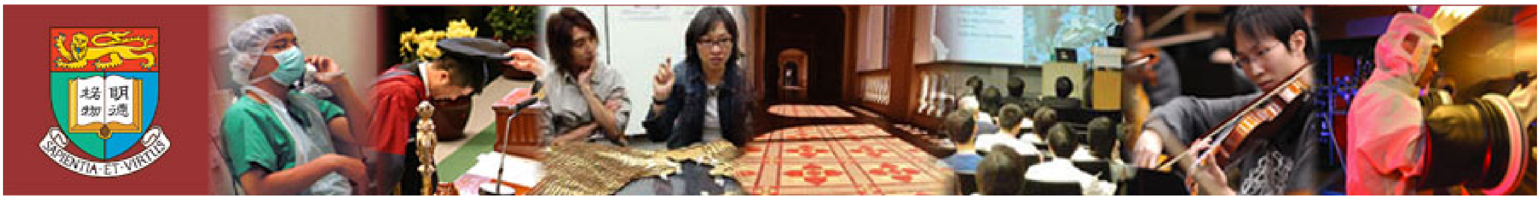

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Comparative Study of Building Performance Assessment Schemes in Hong Kong

DCW Ho[1], KW Chau[2], Y Yau[3], AKC Cheung[4] and SK Wong[5]

ABSTRACT

Having access to information is essential when one needs to make a decision to buy property or renovate a building. However, information concerning the health, safety, and environmental performance of buildings is not always readily available. This creates a need for building performance assessment tools. This paper aims to compare the building performance assessment schemes available for use in Hong Kong, namely The Hong Kong Building Environment Assessment Method (HK-BEAM), The Intelligent Building Index (IBI), The Building Quality Index (BQI), and The Comprehensive Environmental Performance Assessment Scheme for Buildings (CEPAS). Their similarities and differences are pinpointed and discussed in detail. The findings of this study will serve as a guide for practitioners to decide on the schemes that best suit their purposes.

KEYWORDS

Building performance, Building labelling, Green buildings, Health and safety, Hong Kong

INTRODUCTION

Information is essential for making consumption and investment decisions related to property. For example, people want a comfortable, safe, and hygienic place to live. However, these aspects are not always revealed during pre-transaction property inspections. Some of the information is technical in nature and homebuyers may not fully understand the implications of certain building design and management features. In some cases, the cost of obtaining the information for purposes of comparison is too high. The aim of building performance assessment is to provide a path to channel the information to all interested parties. These assessments would be helpful towards revealing the quality of a building and facilitating the screening process in the pre-transaction stage.

At present, there are several building performance assessment schemes that have been developed based on Hong Kong's unique situation, and are now available for use locally. However, these schemes are often portrayed as rival approaches, and the emphasis tends to be placed on their differences rather than similarities. Against this background, there is a continuing need for comparative research that seeks to clarify interrelationships between alternative methods, thus helping practitioners choose the most suitable assessment scheme for addressing specific aspects. Indeed, we believe that this comparative study contributes significantly to the important goal of improving decision making for users, investors, and property and facility managers.

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AN OVERVIEW OF BUILDING PERFORMANCE ASSESSMENT SCHEMES IN HONG KONG

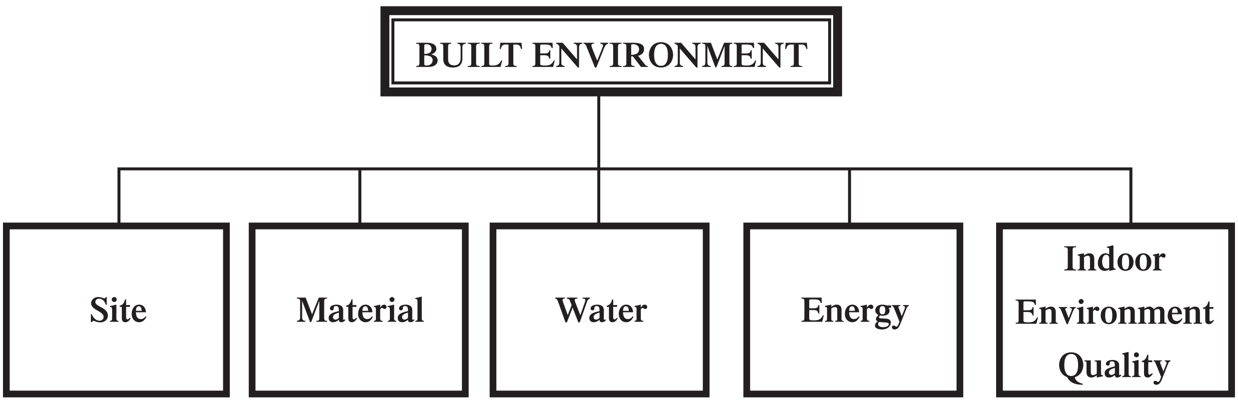
There have been several building performance assessment schemes developed or proposed for use in the local context. These schemes include the Hong Kong Building Environment Assessment Method (HK-BEAM), the Intelligent Building Index (IBI), the Building Quality Index (BQI), and the currently proposed Comprehensive Environmental Performance Assessment Scheme (CEPAS). An overview of these schemes is given below.

The Hong Kong Building Environment Assessment Method (HK-BEAM)

The HK-BEAM scheme was developed in 1996 by the Centre for Environmental Technology Limited (HK-BEAM Society, 2004a; 2004b), and is now owned and operated by the HK-BEAM Society. The approach and documentation in the HK-BEAM was initially an adaptation of the Building Research Establishment Environmental Assessment Method (BREEAM), which originated in the U.K.[1] The scheme was then updated and reviewed, the latest version of which was issued in December 2004.

The structure of the HK-BEAM is organized around 'inputs', as represented in Figure 1. The inputs are categorized into five performance aspects, namely *site, materials, energy, water*, and *indoor environment quality* (HK-BEAM Society, 2004a; 2004b). Under each category, there is a list of specified factors that would affect the quality of the respective input. For example, the efficient use of materials, sensible material selection, and waste minimization can contribute to better performance in the material input of the built environment.

Figure 1 The structure of the HK-BEAM



[1] *The BREEAM was developed by the Building Research Establishment in the U.K (Baldwin, et al., 1998). There are other building assessment schemes focusing on environmental issues available overseas, such as the Leadership in Energy and Environmental Design in the U.S. (US Green Building Council, 2001), Green Building Tool in Canada (Cole and Larsson, 2002), and the Comprehensive Assessment System for Building Environment Efficiency in Japan (Murakami, et al., 2004).*

The Intelligent Building Index (IBI)

The IBI was developed by the Asian Institute of Intelligent Buildings (AIIB) in 2001 to assess building intelligence (Asian Institute of Intelligent Buildings, 2005; Wong, *et al.*, 2001). At that time, it measured building performance in terms of nine quality environment modules, including *environmental friendliness, human comfort,* and *safety and security* measures (So and Wong, 2002). After the outbreak of Severe Acute Respiratory Syndrome (SARS) in 2003, an additional *health and sanitation* module was added to enhance the original framework. The IBI is essentially a design tool providing guidance to designers as to what constitutes an intelligent building, and acts as a platform for assessing an intelligent building objectively (So and Wong, 2002).

The Building Quality Index (BQI)

The outbreak of SARS in early 2003 and frequent fatal building-related accidents have highlighted concerns over the possible dire consequences of building neglect. In order to promote proper building maintenance and management of buildings through the use of market forces, the Faculty of Architecture of the University of Hong Kong developed a BQI to distinguish those poorly performed buildings from the good ones (Ho, *et al.*, 2004). At present, the BQI comprises two indices, namely the Building Health and Hygiene Index (BHHI) and the Building Safety and Conditions Index (BSCI). With assistance offered by local professional bodies and tertiary institutions, the Faculty developed the BHHI and BSCI assessment frameworks and carried out pilot schemes for a sample of multi-storey private residential buildings in Hong Kong during the summers of 2003 and 2004.

The hierarchy of the BHHI is presented in Figure 2. At the top is the objective (i.e., a healthy built environment). It is then divided into *Design* and *Management* on the second level. The *Design* aspect of a building represents the 'hardware' of a building, which is usually hard to change technically or economically once a building is put into use (Ho, *et al.*, 2004). On the other hand, the *Management* aspect of a building represents the 'software', which is dynamic and relatively easy to change even after a building is occupied. The classification of building factors into *Design* and *Management* has the advantage of dividing the factors into groups that are within and beyond the control of the owners. This helps owners identify the possible actions that could be taken to improve the health and hygiene standards of their buildings. The assessment scheme was designed after an intensive workshop was conducted with expert representatives from key professional bodies and other universities. The framework for the BSCI is very similar to that of the BHHI, except for its focus on building-associated risks and condition problems (Ho and Yau, 2004). The assessment framework of the BSCI is again classified into intrinsic *Design* and controllable *Management* aspects, as shown in Figure 3.

The Comprehensive Environmental Performance Assessment Scheme for Buildings (CEPAS)

In light of increasing public awareness of our deteriorating natural and built environment, the CEPAS was proposed as a standard yardstick for determining the environmental performance of buildings in Hong Kong (Hui, 2004). As a green building labelling scheme initiated under the 2001 Government Policy Objectives, the CEPAS endeavours to address both physical and human-related issues amongst the core aspects of sustainability. While placing much emphasis on traditional environmental performances, such as energy, indoor air quality, and the maintenance of building services installations, the CEPAS also considers other social-economic factors, such as impacts on surroundings,communal interactions, building economics, transportation, heritage conservation, etc.

Eight performance categories were identified for the CEPAS, which are *Indoor Environmental Quality (IEQ), Building Amenities, Resources Use,*

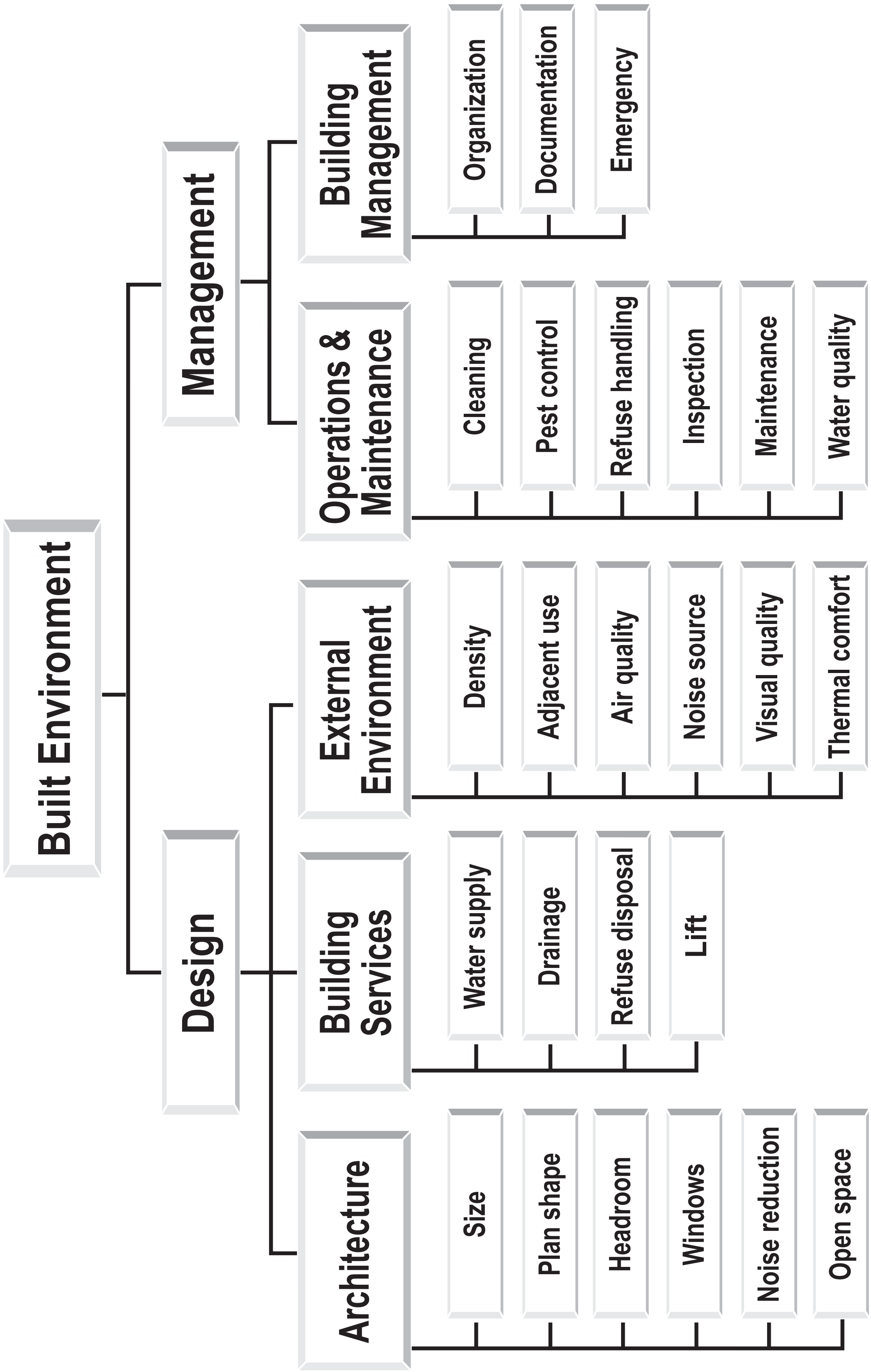
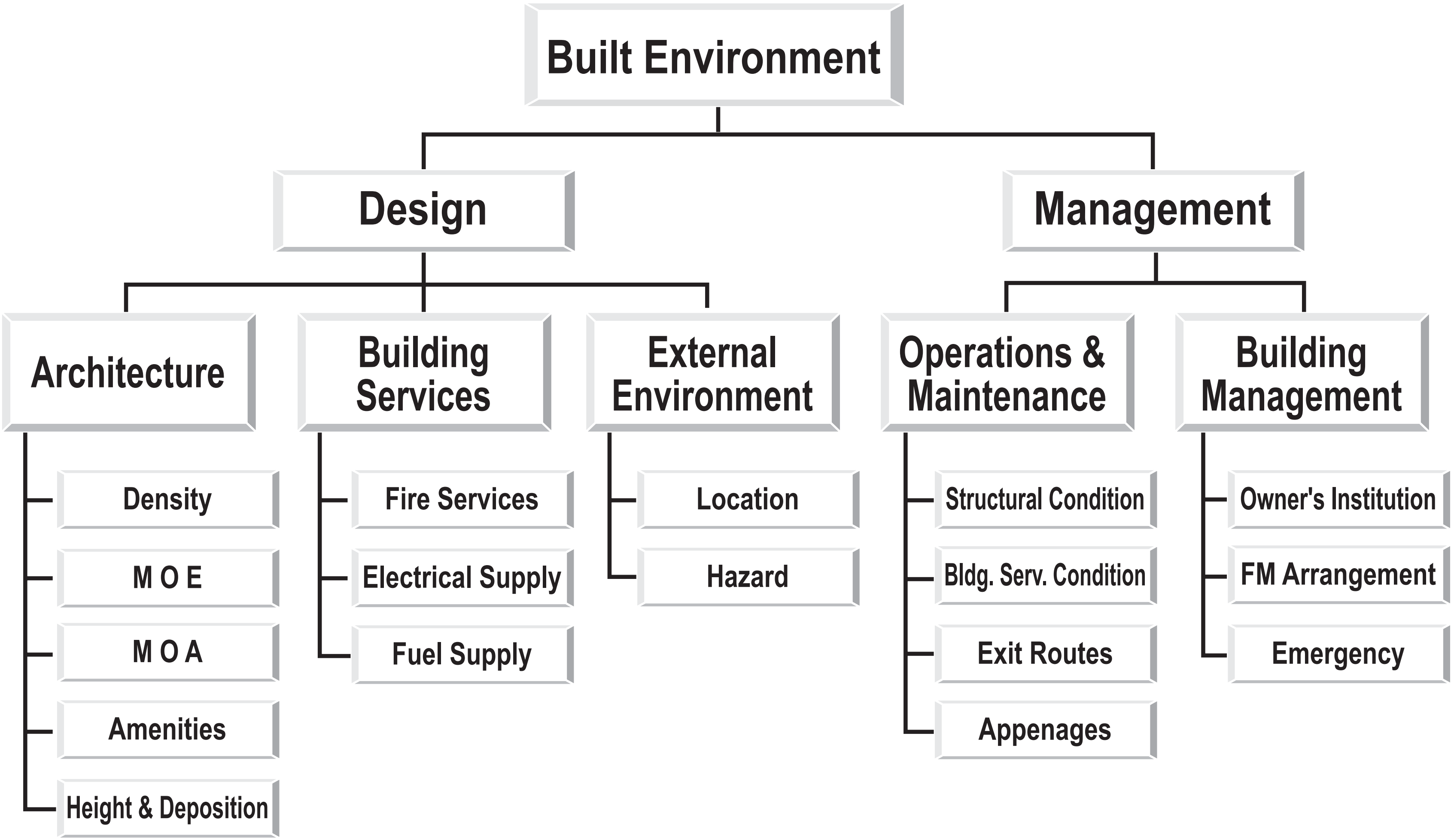


Figure 2 Hierarchy of the BHHI

Source: Ho, et al., 2004

Figure 3 *Hierarchy of the BSCI*
Source: Ho and Yau, 2004



Loadings, Site Amenities, Neighbourhood Amenities, Site Impacts, and Neighbourhood Impacts. Also, the major sustainability considerations at the building level were incorporated (Hui, 2004). The *IEQ, Building Amenities, Site Amenities*, and *Neighborhood Amenities* are mainly human-related factors, while the remaining categories are mainly physical factors. The relationship among these categories is illustrated in Figure 4.

COMPARISON OF DIFFERENT SCHEMES

As the objectives of these building performance assessment schemes diverge, they have different features to suit their purposes. In the following section, the four schemes reviewed above are compared and their similarities and differences are discussed. The comparison carried out is based on the nature, purpose, and scope of assessment, targeted building groups, stages of building life-cycle involved, assessment objectivity, performance rating, factor weighting, and the presentation of a final rating. A summary of the comparison is given in Table 1.

Figure 4 Matrix of Performance Criteria for the CEPAS

Source: Hui, 2004

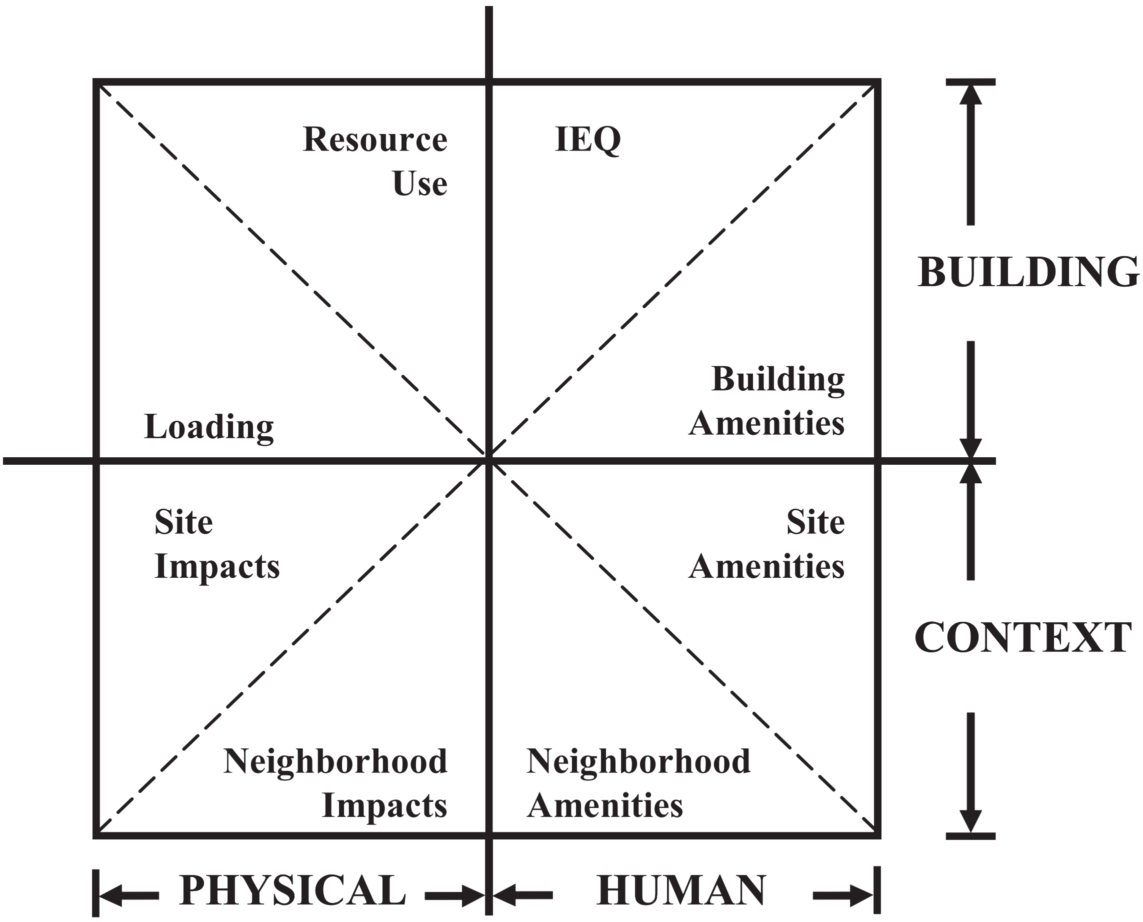


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Table 1 Comparison of the features of different schemes

		HK-BEAM	IBI	BQI	CEPAS
Nature of Assessment	Voluntary	•	•	•	•
	Mandatory				
Purpose of Assessment	Building labelling	•			•
	Building rating		•	•	
Target Building Groups	Residential buildings	•	•	•	•
	Non-residential buildings	•	•		•
	New buildings	•	•	•	•
	Existing buildings	•		•	•
Scope of Assessment	Health and hygiene	●	•	•	●
	Safety	●	•	•	●
	Green issues	•	•		•
	Comfort	●	•		●
	Information technology	●	•		
Stages of Building Life-cycle Influenced	Planning	•			•
	Design	•	•	•	•
	Construction	•	•		•
	Operation	•		•	•
	Demolition	•			•
Assessment Objectivity	Objective judgement	•	•	•	•
	Subjective judgement	●	•	•	●
Nature of Factors	Prescriptive-based	•	•	•	•
	Performance-based	•	•	•	•
Rating Scale	Dichotomous scale	•	•	•	•
	Linear scale		•	•	
	Non-linear scale	•	•		•
Weighting of Factors	Equal weights	•			
	Preset different weights		•		
	Weighted by expert panel			•	•

Key: ● = Applicable; • = Marginally applicable

Nature and Purpose of Assessment

All four schemes are not mandatory in nature. While all of them are for benchmarking building performance in various aspects, they serve different purposes. The IBI and BQI are building rating systems, while the HK-BEAM and CEPAS are building labelling systems.[2] Moreover, unlike the other building performance assessment schemes, which aim for an in-depth assessment of building performance, the BQI aims to provide a low cost, objective, quick, and yet balanced assessment of building attributes on the health and safety of occupants. It is designed to cover as many buildings as possible with limited resources and within the shortest possible time.

Target Building Groups

The HK-BEAM and CEPAS cover all building types in Hong Kong, be they new or old. However, for both the HK-BEAM and CEPAS, only single-ownership buildings are eligible for assessment. Although the coverage of the IBI with respect to building types is as wide as that of the HK-BEAM and CEPAS, most of the parameters measured under the IBI cater to new developments only. It is noted that the objective of the IBI is to provide a design tool to give guidance to designers as to what constitutes an intelligent building. In contrast, the BQI is intended to classify the living environment of most people in Hong Kong regarding health and safety conditions. The BQI is tailored to multi-storey residential buildings with multiple dwelling units and co-owned common areas.

Scope of Assessment

Among the four schemes, the coverage of the IBI is the widest in terms of scope of assessment. It evenhandedly covers health and hygiene, safety, energy efficiency, comfort, and high-technology aspects. The HK-BEAM and CEPAS place their emphases on the first three and four aspects, respectively. The scope of the BQI is the most focused among others, assessing only health and safety issues.

Stages of the Building Life-cycle Assessed

As the HK-BEAM and CEPAS seek to measure and label the performance of buildings over the whole life cycle, the assessment spans from the planning stage, through the design, construction, commissioning, operation, maintenance, and management stages, and finally to deconstruction. In the BQI framework, assessment factors capture some important aspects affecting the design, as well as day-to-day maintenance and operations during the occupancy phase of a building. Thus, it has an influential impact on a project during its design and operation stages. As aforementioned, the IBI serves as a design tool, and its impact is confined to the design stage of a project. However, since there is a *Construction Process* and *Structure* module in the IBI assessment framework, the use of the scheme could be extended to the construction stage.

Objectivity of Assessment and the Nature of Assessment Factors

Objective criteria for assessment were emphasized in all the schemes under study. This provides a common platform on which assessment can be made easier and more straightforward, eliminating possible subjective judgement due to different assessors. For example, in the IBI, the ratio of life-cycle cost to rent is an objective judgement.

Objective criteria are commonly used in all schemes. Assessors' subjective judgement is also needed in both the IBI and BQI to rate the performance of certain aspects of a building during inspection. The major problem of incorporating subjective judgement is the inconsistency. In the BQI, inconsistency is reduced

[2] *According to the definitions provided by Larsson (2004), these two systems involve an assessment protocol for compiling an overall building performance score. The only difference lies in the fact that more elements, like the implementation of the protocol at the industry level by means of trained assessors, a training program for assessors, and a marketing program to publicize the system to the industry, are included in a building labelling system.*

by providing a "scoring manual" to assessors, in which scores could be assigned to a set of descriptions illustrated with photos. This helps an assessor rate the conditions of a building in a more consistent manner. As for the CEPAS and HK-BEAM, the use of subjective judgement is very limited. The only exception to the CEPAS and HK-BEAM is the assessment of innovative design, which can bring bonus points to certain assessment factor categories.

Another feature that distinguishes schemes from each other is the use of prescriptive, or performance-based, assessment factors. Factors that are prescriptive in nature dictate how and what should be assessed rather than only specifying the objective to be achieved. For instance, to minimize energy loss in a building, we can assess the overall thermal transfer value of the building (performance assessment) or check if a particular type of heat-insulated material has been used (prescriptive assessment). Both types of assessment factor are common to all the schemes studied.

Performance Rating

The purpose of a rating system is to convert the raw data into a score so that we know about the building performance for a particular area or how many credits should be given to the building factor being assessed. This is vital to all building assessment and labeling schemes. Dichotomous scale is common to all four schemes. In this scale, the building factors are rated basically in dichotomous yes-or-no answers. The benefit of such a rating scheme is a reduction of the time used for the assessment and a minimization of the degree of subjectivity in the assessment process.

In the IBI, HK-BEAM, and CEPAS, ratings for most factors are not scalar. A building either satisfies the requirement to receive credit or it fails to do so. The building will be awarded credit even if other criteria are substantially below par. The implication is that an *excellent* graded building can have several items that are substantially below average.

On the other hand, most factors in the BQI and a few factors in the IBI are rated on linear scales.[3] The use of linear scales can avoid the distortion of information during the scaling or transformation process. By and large, the use of linear scales allows for a finer differentiation of performance grading, and can provide a more complete picture of performance. In establishing the scales, industry norms or relevant statutory provisions are taken as reference points. In some circumstances, more than two discrete categories have to be allowed to give a finer differentiation to building performance. In the BQI, a five-point scale has been adopted – poor, below average, average, above average, and good. Such a scale helps ease subjective judgments on both quantitative and qualitative selection criteria, and it works well even for inexperienced assessors (Schniederjans, *et al.*, 1995 and Baird, *et al.*, 1996).

Weighting of Factors

Weightings represent the relative importance of a building factor towards the overall goal of the assessment. They affect the degree of influence by each building factor on the overall result. The factor weightings of the HK-BEAM are varied and inherent. Or put it another way, the weightings are determined by the maximum credits attainable for these factors (Todd, *et al.*, 2001). The weightings can be changed by adding or dropping factors under the assessment scheme or adjusting the credits allocated to the factor. Similarly, the relative importance of each factor with respect to the objective of each category is determined inherently in the IBI. In particular, however, different sets of predetermined weights for the ten quality environment modules are designated to buildings of different uses in the IBI. For instance, "life cycle costing" is weighted as 1 in residential buildings, but 5 in educational institutions; "image of high technology" is

[3] *In a linear scale, the score of the factor is calculated based on a linear projection from a predetermined reference point. For example, the raw rates, ranging from X_1 to X_{10}, can be transformed to a continuous linear scale ranging from 1 to 10, or mathematically, $[X_1, X_{10}] \rightarrow (1,10)$.*

weighted as 3 in residential buildings, but 6.5 in commercial (office) buildings. Therefore, by changing the weightings, the IBI can be configured to assess different building types.

While both the HK-BEAM Society and Asian Institute of Intelligent Buildings have not mentioned how their factor weightings are determined, the BQI and CEPAS obtain the weightings from a group of external experts with different backgrounds. The experts' options are elicited because there is a general lack of objective empirical scientific evidence[4] for determining the relative importance of the effect of some aspects of a building on its occupants and the environment. In the CEPAS, each factor category is allocated with a predetermined weighting, which directly influences the cumulative performance scores. These weighting factors were developed from a consultation forum, held in July 2003, which solicited opinions from local building professionals, building user groups, and green groups on the relative importance of building performance issues.

In arriving at the final set of weightings in the CEPAS, the experts were asked to assign absolute weightings for each factor. Nonetheless, it was difficult, if not impossible, for the experts to provide a consistent weighting for each factor once the number of factors to be considered is large. Saaty (1980) stated that the intuitive and cognitive capacities of human beings restrict the maximum number of factors to be considered simultaneously in order to achieve a consistent result. In this regard, the weighting of each factor in the BQI is pre-determined by expert panels[5] using the Analytic Hierarchy Process (AHP), which was developed by Saaty (1980). The use of the AHP allows for more consistent and reliable results regarding the relative importance of the factors. This increases the public's acceptance of the results.

Assessment Procedures

The HK-BEAM requires building owners to assume the initiative to approach HK-BEAM assessors with their selected buildings for evaluation. Owners provide detailed information, at their own cost, for assessors to complete the checklist. Assessments rely on the accuracy of information supplied by owners. Assessors validate the data and appraise the project using HK-BEAM criteria. A Provisional Assessment Report is then produced listing those credits that have been achieved and potential performance areas that can be improved. Owners can take assessors' proposals and pursue further credits before submitting their buildings for final assessment. The validity of certification lasts for five years. The assessment and certification processes of the CEPAS are more or less the same as those of the HK-BEAM. The validity of assessment results for the operational stage of existing buildings in the CEPAS also lasts for five years.

As the aim of the BQI is to give a general appraisal of all residential buildings in Hong Kong, this cannot be achieved by solely relying on voluntary participation from building owners. Owners' input is viewed as necessary, but should not be the only input in the assessment procedure. Instead, most of the information is obtained from publicly available sources. For example, building design is assessed by gathering information from approved building plans kept by the Buildings Department.[6] In order to reveal actual conditions, a building survey will also be carried out. Inspection will be confined to common areas of the building so that it will not be necessary to seek consent from every individual owner. An appraisal of the performance of the building

[4] One example of obtaining weighting through scientific research is the calculation of the total energy embodied in the building material used.

[5] Several workshops were carried out between 2003 and 2005 to collect views from experts on the relative importance of different building factors to the health and safety performance of residential buildings.

[6] Acknowledgement has been made to the Buildings Department for facilitating the retrieval and copying of plans for the BQI Pilot Scheme conducted in 2003 and 2004.

management agent is also required, but it is limited to the information related to normal building operations such as incident records, as-built drawing, and post-occupancy surveys. Therefore, the costs to be borne by owners are trifling.

Applicants for a building performance assessment sometimes may disagree with the assessment results. Therefore, an appeal mechanism becomes essential to address the grievances of these applicants. Among the schemes, appeal processes are provided in the HK-BEAM, and have been proposed for the BQI and CEPAS. On the other hand, there are no explicit assessment, certification, and appeal procedures for the IBI.

APPLICATION OF THE SCHEMES

Every nation or city has its unique environmental, ecological, social, cultural, economical, and technological conditions. Given the importance of a building performance assessment scheme to a society, it is necessary to devise an assessment scheme that is pertinent to its specific purposes (e.g. sustainability and the health and safety of the built environment) and specifically adapted to deal with local conditions.

The IBI, HK-BEAM, and CEPAS consider a wide variety of factors, which are put into different categories. Yet, their comprehensiveness comes with high implementation costs. Therefore, it is more suitable as a design guide for developers and designers. The relatively low-cost and simple assessment procedures of the BQI make it the most advantageous for large-scale first 'screening' of building performance in health and safety aspects. The government or organizations managing a large portfolio of properties can make use of the BQI to classify multi-storey residential buildings according to their health and safety conditions. As for the HK-BEAM and CEPAS, they cover more or less the same factors with specific concentrations on green building issues, and their assessment methods are similar. They are apt for labelling buildings that excel in environmentally friendly performance. Unlike the other three schemes, the IBI takes a balanced view of different categories of building factors, and hence does not have a sharp focus. Therefore, the IBI best serves as a set of design guides for high-quality buildings in terms of various aspects.

The study revealed that the objectives, target groups, assessment procedures, and resources required differ among the four schemes. The comparison suggests that these schemes do not necessarily compete with, but rather complement, each other, with each scheme serving different purposes.

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REFERENCES

Asian Institute of Intelligent Buildings (2005), *Intelligent Building Index (IBI),* available at http://www.aiib.net/ibi-index.htm (accessed on 4 May 2005).

Baird G.; Gray J.; Isaacs N.; Kernohan D. and McIndoe G. (1996) *Building Evaluation Techniques,* McGraw-Hill, New York.

Baldwin R., Yates A., Howard N. and Rao S. (1998), *BREEAM 98* for *Offices: An Environmental Assessment Method for Office Buildings*, Building Research Establishment, Garston, Watford.

Cole R.J. and Larsson N. (2002), *GBTool (Green Building Tool) User Manual,* Green Building Challenge, Vancouver.

HK-BEAM Society (2004a), *Hong Kong Building Environmental Assessment Method - New Buildings,* HK-BEAM Society, Hong Kong.

HK-BEAM Society (2004b), *Hong Kong Building Environmental Assessment Method - Existing Buildings,* HK-BEAM Society, Hong Kong.

Ho D.C.W., Leung H.F., Wong S.K., Cheung A. K.C., Lau S.S.Y., Wong W.S., Lung D.P.Y. and Chau K.W. (2004), Assessing the Health and Hygiene Performance of Apartment Buildings, *Facilities*, 23:3/4, 58-69.

Ho D.C.W. and Yau Y. (2004), Building Safety

& Condition Index: Benchmarking Tool for Maintenance Managers, *Proceedings of the CIB W70 Facilities Management and Maintenance Symposium 2004* held on 7 & 8 December 2004 in Hong Kong, pp.149-155.

Hui M.F. (2004) Comprehensive, Environmental Performance Assessment Scheme, *Proceedings of Symposium on Green Building Labelling* held on 19 March 2004 in Hong Kong, pp.54-60.

Larsson N. (2004), An Overview of Green Building Rating and Labelling Systems, *Proceedings of Symposium on Green Building Labelling* held on 19 March 2004 in Hong Kong, pp.15-21.

Murakami S., Ikaga T. and Endo J. (2004), CASBEE: New Labelling System Based on Environmental Efficiency & Designed to Fit All Lifecycle Stages, *Proceedings of Symposium on Green Building Labelling* held on 19 March 2004 in Hong Kong, pp.24-33.

Saaty T.L. (1980), *The Analytic Hierarchy Process,* McGraw-Hill, New York, NY.

Schniederjans M.J., Hoffman J.J. and Sirmans G. S. (1995), Using Goal Programming and the Analytic Hierarchy Process in House Selection, *Journal of Real Estate Finance and Economics*, 11, 167-176.

So A.T.P. and Wong K.C. (2002), On the quantitative assessment of intelligent buildings, *Facilities*, 20:5/6, 208-216.

Todd J.A., Crawley D., Geissler S. and Lindsey G. (2001), Comparative assessment of environmental performance tools and the role of the Green Building Challenge, *Building Research & Information*, 29:5, 324-335.

US Green Building Council (2001), *Leadership in Energy and Environmental Design (LEED) Environmental Building Rating System, Version 2.0*, US Green Building Council, Washington, D.C.

Wong K.C., So A.T.P. and Leung A.Y.T. (2001), *The Intelligent Building Index: IBI manual, Version 2.0*, Asian Institute of Intelligent Buildings, Hong Kong.