THE EXPANDED ROLE OF QUANTITY SURVEYOR IN GREEN BUILDINGS

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ABSTRACT

As we are facing climate change worldwide, sustainable or "green" building has been widely discussed on how to implement it onto the development for future buildings. The objectives of sustainable design and construction are to reduce, or completely avoid depletion of critical resources like energy, water, and raw materials; prevent environmental degradation caused by facilities and infrastructure throughout their life cycle; and create built environments that are comfortable and productive. This caused the construction community (architects, engineers, quantity surveyors, and environmentalists) to rethink the way buildings are constructed and the need to reduce the cost escalations and construction time frames. So in view of that, what can we expect from the design and the function of future buildings? We need a breakthrough in technologies, not only in human beings interaction, but with their surrounding environment. Future technology will be focusing on producing unique solutions and flexible components for continuous adaptability and cost efficiency. This paper attempts to consider the expanded role of Quantity Surveyor (QS) in the sustainable buildings. The research methodology employed includes literature review and case studies. The findings show the role of (QS) will involve, but not limited to, life cycle costing, value engineering, cost comparison of different building materials and cost of achieving green rating.

Keywords: quantity surveyor, life cycle cost, relevance, cost efficiency, sustainable.

INTRODUCTION

As the world population increases, we need more housings and buildings to provide us basic shelter and additional recreational needs. As we are facing climate change worldwide, sustainable building or "green" building has been widely discussed on how to implement it onto the proposed development for future buildings. It is also evident that the recent climate changes and the continuous consumption of natural resources have significant adverse impacts on our built environment. The main objectives of sustainable design are to reduce, or completely avoid depletion of critical resources like energy, water, and raw materials; prevent environmental degradation caused by facilities and infrastructure throughout their life cycle; and create built environments that are liveable, comfortable, safe, and productive. The world's population is predicted to increase from the current figure of 6 billion to 9 billion by 2050. Until then, resources would be scare and rising of energy costs and a preoccupation with preventing and minimising the effects of next man-made or natural disaster will undoubtedly shape our vision of built environment. To keep pace with these developments, approximately two thirds of the world's cities will need to be re-planned and rebuilt over the next 20 years. This will throw up many challenges for urban planners, some of which are mutually incompatible. New buildings need to be as energy-efficient, environmentally friendly and safe as possible but, at the same time, with tight deadlines and limited budgets. Quantity Surveyor (QS) is the cost expert in the construction industry, hence the traditional roles of have to be developed to accommodate green buildings in conjunction with the ever changing construction trend to make themselves stay relevant and sophisticated in the industry.

TRADITIONAL ROLE OF QUANTITY SURVEYOR

The core competencies of the QS profession are the quantification of building materials required for a construction endeavour, together with the management of the associated cost (cost management) (Tay, 2015). In addition, the QS is also expected to prepare the contract documents and partake is assessment of claims in relation to the contract (contracts management). Traditional quantity surveying services in relation to the building delivery process thus include the following (not in order of significance):

- Feasibility studies
- Measurements
- Cost planning and estimating
- Procurement strategizing and management
- Construction financial controlling
- Preparation of BoQ and tender documents
- Preparing of financial statements
- Preparation of payment assessments and invoices (including interim payments)
- Assessment of variations
- Cost Control
- Value Engineering

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Future technology will be focusing on producing unique solutions and flexible components for continuous adaptability and cost efficiency. The increase in devastating world weather events causes the construction community (architects, engineers, quantity surveyors, and environmentalists) to rethink the way buildings are constructed and the need to reduce the cost escalations and construction time frames. This is where QS's importance comes into the picture in a project development. The QS is the key advisor at all stages of the property life-cycle and has sound knowledge on the technologies and innovations. QSs in this new age need to keep abreast of the alternative building materials so as to give good advice on the cost of construction and propose a suitable method or building material for the purpose of achieving the green building rating. In order to deliver cost services for green buildings effectively, QSs are required to progressively develop their skills and knowledge. The understanding of the green products and materials is one of the key advantages of a QS to remain sustainable in the profession. In the following sections of this paper, we will do a literature review on the roles of a modern age QS in green buildings and a case study of the role played by the QS in a green building project in Singapore.

Green buildings have been promoted by the construction industry. There are changes in design, procurement, and management processes in order to integrate the principles of sustainability into buildings. Most industry professionals have experienced challenges in moving from traditional design and construction process to a new delivery method suitable for the Green Building Development. Professional QSs are of no exception, they have to move with the new trend of green buildings. A question has been raised: "are there any changes to the traditional functions of QSs, under the new wave of the Green Building Development?"

Based on questionnaire survey and interviews conducted in South Australia, the findings by Ma & Luu (2013) indicate that the traditional roles of QSs have developed to accommodate green buildings in conjunction with new roles. These changing roles in relation to green buildings include:

- sustainability strategy development
- life cycle cost appraisal

- consulting on green star system
- advising on engineering services solutions, and
- valuing sustainability of a property.

Ma and Luu (2013) states that, in a green project, QSs provide not only advices to clients/developers to establishing their sustainability targets, but also the comparable information of alternatives to the design team. This is significantly important in selecting the most cost effective option for a sustainable design. QSs' contributions also present in the later stages of the project including the preparation of tender documentations, pre-qualification of tenders and tender evaluations. These traditional tasks conducted in sustainability perspective play a major part in choosing the most suitable contractor for a green project. With the expertise in cost management, and knowledge of construction methodologies, QSs are in an important position to assist clients in achieving their sustainable objectives over the life cycle of a green project.

Ma and Luu (2013) also states that in order to deliver cost advisory services for green projects effectively to clients and other industry professionals, QSs are required to progressively develop their skills, and knowledge. It has been revealed that understanding of green products and materials is one of the key advantages for QSs to remain sustainable in the profession.

Seah (2009) states that, the world today presents different opportunities for the QS as compared to the past. The current QS requires to be equipped with the necessary skills and competencies to ride the next global wave of sustainable development in order to stay relevant. Aside from the traditional roles that a QS may feature, we will explore the various new and exciting challenges for the QS in this new era. Seah (2009) has identified the following as the expanded role of the QS in green building projects:

1. Green Costing

Cost models have to be updated to cater to Clients' needs in regards to the extra over costs for achieving the different levels of green building certification. The cost model for green buildings may vary from country to country due to the use of different green building rating system, maturity of the construction industry and the availability of materials and technology. In Singapore, the Building and Construction Authority (BCA) of Singapore has reported a cost premium of 2% to 8% for green mark platinum projects in Singapore whereas in Australia, the cost premium of achieving a similar level of certification ranges from 9% to 11% premium. The strength of the QS will be to adjust high level cost models at the feasibility stage to fit the budget and inform the design consultants on the parameters of efficiencies, design factors, concepts and controlled quantities factors and rates. This will be underlined with value management ethos as well as risk management concepts.

2. Carbon Footprint

Carbon footprint i.e. the current level of carbon emissions is essential for building owners to set benchmarks to measure carbon performance and to compare amongst other properties.

The carbon footprint for buildings includes embodied carbon and operational carbon. The embodied carbon of a building are from the CO2 produced during the manufacture of materials, their transport and assembly on site, maintenance and replacement, disassembly and decomposition. Operational carbon is carbon emissions due to the operations of the building.

The QS may add value via executing the role of a cost and carbon management consultant through the integration of cost and carbon footprint. With an established methodology, the QS will be equipped to measure the carbon footprint as well as to create various carbon models for different developments. Costing benchmarks such as $/m2 GFA may be compared against carbon benchmarks such as kg/m2 of CO2 with carbon offset factors for green cover and carbon credits.

3. Life Cycle Costing / Life Cycle Assessment

The field of Life Cycle Costing (LCC) will grow in importance in the next few years and the QS, who is an expert in cost management, is in an excellent position to gear itself for this role. LCC can be used to assist the management in the decision-making process to go green.

LCC could be applied to include environmental, social and sustainability analysis, commonly known as Life Cycle Analysis (LCA). Life-cycle assessment is a holistic methodology that attempts to quantify the environmental impacts of a product (or a larger system such as a building) through all stages of its life, including extraction and processing of the raw materials used to make it, manufacturing or construction impacts, operation and maintenance, and eventual recycling or disposal.

4. Property Performance Reporting

There are Property Performance Reporting (PPR) systems that provide independent risk assessments which measure and benchmark property performance against contemporary standards and to provide strategic measures against international and industry standards, governments reporting targets, property measurement norms and rating tools. These can be done on both a property portfolio basis and individual building basis. The PPR represents the assessment of a building's performance as an 'indexed rating' comprising of three corporate social responsibility (triple bottom line) categorised below and in this way owners can compare the buildings and how they are being managed so that the building retains value and remains competitive.

- Environmental Performance
- Social Equity Indicators
- Building Condition and Compliance

Part of the QS's scope of work includes due diligence exercises or building surveying and such PPR assessments would dovetail into QS's core competencies as well.

5. Green Building Rating Assessment

The prevalent use of green building rating systems such as LEED and Green Mark in international projects has created new inroads for the QS to exploit. Courses such as the LEED Accredited Professional and the Green Mark Manager certification have been created to enhance the understanding of the relevant Green Building rating system and environmentally sustainable designs. With a greater understanding of the green building rating systems, the QS would be able to in a better position to advise the Client both on the costing and sustainable designs.

6. Building Information Model

With the advancement in building information modelling (BIM) systems, the use of object orientated CAD may be able to contain information such as Green Assessment points, intelligent advice on usage, LCA with carbon, specifications and real time costing as well. The other key advancement to note is the automatic generation of bills of quantities from BIM. The apparent advantage of utilizing such systems would be a fundamental shift in the role of QSs to focus on higher value added cost estimating activities. Therefore, it is pertinent that the QS has to come to grasp with the advancement in information technology to stay relevant.

HOWARD (2015) states that the QS has traditionally been the professional accounting for financial cost, benefits and value and into the future, we might expect the QS to also be best placed to account for Greenhouse Gas costs, benefits and value.

The QS is ideally placed to take on this role because the QS understands buildings, specifications and measurement, traditionally the skills needed to develop the Bill of Quantities for a building to accurately determine costs and against which to manage costs through the construction phase. If the QS is measuring quantities and knows the details of specification, then the QS is best placed to measure physical material quantities and then determine the initial materials embodied environmental impacts and costs to the Developer.

In partnership with building services engineers who can estimate operating energy, water and wastes, the QS could then assess the whole building full life cycle environmental impacts and costs alongside the financial life cycle costs, understand the full cost story and implications for the building owner and tenant – different stakeholders – Developer, Owner, Tenant will be responsible (pay) for difference of the costs or benefit from different revenue streams from perhaps the purchase or sale of Greenhouse Gas credits.

Gardiner & Theobald states that QSs can encourage the construction industry to use more recycled materials from buildings which are being demolished, such as steel beams and crushing old brick and concrete for use in new concrete. In many cases this can save money as well as reducing environmental costs. QSs should also take into consideration on the shared expectations of all stakeholders' interest in an organisation's performance in order to achieve the objectives.

Gardiner & Theobald also states that the QS's role is fundamental. Above all, buildings must be affordable and constructed at an economic cost which people are prepared to pay. Sustainable development is absolutely vital, but must be balanced against longer-term economic issues. These are the challenges faced by the QS today in constructing our common future.

A research done by Ma (2013) in South Australia shows that the awareness of Green Building Development (GBD) has grown significantly since 2004. It is believed that the earliest the QSs join the green project team, the more cost effective the project would be. This is due to a few reasons given below:

1. Moving from traditional design and construction processes to a new method of delivery suitable for the GBD, professional QSs are of no exceptional to keep pace with the new trend. When QSs involved early in the planning phase, they are able to conduct feasibility and cost planning of the developments.

2. QSs provide not only advices to clients, but also providing information of alternatives to the design team. This would enable the selection of the most cost effective option for sustainable design. It would be too late for any cost remedy if QSs are involved say, in the construction phase of the development. By then, the material would have been firmed up and tender would have been called.

3. With the expertise in cost management and knowledge of material, QSs are in an imperative role to influence client in achieving their sustainability goals.

4. In the light of technology, knowledge of green building includes the use of Building Information Model (BIM) tool.

Ma (2013) also suggested that QS should:

1. Upgrade themselves with relevant skills and knowledge in sustainable development via research
2. Attend seminars on green building
3. Building up cost database by collecting costs from suppliers on green building services and products.

GREEN BUILDING DEVELOPMENT IN SINGAPORE

Singapore has established a series of long-term goals and ten-year plans to reconcile rapid economic development and environmental sustainability. It has pursued its vision of being a clean, green city using targeted policy portfolios and strong spatial planning. In Singapore, to encourage a long-term view of the sustainability of buildings, the Building and Construction Authority (BCA) launched a Green Mark Scheme in January 2005 as an initiative to shape a more environmentally friendly and sustainable built environment. The first Singapore Green Plan was first released in 1992 by then Ministry of the Environment, followed in 2002 by a new 10-year national plan, developing a national approach of integrated planning and close attention to detail. In 2009, the Ministry of the Environment and Water Resources (MEWR) and the Ministry of National Development (MND) released the Sustainable Singapore Blueprint (SSB), which outlined 5-year plans to make Singapore a liveable and lively city-state, and key strategies for Singapore's sustainable development in the long-term.

Table 1: Number of green buildings completed per year in Singapore.

Year (FY)	Number of Green Mark building projects	Gross Floor Area (million m2)
2005	17	1.1
2006	16	1.0
2007	94	3.6
2008	112	4.3
2009	188	5.3
2010	304	7.7
2011	444	13.4
2012	398	9.9
2013 (up to Sep)	123	3.2
Total	1696	49.5

Table 2: List of completed green mark award-winning green buildings where QS are engaged

S/No.	Project Title	Green Mark Award	QS Firm Involved
1	NUS University Town	Gold^{Plus} award 2009	Langdon & Seah Singapore Pte Ltd
2	The Hive (South Spine Learning Hub)	Platinum award 2013	Davis Langdon KPK (Singapore) Pte Ltd
3	Changi Airport Terminal 3	Gold award 2009	CPG Consultants Pte Ltd
4	Gardens By the Bay	Platinum award 2013	CPG Consultants Pte Ltd Langdon & Seah Singapore Pte Ltd
5	Crest Secondary School	Platinum award 2013	Barton Bruce Shaw Pte Ltd
6	DNV GL Technology Centre	Gold^{Plus} award 2013	Northcroft Lim Consultants Pte Ltd
7	313 @ Somerset	Platinum award 2008/2013	WT Partnership (S) Pte Ltd
8	Kampong Admiralty	Platinum award 2015	Davis Langdon KPK (Singapore) Pte Ltd
9	Ventus	Platinum award 2012	Davis Langdon KPK (Singapore) Pte Ltd
10	Bedok Integrated Complex	Targeting for Platinum Award	Langdon & Seah Singapore Pte Ltd

11	City Square Mall	Platinum award 2007/2012/2015	Rider Levett Bucknall LLP
12	Republic Plaza	Gold award 2005/2009 Platinum award 2012/2014	Rider Levett Bucknall LLP
13	Capitagreen	Platinum award 2012	Langdon & Seah Singapore Pte Ltd
14	The Star	Gold award 2009	Langdon & Seah Singapore Pte Ltd
15	Samwoh Eco-green Building	Platinum award 2010/2014	Samwoh Corporation Pte Ltd
16	Tsao Residence	Platinum award 2014	Samwoh Corporation Pte Ltd
17	Zero Energy Building @ BCA Academy	Platinum award 2009	Langdon & Seah Singapore Pte Ltd
18	11 Tampines Concourse	Gold^{Plus} award 2009/2012/2015	KPK Quantity Surveyors (Singapore) Pte Ltd
19	Parkroyal on Pickering	Platinum award 2012	Rider Levett Bucknall LLP
20	Ocean Financial Centre	Platinum award 2008	KPK Quantity Surveyors (Singapore) Pte Ltd
21	ITE Headquarters & ITE College Central	Platinum award 2012	Langdon & Seah Singapore Pte Ltd
22	Tree House	Platinum award 2010	Langdon & Seah Singapore Pte Ltd
23	Khoo Teck Phuat Hospital	Platinum award 2009	CPG Consultants Pte Ltd
24	Pasir Ris Sports Centre	Gold^{Plus} award 2012/2015	CPG Consultants Pte Ltd
25	Ng Teng Fong General Hospital & Jurong Community Hospital	Platinum award 2013	Langdon & Seah Singapore Pte Ltd
26	Resort World Sentosa	Gold^{Plus} award 2009	DLS/KPK IR Pte Ltd
27	W Hotel - Sentosa Cove	Platinum award 2010	Langdon & Seah Singapore Pte Ltd
28	Wisma Geylang Serai	Targeting for Platinum Award	Franklin + Andrews Pte Ltd

CASE STUDY – KHOO TECK PUAT HOSPITAL

In the paragraph below, we will look at a case study on the expanded role played by the QS in a green building project.

The case study for this paper is called Khoo Teck Puat Hospital (KTPH) owned by Ministry of Health (MOH) which was completed in year 2010 at the cost of approximate S$700 million. It aims to be a healthcare building for the future through, first, achieving a visually pleasing design that sustain with time and second, the ease and low cost of maintainability resulting from careful overall design and material selection. The outcome of the design necessitated close collaboration between its many stakeholders through an integrated manner.

Situated in the tropics, Singapore needed its own green rating system in order to address the specific requirements in responding to the climatic, natural, economic, social, cultural political and national security constraints that Singapore faces (BCA). A national green rating system, namely the BCA

Green Mark Scheme, was introduced in January 2005 to guide the design and operation of green buildings in Singapore. It is a matrix and point system, with four levels of achievement:

- Green Mark Platinum (Highest)
- Green Mark Gold Plus
- Green Mark Gold
- Green Mark certified (Lowest)

As a relatively new green rating system, there is no healthcare-specific Green Mark system. Green Mark Version 3.0 was adopted for KTPH's design, with Green Mark Platinum set as the target to achieve. KTPH was certified as a BCA Greenmark Platinum building in 2010, the highest recognition as a high performance, resource-efficient building in the Singapore and tropical context.

KTPH Project Team Organization

The organisation chart of the KTPH project team is shown in Figure 1. The integrated design approach advocated in this project brought together, at an early stage, all key stake-holders, e.g. owner, management, building designers (e.g. architects, civil & structural engineers, mechanical and electrical engineers, landscape designers, etc), consultants (e.g. cost, lighting, acoustic, façade, green design, etc), builders, users, operators, and even community representatives.

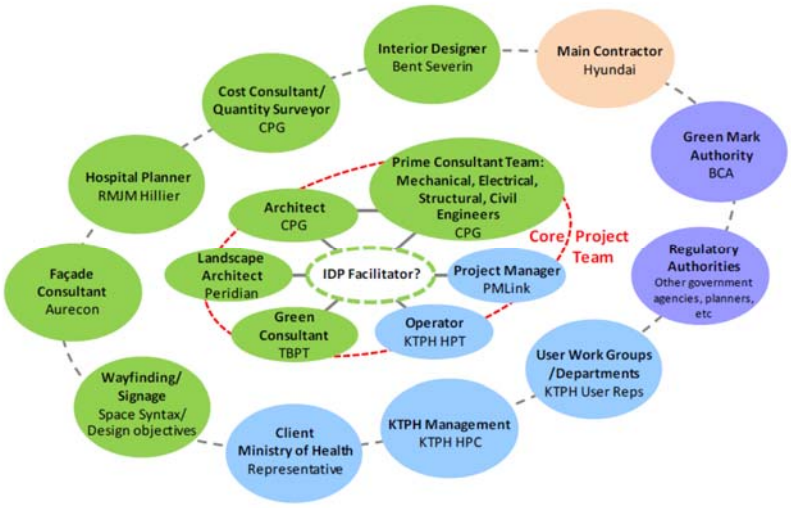

Table 3: The role and activities played by the various team members

Architect (CPG) + Façade Consultant (Aurecon)	Considered various design iterations of shading device, including aesthetics. Make design adjustment based on consultants' input.
Mechanical Engineer (CPG)	Provide the design team ETTV estimate for each iteration of shading device design option. Provide advice on the envelope performance to be targeted.
Green Consultant (TBPT)	Provide advice passive and active design strategy. Performed simulation iterations to support

	the advices. Performed daylight simulations. Performed CFD simulations and wind tunnel tests. Propose design improvement to enhance the performance of the building envelope.
Electrical Engineer (CPG)	Provide advice on estimation of energy consumption. Provide life cycle cost estimation, based on energy consumption.
Civil & Structural Engineer (CPG)	Provide advice on support system for shading devices.
Quantity Surveyor (CPG)	Provide cost estimate for each design iteration.

Role of QS in this project

The role of the QS with green design expertise is:

1. Assist team to set realistic budget, bearing in mind current market condition;
2. Help the team to understand what choices may help keep costs under control;
3. Assist team with life cycle cost analysis and ensure that both costs and credits for green features are accounted for;
4. Assist team in updated cost estimates;
5. Review final bid documents with the design team

The QS provides cost estimate for each design iteration and conducted value engineering (VE) studies.

VE1: Value Engineering Workshop

A VE workshop (VE1) was conducted at the end of the schematic design (SD) stage. An external facilitator was brought in by KTPH to facilitate the VE process. The different options of the main building elements, e.g. link bridges, M&E design strategies, and medical service strategies, etc were presented, their pros and cons discussed. QS participated actively in the VE workshop including providing cost estimates for the alternative Green Building Technology (GBT) products and construction. At the end of the VE workshop, decisions were made regarding which major design options were to be selected.

VE2: Value Engineering Workshop

A second VE workshop (VE2) was conducted during design development, primarily to decide on the façade screen design options generated. Again, an external facilitator was appointed to facilitate the VE process. The different façade screening options were presented and evaluated. QS took part in the VE workshop and provided cost estimates of alternative façade system. At the end of the VE workshop, decision regarding which option to adopt was made.

Each design iteration of the façade system were analysed in terms of its envelop thermal transfer value (ETTV) performance (by mechanical engineer), daylight performance and natural ventilation performance (by green consultant), construction cost estimate (by quantity surveyor), and estimation of life-cycle electrical consumption as an outcome to the resultant cooling load (by electrical engineer). These factors of considerations were deliberated at the VE2, allowing an informed decision to be made, balancing the considerations for view, daylight, natural ventilation, shading coefficient, aesthetic, capital expenditure, and life-cycle cost, etc.

Cost Advice During Design Development

QS provided cost advice during the design development (DD) stage. Throughout the DD, the building professionals were essentially developing the design into more specific systems and components, supported with design tools such as calculations, simulations and metrics.

During the design development stage, the QS faced the challenge of allocating sufficient budget for the proposed GBTs as there were no or limited cost information available in local context. The QS has to contact specialists or overseas suppliers for cost advice. The accuracy of the cost will depend on the adequacy and availability of information. For quotations that are in foreign currencies, the QS has to exercise extra care to account for the differences in exchange rates and to include the shipping and training cost related to the products.

Concurrently, the QS also checked on the products' procurement period and the suppliers' track records and ensured the products comply with local codes.

Life Cycle Cost and Life Cycle Analysis

QS provided the Life Cycle Cost (LCC) and Life Cycle Assessment (LCA) in this project. Life cycle cost (LCC) provides consideration of cost based on whole-life principle, which includes considerations for initial capital expenditure as well as costs associated to maintenance, operation and disposal. The use of LCC tools facilitate the project team by allowing decisions to be made based on the long-term cost impact of each iteration option. Life cycle assessment (LCA) tools such as ISO 14040 (2006) assesses environmental impact of the entire life cycle of a development, including materials processing, manufacture, distribution, use, repair, maintenance, disposal and/or recycling.

The value-added services of a QS for this project are:

1. Advising the client on the total cost impact of the building;
2. Do a cost comparison of using green materials;
3. Maintain a database of green building products from various specialists and suppliers;
4. Monitor cost closely during construction.

CHALLENGES AHEAD IN EXPANDING TRADITIONAL ROLE OF QS

As can be seen from the above, green buildings will be the buildings in the future. The effectiveness in promoting sustainable practices depends on the cost of implementation, ease of training, recognition and ease of achieving. However, there are many challenges ahead in implementing additional roles of a QS. There are a few considerations to address in order to be committed to the concept, such as:

1. Less awareness in social responsibility;
2. Less awareness in sustainable construction;

3. Less influential ability that can make current expensive sustainable methods more economically viable in the future;
4. Additional cost incurred in attending courses or seminars to broaden QS's horizon on green products;
5. Lack of sufficient cost database on green building services and products;
6. Lack of skill and knowledge on life cycle costing and life cycle assessment.

CONCLUSION

This paper presented the need for QS to transform and evolve into the ever changing construction world to stay relevant and indispensable. The QS's role is fundamental. However, implementing green building is not without its challenges. This challenge calls for transformation in the way QSs function. Most of the QS lack of knowledge and skills of green materials and products. Some may not have sufficient database for cost comparison and estimation. It has been observed that few traditional practitioners possessed detailed knowledge of the complex engineering and operational requirement. For example, the cost for specialist items are given by the specialists or manufacturers and the QS could not derive the rate from scratch or keep a cost data from it. With the growing demand on green buildings, most QS firms have expanded their core traditional services and applied life cycle costing (LCC) techniques to evaluate the financial performance of products, building equipment and elements in long-term. Henceforth, QS has to acquire such skills in order to provide and advise the necessary.

In summary, a competent QS in order to play his expanded role in green buildings shall:

1. Understand what is green buildings and Green Mark Criteria (rating tool)
2. Understanding Green Designs and Integration (including Knowing Green Products & Technologies)
3. Costing for Green (value engineering)

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