulae, $PDIS_k$ and $VIIS_k$ positively associated with all F_{ki} and G_{kj}, provided that w_{ki} and v_{kj} are all positive. To put differently, the higher an attribute rating F_{km} (or G_{kn}), the higher the resultant $PDIS_k$ (or $VIIS_k$) will be, keeping other ratings constant.

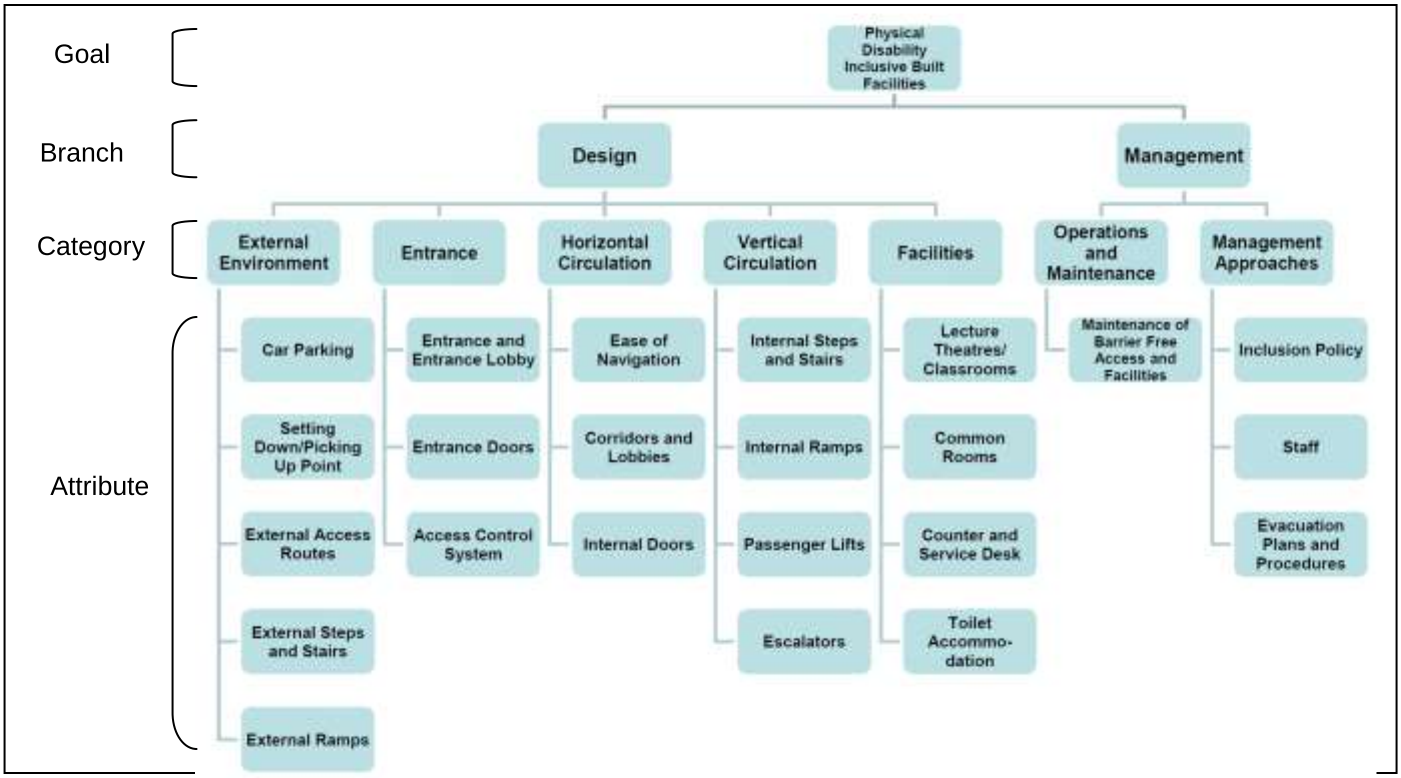

Figure 1. Hierarchy of assessment attributes in relation to the physical disability inclusiveness of university buildings.

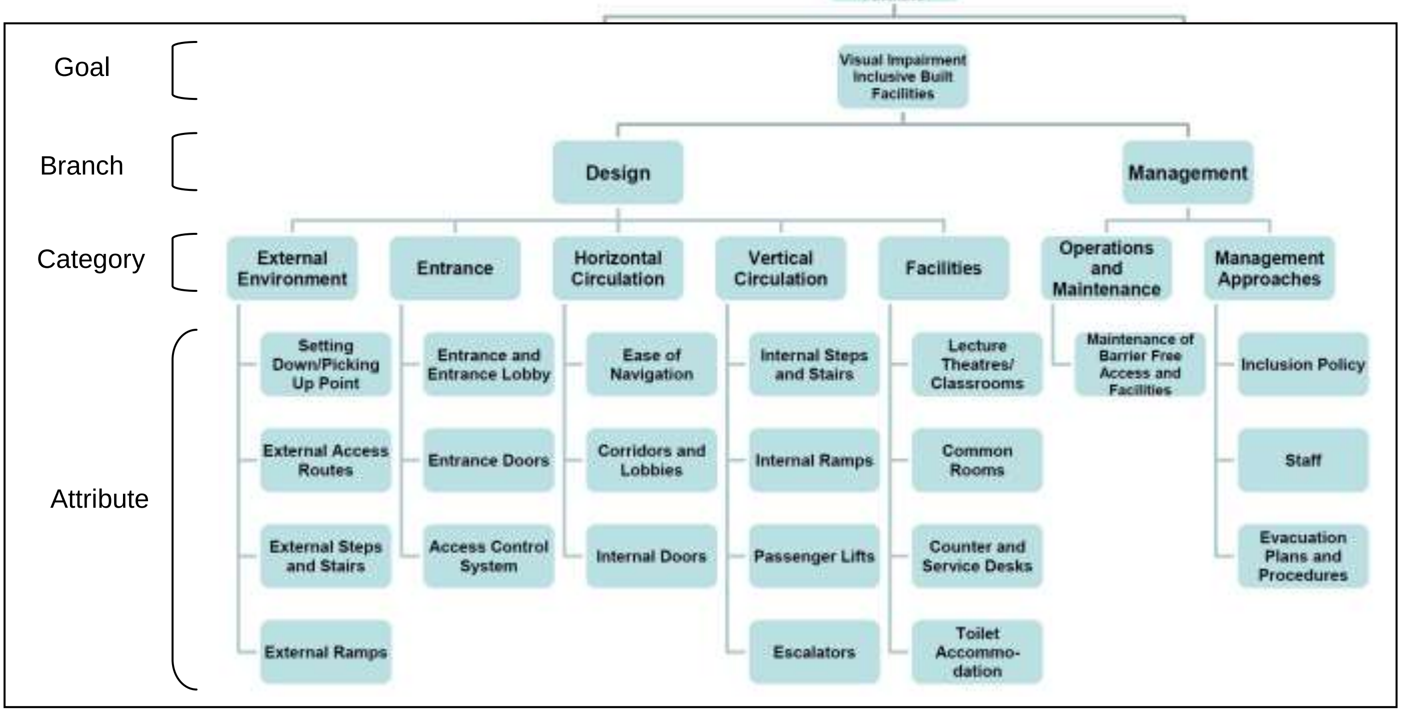

Figure 2. Hierarchy of assessment attributes in relation to the visual impairment inclusiveness of university buildings.

Since there are over twenty attributes and some fifty parameters in each of the hierarchies, it is difficult, if not impossible, for decision makers to give a set of consistent weightings to individual attribute and parameter using the direct weighting approach. In this regard, this study adopts the non-structural fuzzy decision support system (NSFDSS) for more credible determination of factor weightings. The NSFDSS as a multi-criteria decision making technique is easy to operate but still able to generate consistent weighting results. In it, a decision problem is broken down into a series of pair-wise comparisons among decision elements, thus reducing the difficulty of making a judgment [10]. The fuzzy sets adopted in the system facilitate comparisons and judgments even when vague words and expressions (e.g. 'the same', 'marginally different' and 'significantly different') are used [11]. On account of its beauty, the NSFDSS has been adopted for weight determination in a wide range of areas like site layout planning, renewal project evaluation and residents' decision-making for participation in housing maintenance [10,12,13].

The workflow of the NSFDSS and computational details of the technique are detailed in the literature so they are not repeated here [12,14]. The workshops for weighting the inclusion categories, attributes and parameters were held in Hong Kong between October 2011 and January 2012, and between March and July 2012, with twenty local building professionals (including architects and building surveyors), 22 persons with physical disability and twenty-one persons with visual impairment participated in the workshops.

IV. Assessments using the BIAS

Assessing the disability inclusiveness of a university building using the BIAS is a four-stage process. What comes first is desk study in which site layout and building plans are studied. Conducted afterwards is on-site evaluation during which visual inspection and measurements are performed. It is then followed by documentary inspection and structured interviews. Documents relevant to disability inclusion policy in a university, including maintenance plans and working manuals for disability, are examined. Lastly, the information and data collected in the preceding stages are verified and consolidated. By following these procedures, forty-eight university buildings from four universities in Hong Kong were assessed during the period between March and September 2013. Among the surveyed buildings, twenty-five buildings (52.1%) came from the University of Hong Kong (HKU), eight (16.7%) from City University of Hong Kong (CityU), seven (14.6%) from Hong Kong Baptist University (HKBU) and eight (16.7%) from Hong Kong Polytechnic University (HKPU). The PDIS and the VIIS assessment results of the buildings are summarized in Tables II and III respectively.

Because it is not the aim of this research to compare which university is the most disability inclusive, how individual university scored in the PDIS and the VIIS is not further discussed. But for HKU to score the highest in the PDIS and the VIIS, buildings from this case were not more disability inclusive in their design but more disability inclusive management is the reason for the higher scores. It is also noted that the physical disability inclusion performance and the visual impairment inclusion performance of the buildings were correlated, that the higher the PDIS, the higher the VIIS, and vice versa.

TABLE II. SUMMARY STATISTICS OF THE PDIS ASSESSMENT RESULTS

	HKU	PolyU	CityU	BU	Overall
Maximum	76.3%	68.2%	69.3%	69.6%	76.3%
Mean	69.0%	65.7%	62.4%	64.3%	66.7%
Median	71.4%	66.6%	61.2%	64.9%	68.0%
Minimum	52.3%	62.1%	55.8%	57.0%	52.3%
σ	6.6%	2.1%	5.2%	5.0%	6.1%

TABLE III. SUMMARY STATISTICS OF THE VIIS ASSESSMENT RESULTS

	HKU	PolyU	CityU	BU	Overall
Maximum	77.2%	66.8%	67.9%	72.1%	77.2%
Mean	69.2%	64.0%	63.4%	65.1%	66.8%
Median	70.2%	64.9%	62.9%	64.8%	66.5%
Minimum	58.6%	57.1%	60.1%	57.1%	57.1%
σ	5.1%	3.1%	2.5%	5.0%	5.1%

Despite this finding to the contrary, the PDIS and the VIIS indicate merely the overall disability inclusion performance, and only by looking further down to the category level we can know better the performance of *Design* and *Management* in the two scores. For categories in the PDIS, *Operations and Maintenance* is the best performed category that the access and facilities of the buildings are well maintained with almost no defects. Not many barriers were identified for the attributes under *Vertical Circulation* such that passenger lifts were of sufficient space and suitably accommodated for wheelchair users and those with ambulant disability to use and operate, and entrances and entrance lobbies were adequately spaced and appropriately surfaced. Yet, performance with respect to *Facilities* and *Management Approaches* was found poor because (1) passages in lecture theatres or classrooms were too narrow for wheelchair to pass across and were very often not provided with wheelchair space; (2) inclusion policy was not properly adopted and implemented in the universities studied; (3) the staff who were responsible for assisting persons with physical disabilities were not around and they did not receive training in communication with persons with physical disability; and (4) evacuation plans and procedures are not implemented to facilitate evacuating persons with physical disability in case of emergency.

When it comes to categories in the VIIS, *Operations and Maintenance* was again the best performed category but some defects such as missing braille and tactile information on handrails were observed. Some problems were noted with respect to the vertical circulation – insufficiently contrasted nosings and handrails and missing braille and tactile information on handrails. Besides, some essential indication and notification in passenger lifts, without which persons with visual impairment may be trapped inside the lifts were not provided. For *Facilities*, absent of visual impairment friendly features such as contrasted controls and sockets in lecture theatres or classrooms and contrasted sanitary fitments in toilet accommodations were some of the reasons for the poor performance. Again *Management Approaches* is a poorly performing category in VIIS and the reasons behind are similar to those stated in the PDIS.

V. Discussion

The BIAS framework is developed in this study to fill the current knowledge gap. At the time during the hierarchies were constructed, factors and elements that made up a physical disability and visual impairment inclusive university building were inquired. For buildings to be disability inclusive, both design and management are indispensable. For the time being, property management for disability inclusion has remained largely understudied. More than merely contributing to knowledge, this research does have practical implications. Stated briefly, the PDIS and the VIIS developed can be of practical use in three ways. First, although not developed as a design guide for disability inclusive buildings, architects or designers or any interested parties may refer to the PDIS and the VIIS and their rating scales when they plan and design works. Second, the weights of the PDIS and the VIIS categories, attributes and parameters dissected what building professionals and persons with physical disability or visual impairment saw as important to disability inclusive buildings. To building professionals and those in authority to oversee inclusion issues, they are essential information without which they cannot prioritize improvements and/or take appropriate measures to augment disability inclusiveness. For better inclusiveness, it pinpointed that more management actions such as training staffs to build their disability awareness are essential. Lastly the PDIS and the VIIS are simple, more objective and quantitative than access audit or access appraisal which is presently in use. With the two, physical disability and visual impairment inclusiveness of buildings can be assessed more easily with less hassle, no matter a building is still in planning and design stage or already occupied, or whether it is going to initiate improvement works or simply a periodic review. In management language, the inclusion performance of a building can be benchmarked.

Ahead of genuinely fantastic to facilities managers, building professionals, facilities owners and building users, the PDIS and the VIIS still entail some 200 items in their assessment (i.e. 216 items in the PDIS and 155 items in the VIIS) and have to be further reduced and simplified while remaining comprehensive. As it is, this study has set the research design and the strategy to collect data for assessing building disability inclusiveness. It is in pole position to adjust and apply the BIAS framework to study other types of buildings such as health care facilities and office buildings.

VI. Conclusion

Underpinned the embarkation to develop a simple, quantitative and more objective building disability inclusiveness assessment scheme, it was accepted that persons whether or not with disabilities should have equal rights and rights of persons with disabilities to access and use buildings should be fostered and safeguarded. Aligned with this research aim, subjects relevant to assessment of building disability inclusion performance were reviewed, particularly guides and standards of barrier-free access and universal design for constructing the BIAS framework. Originally seeking to develop the BIAS to assess and represent the overall disability inclusiveness of buildings in a single score, it was later found unsuitable. It would be more desirable to present the inclusiveness of a particular disability in a score. The final product was the PDIS and the VIIS.

In sustainable buildings, disability inclusion is indeed a relevant issue for it presents elements in social and economic sustainability. No matter whether a society is a young or an aged one, it is something that should be championed, as the philosophy behind disability inclusion in built facilities is building for all, rather than for the disabled only. An inclusive environment built will in the end benefit everyone.

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