Report for HKIS-funded Research Project

Sustainable Development Worldwide: Costs of Green Buildings

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Executive Summary

The aim of this study is to systematically review the current green building assessment practices, in terms of assessment standards, government policies, and, more importantly, the costs of green building projects, across the globe.

To achieve this aim, this report includes:

1. Systematic comparisons of the development history, administration cost, and assessment mechanism and scopes of seven widely adopted green building assessment standards;
2. Introduction of green building policies of seven countries which developed the seven green building assessment standards; and
3. Investigation of the costing of green buildings across the globe.

For the investigation as indicated in the above item 3, a questionnaire survey was designed to measure the cost and features of green building projects in different countries. The survey was sent via various professional institutes, green building consultants, architectural, engineering and construction firms, and so on, in countries across the globe, including Brunei, China, Hong Kong, Japan, New Zealand, Singapore, Sri Lanka, Philippines, Middle East, Nigeria, and so on. The data collected was then analyzed using SPSS. The study results indicate that, when comparing with conventional building projects, i) there is 34.06% increase in capital cost in green building projects on average, ii) the increase in capital cost in green academic projects (66.57%) is significantly higher than that of green residential (4.5%) and commercial projects (7.26%), iii) amongst the various green building design and features, green planning & design and green construction are the most frequently adopted ones, which incurred 9.9% increase and 27.82% decrease in the spending of the items respectively, and iv) the values of green building projects are higher in terms of price, rental cost and premium in market valuation (increase in 6-8%).

Even though the capital cost of green buildings is found to be higher, green building projects can still be profitable when the increase in selling price and rental cost, and the potential reduction of operational and construction cost are also taken into consideration. The results indicate that green construction methods, e.g., prefabrication, can reduce cost. However, precast construction is not a linear process. It is important to further investigate the impact of different levels and approaches of precast construction on time and cost of green projects. Therefore, the results of the current research act as foundation for further investigating various green construction methods, life cycle costing, tangible and intangible benefits of green building projects in-depth.

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Sustainable Development Worldwide : Costs of Green Buildings

1. Research Background

Globalization and the rise of the term 'sustainability' have combined with an increased awareness of green buildings in the past decades. In fact, buildings are responsible for 36% of CO2 emissions globally (European Commission, 2016). In Hong Kong, buildings even account for 92% of the citywide electricity consumption (Poon, 2014). These figures imply the significant environmental impact brought by buildings. All these resulted in an increasing number of assessment standards and government policies for green buildings worldwide.

To facilitate green building developments, a number of assessment tools were developed in the previous decades. For instance, following the development of the first three assessment standards in the 1990s, which are the BREEAM (BRE Environmental Assessment Method) launched in 1990 the BEAM Plus (Building Environmental Assessment Method) launched in 1996, and the LEED (Leadership in Energy and Environment Design) launched in 1998, there has been an increasing number of standards developed around the world, such as the Green Star launched in 2003, the CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) launched in 2004, and the ESGB (Evaluation Standard for Green Building) launched in 2006.

A green building is defined as "facility that is designed, built, operated, and disposed of in a resource-efficient manner using ecologically sound approaches and with both human and ecosystem health as goals" (Kibert, 2012). In fact, environment and human are just two of the three key pillars of sustainability, while the third pillar is economic. Even though the positive effects of green buildings on environment [e.g., reduction of construction and demolition waste, lower CO_2 emission, higher energy efficiency, etc. (Akadiri and Olomolaiye, 2012; Jo et al., 2009; Turner and Frankel, 2008)] and social aspects [e.g., enhanced occupants' comfort, health, productivity, etc. (Singh et al., 2010; Zuo and Zhao, 2014)] have been widely acknowledged, the number of green building developments is still very limited worldwide. Previous studies have attributed this to the poor performance of green buildings in the economic aspect, one of the key, but often overlooked, pillars in sustainability. "Green costs more" has been considered as a common perception presented by quantity surveyors to construction clients (e.g., Bartlett and Howard, 2000).

Therefore, to foster the development of green buildings around the world, the economic aspect of green buildings definitely deserves more attention. It is actually argued that the commonly adopted figure of 5-15% as the extra cost for green has seriously overestimated the building cost of a green building (Bartlett and Howard, 2000). In view of the above, this study aims to systematically review the current green building assessment practices, in terms of assessment standards, government policies, and, more importantly, the cost of green buildings, across the globe. To achieve this aim, the objectives of the study include the followings:

1. to review and compare the different green building assessment standards adopted by different countries in the world;
2. to review the government policies and incentives related to green buildings worldwide;
3. to investigate the costs of green buildings qualified under different assessment standards in different countries.

2. Green Building Assessment Standards

To achieve Objective 1, seven green building assessment standards were firstly selected, because they are the most widely adopted, influential and technically advanced ones as used in different countries around the world (e.g., Lee, 2013; Nguyen and Altan, 2011). The seven standards are then compared systematically across the development history, rating mechanism, assessment scope, and so on. These standards include: SBTool (developed by International Initiative for a Sustainable Built Environment, Canada), BREEAM (Building Research Establishment Environmental Assessment Method; developed by Building Research Establishment, the United Kingdom), LEED (Leadership in Energy and Environmental Design; developed by Green Building Council for the Department of Energy, the United States), CASBEE (Comprehensive Assessment System for Built Environment Efficient; developed by the Japan Sustainable Building Consortium under the Ministry of Land, Infrastructure, Transport and Tourism, Japan), BEAM Plus (developed by the Hong Kong Green Building Council, Hong Kong), ESGB (Evaluation Standard for Green Building – developed by Green Building Office, China) and Green Star (developed by the Green Building Council of Australia). The comparison results are summarized in Tables 1 to 4.

As shown in Table 1, BREEAM is the first green building standard which was developed in 1993. It acts as the foundation for the development of LEED, CASBEE, BEAM Plus, SBTool, and ESGB later on. Since the first development in the 1990-2004, six out of the seven standards have undergone one to two updates. Amongst these seven standards, BREEAM and LEED are considered the most widely adopted ones, in which BREEAM is involved in more than 21 countries and LEED is involved in more than 100 countries (Nguyen and Altan, 2011). Meanwhile, the number of projects registered and certified under these two standards is above 610,000 and 31,000 respectively around the world.

Then, the assessment mechanism and scoring system of the seven green building standards are summarized in Table 2 systematically. SBTool and BREEAM have the highest number of assessment criteria (125 and 114 respectively), followed by LEED (107), BEAM Plus (88), ESGB (80), CASBEE (50), and Green Star (30). By comparing the standards of BREEAM, LEED, CASBEE, Green Star and BEAM Plu, Nguyen and Altan (2011) considered the certification method of CASBEE as sophisticated, followed by BREEAM and BEAM Plus (average), and LEED and Green Star (basic). On the other hand, it is also suggested that the efficiency of CASBEE is very high, followed by LEED (high), and BREEAM, BEAM Plus and Green Star (average). As an extent of Nguyen and Altan's works, this study further compared the complexity and efficiency levels of SBTool and ESGB. The conclusion is that SBTool is at the complexity level of sophisticated, similar to that of CASBEE, while ESGB is at the basic level. Meanwhile, the efficiency level of SBTool is high, while that of ESGB is average.

Table 1 Development History of the Seven Green Building Standards

Standard / Development	SBTool	BREEAM	LEED	CASBEE	BEAM Plus	ESGB	Green Star
First version	2007	1993	1998	2002	1996	2006	2003
Latest version	2015	2016	2014	2010	2017	2006	2016
Developed based on	BREEAM	-	BREEAM	BREEAM, LEED, SBTool	BREEAM	BREEAM, LEED, SBTool	-
Developed by	IISBE (International Initiative for Sustainable Built Environment), Canada	Building research establishment (BRE), UK	US Green Building Council, US	Japan Sustainable Development Group	Hong Kong Green Building Council	Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD)	Green Building Council of Australia

Table 2 Structure and Mechanism of the Seven Green Building Standards

Mechanism \ Standard	SBTool	BREEAM	LEED	CASBEE	BEAM Plus	ESGB	Green Star
No. of Categories	29	69	107	6	23	80	30
No. of Criteria	125	114	-	6	88	-	-
No. of Sub-criteria	-	-	-	50	-	-	-
Calculation approach	Weighted	Simple addition	Simple addition	Weighted (weighting coefficients are modified to suit local conditions, e.g. climate)	Simple addition	Weighted	Simple addition
Credit allocation	Score-based system	Score-based system (building performance rate based on overall score)	Score-based system (building performance rate based on overall score)	Building rated based on BEE (building environment efficiency) factors	Score-based system (building performance rate based on overall score)	Score depends on number of options achieved and satisfied	Score-based system (building performance rate based on overall score)
Level of weighting	Applied at one level	Applied to each issue category (consensus based on scientific/open consultation)	All credits are equally weighted The number of credits allocated to each issue is in de facto weight	Highly complex weighting system applied at each level	Applied at one level	Applied at one level	Applied to each issue category (industry survey based)

Rating level	Overall grade	Overall grade	Overall grade	Environmental impact	Overall grade	Overall grade	Overall grade
	-1 (Deficient)	Pass	Certified	Poor	Bronze	1-star	One star
	0 (Minimum acceptable performance)	Good	Silver	Fairly poor	Silver	2-star	Two star
	1-4 (Intermediate performance level)	Very good	Gold	Good	Gold	3-star	Three star
	+5 (Best practice)	Excellent	Platinum	Very good	Platinum	-	Four star
	-	Outstanding	-	Excellent	-	-	Five star
	-	-	-	-	-	-	Six star
Information available to the public	User guide, Master list of criteria and Excel checklists	Checklists and Pre-assessment Estimator	PDF, Excel Checklists, Guides	Assessment Tool and Manuals (Partly Japanese)	Checklists, Manuals, Pre Assessment Tools	Manual	Excel Tools and Technical Manuals
Submission of actual building performance data (at first certification, if applicable)	✓	✓	-	-	-	✓	✓
No. of phase in certification	2-3	1	2	2	2	1	1

Validation of assessment by 3rd party	√	√ BRE	√	√ Third party agencies, e.g. JSBC (Japan Sustainable Building Consortium)	√	√ National Chinese Institute for Building Sciences and provincial-level Institutes for Building Sciences	√ GBCA (Green Building Council of Australia) nominated assessors

Source: Geng et al., 2012; Lee, 2013; Nguyen and Altan, 2011; Saunders, 2008

Amongst the seven standards, BREEAM, ESGB and Green Star adopt a single phase certification system, in which certification can only be obtained during the operation phase, covering assessments of pre-design, design, construction and operations. Actual building performance data, together with predicted performance data and design specifications are all included in the assessments. However, for LEED, CASBEE, and BEAM Plus, a two-phase certification system is adopted, where the first assessment is made for pre-design, design and construction phases. Design specifications and predicted performance data are used at the first certification assessment, while actual building performance data is not needed. There is a need for recertification after obtaining the first certification for a few years. The recertification would be another assessment tool designed for existing buildings, using actual performance data for assessment.

There is no definite answer on whether the single-phase or the two-phase approach is better. However, according to Lee (2013), the use of two-phase certification system provides flexibility to project clients who have various levels of control over building design, construction and, more importantly, tenants fit-out. Since there are large number of buildings in Hong Kong which are occupied by tenants, the two-phase certification arrangement, as adopted by BEAM Plus, is considered more appropriate for Hong Kong.

Next, the administration cost of the seven green building standards is summarized in Table 3. Due to the different business models adopted by the seven green building standards, it may not be appropriate to compare the administration cost amongst them directly. In general, the tools of all of the seven green building standards are free of charge. However, the technical manual has to be purchased for LEED and Green Star, or is limited to members or training participants for SBTool and BREEAM respectively. In addition to certification fee, some additional fee may also be required, such as assessment fee, collation fee, appeal fee, and also credit interpretation fee, depending on the requirements of specific standards.

Lastly, the building type, project stage and assessment scope covered by the seven green building standards are also compared in Table 4. All seven standards provide assessments

Table 3 Cost of the Seven Green Building Standards

Standard / Cost	SBTool	BREEAM	LEED	CASBEE	BEAM Plus	ESGB	Green Star
Information pack /tool	The tools are available free of charge while membership is needed for the use of SBTool performance rating software	Estimator tools are available free of charge. Guidance is currently available to people who attend the training courses.	The tools are available free of charge and Technical Guidance is available for £100	The assessment tool and guidance are available free of charge	The Manuals are available free of charge	The Manuals are available free of charge	The tools are available free of charge and the technical manual is available for £224
Certification fee	Not known[1]	£740-1500	£1133-11331	£1100-1500	£6680-12525	N/A[2]	£2550-7185
Assessment/Collation fee		£2000-10000	Up to £37770	Not known	£4920-121650		£2015-030
Appeal		Free	£252	Not known	£1480 base charge + £450 per credit		£403
Credit interpretation		Free/ Unlimited number	£111 for unlimited number	Not known	£200 per credit		Free/ Maximum of two

Source: Nguyen and Altan, 2011; Saunders, 2008
1 - Cost information not made public
2 - Case-based

for new buildings, existing buildings and renovation works. However, only SBTool, LEED, and Green Star have schemes for interior works, CASBEE, BEAM Plus and ESGB do not have scheme for core and shell, and ESGB does not have scheme for mixed-use projects. On the other hand, all of the standards cover design and construction phases, while only SBTool, BREEAM, ESGB, and Green Star cover operation phase. This is because LEED, CASBEE and BEAM Plus adopt recertification system for separate assessments of actual building performance at operation stage.

Amongst the seven schemes, common assessment items can be summarized into nine aspects, namely: site suitability, energy and resource consumption, environmental loadings, materials use, water use, indoor environmental quality, service quality, social and economic, and cultural and perceptual. As shown in Table 4, SBTool has the widest scope, covering 29 assessment aspects, while CASBEE is the narrowest, which covers only 16 key aspects. In fact, except SBTool, the rest six standards cover 16 to 20 key assessment aspects, which are comparable.

In general, all of the seven standards cover the key aspects of site suitability, energy and resource consumption, environmental loadings, materials use, water use, indoor environmental quality, and service quality, though the sub-criteria may be different from one and other. However, the aspect of social and economic is only covered by SBTool, BREEAM and LEED, while the aspect of cultural and perceptual is only covered by SBTool.

Table 4 Assessment of the Seven Green Building Standards

Assessment \ Standard		SBTool	BREEAM	LEED	CASBEE	BEAM Plus	ESGB	Green Star
Building type								
New		✓	✓	✓	✓	✓	✓	✓
Interiors		✓	-	✓	-	-	-	✓
Core and shell		✓	✓	✓	-	-	-	✓
Existing		✓	✓	✓	✓	✓	✓	✓
Renovated		✓	✓	✓	✓	✓	✓	✓
Mixed-use		✓	✓	✓	✓	✓	-	✓
Project Stage								
Pre-design		✓	✓	✓	✓	✓	✓	-
Design		✓	✓	✓	✓	✓	✓	✓
Construction		✓	✓	✓	✓	✓	✓	✓
Operations		✓	✓	-	-	-	✓	✓
Assessment Scope								
Site suitability	Site suitability (Geophysical analysis, ecological analysis, transportation analysis, soil pollution analysis, etc.)	✓	✓	✓	✓	✓	✓	✓
	Urban design and site development (site planning for project, landscaping, pedestrian walkway design, etc.)	✓	-	✓	✓	✓	✓	✓
	Transportation	-	✓	✓	-	✓	-	✓
Energy and resource consumption	Use of renewable energy	-	✓	✓	✓	✓	✓	✓
	Reduction of the use of non-renewable energy resources	✓	✓	-	✓	✓	-	✓
	Electrical peak demand (embodied energy analysis, operational energy stimulation)	✓	-	-	-	✓	✓	✓
	Greenhouse gas emissions	✓	✓	✓	✓	✓	✓	✓

Environmental loadings	Other atmospheric emissions	✓	-	-	-	-	-	-
	Other local and regional impacts (impact on site terrain or ecology, impacts on adjacent lands, pollution of aquifers or water ways, etc.)	✓	✓	✓	-	-	✓	-
	Heat island effect	✓	✓	✓	✓	✓	✓	✓
Materials use	Materials (minimization of virgin materials use, minimization of potable water use, material re-use and recycling, etc.)	✓	✓	✓	✓	✓	✓	✓
	Solid wastes (solid waste recycling and disposal)	✓	✓	✓	✓	✓	✓	✓
Water use	Potable water	✓	✓	✓	✓	✓	✓	✓
	Rainwater, storm water and wastewater (wastewater treatment design)	✓	-	✓	-	-	✓	✓
Indoor environmental quality	Indoor air quality	✓	✓	✓	✓	✓	✓	✓
	Ventilation (design for natural ventilation, hybrid ventilation, mechanical ventilation)	✓	✓	✓	✓	✓	✓	✓
	Air temperature and relative humidity	✓	✓	✓	✓	✓	✓	✓
	Daylighting and illumination (daylighting design and prediction, indoor and outdoor artificial lighting design)	✓	✓	✓	✓	✓	✓	✓
	Noise and acoustics	✓	✓	✓	✓	✓	✓	✓
Service quality	Safety and security during operations (occupant egress from tall building, construction safety, operation during outages, skills and knowledge of operating staff)	✓	✓	-	-	✓	-	-
	Functionality and efficiency (plan and volumetric efficiency)	✓	-	-	-	✓	-	✓
	Flexibility and adaptability (in building systems to the changing occupant	✓	-	-	✓	-	-	✓

	requirements, e.g. adaptability to future energy system)							
	Optimization and maintenance of operating performance (including testing and commissioning)	√	√	√	√	√	√	√
Social and economic aspects	Social aspects (access and use for mobility-impaired persons, access to and use of public/private open space)	√	-	-	-	-	-	-
	Construction cost	√	-	-	-	-	-	-
	Life cycle cost	√	-	-	-	-	-	-
	Operating and maintenance cost	√	√	√	-	-	-	-
	Investment risk	√	-	-	-	-	-	-
	Affordability of residential rental	√	-	-	-	-	-	-
Cultural and perceptual aspects	Culture and heritage (maintenance of heritage value of existing structures)	√	-	-	-	-	-	-
	Perceptual (user and occupant satisfaction)	√	-	-	-	-	-	-

Source: Alyami and Rezgui, 2012; Geng et al., 2012; Lee, 2013; Nguyen and Altan, 2011; Saunders, 2008; Mao et al., 2009

3. Government Policies & Incentives for Green Buildings

To achieve Objective 2, the government policies and incentives for green development in the seven countries /cities which have developed the widely adopted green building standards as mentioned in Section 2 (i.e., Hong Kong, United Kingdom, United States, Canada, Australia, Japan and China), are introduced briefly in this section.

3.1 Green Building Policies in Hong Kong

Since 1st April 2011, certification by BEAM Plus is one of the prerequisites for granting gross floor area (GFA) concessions for certain green and amenity features in development projects in Hong Kong.

In addition to the BEAM Plus certification, the followings are also required:

- Compliance with the sustainable building design guidelines on building separation, building set back and site coverage of greenery in PNAP APP-152, where applicable;
- For domestic /composite development, compliance with the requirements of PNAP APP-156 on Design and Construction Requirements for energy efficiency of residential buildings, where applicable;
- Compliance with the submission requirements, GFA concessions cap and relevant acceptance criteria as outline in APP151.

It is also stipulated in the Residential Properties (First-hand Sales) Ordinance (Cap 621) that, for any new residential properties which has been granted with GFA Concessions in accordance to APP151 issued by Buildings Authority, its BEAM Plus assessment rating should be indicated in the sales brochures. There are 3 types of labels, namely projects completed the registration and pending for the assessment process, projects completed provisional assessment with rating granted by the HKGBC, and the projects completed the final assessment with rating granted by the HKGBC.

In general, the overall cap on GFA concessions is set at 10% of the total GFA of the development. Please refer to APP151 for the exception and details (Buildings Department, 2014).

According to the Hong Kong Green Building Council (HKGBC) (2017), there are a total of 516 assessed BEAM Plus projects, in which only 14% awarded the platinum levels. The green building assessment systems adopted in projects in Hong Kong include BEAM Plus l), LEED, Green Building Design Label (3-Star) (assessed and awarded by China Green Building Council), BCA Green Mark (assessed and awarded by the Building and Construction Authority, Singapore), and so on. The Holiday Inn Express Hong Kong SOHO is the first high rise building (hotel) which has achieved platinum or equivalent of all of the above four green building assessment schemes.

3.2 Green Building Policies in Other Countries

3.2.1 United Kingdom

A large number of UK local authorities require BREEAM for new buildings through their local development frameworks. This makes BREEAM a planning condition for many building projects. The rating varies across authorities. For instance, a minimum rating of Excellent for new buildings and Very Good for refurbishment projects are required for buildings of government estates (Government Buying Standards) (Parker, 2012); and BREEAM Excellent for new buildings and Very Good for refurbishment are required for buildings occupied by health authorities in the UK, subject to certain building cost threshold (Parker, 2012).

3.2.2 United States

Since the launching of the Energy Policy Act in 2005, the US government has been offering tax break and incentives for efficiency upgrades to buildings. The Department of Environmental Services has also developed the Green Building Incentive Program, which allows developers to apply for a larger building area, if the project receives office LEED certification from the USGBC (Environmental Protection Agency, 2016). In addition, the US Environmental Protection Agency is in connection with many funding sources for green building developments, which encourages government organizations, industries, homeowners and nonprofit making organizations to go green through grants, tax credits, loans, and so on (Environmental Protection Agency, 2016).

3.2.3 Canada

There is no government incentive for green development in Canada. However, the National Research Council Canada and Natural Resources Canada's Office of Energy Efficiency developed the Model National Energy Code for Buildings, which is a national standard for building energy performance that individual provinces have to adopt and enforce (Canada Green Building Council, 2017). It is found that Building Codes are having the greatest impact on building green (Canada Green Building Council, 2017).

3.2.4 Australia

The Green Star environmental rating system is accepted as the industrial standard for green buildings in Australia. Three states mandate the rating system for government offices and accommodations (Kubba, 2009). Various incentives were also introduced for green building developments, including extra plot ratio, bonus floor space, height allowances, grants, rebates, waiving of development application fees, and reduction of council rates and utility charges.

For instance, the Gold Coast City Council offers plot ratio bonuses for building proposals that show cutting edge, innovative, and/or ecologically sustainable design (Green Building Council of Australia, 2014). The Brisbane City Council offered a Sustainable Development Incentives Program which provided $9 million in rebates for commercial building developments that achieved a 6 Star Green Star As-Built rating in 2009-2010. These cash rebates were provided based on the floor area of each building and were capped at $1 million each (Green Building Council of Australia, 2014).

3.2.5 Japan

The "CASBEE for Japanese Local Government" Program is launched in Japan, in which large scale building projects are required to submit a "CASBEE Assessment Result Sheet" (ISEP, 2009). Thirteen local governments in Japan have made this mandatory (ISEP, 2009). Recognized green projects can be rewarded. For instance, an increase in the maximum allowable floor space will be rewarded for projects achieving CASBEE B+ class (CASBEE, 2017). As of 2012, 24 Japanese local governments have introduced CASBEE for encouraging green building development (CASBEE, 2017).

3.2.6 China

In 2012, the Ministry of Finance and Ministry of Housing and Urban-Rural Development of People's Republic of China announced fiscal subsidy from 45-80 yuan per square meter subsidy for green buildings (广东省建筑节能协会, 2013).

4. Costing of Green Buildings

To investigate the costs of green buildings from a global perspective (Objective 3), a survey study was conducted.

4.1 Survey Design

The survey was designed to include two main parts, including, I) background information of respondents, II) background information of their green building projects, and III) cost information of the green buildings projects.

Purposive sampling was adopted, in which only professionals who have participated in green building projects within the past 2 years were involved in the study. Respondents were invited to fill in the survey based on one single recent green project.

Respondents were recruited through the HKIS and PAQS networks. There are 182 responses received in total. However, since some of the information can be sensitive (e.g., cost-related information), question items were not set mandatory in the survey. There are thus different number of responses in different items and sections, with the largest ones being 102 in Part II and 57 in Part I respectively.

4.2 Background Information

As shown in Table 5, more than 80% of the respondents were quantity surveyors, and nearly 70% of the respondents worked in QS consultant firms. Nearly 70% of the respondents were working at professional levels, while more than 30% of them worked at management or top management levels.

Regarding the green projects that the respondents were participated in, nearly 30% of these projects were located in Hong Kong, followed by Philippines (21%), Brunei (9%), Sri Lanka (7%), Middle East (7%), and so on. The majority of these projects were public (43%)

or private (45%) owned. Only 12.5% are semi-public projects. Most of the green projects were academic buildings (39%) and new commercial buildings (36%). LEED was the most commonly adopted green building assessment standard (45%), followed by BEAMPLUS (17%). Nearly 77% of the projects would be completed by 2017, and the project duration is 2.5 years on average. Please refer to Table 6 for more details.

Table 5 Respondents Background

Respondents' Background		**Frequency**	**Percentage**
Organization	Developer	5	9.26
	Contractor	5	9.26
	QS consultant	37	68.52
	Green building consultant	1	1.85
	Others	6	11.11
	Total	**54**	**100**
Profession	Building surveyor	1	1.89
	Quantity surveyor	44	83.02
	Architect	3	5.66
	Building services engineer	1	1.89
	Project manager	3	5.66
	Others	1	1.89
	Total	**53**	**100**
Position	Senior management	10	20.83
	Management	5	10.42
	Professional	31	64.58
	Others	2	4.17
	Total	**48**	**100**

4.3 Capital cost and Benefits of Green Buildings

As shown in Table 7, the majority of respondents indicated that, when comparing with conventional buildings, green buildings were found to have *higher capital cost* (an increase of 35.3% on average, as indicated by 97% of respondents). However, it is interesting to note that there was a small amount of respondents who indicated a decrease in capital cost in green projects (10% decrease on average, as indicated by 3% of respondents). For the market values, nearly all of the respondents indicate that there would be an increase in the *selling price* (an increase of 8.91% on average, as indicated by 92% of the respondents),

Table 6 Project Background

Project Background		Frequency	Percentage
Project location	Hong Kong	17	29.82
	Philippines	12	21.05
	Brunei	5	8.77
	Sri Lanka	4	7.02
	Middle East	4	7.02
	South Africa	2	3.51
	Japan	2	3.51
	New Zealand	2	3.51
	Singapore	1	1.75
	Indonesia	1	1.75
	Canada	3	5.26
	China	1	1.75
	Others	3	5.26
	Total	**57**	**100**
Project ownership	Public	24	42.86
	Private	25	44.64
	Semi-public	7	12.50
	Total	**56**	**100**
Project type	Academic building	22	39.29
	New Commercial	20	35.71
	New residential	4	7.14
	Existing residential	2	3.57
	Others	8	14.29
	Total	**56**	**100.00**
Green building scheme	LEED	27	45
	BEAMPLUS	10	17
	BCA Green Mark	2	3
	CASBEE	1	2
	Living Building Challenge	1	2
	GSAS-Global Sustainability Assessment System	1	2
	Others	18	30
	Total	**60**	**100**

rental cost (an increase in 6.09% on average, as indicated by all of the respondents) and *market valuation premium* (an increase in 7.7% on average, as indicated by all respondents) in a green building project. Lastly, the payback period is 10.3 year on average (n=10).

In addition to selling price, rental cost and market valuation, developers of green buildings in some cities /countries, like Hong Kong and Singapore, can also be benefited from GFA concession scheme (Qian et al., 2016). As mentioned in Part 3, the GFA concessions can be as high as 10% of the total GFA of the development in Hong Kong. In fact, the GFA concession scheme has been a strong encouragement for developers to build green, and the number of registered green buildings in Hong Kong has increased almost one-third within one year after the launching of the scheme in 2011 (Liu and Lau, 2013).

Table 7 Percentage of Change in Capital cost and Values of Green Buildings as a Whole (when comparing with conventional buildings)

% of change in Cost	**When comparing with conventional buildings…**		
Capital cost n=37	**Increase** (97%)	**Decrease** (3%)	**Average change**
	35.3%	10%	+34.06%
% of change in Values	**When comparing with conventional buildings…**		
Price per m^2 n=12	**Increase** (92%)	**Decrease** (8%)	**Average change**
	8.91%	12%	7.17%
Rental cost n=11	**Increase** (100%)	**Decrease** (0%)	**Average change**
	6.09%	-	6.09%
Premium in market valuation n=11	**Increase** (100%)	**Decrease** (0%)	**Average change**
	7.70%	-	7.70%

In order to investigate the impact of project type and ownership on the capital cost of green building projects, one way between-groups analyses of variance (ANOVA) were conducted. As shown in Table 8, the *capital cost of green academic buildings* was significantly higher than that of green commercial and green residential buildings (F=33.1; p<0.01), and the *capital cost of public green projects* is also significantly higher than that of private and semi-public green projects (F=20.860; p<0.01).

4.4 Costing of Green Building Elements in Detail

As shown in Table 9, most of the respondents had conducted green analyses and adopted green elements in relation to construction (n=27), followed by planning and design (n=12), efficient use of material (n=9), energy use (n=9), water use (n=9), and so on. An increase in costing is found in site acquisition (30%), maintenance and operation (13%), planning and design (9.9%), and so on, in the sampled green building projects. However, more than 60% of respondents who adopted **green analyses and/or green elements in construction** found a *high level of saving in construction* (i.e., 43% reduction of construction cost; as indicated by 63% of the respondents of this item) through prefabricated concrete and construction safety measures. On average, the *construction cost* of the sampled green building projects is found to have a reduction of around 28%. The differences of spending in each green item, when comparing with traditional projects, are illustrated in Figure 1.

Table 8 One-way Between-groups ANOVA for the Percentage of Change in *Capital cost* of Green Buildings with Different Project Types and Ownerships

% of Change in Capital cost						**Post-hoc test**			
Project Types (A)	**Mean**	**SD**	**F** (ANOVA)	**Sig.** (ANOVA)	**Sig.** (Levene)	**Project Types (B)**	**Mean Diff. (A-B)**	**S.D.**	**Sig.**
New commercial buildings (14)	+7.26	10.10	33.100	0.000	0.313	Academic building	-59.31	6.43	0.000
New residential buildings (3)	+4.50	4.77				Academic building	-62.07	11.05	0.000
Academic buildings (16)	**+66.57**	23.21				Commercial bldgs.. Residential bldgs.	+59.31 +62.07	6.43 11.05	0.000 0.000
Project Ownerships (A)	**Mean**	**SD**	**F** (ANOVA)	**Sig.** (ANOVA)	**Sig.** (Levene)	**Project Ownerships (B)**	**Mean Diff. (A-B)**	**S.D.**	**Sig.**
Public (19)	**+57.68**	57.68	20.860	0.000	0.000	Private Semi-public	+51.46 +43.35	8.20 14.47	0.000 0.014
Private (14)	+6.23	6.23				Public	-51.46	8.20	0.000
Semi-public (3)	+14.33	14.33				Public	-43.35	14.47	0.014

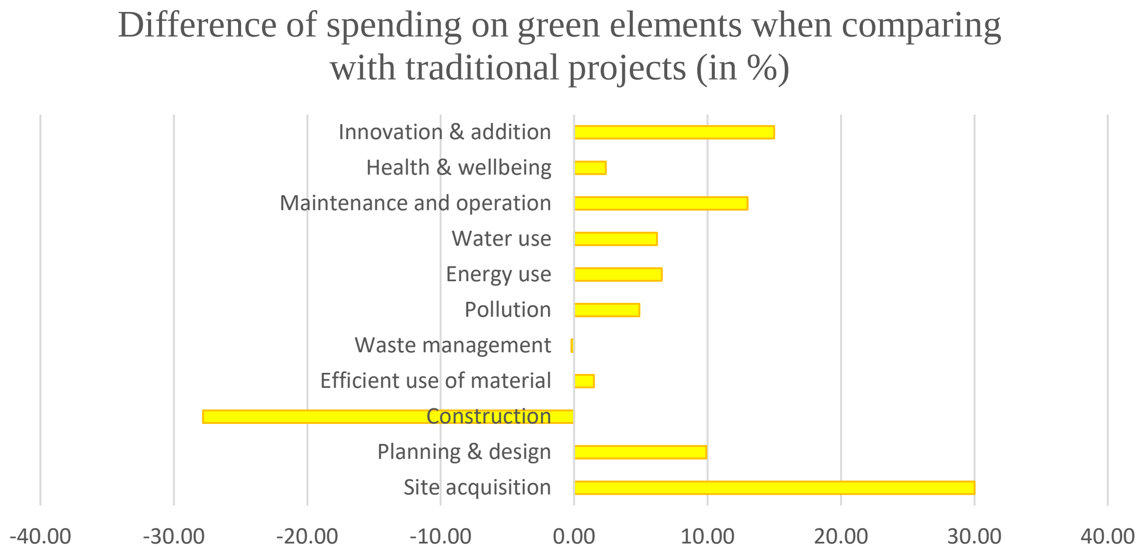

Figure 1 Difference of spending on each green elements

Table 9 Costing of Different Green Building Elements

(Due to the multiple responses, number/frequency of responses, instead of percentage, were used in the first five columns.)

Green building assessment element(s) (n=102 in total, including multiple responses)	**Green analyses conducted**	**Freq.**	**Green element(s) adopted**	**Freq.**	**Spending of the item** (when comparing with conventional buildings) **(%)**		**Average change in spending**
a) Site acquisition (n=1)	- Geophysical consideration	0	- Geophysical consideration	0	Increased (n=1) 30%	Decreased (n=0)	+30.00%
	- Ecological impact	0	- Ecological impact	0			
	- Transportation	1	- Transportation	1			
	- Soil pollution		- Soil pollution	0			
	- Heat island effect	1	- Heat island effect	0			
	- Others (Please specify:_______________)	0	- Others (Please specify: ____________________)	0			
b) Planning & design (n=12)	- Building orientation with better energy performance	6	- Building orientation with better energy performance	6	Increased (n=10) 9.9%	Decreased (n=0)	+9.9%
	- Building configuration for better energy performance	6	- Building configuration for better energy performance	7			
	- Underground space development for saving land resources	2	- Underground space development for saving land resources	1			
	- Building envelope optimization for thermal performance	7	- Building envelope optimization for thermal performance	7			
	- Landscape design	3	- Landscape design	3			
	- Green roof	7	- Green roof	7			
	- Flexibility and adaptability to future needs of occupants and systems	4	- Flexibility and adaptability to future needs of occupants and systems	4			
	- Maintenance of heritage value	2	- Maintenance of heritage value	0			
	- Social values	0	- Social values	0			

	- Others (Please specify: ____________________)	0	- Others (Please specify: ____________________)	0			
c) Construction (n=27)	- Prefabricated concrete	6	- Prefabricated concrete	5	Increased (n=8) 9.19%	Decreased (n=17) 43.06%	-27.82%
	- Construction safety	20	- Construction safety	19			
	- Others (Please specify: Reflective index of roof tile)	1	- Others (Please specify: ____________________)	0			
d) Efficient use of material (n=9)	- Building fabric insulation (e.g., roof, wall, etc.)	7	- Building fabric insulation (e.g., roof, wall, etc.)	7	Increased (n=7) 3.83%	Decreased (n=1) 15.00%	+1.48%
	- Environmental friendly material for HVAC systems	8	- Environmental friendly material for HVAC systems	6			
	- Minimization of virgin materials use	4	- Minimization of virgin materials use	3			
	- Others (Please specify: ____________________)	0	- Others (Please specify: ____________________)	0			
e) Waste management (n=8)	- Reuse of architecture features	2	- Reuse of architecture features	0	Increased (n=2) 1.50%	Decreased (n=3) 1.33%	-0.20%
	- Reuse of warehouse on future projects	2	- Reuse of warehouse on future projects	1			
	- Architectural salvage sales	3	- Architectural salvage sales	1			
	- Recycling shuttering or hoarding	2	- Recycling shuttering or hoarding	2			
	- Reuse of aggregates	2	- Reuse of aggregates	2			
	- Others (Please specify: ____________________)	0	- Others (Please specify: ____________________)	0			
f) Pollution (n=5)	- Atmospheric emissions (e.g., greenhouse gas)	2	- Atmospheric emissions (e.g., greenhouse gas)	3	Increased (n=4) 4.88%	Decreased (n=0)	+4.88%
	- Pollution of aquifers or water ways	3	- Pollution of aquifers or water ways	3			
	- Others (Please specify: ____________________)	0	- Others (Please specify: ____________________)	0			

g) Energy use (n=9)	- Renewable energy (e.g., solar system)	6	- Renewable energy (e.g., solar system)	6	Increased (n=6) 10.17%	Decreased (n=1) 15.00%	+6.57%
	- Peak electricity demand control	3	- Peak electricity demand control	1			
	- Ground source heat pump	0	- Ground source heat pump	0			
	- Others (Please specify: grey water)	1	- Others (Please specify: sensor controlled fittings)	1			
h) Water use (n=9)	- Minimization of potable water use	6	- Minimization of potable water use	5	Increased (n=6) 9.73%	Decreased (n=1) 15.00%	+6.20%
	- Decentralized rainwater system	4	- Decentralized rainwater system	3			
	- Wastewater system	4	- Wastewater system	4			
	- Others (Please specify: ____________________)	0	- Others (Please specify: ____________________)	0			
i) Maintenance and operation (n=8)	- Ample ventilation (natural, hybrid, mechanical) for pollutant, thermal, and humidity controls	3	- Ample ventilation (natural, hybrid, mechanical) for pollutant, thermal, and humidity controls	2	Increased (n=6) 13.00%	Decreased (n=0)	+13.00%
	- Integration of natural lighting and electric lighting systems	4	- Integration of natural lighting and electric lighting systems	4			
	- Acoustics control (e.g., low E insulation window)	5	- Acoustics control (e.g., low E insulation window)	4			
	- Green technology monitor and maintenance system	3	- Green technology monitor and maintenance system	3			
	- Green facility management	3	- Green facility management	3			
	- Others (Please specify: ____________________)	0	- Others (Please specify: ____________________)	0			
j) Health and well-being (n=4)	Please specify: - user requirements, preferences	1	Please specify: - good view, comfortable environment	1	Increased (n=3) 2.37%	Decreased (n=0)	+2.37%
k) Innovation and addition (n=7)	Please specify: ____________________	0	Please specify: ____________________	0	Increased (n=1) 15.00%	Decreased (n=0)	+15.00%

l) Demolition (n=3)	Please specify: ______________________	0	Please specify: ______________________	0	-	-	-
m) Others (n=0)	Please specify: ______________________	0	Please specify: ______________________	0	-	-	-

5. Discussion & Recommendations

The study results indicate that, when comparing with conventional building projects, there is a 34.06% increase in capital cost in green building projects. This finding, to certain extent, echoes some previous studies which indicate that the high upfront cost of green buildings maybe the main barrier in developing green buildings (e.g., Samari et al., 2013). However, there are also an average increase of 7.17% in selling price and 6.09% in rental cost in green building projects. According to the NAHB construction cost survey (NAHB Economics and Housing Policy Group, 2017[1]), construction cost accounts for around 55.6% of the final sales price of a building. If we make a simple assumption that there is no change to the land cost, overhead and other financing cost, the net profit that green building projects can bring along can then be roughly estimated using this ratio. For instance, for a green building project with selling price of one billion dollars ($1,000,000,000), its construction cost can be roughly estimated as $556,000,000. The 34.06% increase in capital cost means an increase of $189,373,600 in cost; while the 7.17% increase in selling price represents an increase of $71,700,000 in profit. This means that the actual extra cost for a green building project is $117,673,600, equivalent to around 12% of the final selling price only.

However, there are a large number of buildings in Hong Kong which are owned and managed by developers and occupied by tenants. In these cases, there are two important factors which are not included in the above calculation for the build-and-sell scenario, which are the saving of the building operation costs and the 6.09% increase in the rental income in green buildings. Previous studies have indicated that green buildings can save 30-40% in energy and water consumption than conventional buildings, while energy and water are the major cost in building operation (Foster et al., 2004; Nalewaik and Venters, 2008). By taking a more conservative percentage of 30 in operational cost saving and, applying the golden ratio of 1 to 5 for construction cost and operation cost (Hughes et al.,

1 The result of the American based study is for reference only. There may be discrepancy in construction cost and sales price ratio across different countries and regions.

2004), the profit of $716,326,400 can be roughly estimated for the previous example, which is nearly 5 times of the extra cost spent on greening. Together with the 6.09% increase in rental income in the long run, green development can have significant profit.

On the other hand, it is also interesting to note that, even though the adoption of green construction methods, in terms of prefabrication and construction safety measures, can result in a reduction of 27.82% of construction cost on average (amongst the respondents who have adopted green construction methods, 63% experienced a cost reduction of 43.06% on average), when comparing with the adoption rate of all of the green methods included in the study, the adoption rate of green construction is 26.47% only. In fact, when comparing projects adopted prefabrication with those which have not, projects adopted prefabrication were found to have an increase of 11.72% in capital cost on average when comparing with traditional projects, while for projects which has not adopted prefabrication, the increase is as high as 37.66%.

Even though prefabrication may increase construction cost through investment in manufacturing facilities, transportation and installation costs, previous studies have indicated significant economic benefits of modular construction in terms of reduction of material use, reduction of construction waste, saving in commissioning and minor repair costs (which can be as high as 2% of the total building cost in a traditional project), and so on (Lawson et al., 2012). More importantly, prefabrication speeds up the construction process, which can reduce the financial charge borne by the client (can be 2 to 3% of over the shorter building cycle), increase clients' profit by starting the business or rental income earlier, and reduce disruption to the locality or existing business. In the case studies conducted by Lawson and his team (2012), the construction period of the modular project was reduced by over 50% relative to site-intensive building, and construction waste was reduced by 70% on-site and most manufacturing waste was recycled. This not only contributes to a significant reduction in construction cost, but also benefits the project from green assessment aspect. Therefore, to enhance cost effectiveness in green building projects, prefabrication methods can be considered.

Lastly, it is interesting to find that the change in capital cost in green academic (public) projects are significantly higher than that of green commercial and residential (private) projects. To enable deeper understanding on this issue, an interview has been conducted with a green expert who has 10 years' experience working in sustainable projects inside and outside Hong Kong. According to the interview, the high cost in green academic projects can be attributed to two main reasons. First of all, when comparing with green commercial and residential buildings, green academic buildings are more likely to have irregular design and large atrium. This results in a higher demand in sustainable materials, like low emissivity window glazing for absorbing skylight /natural lighting. Besides, this also increases the demand for air conditioner and ventilation capacity. Secondly, and more importantly, leaders of academic building projects often have a vision to promote sustainable development to the society through their own projects. Therefore, these projects tend to adopt various new and innovative green building features in a much larger scale, so as to showcase how successful and effective green projects can be.

6. Further Studies

The potential benefits that prefabrication can bring to green projects have been discussed in the previous section. However, in practice, there are different levels of precast manufacturing, namely manufactured components, elemental or planar system, modular and mixed construction systems and complete building systems, in which each has different requirements on design, transportation and installation. The above mentioned economic benefits would clearly be affected by the different levels of precast manufacturing. Hence, further study is recommended to investigate the cost and time effectiveness of this green construction method – precast construction.

In addition to prefabrication, there are other green building features adopted in respondents' projects, however, those features are found to increase the item cost from 1.48% to 30%. For instance, the most common green elements adopted in planning and design stage are building configuration for better energy performance, building envelope optimization for thermal performance and green roof; the most common element adopted for energy use is renewable energy (e.g., solar energy), and the most common element adopted in water use is minimization of potable water use. The findings show us the allocation of green cost in different project elements in general, and indicate the trend of green building feature adoption in the sector. However, it would be meaningful to further study the effectiveness, in terms of not only cost, but also environmental and human impact, of these commonly adopted green features in further studies. Results of the further studies can then be used to inform decision making for various green design options.

On the other hand, previous studies have indicated that green buildings can save 30% energy consumption than conventional buildings (Foster et al., 2004). This implies that the operational cost of green buildings would be lower in a sense that it may be able to offset a certain amount, if not all, of the upfront cost required. This is particularly true in the contemporary world where energy price is getting rocket high. Hence, another recommendation for further study is to investigate the life cycle costing of green buildings.

Meanwhile, this study covers tangible benefits of green buildings only, which include the 6-8% increase in price, rental cost and premium in market valuation. There may be other intangible benefits with high values that green buildings can achieve, such as occupants' health, employees' productivity, absenteeism, reputation of developers, and so on (e.g., Gou et al., 2012; Singh et al., 2011). Therefore, as an extension of the current study, it is recommended to conduct further longitudinal case studies, so as to investigate the economic and non-economic impact or benefits of green buildings awarded under different types of schemes and with different ratings comprehensively.

7. Conclusion

In sum, even though green buildings are found to cost 34.06% more than conventional buildings in the development stage, they can still be profitable if the increase in selling price and rental cost (around 7%), and the potential reduction of operational and construction cost are also taken into consideration. Furthermore, the study found that, amongst the various green building features and elements, green construction methods are the only one which can reduce capital cost, a reduction of 27.82% on average when comparing with traditional projects. However, the adoption rate of green construction methods is not high, 26.47% only. It is postulated that proper adoption of green construction methods, such as prefabrication, can enhance the cost effectiveness of green projects, and cover the increase in cost spending on locality, planning and design, and maintenance and operation, and so on. However, precast construction is not a linear process. It is important to further investigate the impact of different levels and approaches of precast construction on time and cost of green projects. In addition, it is also argued that there are other significant values that green buildings can bring along, such as reduction in energy consumption in the operation stage. Therefore, the results of current research act as foundation for further studies which takes into account the various green construction methods, life cycle costing, tangible and intangible benefits of green buildings in detail.

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10. Appendix

Questionnaire Survey

Part 1 Background information	Page 1-7
Part 2 Costing of green building projects	Page 8-21
Part 3 Benefits of green building projects	Page 22-24

Sustainable Development Worldwide:
Assessment standards, policies and costs of green commercial and residential buildings

Please answer the following questions based on a **RECENT GREEN BUILDING PROJECT** that you are participating in / have participated in within the past 2 years.

We cordially invite you to complete this self-administered questionnaire. Filling in this questionnaire takes approximately 15 minutes. All information obtained will be used for research purposes only. Participant will not be identified by name in any publications of the completed study. All data collected will be removed within 3 years after publication of the first paper. Participation is entirely voluntary. This means that you can choose to stop at any time without negative consequences. If you have any questions about the research, please feel free to contact Dr. Isabelle Chan at +852 2859-7984 or iyschan@hku.hk .

There are 85 questions in this survey

Part I. Background Information

1 [Q001]1. Project location: *

Please also fill in the "other comment" field.

Please choose **only one** of the following:

- Australia
- Brunei
- Canada
- China
- Fiji
- Hong Kong
- Japan
- Malaysia
- New Zealand
- Singapore
- South Africa
- Sri Lanka
- UK
- US
- Other

2 [Q002]2. Project ownership: *

Please choose **only one** of the following:

- Public project
- Private project
- Semi-public project

3 [Q003]3. Project types: *

Please choose **only one** of the following:

- New commercial building
- Existing commercial building
- New residential building
- Existing residential building
- Other

4 [Q004]

4. Project period:

*****

	From	To
Year		

5 [Q005]

5. Gross Floor Area (in ㎡):

*****

Please write your answer here:

6 [Q006]

6. Approximate total project sum:

*****

Please write your answer here:

7 [Q006a]Currency used: *

Please choose **only one** of the following:

- AUD
- BND
- CAD
- RMB
- FJD
- HKD
- JPY
- MYR
- NZD
- SGD
- ZAR
- LKR
- GBP
- USD
- EUR
- Other

8 [Q007]7. Green building assessment system(s) adopted: *

Please choose **all** that apply:

- a) BREEAM
- b) LEED
- c) BEAM Plus
- d) ESGB
- e) Green Star
- f) CASBEE
- g) SBTool
- h) Others

9 [q007other]Please name the green building assessment system(s) adopted: *

Only answer this question if the following conditions are met:
° ((**Q007_SQ008.NAOK** == "Y"))

Please write your answer here:

10 [Q008a]

8. Green building assessment result (if the project has not yet been completed, please indicate the assessment result the project team aims to achieve):

If answered (a) in question 7:

*****

Only answer this question if the following conditions are met:
° ((Q007_SQ001.NAOK == "Y"))

Please choose **only one** of the following:

- Pass
- Good
- Very good
- Excellent
- Outstanding

11 [Q008b]

8. Green building assessment result (if the project has not yet been completed, please indicate the assessment result the project team aims to achieve):

If answered (b) in question 7:

*****

Only answer this question if the following conditions are met:
° ((Q007_SQ002.NAOK == "Y"))

Please choose **only one** of the following:

- Certified
- Silver
- Gold
- Platinum

12 [q008c]

8. Green building assessment result (if the project has not yet been completed, please indicate the assessment result the project team aims to achieve):

If answered (c) in question 7:

*****

Only answer this question if the following conditions are met:
° ((Q007_SQ003.NAOK == "Y"))

Please choose **only one** of the following:

- Bronze
- Silver
- Gold
- Plantinum

13 [q008d]

8. Green building assessment result (if the project has not yet been completed, please indicate the assessment result the project team aims to achieve):

If answered (d) in question 7:

Only answer this question if the following conditions are met:
° ((**Q007_SQ004.NAOK** == "Y"))

Please choose **only one** of the following:

- 1-star
- 2-star
- 3-star

14 [q008e]

8. Green building assessment result (if the project has not yet been completed, please indicate the assessment result the project team aims to achieve):

If answered (e) in question 7:

*****

Only answer this question if the following conditions are met:
° ((**Q007_SQ005.NAOK** == "Y"))

Please choose **only one** of the following:

- 1-star
- 2-star
- 3-star

15 [Q008f]

8. Green building assessment result (if the project has not yet been completed, please indicate the assessment result the project team aims to achieve):

If answered (f) in question 7:

*****

Only answer this question if the following conditions are met:
° ((**Q007_SQ005.NAOK** == "Y"))

Please choose **only one** of the following:

- Poor
- Fairly poor
- Good
- Very good
- Excellent

16 [q008g]

8. Green building assessment result (if the project has not yet been completed, please indicate the assessment result the project team aims to achieve):

If answered (g) in question 7:

*

Only answer this question if the following conditions are met:
° ((Q007_SQ007.NAOK == "Y"))

Please choose **only one** of the following:

- -1
- 0
- 1-4
- +5

17 [q008h]

8. Green building assessment result (if the project has yet been completed, please indicate the assessment result the project team aims to achieve):

If answered (h) in question 7, please fill in:

*

Only answer this question if the following conditions are met:
° ((Q007_SQ008.NAOK == "Y"))

Please write your answer here:

18 [q009]9. Your organization: *

Please choose **only one** of the following:

- Developer
- Contractor
- QS Consultant
- Green Building Consultant
- Other

19 [q0010]10. Profession: *

Please choose **only one** of the following:

- General practice surveyor
- Building surveyor
- Quantity surveyor
- Architect
- Structural engineer
- Building services engineer
- Project manager
- Other

20 [q0011]11. Position:

Please write your answer here:

Part II. Costing of green building projects

21 [2001a1]

1. Building Design and Features

a) How many percent would be added or reduced to the CAPITAL COST for THE GREEN BUILDING PROJECT (as identified in Part I) when comparing with traditional building projects?

*****

Please choose **only one** of the following:

- Increase
- Decrease

22 [2001a2]Percentage of the change (%) *

Only answer this question if the following conditions are met:
° ((2001a1.NAOK == "A1" or 2001a1.NAOK == "A2"))

Please write your answer here:

23 [2001b]b) How many percent would be added or reduced to the TOTAL CONSTRUCTION TIME of THE GREEN BUILDING PROJECT (as identified in Part I) when comparing with traditional building projects? *

Please choose **only one** of the following:

- Increase
- Decrease

24 [2001b2]Percentage of the change (%) *

Only answer this question if the following conditions are met:
° ((2001b.NAOK == "A1" or 2001b.NAOK == "A2"))

Please write your answer here:

25 [2001c1a]

c) How much is the CAPITAL COST PER SQUARE METER OF GFA for THE GREEN BUILDING PROJECT (as identified in Part I) when comparing with traditional building projects?

*****

	Conventional building	Green building
capital cost/m²		

26 [2001c2]

Currency used:

*

Please choose **only one** of the following:

- AUD
- BND
- CAD
- RMB
- FJD
- HKD
- JPY
- MYR
- NZD
- SGD
- ZAR
- LKR
- GBP
- USD
- EUR
- Other

27 [2002a]

2. The followings are items in the whole life cycle costs of a green building.

What have been considered and adopted in THE GREEN BUILDING PROJECT (as identified in Part I)?

How many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Please choose **all** that apply:

- a) Site acquisition
- b) Planning & design
- c) Construction
- d) Efficient use of material
- e) Water management
- f) Pollution
- g) Energy use
- h) Water use
- i) Maintenance and operation
- j) Health and well-being
- k) Innovation and addition
- l) Demolition
- m) Others

You can select more than one if appropriate.

28 [2002other]Please specify: *

Only answer this question if the following conditions are met:
° ((2002a_SQ013.NAOK == "Y"))

Please write your answer here:

29 [2002b1]For site acquistion (a), what green analysis(s) have been conducted?

Only answer this question if the following conditions are met:
° ((2002a_SQ001.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Geographical consideration
- ☐ Ecological impact
- ☐ Transportation
- ☐ Heat island effect
- ☐ Other:

You can select more than one if appropriate.

30 [2002c1]For site acquistion (a), what green element(s) have been adopted?

Only answer this question if the following conditions are met:
° ((2002a_SQ001.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Geographical consideration
- ☐ Ecological impact
- ☐ Transportation
- ☐ Heat island effect
- ☐ Other:

You can select more than one if appropriate.

31 [2002d1]

For site acquisition (a), how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ001.NAOK == "Y"))

Please choose **only one** of the following:

- ○ Increase
- ○ Decrease

32 [2002E1]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002d1.NAOK == "A1" or 2002d1.NAOK == "A2"))

Please write your answer here:

Please enter a number between 1 to 100.

33 [2002b2]For planning and design (b), what green analysis(s) have been conducted?

Only answer this question if the following conditions are met:
° ((2002a_SQ002.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Building orientation with better energy performance
- ☐ Building configuration for better energy performance
- ☐ Underground space development for saving land resources
- ☐ Building envelope optimization for thermal performance
- ☐ Landscape design
- ☐ Green roof
- ☐ Flexibility and adaptability to future needs of occupants and systems
- ☐ Maintenance of heritage value
- ☐ Social values
- ☐ Other:

You can select more than one if appropriate.

34 [2002c2]For planning and design (b), what green element(s) have been adopted?

Only answer this question if the following conditions are met:
° ((2002a_SQ002.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Building orientation with better energy performance
- ☐ Building configuration for better energy performance
- ☐ Underground space development for saving land resources
- ☐ Building envelope optimization for thermal performance
- ☐ Landscape design
- ☐ Green roof
- ☐ Flexibility and adaptability to future needs of occupants and systems
- ☐ Maintenance of heritage value
- ☐ Social values
- ☐ Other:

You can select more than one if appropriate.

35 [2002D2]

For planning and design (b), how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ002.NAOK == "Y"))

Please choose **only one** of the following:

- Increase
- Decrease

36 [2002e2]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002D2.NAOK == "A1" or 2002D2.NAOK == "A2"))

Please write your answer here:

37 [2002b3]For construction (c), what green analysis(s) have been conducted?

Only answer this question if the following conditions are met:
° ((2002a_SQ003.NAOK == "Y"))

Please choose **all** that apply:

- Prefabricated concrete
- Construction safety
- Other:

You can select more than one if appropriate.

38 [2002c3]For construction (c), what green element(s) have been adopted?

Only answer this question if the following conditions are met:
° ((2002a_SQ003.NAOK == "Y"))

Please choose **all** that apply:

- Prefabricated concrete
- Construction safety
- Other:

You can select more than one if appropriate.

39 [2002d3]

For construction (c), how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ003.NAOK == "Y"))

Please choose **only one** of the following:

- Increase
- Decrease

40 [2002e3]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002d3.NAOK == "A1" or 2002d3.NAOK == "A2"))

Please write your answer here:

41 [2002b4]For efficient use of materials (d), what green analysis(s) have been conducted?

Only answer this question if the following conditions are met:
° ((2002a_SQ004.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Building fabric insulation (e.g., roof, wall, etc.)
- ☐ Environmental friendly material for HVAC systems
- ☐ Minimization of virgin materials use
- ☐ Other:

You can select more than one if appropriate.

42 [2002c4]For efficient use of materials (d), what green element(s) have been adopted?

Only answer this question if the following conditions are met:
° ((2002a_SQ004.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Building fabric insulation (e.g., roof, wall, etc.)
- ☐ Environmental friendly material for HVAC systems
- ☐ Minimization of virgin materials use
- ☐ Other:

You can select more than one if appropriate.

43 [2002d4]

For efficient use of materials (d), how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ004.NAOK == "Y"))

Please choose **only one** of the following:

- ○ Increase
- ○ Decrease

44 [2002e4]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002d4.NAOK == "A1" or 2002d4.NAOK == "A2"))

Please write your answer here:

45 [2002b5]For waste management (e), what green analysis(s) have been conducted?

Only answer this question if the following conditions are met:
° ((2002a_SQ005.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Reuse of architecture features
- ☐ Reuse of warehouse on future projects
- ☐ Architectural salvage sales
- ☐ Recycling shuttering or hoarding
- ☐ Reuse of aggregates
- ☐ Other: ______

You can select more than one if appropriate.

46 [2002c5]For waste management (e), what green element(s) have been adopted?

Only answer this question if the following conditions are met:
° ((2002a_SQ005.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Reuse of architecture features
- ☐ Reuse of warehouse on future projects
- ☐ Architectural salvage sales
- ☐ Recycling shuttering or hoarding
- ☐ Reuse of aggregates
- ☐ Other: ______

You can select more than one if appropriate.

47 [2002d5]

For waste management (e), how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ005.NAOK == "Y"))

Please choose **only one** of the following:

- ○ Increase
- ○ Decrease

48 [2002e5]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002d5.NAOK == "A1" or 2002d5.NAOK == "A2"))

Please write your answer here:

______

49 [2002b6]For pollution (f), what green analysis(s) have been conducted?

Only answer this question if the following conditions are met:
° ((2002a_SQ006.NAOK == "Y"))

Please choose **all** that apply:

- [ ] Atmospheric emissions (e.g., greenhouse gas)
- [ ] Pollution of aquifers or water ways
- [ ] Other:

You can select more than one if appropriate.

50 [2002c6]For pollution (f), what green element(s) have benn adopted?

Only answer this question if the following conditions are met:
° ((2002a_SQ006.NAOK == "Y"))

Please choose **all** that apply:

- [ ] Atmospheric emissions (e.g., greenhouse gas)
- [ ] Pollution of aquifers or water ways
- [ ] Other:

You can select more than one if appropriate.

51 [2002d6]

For pollution (f), how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ006.NAOK == "Y"))

Please choose **only one** of the following:

- ○ Increase
- ○ Decrease

52 [2002e6]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002d6.NAOK == "A1" or 2002d6.NAOK == "A2"))

Please write your answer here:

53 [2002b7]For energy use (g), what green analysis(s) have been conducted?

Only answer this question if the following conditions are met:
° ((2002a_SQ007.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Renewable energy (e.g., solar system)
- ☐ Peak electricity demand control
- ☐ Ground source heat pump
- ☐ Other:

You can select more than one if appropriate.

54 [2002c7]For energy use (g), what green element(s) have been adopted?

Only answer this question if the following conditions are met:
° ((2002a_SQ007.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Renewable energy (e.g., solar system)
- ☐ Peak electricity demand control
- ☐ Ground source heat pump
- ☐ Other:

You can select more than one if appropriate.

55 [2002d7]

For energy use (g), how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ007.NAOK == "Y"))

Please choose **only one** of the following:

- ○ Increase
- ○ Decrease

56 [2002e7]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002d7.NAOK == "A1" or 2002d7.NAOK == "A2"))

Please write your answer here:

57 [2002b8]For water use (h), what green analysis(s) have been conducted?

Only answer this question if the following conditions are met:
° ((2002a_SQ008.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Minimization of potable water use
- ☐ Decentralized rainwater system
- ☐ Wastewater system
- ☐ Other:

You can select more than one if appropriate.

58 [2002c8]For water use (h), what green element(s) have been adopted?

Only answer this question if the following conditions are met:
° ((2002a_SQ008.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Minimization of potable water use
- ☐ Decentralized rainwater system
- ☐ Wastewater system
- ☐ Other:

You can select more than one if appropriate.

59 [2002d8]

For water use (h), how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ008.NAOK == "Y"))

Please choose **only one** of the following:

- ○ Increase
- ○ Decrease

60 [2002e8]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002d8.NAOK == "A1" or 2002d8.NAOK == "A2"))

Please write your answer here:

61 [2002b9]For maintenance and operation (i), what green analysis(s) have been conducted?

Only answer this question if the following conditions are met:
° ((2002a_SQ009.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Ample ventilation (natural, hybrid, mechanical) for pollutant, thermal, and humidity controls
- ☐ Integration of natural lighting and electric lighting systems
- ☐ Acoustics control (e.g., low E insulation window)
- ☐ Green technology monitor and maintenance system
- ☐ Green facility management
- ☐ Other: ____________

You can select more than one if appropriate.)

62 [2002c9]For maintenance and operation (i), what green element(s) have been adopted?

Only answer this question if the following conditions are met:
° ((2002a_SQ009.NAOK == "Y"))

Please choose **all** that apply:

- ☐ Ample ventilation (natural, hybrid, mechanical) for pollutant, thermal, and humidity controls
- ☐ Integration of natural lighting and electric lighting systems
- ☐ Acoustics control (e.g., low E insulation window)
- ☐ Green technology monitor and maintenance system
- ☐ Green facility management
- ☐ Other: ____________

You can select more than one if appropriate.

63 [2002d9]

For maintenance and operation (i), how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ009.NAOK == "Y"))

Please choose **only one** of the following:

- ○ Increase
- ○ Decrease

64 [2002e9]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002d9.NAOK == "A1" or 2002d9.NAOK == "A2"))

Please write your answer here:

____

65 [2002bc10]For health and wealth being (j):

Only answer this question if the following conditions are met:
° ((2002a_SQ010.NAOK == "Y"))

Please write your answer(s) here:

what green analysis(s) have been conducted?	
what green element(s) have been adopted?	

66 [2002d10]

For health and wealth being (j), how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ009.NAOK == "Y"))

Please choose **only one** of the following:

- Increase
- Decrease

67 [2002e10]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002d9.NAOK == "A1" or 2002d9.NAOK == "A2"))

Please write your answer here:

68 [2002bc11]For innovation and addition (k):

Only answer this question if the following conditions are met:
° ((2002a_SQ011.NAOK == "Y"))

Please write your answer(s) here:

Green analyses conducted	
Green elements adopted	

69 [2002d11]

For innovation and addition (k), how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ011.NAOK == "Y"))

Please choose **only one** of the following:

- Increase
- Decrease

70 [2002e11]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002d11.NAOK == "A1" or 2002d11.NAOK == "A2"))

Please write your answer here:

71 [2002bc12]For demolition (I):

Only answer this question if the following conditions are met:
° ((2002a_SQ012.NAOK == "Y"))

Please write your answer(s) here:

what green analysis(s) have been conducted?

what green element(s) have been adopted?

72 [2002d12]

For demolition (I), how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ012.NAOK == "Y"))

Please choose **only one** of the following:

- Increase
- Decrease

73 [2002e12]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002d12.NAOK == "A1" or 2002d12.NAOK == "A2"))

Please write your answer here:

74 [2002bc13]For "other":

Only answer this question if the following conditions are met:
° ((2002a_SQ013.NAOK == "Y"))

Please write your answer(s) here:

what green analysis(s) have been conducted?

what green element(s) have been adopted?

75 [2002d13]

For "other", how many percentage would be added or reduced to the spending to each of the items when comparing with conventional building projects?

Only answer this question if the following conditions are met:
° ((2002a_SQ013.NAOK == "Y"))

Please choose **only one** of the following:

- Increase
- Decrease

76 [2002e13]Percentage change (%)

Only answer this question if the following conditions are met:
° ((2002d13.NAOK == "A1" or 2002d13.NAOK == "A2"))

Please write your answer here:

Part III. Benefits of green building projects

77 [3001a1]

1. How much or how many percentage would be added or reduced to each of the following items when THE GREEN BUILDING PROJECT (as identified in Part I) is compared with conventional building projects?

- **Change in price per square meter**

Please choose **only one** of the following:

- Increase
- Decrease

78 [3001a2]Percentage change (%)

Only answer this question if the following conditions are met:
° ((3001a1.NAOK == "A1" or 3001a1.NAOK == "A2"))

Please write your answer here:

79 [3001b1]

- **Change in rental price**

Please choose **only one** of the following:

- Increase
- Decrease

80 [3001b2]

Percentage change (%)

Only answer this question if the following conditions are met:
° ((3001b1.NAOK == "A1" or 3001b1.NAOK == "A2"))

Each answer must be between 1 and 100

Please write your answer here:

81 [3001c1]

- **Change in premium in market valuation**

Please choose **only one** of the following:

- Increase
- Decrease

82 [3001c2]

Percentage change (%)

Only answer this question if the following conditions are met:
° ((3001c1.NAOK == "A1" or 3001c1.NAOK == "A2"))

Each answer must be between 1 and 100

Please write your answer here:

83 [3002]

2. Please indicate your degree of agreement to the following statements.

There is an improvement in ...... in THE GREEN BUILDING PROJECT (as identified in Part I) when comparing with conventional buildings.

Please choose the appropriate response for each item:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
a) Ethical Investment Opportunities	○	○	○	○	○
b) Tenant Retention	○	○	○	○	○
c) Reduction in Risks and Relative Insurance Costs	○	○	○	○	○
d) Reduction in environmental and emission costs	○	○	○	○	○
e) Reduction in Operation and Maintenance Cost	○	○	○	○	○
f) Building Value	○	○	○	○	○
g) Return on Investment	○	○	○	○	○

84 [3003]

3. What is the payback period for the additional costs of the green building designs and features? ***(in years)***

Please write your answer here:

~ End of Survey ~

Thank you!

01.01.1970 – 08:00

Submit your survey.
Thank you for completing this survey.