BEAM Plus Implementation in Hong Kong: Assessment of Challenges and Policies

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ABSTRACT: Green building development has increasingly gained momentum globally due to growing public concerns and government policies. A variety of rating systems have been developed to assess the sustainability of a construction project. In Hong Kong, BEAM Plus is the most preferred system among the practitioners, however, its implementation is slow due to industry and policy-level challenges. While scholarly works relating to the performance and assessment factors of rating schemes have been conducted, limited efforts have been made towards the investigation of the challenges to the implementation of BEAM Plus. This research, therefore, conducted a thorough investigation to identify the challenging factors, and potential policies to encourage the use of BEAM Plus among construction stakeholders. A comparison of BEAM Plus with leading green building assessment schemes is made and the current policies regarding the implementation of these schemes in Hong Kong and other countries are discussed. Questionnaire surveys and expert interviews were conducted to validate the challenges and potential policies. The collected data is studied using Analytical Hierarchy Process and the responses from the interviews are found to mostly aligned with the AHP results. It is found that 'high initial cost' is the most critical factor affecting the application of BEAM Plus whereas 'shortage of green building experts' is the least important concern. The study revealed that 'gross floor area concession' is the most attractive policy whereas the effectiveness of the 'assessment fee subsidy' is insignificant. It is also disclosed that significant changes are required in existing policies such as gross floor areas should be granted on the level of green achievements instead of only registering for the scheme.

Keywords: BEAM Plus, Green Building Assessment Schemes, Government Policies, Energy Efficiency, Sustainability

1. INTRODUCTION

Building and construction sector represent one of the main contributors to environmental deterioration and global warming (Hong et al. 2015; Wong and Kuan 2014). For example, the building sector in China in 2005 accounted for 40-45% of the total energy use from the life cycle perspective (Chen and Lee 2013). In the United States, buildings use 70% of the electricity and emit more than 30% of the greenhouse gas emissions (ASE 2018). In Hong Kong, the situation is even worse; as per the Construction Industry Council (2017), buildings account for 90% of electricity usage and 60% of carbon emissions. Due to the increased pressure on the building sector to enhance the energy performance, several environmental rating systems have been developed and implemented in different economies such as the US Green Building Leadership in Energy and Environmental Design (LEED), the British Research Establishment Environmental Assessment Method (BREEAM), Japan Comprehensive Assessment System for Built Environment Efficiency (CASBEE), China Green Building Label (GBL), and Hong Kong Building Environmental Assessment Method (BEAM Plus) (Guo and Lau 2014; Wong and Kuan 2014). These green building assessment tools are considered as one of the most effective methods of improving the environmental performance of any building and are developed for a different type of buildings including industrial buildings, residential buildings, commercial buildings and other types of buildings (Guo and Lau 2014; Wong and Kuan 2014).

The building industry in various countries has taken strides for the implementation of 'green measures' for green building construction (Hwang and Tan 2012). In line with the trend, the Hong Kong government has also shifted its focus to green development. BEAM Plus scheme (formerly known as HK-BEAM) was launched in 1996 (Chen and Lee 2013) and utilized as a green building assessment tool to evaluate the level of sustainability in a construction project. To encourage the usage of BEAM Plus, the Hong Kong government has established some policies such as gross floor area concession and tax deduction for the construction companies. Although these policies have resulted in an increase in the number of registered projects for the scheme, the proportions of projects that received a bronze or above (based on the number of credit points earned in six categories of BEAM Plus) are lacking behind the other developed countries in the region. Despite this issue, surprisingly, the research on the challenges and potential policies to popularize BEAM Plus in Hong Kong is limited. Past researchers have addressed the deficiencies in various green building schemes on a contextual basis and proposed new frameworks of indicators, weightings, and benchmark criteria such as Chen et al. (2015); Kajikawa et al. (2011); Gou and Lau (2014); Mustapha et al. (2016); Doan et al. (2017); Kamaruzzaman et al. (2016); Apratwum et al. (2019); Kamble and Bahadure (2019) but failed to address the important notion of recommending the strategies that can be put forward to overcome the barriers of BEAM Plus's implementation especially in Hong Kong construction industry.

With the current condition of implementing BEAM Plus in the industry and to fulfill the government's ambition to reduce carbon intensity by 65-70% in 2030 (Hong Kong Environmental Bureau, 2017), the aim of this research is to evaluate and prioritize the challenges of BEAM Plus implementation in Hong Kong and to propose potential measures for the government to increase the adoption of the scheme. The aim is achieved by 1) providing an overview of BEAM Plus usage in Hong Kong, 2) comparing BEAM Plus with other green building schemes, 3) comprehending the obstacles in BEAM Plus implementation encountered by construction industry stakeholders, and 4) recommending a set of potential policies to facilitate BEAM plus application in Hong Kong. The analytical hierarchy process (AHP) was adopted to prioritize the BEAM-Plus challenges and policies due to its popularity in decision-making (Saaty 1994). AHP served as a logical decision-making method by sorting challenges into groups for easier analysis. A pairwise comparison was conducted to evaluate the intensity of one challenge outweighing the alternatives, thus, giving reliable results. Franek and Kresta 2014 suggested that humans are better at estimating one opinion over no more than two alternatives. Therefore, this study used a 3x3 matrix for the comparison. The further validation of challenges and policies was conducted through experts' interviews.

The rest of the articles is organized as follows. Section 2 provides the background where general green building assessment, the implementation of BEAM Plus in Hong Kong, and comparative analysis of BEAM Plus and other assessment schemes. Section 2 also presents the challenges and policies for adopting BEAM Plus in Hong Kong. Section 3 introduces the research methodology. Section 4 unveils the data collection strategies through a questionnaire survey and expert interviews. Results and analysis of priorities of challenges and policies established through AHP techniques are given in section 5. Section 6 provides a detailed discussion on the challenges and policies using expert interviews and validates the resulted themes from literature. Section 7 presents the conclusions from the study.

2. BACKGROUND

2.1.Green Building Assessment

Buildings and construction activities impact the environment and residents both positively and negatively. The positive impacts include satisfying human needs by providing building and ancillary facilities, provision of employment for the workers, and contribution to the region's economy. The negative impacts include waste disposal, the creation of noise and dust, water pollution, and energy consumption.

According to the World Business Council for Sustainable Development, buildings account for 40% of the total energy consumption. Not only that buildings consume energy, they also produce Greenhouse Gas emission (GHG) which is responsible for global warming. The carbon emission of buildings across the world will reach 42.4 billion tonnes in 2035 (WBSCD,2007). Green building constructions provide an opportunity to reduce these negative impacts on the occupants and the environment. Though there is no consensus on the definition of green building, however, ASTM Standard defines it as "a building that provides the specified building performance requirements while minimizing disturbance to and improving the functioning of the local, regional and global ecosystems both during and after its construction and specified service life" (ASTM, 2008). Green building assessment tools are developed to serve as a guideline for addressing environmental problems during the design, construction, and operation-maintenance stages of a building project.

Examples of famous assessment tools developed by the green building councils of different countries are given as follows.

BREEAM

BREEAM was first introduced in 1990 in the United Kingdom which was the first green assessment tool ever developed (BRE 2018). Later in 2016, BREEAM international was launched to show alignments with other schemes through reflection on "local environmental pressures, varying climates and population densities" (BRE 2018, p.5). BREEAM has been adopted in 85 countries and the number of registered projects across the globed exceeded 2.5 million.

LEED

LEED was developed in the United States in 1993 and considered the most popular scheme worldwide due to the ease of use. LEED operations facilitate the certification process and time (Geng et al. 2012). The federal government in the US has incorporated LEED as a compulsory parameter for both government-owned and funded buildings (Keller 2012). US government has also initiated grant programs providing monetary incentives to cities and communities with satisfactory green building performance and engagements (USGBC 2019).

CASBEE

CASBEE was developed by the effort from both the industry, government sector, and researchers in Japan in 2001. Comparing to other schemes, CASBEE incorporated the concept of building environmental efficiency, which is calculated by dividing the quality of building performance with the environmental load as the rating method (Institute for Building Environment and Energy Conservation 2014). Despite its long history and uniqueness, it is not widely adopted. Wong and Abe (2014) suggested that CASBEE is too complex for an already complicated building atmosphere in Japan, and with the diversity of assessment options with vast incentives and grants programs, the idea of adopting CASBEE is less attractive. To improve the recognition of CASBEE, Japan government put forward numerous award schemes such as incentives, tax deductions, and decent mortgage rates in collaboration with banks (Sasataniet al. 2015).

Green Mark

The green mark was launched in 2005 in Singapore. Singapore government has undertaken substantial measures to advance the use of Green mark in the public and private sectors. It is mandatory that "public sector buildings with air-conditioned floor areas of more than 5000 square meters must achieve the Green Mark Platinum rating" and for private sectors, the government has introduced an incentive of Sg$20million (1Sg$=0.71US$) for buildings achieving Gold or higher ratings (BCA 2013, p. 16).

2.2.Overview of Beam Plus in Hong Kong

The history of BEAM could be traced back to December 1996 where it was first launched as the HK-BEAM. BEAM was a voluntary scheme for the assessment and certification of the green buildings using various parameters, such as sustainable site, materials, and energy use. BEAM had four different versions due to the multiple revisions conducted by BEAM Society Technical Review Panels in 1999 and 2003. Owing to the rising concerns on global climate change, BEAM Plus was therefore introduced in 2010 aiming to provide the guideline for planning and constructing sustainable buildings (HKGBC 2019). BEAM Plus comprises four manuals for 1) new buildings, 2) existing buildings, 3) interiors and 4) neighborhood prospects. The description of the manuals is given as follows.

1) BEAM Plus New Building covers the demolition, design, construction, and execution of all types of new buildings including commercial, residential, and industrial. By adopting an affordable range of best practices, it seeks a reduction in the environmental impacts of a new building and improvements in environmental quality and users' satisfaction. The principles can also be applied to renovation, alteration, and additions to the buildings (HKGBC 2019).

2) BEAM Plus Existing Building measures the actual performance of a building and evaluates its facility management practices. All facets of management and operation-maintenance are covered in the assessment and can be analyzed at any time during a building's operational life (HKGBC 2019).

3) BEAM Plus Interiors entails the design and construction of fit-out, renovation, and refurbishment work in non-domestic, occupied spaces. It can be adopted by landlords renovating individual units, or by the occupants of space if they are responsible for fit-out works of the building (HKGBC 2019).

4) BEAM Plus Neighborhood focuses on assessing sustainability performance at the inception stage, thus, facilitating urban sustainability for a smoother implementation of the principles in the subsequent development stages. It is concerned with the design of space between buildings and emphasizes socio-economic elements of development (HKGBC 2019).

BEAM Plus is intended to reduce the environmental impacts of a building throughout its design, planning, construction, and operation stages. It also provides a performance standard to quantify the degree of accomplishments, and give recognition and awards based on attaining at least the minimal requirements. As per the HKGBC (2019), 1185 projects were assessed under the new building scheme as at 2019, whereas only 136 projects were assessed under the other three BEAM Plus manuals (existing buildings, interiors, and neighborhood). Therefore, this study is focused on the BEAM Plus New Buildings Manual.

[Insert Figure 1)

As per the data provided by the HKGBC (2019), fig. 1 shows that the number of projects under BEAM Plus's new building scheme showed an upward trend and increased from 504 in 2012 to 1185 in 2019. Although the participation seems to be active within the construction industry, only 442 out of 1185 new building applications (37%) were rewarded with awards i.e. Platinum, Gold, Silver, Bronze. Remaining 63% were either registered or unclassified projects.

2.3.Comparative analysis of BEAM Plus and other assessment schemes

There are several green assessment schemes practiced in different countries. In the comparative study of schemes, the selection of schemes is based on 1) the popularity and diversity of applications in the global context, 2) history and the role in promoting sustainable buildings, 3) similarity with the BEAM Plus, 4) alignments with the Hong Kong construction environment, and 5) ease of access. The comparative analysis is conducted to determine the main similarities and differences that exist among these schemes in five regions (USA, UK, Singapore, Japan, and Hong Kong) in order to establish potential recommendations that should be adopted by the Hong Kong governments. Based on the selection criteria, BREEAM, LEED, CASBEE, and Green Mark were chosen for the study.

A brief comparison of each scheme in terms of their background information, weighting score, assessing areas, certification method, and the cost is in Table 1, 2, 3, and 4. Table 1 provides general information on each scheme. Table 2 presents the weighting of each scheme. Both BEAM Plus and BREEAM acknowledged the variations of assessing different categories by allocating different weightings to each category while LEED and green mark is more simplified using additive scoring. Table 3 provides the assessment procedure, certification duration, and costs. Table 3 suggests that the BEAM Plus and LEED cost less in both registration and certification fee in comparison to BREEAM, however, BREEAM takes a longer time for the award of certificate after the completion of the project. Table 3 shows a detailed assessment area checklist.

[Insert Table 1]

[Insert Table 2]

[Insert Table 3]

[Insert Table 4]

2.4.Challenges to the implementation of BEAM Plus in Hong Kong

All type of green building assessment tools faces challenges which are limiting their adoptions in the building and construction sector. Therefore, in order to establish challenges for the implementation of BIM Plus in Hong Kong, a thorough literature review of documents discussing green building assessments in various countries is conducted. In the view of property developers, the decisions tend to be based on the economic returns, and obtaining a high score does not guarantee an equivalent return (Kajikawa et al., 2011). Moreover, certifications under BEAM Plus create a sustainable and well-presented company image but do not necessarily provide business opportunities (Hui et al. 2017; Olanipekun et al. 2018). In the Hong Kong context, Gou and Lau (2014) identified that there is a shortage of space for green implementations and the humid temperature adds to the difficulty in including green strategies into building operations. Considering the difficulties and additional expenses in constructing green buildings, its cost-effectiveness is highly questionable among developers. Table 5 presented nine challenging factors identified in previous pieces of literature, divided into three groups namely time and cost (F1), unforeseeable benefits (F2), and social and managerial issues (F3).

Time and cost: F1 includes E1) the high cost incurred during planning & construction phase of the project; E2) the extra time spent on the adoption of the green features and applying BEAM Plus; and E3) the complex procedures that are needed to be followed before achieving green requirements (Parker and BSRIA 2012; CIC and HKGBC 2017; Kajikawa et al. 2011; Hui et al. 2017; Geng et al. 2012; Wong and Abe 2014; Sasatani et al. 2015; Hwang and Tan 2012; Leong et al. 2013; Chen et al. 2017; Yang et al. 2006; Qian et al. 2015).

Unforeseeable benefits: F2 entails challenges that are difficult to predict including E4) lifecycle cost reduction throughout the building lifespan, planning, designing, construction, and maintenance cost; E5) the challenge that exists between balancing human needs and the limited available natural resources for long term development; and E6) the undetermined effects that green building may have on the occupants' happiness and productivity (Kajikawa et al. 2011; Hui et al. 2017; Geng et al. 2012; Bond and Perrett 2012; Matisoff et al. 2014; Suzer et al. 2015; Lee 2016; Thatcher and Milner 2016).

Social and managerial issues: F3 includes E7) the low level of public's understanding on the benefits of BEAM Plus; E8) insufficient motivating rewards from the government on BEAM Plus applications; and E9) lack of green building certified professionals (CIC and HKGBC 2017; Geng et al. 2012; Wong and Abe 2014; Sasatani et al. 2015; Hwang and Tan 2010; Qian et al. 2015; Bozovic-Stamenovic 2016; Agyekum et al. 2019; Lutzkendorf et al. 2013).

The 9 challenging factors are then incorporated into the design of questionnaires and interviews from local experts to provide validation in the Hong Kong context.

[Insert Table 5]

2.5.Potential Policies for the implementation of BEAM Plus in Hong Kong

To encourage BEAM Plus, the Hong Kong government has implemented the BEAM Plus scheme in several public projects such as EMSD headquarters, Science Park, and the Hong

Kong Children Hospital. It is announced that any new public building meeting at least one of the three criteria has to achieve gold rating or above i.e. building must 1) be developed by the Housing Authority, 2) exceed 10,000 square meters in covered area, and 3) exceed 5000 square meters of central air conditioning (Hong Kong Environmental Bureau 2015).

Further, BEAM Plus certification, provisional, and final assessment, regardless of the ratings, is the prerequisite of 10% gross floor area (GFA) concessions, which implies an exemption of "green features and non-mandatory plant rooms and services" from GFA calculation (Hong Kong Building Department, 2011, p.1). Apart from that, Electrical and Mechanical Services Department has introduced an incentive for the construction companies (i.e. to be eligible to apply for a 1) 100% profit tax deduction in the year of purchase for the capital expenditure incurred on the provision of purchasing eligible machinery; and 2) 20% profit tax deduction for the capital expenditure incurred on the construction of eligible installations to be provided in each of the five consecutive years starting from the year of acquisition) if their project attains final bronze grading or satisfactory performance in the 'Energy Use category' of BEAM Plus (EMSD 2018; IRD 2018). With current government endorsements and BEAM Plus conditions, it is crucial to increase both the participation and success cases under this scheme. The current study has explored and compared different policies in other countries that would be the fundamental outline for strategies recommendations to expand the use of BEAM Plus in Hong Kong. Table 6 summarized the measures undertaking in Hong Kong, the UK, the USA, Japan, and Singapore. USA has the most endorsements to motivate the usage of LEED, which reflects the active engagement from the local governments. These endorsements are categorized into three groups: incentives (A1), finance (A2), and building space (A3).

Incentives: A1 includes M1) incentives given by the government through tax reduction, exemptions, and credits; M2) the assistance rendered by the government or external organization to pay a percentage of assessment fees; and M3) refunds made by the government

(HKGBC 2019; Geng et al. 2012; Keller 2012; USGBC 2012; Institute of Building Environment and Energy Conservation 2014; Wong and Abe 2014; Sasatani et al. 2015; BCA 2013).

Finance: A2 entails the M4) provision of funding by the government organization for installation of green building features; M5) availability of loan to finance the construction of certified green buildings; and M6) availability of better interest rate for buyers that are interested in buying a property with green ratings (BRE 2018; (HKGBC 2019; Geng et al. 2012; Keller 2012; USGBC 2012; Institute of Building Environment and Energy Conservation 2014; Wong and Abe 2014; Sasatani et al. 2015; BCA 2013).

Building space: A3 includes M7) Exemption of certain floor area in the gross floor area calculation; and M8) the allowance of extra stories on top of the maximum allowable height ((HKGBC 2019; Geng et al. 2012; Keller 2012; USGBC 2012; Institute of Building Environment and Energy Conservation 2014; Wong and Abe 2014; Sasatani et al. 2015; BCA 2013).

[Insert table 6]

3. RESEARCH METHODOLOGY

This study has employed a mixed research approach using both quantitative and qualitative methods (figure 2). First, a brief overview of BEAM Plus history and implementation in Hong Kong was conducted. Second, different green building assessment schemes and policies were compared to identify the differences in assessment, weighing criteria, and costs. Third, a thorough literature review was carried out to determine the potential motivating policies and challenges to the implementation of BEAM Plus in Hong Kong. Fourth, an expert questionnaire survey was conducted to reveal the importance of motivating policies and challenging factors. Fifth, the questionnaire responses were analyzed using the Analytical hierarchy process (AHP).

Sixth, beyond the quantitative results, semi-structured interviews of experts were conducted to provide explanations of their responses. This verbatim data was analyzed and integrated with the survey findings in the discussion section.

[Insert figure 2]

4. DATA COLLECTION

4.1.Questionnaire survey

A questionnaire survey was conducted to find the relative importance within each group of challenges and policies. The questionnaire survey composed of three sections. Section one included multiple-choice questions regarding the respondents' background information, views on BEAM Plus, and the reasons for implementation. Section two illustrated the analytical hierarchy structure with descriptions of different groups of challenges and policies. Following the structure (given in figure 4 and 5), a pairwise comparison of sub-criteria under the same group (i.e. Comparison of E1 to E2, E1 to E3 and E2 to E3 under the "F1-time and cost') and comparison between groups in the same hierarchy level (i.e. Comparison of F1 to F2, F1 to F3 and F2 to F3) was created. Respondents were then required to rate the pairs on an AHP judgement scale of 1-9 [1=equal importance; 3=moderate importance; 5=strong importance; 7=very strong importance; 9=absolute importance; 2,4,6,8=intermediate values between two adjacent values). Figures 3 and 4 show the AHP hierarchal structure for this study.

[Insert figure 3]

[Insert figure 4]

For the questionnaire, "convenient sampling" was applied i.e. respondents were selected based on their accessibility and willingness to participate. Both web-based online and paper formats were used to carry out the survey depending upon the convenience of the respondents. The questionnaire was administered to individuals working in the Hong Kong construction industry including contractor, consultant, client, supplier company.

Besides, using “purposive sampling” (Tariq and Zhang 2020), six experts, who possessed the extensive working experience and had frequent exposure to green building projects, were invited to complete were interviewed after the completion of questionnaires.

4.2.Experts’ interviews

Although questionnaires can include both closed and open questions, it is deemed to be short, simple, and the use of open questions should only consist of one to three sentences for a higher response rate (Rowley 2014; Opoku et al. 2019). With the constraints of a questionnaire, interview as a qualitative research tool could provide in-depth data, revealing more interpretations of the challenges and possible policy in promoting BEAM Plus applications. Semi-structured interviews were adopted in this research. According to Flick (2009), interviews are carried out to ask questions facilitating the reconstruction of the subjective theory, the knowledge, and the experience possessed by the interviewees. It is usually characterized to have a set of fixed questions such as the open questions, hypotheses-directed questions, and confrontational questions created based on new perspectives developed during the interview. This operation is more flexible and open but also relies heavily on the researchers’ ability to discern issues arise from immediate responses. The experts were asked 4 main questions: 1) your comments on the application of BEAM Plus in Hong Kong? 2) why you have given one particular group of challenges and policies higher scores than the other groups? 3) Which policies do you believe are more/less applicable to Hong Kong? and 4) GFA concession, assessment fee subsidy or financial support on green technology are the main policies in Hong Kong currently, please comment.

5. RESULTS AND ANALYSIS

5.1.Challenges and Policies Prioritization using Analytical Hierarchy Process (AHP)

The challenges and motivational policies found through a literature review were validated through a questionnaire survey using Analytical Hierarchy Process (AHP). AHP helps to sort elements into smaller groups for easier analysis. AHP is operated in a pairwise comparison considering the human capacity to evaluate the importance of one factor over alternatives to provide reliable results. Franek and Kresta (2014) reported that humans are better in estimating one opinion (factor) over no more than two other opinions (factors). Therefore, this study made use of the 3x3 matrix for comparison. A questionnaire commonly requires a large sample size to be appropriate for generalization from a population of interest on a certain topic (Ponto 2015). AHP, on the other hand, does not need a large sample size to be representative and many researchers considered sample size larger than 30 sufficient to be used for analysis (Darko et al. 2019). Fig. 5 summarized the procedures of AHP practice.

[Insert figure 5]

5.2.Respondents background

From 2nd October 2019 to 5th November 2019, 78 questionnaires were delivered and 47 completed questionnaires were returned. After the AHP consistency test, 5 invalid responses were discarded. Only 42 responses were used for data analysis making an effective response rate of 54%. Table 7 shows that that 6 (14%), 12 (29%), 14 (33%), 3 (7%) were from clients, consultants, contractors, and suppliers, respectively. The remaining 7 (17%) fell under the category of others including BEAM reviewers, assessors, and sustainable building researchers. Most of the respondents had more than 5 years of experience and around 30% had more than 15 years of industrial experience. 93% of the respondents had heard about BEAM Plus and 55% were involved in BEAM Plus registered projects. 79% of respondents considered BEAM

Plus effective in promoting green building development.

[Insert table 7]

5.3.Consistency Ratio of AHP Questions

Table 8 shows that the consistent ratio of each pairwise comparison for both challenging factors and policy. Following Saaty and Vargas (2012), the threshold limit for consistency ratio was taken as 0.1. The consistent ratio of the aforementioned five respondents (i.e. 13, 17, 19, 31, 37) was larger than the threshold value and perceived as invalid. Therefore, their results were removed from the final analysis.

[Insert table 8]

5.4.The priority of challenging factors and Policies

By calculating the geometric mean of the priority judgment of respondents, the global priority was determined. Table 9 shows the priority value of each factor in descending order, the priority ranges from 0.144 to 0.029 with initial cost as the most critical factor. Table 10 shows the priority value of each endorsement in descending orders, the priority value ranges from 0.278 to 0.030. Gross floor area concession was the most critical policy with priority value significantly higher than the other measures.

[Insert table 9]

[Insert table 10]

6. DISCUSSIONS

Discussions on challenges and policies are made using excerpts from literature and interviews. 6 experts having vast experience in green buildings and BEAM Plus were interviewed; details of interviewees are shown in table 11.

[Insert table 11]

6.1. Theme 1: Popularity

In the questionnaire survey, the respondents were asked background questions such as 'have you heard of BEAM Plus ever?' 'did your workplace implemented BEAM Plus?' and 'do you consider BEAM Plus effective in promoting green building development?'. The survey data indicated a significant number of participants recognized the existence of BEAM Plus although not everyone was involved in BEAM Plus registered projects. The interviewees (R1 through R6) were also asked to comment on the application of BEAM Plus in Hong Kong. The interviewees ascertained the high reputation of BEAM Plus in Hong Kong but mentioned that, in practice, it is somewhat limited to new buildings only.

6.2. Theme 2: Challenging factors

Challenging factors mean the hurdles prohibiting the stakeholders, mostly developers, in applying BEAM Plus or accomplishing a higher rating. Understanding the obstacles of implementation is a primary step to recommend suitable solutions through policy establishment.

6.2.1. Cost and time

Cost and time is undoubtedly the most critical factor in business operations. Both these factors should be considered simultaneously because an extended time on project completion could contribute to the demand for additional resources such as an increase in labor, administrative staff, and equipment, thus lowering the profit margin (Beirise & Overman, 2009). The cost premium of a green building is between 5% and 10% with an over-budget of 4.5% to 7% caused by the higher occurrence of project delays and insufficient green building management skills (Hwang et al. 2017). Interviewees (R1 through R6) have pointed out that BEAM Plus requires longer design time, pre-occupation applications, and higher project cost, thus validating the highest priority value of this factor from the questionnaire survey. This agrees with the other assessment schemes as they also require additional cost and time (Table 3). For instance, Ross et al (2007) found that buildings that are certified under the LEED scheme would incur a 10% extra cost.

6.2.2. Lifecycle cost reduction

A considerable number of researchers have published research papers that showed that the adoption of green building assessment tools has caused lifecycle cost reduction. For example, Tjenggoro and Prasetyo (2018) compared green building procurement with traditional procurement and found 63% and 53% reduction in water and electricity usage, respectively. Interviewee R1 also considered green building a valuable investment. On the contrary, interviewee R3 suggested that the exact reduction of lifecycle cost is less foreseeable within the industry. Despite the energy reduction, the lifecycle cost is less likely a concern for developers as reflected from its fifth ranking. Some interviewees put forward that the energy price is relatively low in Hong Kong which is not a distinctive benefit towards encouraging developers in adopting green building assessment tools. Therefore, the impact of the lifecycle cost in BEAM Plus implementation is not fixed but varies among different owners and company operational models. Besides, the saving of energy cost might not be the primary goal of a developer constructing a building for merchandise purposes, instead of personal use.

6.2.3. Lack of green building experts

Although numerous literature has pointed out that insufficient green expertise is one of the most critical barriers in the adoption of green building assessment tools. It is no doubt that availability of green building experts would facilitate the implementation of green building assessment tools as they can create awareness about the tools, engage in dialogue with the government or organizations for the provision of funding for the installation of green building features, etc.. For example, Fan et al. (2015) suggested that project success and developments are hindered by the lack of availability of green building experts. Pham et al. (2019) also suggested that the incompetence of managers is the top obstacle to executing a sustainable construction in Vietnam. These studies were carried in different countries and might not be applicable in Hong Kong. The lack of green building experts is the least challenging factor from the interviewees' (R1 through R6) point of view and the same was reflected in the questionnaire survey results.

6.3. Theme 3: Policies

6.3.1. Extra building space

Additional building space can be classified into two aspects, GFA concession, and extra height allowance. Extra space is the most attractive incentive; with GFA concession being more critical than height allowance. According to Chau et al. (2018), GFA concession is the major reason for developers to enact BEAM Plus. Statistically, after the introduction of GFA concession, the registered projects increased from 225 in 2011 to 641 in 2015. Both the survey data and the positive attitudes from interviewees (R1 through R6) towards GFA concessions further confirmed the effectiveness of this policy in promoting green building assessment scheme.

However, the operation of granting GFA concession in BEAM Plus only requires projects to be registered without any ratings. This creates a loophole and a reason for developers to put less effort into optimizing the building performance. Singapore, on the other hand, grants 2% concession for Green mark platinum and 1% for gold plus (HK Building Department, 2019). GFA concession in Hong Kong is more flexible with the rationale to encourage the adoption of green features anyway while Singapore government targets at obtaining a higher rating for green buildings. It contributed to a large increase in projects with Gold plus and Platinum, from 82 in 2009 to 125 in 2012. LEED has a similar mechanism, 0.5, 0.35, 0.25% concession for LEED platinum, gold, and silver respectively (HK Building Department, 2019). Learning from the success of Green Mark in Singapore and LEED in the USA, it is possible for Hong Kong to carry out a similar mechanism, the benchmark for the percentage of area to be awarded, however, requires further investigation.

6.3.2. *Tax reductions and rebates*

Tax reductions and rebates are the third and fourth attractive measures. Limited research has justified the differences in attractiveness between them. It is noteworthy that both of these measures are monetary incentives; the differences in the number of capital received highly depend on the types of tax such as profit tax, property tax, and the amount of tax reduction and rebates granted. It is observed that the difference in priority value between the two measures was negligible i.e. 1.3% from the questionnaire results conducted in Hong Kong. Therefore, it is reasonable to suggest that both have similar impacts on enhancing BEAM Plus engagements. 4 (R1 through R4) out of 6 interviewees viewed tax and rebates as the second most attractive measures after extra space because tax reduction is conducted continuously while the assessment fee is the one-off payment with a lower sum. In the same way, more than 10 states in the United States offer tax relief and rebates for employing LEED certification (Matisoff et al, 2016). Tax incentives have also been found to be a positive measure that encourages the adoption of BREEAM (BRE, 2014).

6.3.3. *Financial support on green technology adaptions*

Most countries provide financial assistance for the installations of green innovations. More than 5 states in the United States of America provide grants for LEED certification with certain requirements (Matisoff et al, 2016). However, the interviewees (R1 through R6) pointed out that the cost of green features is relatively low. Subsidies can be effective towards small developers or existing building renovations but for new building construction and major developers, the financial support would less likely be a consideration.

6.3.4. *The green loan from a lender*

The green loan from a lender attained the second-lowest ranking which is consistent with Hwang et al. (2017). This measure is conducted by all five discussed countries, however, it remains in the embryo stage in Hong Kong. The green loan is defined as a loan exclusively available to finance green projects. Green loan is an effective policy adopted in the United Kingdom, the United States of America, and Singapore and found to have a positive impact on the adoption of BREEAM, LEED, and Green Mark, respectively, in these countries. Interviewees again pointed out the fact that such an incentive might be beneficial for small developers. Banks and financial experts usually do not have sufficient knowledge and awareness of green buildings (Shan et al. 2017), which could hinder the green loan development in Hong Kong. Some interviewees (R1 and R3) mentioned that the construction industry should not interfere in the bank's decisions.

6.3.5. Assessment fee subsidy

The assessment fee for BEAM Plus is higher than other schemes such as BREEAM and CASBEE and costs HK$69,000 to HK$687,000 (1HK$=0.13US$) for the registration fee and HK$154,400 to HK$3,044,300 for a certification fee. Most interviewees (R2, R4, R5, and R6) have consensus that the effectiveness of subsidizing assessment fees is questionable because the registration or certification fee accounts for a small proportion of expenses in entire project cost, and it is unlikely a concern from the developers' perspective. Interviewees agreed that the assessment fee subsidy would be a favorable measure but expects it to have a minor contribution in popularizing BEAM Plus applications.

7. CONCLUSION

This paper assessed the challenges and policies for the implementation of BEAM Plus in the Hong Kong construction and building industry. This paper firstly provided an overview of BEAM Plus and then compared it with other assessment schemes i.e. BREEAM, LEED, CASBEE, and Green Mark in terms of background information, assessing area, weightings, and certification method to evaluate the differences and similarities. The challenges and policies were then identified from the literature and worldwide practices. To validate the effects of challenging factors and policies, a questionnaire survey and semi-structured expert interviews within local construction industry stakeholders were conducted. The questionnaire was analyzed using an analytical hierarchy process (AHP). Interviews were conducted to further validate the results of the AHP analysis. The AHP results correlate with most of the responses from the interviews. From the result, it was found that the most critical challenges were initial cost and longer implementation time, while lack of green building experts had the least impact towards BEAM Plus implementation. Among the policies, the most attractive measures were gross floor area (GFA) concession and extra height allowance, and the least attractive policy was an assessment fee subsidy. Although the interview responses mostly aligned with the results obtained from the questionnaire analysis, two key issues were put forward. Firstly, modifications are needed in current policies including tightening the GFA requirement. Secondly, alongside the market driving force and regulatory requirement, government incentives are required for the long-term development of green buildings.

Hong Kong government has attempted to build an environmentally friendly society including the establishment of sustainable development funds, recycling funds, and so on but the limited focus was put in the past on the construction and building industry which accounts for the majority of carbon emissions. Financial motivation can lead to burdens on the government budget, therefore it requires a thorough examination and evidence on the foreseeable effects of the specific measures. The results of this study showed the stakeholders' views on the attractiveness of each measure, therefore allowing the government to better allocate the resources and consider the value of the proposed methods. This study has also brought insights to the policy practitioners on the deficiency of current measures including the GFA concession and suggests possible improvements by learning from other countries. Moreover, this study has summarized different schemes and policies in the world which could provide a clear overview of the development of green building assessments to facilitate future research.

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Table 1. General information about different green assessment schemes

	BEAM Plus	BREEAM	LEED	CASBEE	Green Mark
Name	Building Environmental Assessment Method Plus	Building Research Establishment Environmental Assessment Method	Leadership in Energy and Environmental Design	Comprehensive Assessment System for Built Environment Efficiency	Green Mark
Year	2010 (HK-BEAM, 1996)	1990	1995	2002	2005
Location	Hong Kong	UK	USA	Japan	Singapore
Focusing location	Mainly Hong Kong	Global	Global	Mainly Japan	Mainly Singapore
Operator	BEAM Society Limited (BSL)	BRE Global Limited	US Green Building Council	Institute for Building, Environment, and Energy Consumption	Building and Construction Authority
Types of Schemes	• New Buildings • Existing Buildings • Interiors • Neighborhood	• New Constructions • Infrastructure • In-Use • Refurbishment • Communities	• Building Design and Construction • Interior Design and Construction • Operations and Maintenance • Residential • City and Communities	• New Construction • Pre-Design • Existing Buildings • Renovations	• New Buildings • Existing Buildings • User-Centric • Beyond Buildings

Table 2. Scoring and weightings of different green assessment schemes

	BEAM Plus New Building v2.0 (HKGBC, 2019)	BREEAM UK New Construction Non-domestic Buildings (BRE, 2018)	LEED v4.1 Building Design and Construction (USGBC, 2019)	CASBEE for Building (New Construction) (IBEEC, 2014)	Green Mark for Non-Residential Buildings NRB: 2015 (BCA, 2015)
Awarding criteria	Platinum: ≥75%; Gold: ≥65%; Silver: ≥ 55%; Bronze: ≥40%. Min. 20% for each Category	Outstanding: ≥85%; Excellent: ≥70%; Very good: ≥55%; Good: ≥45%; Pass: ≥30%.	Platinum: ≥80 pts (73%); Gold: ≥60 pts (55%); Silver: ≥50 pts (46%); Certified: ≥40 pts (37%). 110 points in total	Excellent S: BEE ≥3, Q ≥50; Very good A: BEE =1.5-3 or BEE ≥3, Q ≤50; Good B+: BEE =1-1.5; Fairly poor B-: BEE =0.5-1; Poor C:BEE <0.5.	Platinum: ≥70%; Gold Plus: ≥60%; Gold: >50%
Weighing method	Weighted scoring	Weighted scoring	Additive scoring	Formula BEE=Q/L	Additive scoring
Weighing (%)					
Management	14.32	15.36	10.9		5.71
Site	8.13	4.64	7.27		5.36
Transportation	1.5	10	7.27		1.07
Pollution	2.25	4.67	1.82		0
Ecology	6	12.88	6.36		0.71
Waste	1.93	4.36	1.82		2.86
Material use	6.43	7.5	5.45	BEE=Q/l	12.86
Energy use	29	16	23.64		32.14
Water use	7	7	10		5.71
Indoor environment quality	22	13	14.55		17.14
Social	0.72	2.45	5.45		3.57
Economics	0.72	2.1	0		1.43
Innovations	Additional 10	Additional 10	5.45		11.43
Total	100	100	100		100
Highest weighing	2nd highest weighing	3rd highest weighing			

BREEAM: Weighting composition varies for different assessment types including fully-fitted, simple building, shell, and core, shell only. Fully fitted is considered in this table

LEED: Weighting composition varies for different building types including new construction, core, and shell, school, retail, data centers, warehouses and distribution centers, hospitality, healthcare. New construction is considered in this table

CASBEE: **BEE**-Built Environment Efficiency, **Q**-Environmental Quality of Building

$$\text{BEE} = \frac{Q}{L} = \frac{25\times(score\ for\ environmental\ quality - 1)}{25\times(5 - score\ for\ environmental\ load\ reduction)}$$

Table 3. Assessment procedure, certifications duration, and cost of different schemes

Scheme	Assessment procedure	Certification duration	Registration fee HKD	Certification fee HKD
BEAM Plus	Both provisional and final assessments are compulsory for new buildings		\$69000-\$687000	\$154400-\$3044300
	1. Online registration	(90 days limit after registration)		
	2. Registration fee payment made to HKGBC			
	3. Acknowledgment letter on completion of the project registration issued by HKGBC registration issued by HKGBC	14 days		
	4. Return signed assessment agreement to BSL			
	5. Assessment fee payment made to BSL	(90 days limit after agreement)		
	6. Commencement of project assessment	(2 years limit after the letter)		
	7. Project assessment, comments, and review	45 days	Varies from area $<2500m^2$ to $600000m^2$	Varies from area $<2500m^2$ to $600000m^2$
	8. Issue of certification (PA/FA)	14 days		
BREEAM	1. Pre-assessment stage		\$2500	\$7200-\$37000
	2. Registration			
	3. Design stage assessment			
	4. Interim certification (Optional)			
	5. Construction stage assessment			Varies from area $<500m^2$ to $>10000m^2$
	6. Final/post construction certification	90-180 days		
LEED	1. Registration		\$9600-\$12000	\$22800-\$300000
	2. Apply for LEED certification			
	3. Certification review fee payment made			
	4. Standard review: Preliminary review OR	20-25 days		
	5. Split review:			
	Design phase preliminary review	20-25 days		
	Post-construction preliminary review	20-25 days		
	6. Certification			Varies from area $<250000ft^2$ to $>750000ft^2$
CASBEE	No details provided	No details provided	No details provided	\$28850-\$72150
Green Mark	1. Application	No details provided	Not applicable	\$114980-\$275950
	2. Pre-assessment			
	3. Actual assessment			
	4. Site verification upon project completion			
	5. Certification			Varies from area $<150000ft^2$ to $>1000000ft^2$

Table 4. Assessing areas of different green assessment schemes

Assessing Areas	BEAM Plus	BREEAM	LEED	CASBEE	Green Mark
Management					
Integrated design process	•	•	•		•
Lifecycle assessment	•	•	•		
Green experts engagement	•	•	•		•
Responsible and environmental construction practices	•	•			
Construction management	•	•			
Environmental management	•	•			
Commissioning and handover	•	•	•	•	•
Aftercare and facility management	•	•		•	•
Site					
Landscaping	•			•	•
Neighborhood amenities	•			•	
Sustainable urbanism	•				•
Reuse preoccupied and contaminated land		•	•		
Project risk assessments		•			
Site assessment		•	•		
Site protection	•		•		
Open space		•	•		
Outdoor thermal comfort	•			•	
Surrounding diversity and diverse use within the construction			•		
Transportation					
Travel plan		•	•		
Sustainable transport options	•	•	•	•	•
Transport accessibility	•	•	•	•	
Pollution					
Noise control	•	•		•	
Light control	•	•	•	•	
Air pollution		•		•	
Refrigerants impact	•	•	•	•	•
Ecology					
Biodiversity	•	•	•	•	
Heat island effect	•		•	•	•
Wind, sand effects	•			•	
Ecology assessments and management		•		•	
Ecology value enhancement		•			
Flooding, stormwater, rainfall management	•		•		
Design for climate change adaptations	•	•		•	
Waste					
Efficient waste handling facility	•	•			
Reuse existing building and elements	•			•	
Waste reduction	•	•	•	•	•
Waste management		•	•		
Material use					
Standardized design	•				
Use of sustainable materials	•	•	•	•	•
Use of regional materials	•				
Use of recycled materials	•	•		•	
Material and building protection	•	•			
Responsible material sourcing		•	•		
Material usage reductions		•		•	
Low carbon embodied materials	•			•	•

Energy use					
Low carbon, passive design	•	•			
Energy monitoring and management system	•	•	•		
Overall energy performance	•	•	•	•	•
Renewable energy	•	•	•	•	•
Energy-efficient appliances	•	•	•	•	•
Optimized facilities performance	•	•	•		
Laboratory system		•			
Greenhouse gas emission	•	•	•		
Grid harmonization			•		
Water use					
Water monitoring	•	•	•	•	•
Water-saving	•	•	•	•	•
Water handling system	•	•	•		•
Water recycling	•			•	•
Indoor environment quality					
Ventilation	•	•	•		•
Occupants well being	•				•
Views	•	•	•		
Acoustics	•	•	•	•	•
IAQ	•	•	•	•	•
Thermal comfort	•	•	•	•	•
Artificial lighting	•	•	•	•	•
Nature lighting	•	•	•	•	•
Glare control		•		•	
Indoor contamination	•				•
Service life of building component				•	
Future change of building usage (spatial margin, floor load margin)		•		•	
System renewal				•	
Construction product emission		•	•		•
Social					
Regional priority			•		
Continuation of local character				•	
Local contributions		•		•	
Security		•		•	•
User participation	•	•			
Social sustainability					•
Economics					
Lifecycle cost	•	•			
Capital cost reporting		•			
Cost-efficient design					•
Innovations					
Exemplary performance		•	•		•
Complementary certification	•				•
Unaddressed practices, technology	•		•		•

Table 5. Challenging factors identified in the literature

Challenging factors	Literature*
Group F1. Time and Cost	
E1 High initial costs	[1, 2, 3, 4, 5, 6, 7, 8, 11, 12]
E2 Longer implementation time	[5, 6, 8, 11, 9]
E3 Complex procedure and requirements	[5, 6, 8, 10]
Group F2. Unforeseeable benefits	
E4 Reduced lifecycle cost	[3, 4, 5]
E5 Sustainable environment	[13, 14, 15]
E6 Improved social life	[14, 16, 17]
Group F3. Social and managerial issues	
E7 Low public awareness	[6, 18, 19]
E8 Insufficient government incentives	[2, 5, 6, 12, 20]
E9 Lack of green building experts	[2, 7, 8]

* [1] Parker and BSRIA (2012); [2] CIC and HKGBC (2017); [3] Kajikawa et al. (2011); [4 Hui et al. (2017); [5] Geng et al. (2012); [6] Wong and Abe (2014); [7] Sasatani et al. (2015); [8] Hwang and Tan (2012); [9] Leong et al. (2013); [10] Chen et al. (2017); [11] Yang et al. (2016); [12] Qian et al. (2015); [13] Bond and Perrett (2012); [14] Matisoff et al. (2014); [15] Suzer (2015); [16] Lee (2016); [17] Thatcher and Milner (2016); [18] Bozovic-Stamenovic (2016); [19] Agyekum et al. (2019); [20] Lutzkendorf et al. (2013).

Table 6. Government or organizational endorsements in different countries

Government/organizational Endorsements	Hong Kong	UK	USA	Japan	Singapore
Group A1. Incentives					
M1. Tax incentives	•		•	•	
M2. Assessment fee subsidy	•				
M3. Grant and rebates			•	•	•
Group A2. Finance					
M4. Financial support on green technology adaption	•		•		•
M5. Green loan from lenders	•	•	•	•	•
M6. Better interest rate for green building buyers		•	•	•	
Group A3. Building space					
M7. Gross floor area concession	•		•	•	•
M8. Extra height allowance			•		

Table 7. Background information of respondents

Parameters	Percentages
Occupation	
Client	14
Consultant	29
Contractor	33
Suppliers	7
Others	17
Years of experience	
Above 20	17
16-20	12
11-15	10
6-10	21
Less than 5	40
Have you ever heard of BEAM Plus?	
Yes	93
No	7
BEAM Plus implemented in your workspace?	
Yes	55
No	45
Do You Consider Beam Plus Effective In Promoting Green Building Developments?	
Yes	79
No	9
I don't know	12

Table 8. Consistency ratio of all survey responses

ID	Challenges				Policies			
	F1, F2, F3 (3x3 matrix)	E1, E2, E3 (3x3 matrix)	E4, E5, E6 (3x3 matrix)	E7, E8, E9 (3x3 matrix)	A1, A2, A3 (3x3 matrix)	M1, M2, M3 (3x3 matrix)	M4, M5, M6 (3x3 matrix)	M7, M8 (2x2 matrix)
1	0.002	0.028	0.028	0.016	0	0	0.005	0
2	0	0	0.046	0.005	0.032	0.019	0.016	0
3	0.025	0	0	0.046	0.038	0.008	0.046	0
4	0.008	0.028	0.012	0.025	0.046	0.046	0.003	0
5	0.006	0	0.003	0.046	0.046	0.046	0.028	0
6	0.033	0.046	0.001	0.002	0.016	0.046	0.019	0
7	0	0.046	0	0	0.046	0.046	0.046	0
8	0.006	0	0	0	0.046	0	0.046	0
9	0.008	0.008	0.008	0.046	0.002	0.046	0.016	0
10	0	0.046	0.046	0.046	0.008	0.046	0.046	0
11	0.046	0	0	0.046	0.046	0.016	0.046	0
12	0.008	0.016	0	0.046	0	0.025	0.046	0
13	1.232	0.016	0.046	0.483	0.317	0.967	0.025	0
14	0.03	0	0.008	0.028	0	0.046	0	0
15	0.016	0.005	0.001	0.038	0.046	0.002	0.046	0
16	0.038	0.016	0.046	0.008	0.046	0.046	0.021	0
17	0.431	0	0.967	0.141	0.547	0.424	0.424	0
18	0	0	0	0	0.033	0.033	0	0
19	0	0	0	0.046	0.431	0.483	0.5	0
20	0.038	0.016	0.002	0.012	0.032	0.008	0.046	0
21	0.016	0.016	0.005	0.038	0.033	0.011	0.046	0
22	0.038	0.046	0.005	0.025	0.019	0.002	0.046	0
23	0	0	0.038	0	0.046	0.038	0.008	0
24	0.038	0	0.005	0.046	0.028	0.008	0.016	0
25	0	0	0	0	0	0	0	0
26	0.016	0.016	0.046	0.002	0	0.016	0	0
27	0.032	0.001	0	0.032	0.046	0.046	0.046	0
28	0.021	0.032	0	0.356	0.019	0.032	0	0
29	0.012	0	0.046	0.046	0	0.012	0.046	0
30	0.016	0.028	0.002	0.046	0.046	0.003	0.046	0
31	1.383	0.021	1.232	0.008	0.254	0.452	0.141	0
32	0.5	0	0	0.016	0.016	0	0.046	0
33	0.038	0.046	0.016	0.016	0.032	0.016	0.016	0
34	0.011	0.046	0.005	0.028	0.002	0.028	0.028	0
35	0.046	0.001	0	0.021	0.025	0.016	0.008	0
36	0.016	0.008	0	0.046	0	0	0.025	0
37	0.016	0.008	0	0.483	0.016	0.046	0	0
38	0	0.008	0.028	0.038	0.032	0	0.09	0
39	0	0.016	0.046	0.028	0.016	0.016	0.016	0
40	0.016	0.046	0.025	0.046	0.016	0.019	0.046	0
41	0.046	0.033	0.046	0.03	0.046	0.016	0.046	0
42	0.016	0.003	0.008	0.046	0.008	0	0	0
43	0	0	0.046	0.032	0.016	0.032	0.016	0
44	0	0	0	0.008	0.046	0.016	0	0
45	0.033	0	0	0.046	0.046	0.016	0	0
46	0.046	0	0	0.005	0	0	0.046	0
47	0.046	0	0	0.005	0	0.046	0.003	0

Table 9. The priority values of the challenging factors

Challenging factors	Overall priority
E1 High initial costs	0.144
E2 Longer implementation time	0.094
E3 Complex procedure and requirements	0.085
E8 Insufficient government incentives	0.079
E4 Reduced lifecycle cost	0.053
E6 Sustainable environment	0.050
E7 Low public awareness	0.049
E6 Improved social life	0.031
E9 Lack of green building experts	0.029

Table 10. The priority values of potential policies

Policies	Overall priority
M7 Gross floor area concession	0.278
M8 Extra height allowance	0.097
M1 Tax reduction/incentives	0.067
M3 Grants and rebates	0.054
M6 Better interest rate for green building buyers	0.045
M4 Financial support on green technology adaptions	0.043
M5 Green loan from the lender	0.035
M2 Assessment fee subsidy	0.030
M7 Gross floor area concession	0.278

Table 11. Experts details

ID	Date	Type of company	Position	Years of experience	Interview duration
R1	4/10/2019	Assessment service vendor	General manager	40 years	1 hour
R2	16/10/2019	Green building and energy consultant	Managing director	33 years	0.5 hour
R3	17/10/2019	Architectural firm	Director of sustainable design	>20 years	1 hour
R4	28/10/2019	Green architectural firm	Founder, director of sustainable design	16-18 years	0.5 hour
R5	29/10/2019	Contractor	Environmental engineer	8 years	0.5 hour
R6	31/10/2019	Academia	Associate department head, green building assessment scheme technical reviewer	34 years	0.5 hour

List of Figures

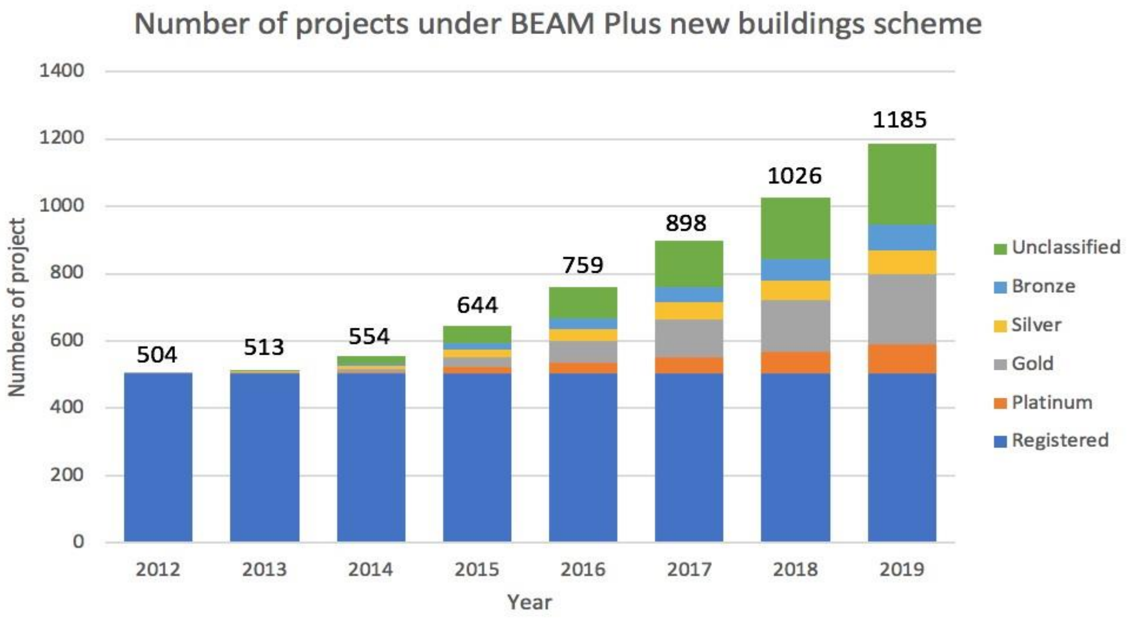

Fig. 1 Number of projects under BEAM Plus new buildings scheme

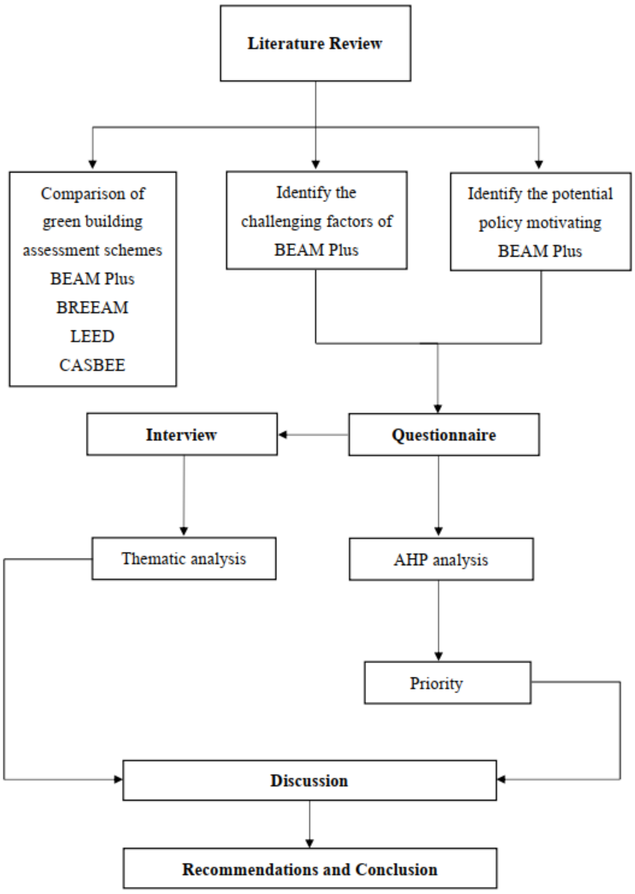

Fig. 2 Research framework

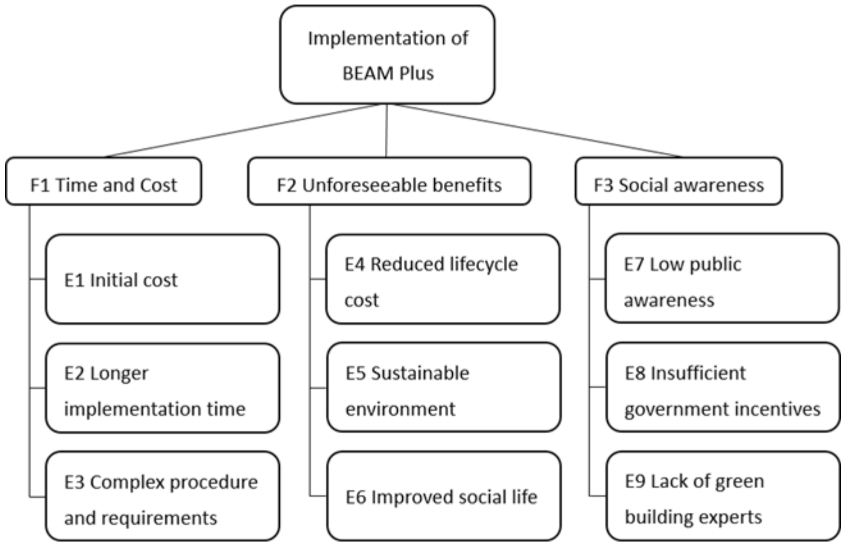

Fig. 3 Challenges to the implementation of BEAM Plus in Hong Kong

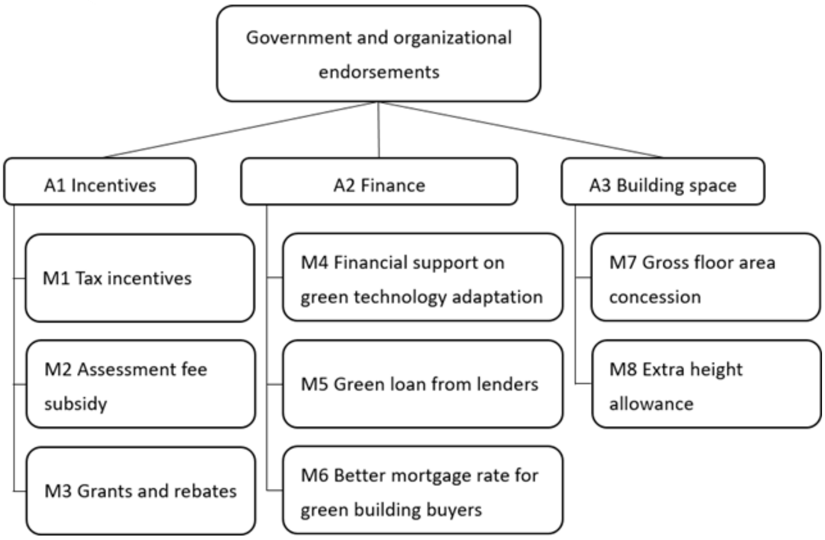

Fig. 4 Policies for the implementation of BEAM Plus in Hong Kong

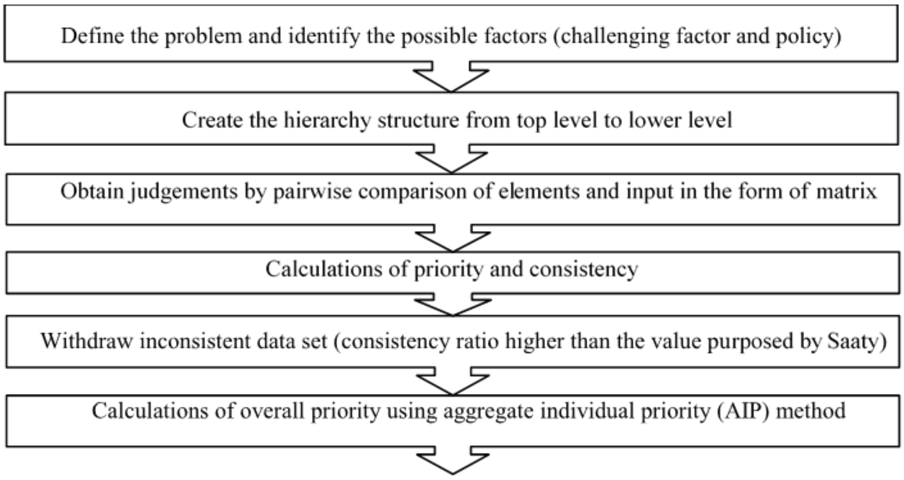

Fig. 5 AHP workflow modified from Saaty (1995)