IDENTIFYING THE SUCCESS FACTORS AND FAILURE FACTORS OF GREEN BUILDING PROJECTS

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ABSTRACT

There is a global trend of green building projects over the world. In mature green building markets like the United States and Australia, there are well established green building certification systems and advanced technologies are often used in green building projects. On the other hand, in developing green building markets such as India and Korea, green building certification systems are still evolving and there is a steady increase in the number of green building projects. Despite the difference in the two kinds of green building markets, green building projects may face similar needs and challenges for successful project execution. Through questionnaire survey, this study aims to identify the success factors and failure factors of green building projects, and to compare the factors in mature green building markets with those in developing green building markets. Over 37 green building experts have completed the survey in this study. The findings show that commitment from project participants and effective collaboration among participants are common key success factors for green building projects, whereas cost consideration and lack of incentives from government are major failure factors in both kinds of green building markets. The findings also show different perceived importance of issues like collaboration, green building technologies, and project delivery methods in the two kinds of markets. This study helps practitioners in the industry to strategize and manage their green building projects effectively.

Keywords: *Failure Factor; Green Buildings; Project Management; Success Factors.*

1. INTRODUCTION

Buildings are the major contributors to energy consumption in any country. Both commercial and residential buildings together are responsible for between 20% and 40% of the world's energy consumption and these values are rising steadily every year (Pérez-Lombard *et al.*, 2008). Construction of green buildings involves innovative and at times complex design initiatives and faces a lot of challenges and obstacles during its design and construction. Since green buildings are designed and built to minimize environmental impact and consume less energy and resources than traditional buildings, successful execution of these projects is imperative. However, the growth of green buildings is not evenly spread across the world. Some countries like the United States and Australia adapted to this practice early and have evolved in terms of establishing green building certification systems and use of advanced technologies. Governments in these countries have passed laws to make green building measures mandatory. The Energy Efficiency Directive passed a legislation that requires EU governments should only purchase buildings which are highly energy efficient and EU countries must draw-up long-term national building renovation strategies which can be included in their National Energy Efficiency Action Plans (Energy Efficiency Directive, 2012). States in the US have enacted green building legislation, in which it is mandatory to satisfy Leadership in Energy and Environmental Design (LEED) standards in building construction (Washington State Legislature, 2005). On the other hand, in countries and regions like Hong Kong, India and Korea, green building certification systems are still evolving and there is a steady increase in the number of green building projects (Hwang and Tan; 2012b, Chan *et al.*, 2009). While the adoption of green building standards and technologies in developing green building markets started later than the mature green building markets, the rise of green building industry has been steady in

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the developing markets. Despite the differences, delivering successful green building projects and minimizing failure are top priorities in both types of markets. Therefore, the objectives of this study are (i) to identify the factors affecting the success and failure of green building projects, and (ii) to compare the importance of success and failure factors in mature and developing green building markets. This study considers countries like United States and Australia as mature green building market and countries or regions like Hong Kong, India and Korea as developing green building markets, according to the history of green building certification system adoption. Success and failure factors have been identified based on literature review. A questionnaire survey was conducted to determine the importance of the factors in two different green building markets.

2. LITERATURE REVIEW

2.1. GREEN BUILDINGS

When addressing green buildings, the terms 'green building' and 'sustainable construction' are commonly used and interchangeable in general. The United States Environmental Protection Agency (US EPA) defines green buildings as "the practice of increasing the efficiency with which buildings and their sites use energy, water and materials, and reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal- the complete building life cycle" (USEPA, 2015). The International Council for Research and Innovation in Building and Construction (CIB) defines 'sustainable construction' as "a holistic process aiming to restore and maintain harmony between the natural and built environments, and to create settlements that affirm human dignity and encourage economic equity" (CIB, 1999). Regardless of these perceptions, green buildings have been growing rapidly worldwide. In the United States alone, buildings contribute 41% of energy consumption and an estimated 40-48% of new non-residential construction by value will be green by the year 2015 (USGBC, 2015). There are over 10,000 USGBC LEED certified projects. On the other hand, the BEAM Plus certification system has certified over 600 projects in Hong Kong, where as the Green Mark certification system has certified over 250 building projects in Singapore by 2009 and is projected an increase of 68% in the next three years (McGraw Hill Construction, 2013; HKGBC, 2015). It can be observed from the numbers that countries like the US and Australia have adopted green buildings/sustainable practices at an early stage and have grown considerably in recent years in terms of number of buildings certified. Asian countries in general picked up green buildings/sustainable practices in the mid-late 2000s. Countries and regions like Hong Kong, India, and Korea have now established their own green building standards and showed growing numbers of green buildings and adoption of green buildings technologies. Despite the differences in the two kinds of green building markets, green building projects may face similar needs and challenges for successful project execution. While previous literatures have studied the challenging nature of green building projects, there is a gap in identifying various success and failure factors in green building projects and studying their importance in different green building markets. This study aims to fill the gap by collecting expert opinions from a questionnaire survey.

2.2. SUCCESS FACTORS

In this study, success denotes when a project meets or exceeds all its initial requirements in terms of schedule, cost, quality, green building certification, etc. Based on studied literature, the success factors were classified into four different categories, which are *(1) cost, (2) project management, (3) technology and human resources, and (4) green building codes and rating standards*. Providing innovative financial methods can reduce the high premium costs of green building projects and help more people involved. Effective collaboration and selection of integrated and collaborative delivery process will foster project relations and create more flexibility during project delivery (Lippaiova and Sebestyen, 2012). Design charrates, engaging community during project discussions and innovative management approaches can eliminate design errors and contribute to the project success by saving costs (Robichaud and Anantatmula, 2010). In terms of technology and human resources, use of advanced technologies and having skilled project participants will help achieve high performance and higher green building grade

(Heerwagen, 2000). Studies on case study projects cited engaging green building specific participants and clarity in green building standards can help participants understand the green building projects better and make the overall process straight forward. Table 1 lists the selected success factors from literature review and case study analysis with their categories.

Table 1: Success and Failure Factors

Success Factors	Failure Factors
Cost	
A1: Innovative financing and adequate finance	A1: High premium cost
	A2: Lack of government incentives
Project Management	
B1: Effective collaboration among participants	B1: Lack of collaboration within project team
B2: Selection of companies relative to project size	B2: Setting ambitious project goals
B3: Integrated and collaborative delivery process	B3: Lack of a flexible procurement and bidding process
B4: Design charrettes and community engagement	B4: Lack of management and time for green practices
B5: Innovative management approaches	
Technology and Human Resources	
C1: Skilled project participants	C1: Lack of green building expertise
C2: Support from senior management	C2: Lack of interest from client and market demand
C3: Early involvement of the project participants	C3: Lack of interest from project participants
C4: Commitment of all project participants	C4: Resistance to change to green practices
C5: Use of advanced machinery and innovative technologies	C5: Lack of information regarding green technologies
C6: Effective feedback and troubleshooting	
Green building Codes and Rating Standards	
D1: Effective environmental compliance and auditing programs	D1: Complex green building codes and regulations
D2: Early involvement of LEED professional	D2: Conflicts in LEED credits or process selection

2.3. FAILURE FACTORS

Failure denotes when a project fails to meet its initial requirements in terms of schedule, cost, quality and green building certification, etc. Similar to the success factors, the failure factors were classified into four afore mentioned categories, namely *(1) cost, (2) project management, (3) technology and human resources, and (4) green building codes and rating standards*. Common cost related factors are high premium cost and lack of government incentives. The factor high premium cost is constantly mentioned during the discussions of green building challenges. Green building projects involves installation of advanced technologies and green building materials which costs significantly higher than traditional materials. Hence there is a high investment upfront for green building projects and a major obstacle for since its early days (Yudelson, 2007). In addition, lack of governmental incentives provides no motivation for owners to pursue green buildings. In the project management category, factors like lack of collaboration and flexible procurement bidding process will minimize collaboration and give less time for participants to work together (Kibert, 2007). Setting ambitious goals can cause scope creep and make execution tough for project participants when meeting project goals and deadlines (Kibert, 2007). Lack of proper management techniques to implement green practices can also cause failure as majority of the savings are achieved in the operational stage and in the technology and human resources category, lack of green building expertise will be more challenging for project participants to execute complex green building tasks (Hwang and Tan, 2012a). Lack of interest from client, project participants and market demand will be another cause of failure as the non-commitment of the client and project participants will

hamper the efficiency of the project and no demand in the local market will have a negative impact on project finance. Resistance to change to green practices and lack of information regarding green building practices will also cause significant challenge in green building projects, particularly in the indoor environmental quality category (Kibert, 2007). In addition to published literature, green building case studies have identified complex codes and the low level of involvement of green building consultants as a major factor in project failure. The summarized failure factors with their corresponding categories are shown in Table 1.

3. METHODOLOGY

To identify and rank the different success and failure factors, an online questionnaire was prepared to collect expert opinions. Information on respondents profile and the importance of success and failure factors were collected. Respondent profile information included country, role, years of construction experience and years of green building experience. Success and failure factors are rated by a Likert scale measurement of 1-5 with 1 being strongly disagree to 5 being strongly agree. Countries with most green building projects and countries with an increase in trend of green building projects were targeted in this study. The targeted countries or regions were Australia, United States, Hong Kong, India and Korea. Among the selected countries or regions, Australia and United States were classified as mature green building market while Hong Kong, India and Korea were classified into developing green building market. Targeted population of the survey were green building professionals and a total of 300 questionnaires were sent with 50 responses received. Out of the 50 received responses, 37 responses were valid and complete. These 37 responses were then used for analysis. Out of the 37 respondents, 15 were from Australia, 9 from the US, 6 from Korea, 5 from Hong Kong and 2 from India. Majority of the respondents were engineers and contractors whereas respondents from client, project management and education sectors were also present. Out of the 37 respondents, 40% respondents had 15 or more years of experience in the construction industry and 48% of the respondents were involved in more than five green building projects. From the responses we found that the perceived failure rate of green building projects by the participants was 14%. This highlights the existence of challenges in green building projects and the need for identifying the factors leading to failure of green building projects.

4. RESULTS

4.1. SUCCESS FACTORS

Respondents were asked to rate each success factor on a scale of 1 to 5 with 1- strongly disagree, 2- disagree, 3- neutral, 4- agree and 5- strongly agree where the numbers 1 to 5 were assigned as weights for each option. Table 2 lists all the success factors and their importance as perceived by the green building experts. The weighted average of each factor has been calculated and listed along with the percentages of respondents who have chosen the option ‘agree’ or ‘strongly agree’. This helps us to identify how many participants agree with the selected list of success factors. The overall rank of each factor is listed in the last column. Table 2 shows that the percentage of participants agreeing with the success factors was more than that of failure factors. Among the different success factors, majority of the respondents agreed on the success factors that fall under the technology and human resource category. Key success factors includes, effective collaboration, having skilled participants, support from senior management, early involvement of all project participants and early involvement, commitment from all project participants and effective feedback and troubleshooting. The agree percentage of these factors were more than 70% thus emphasizing their importance. In addition to these factors, innovative financing methods, selection of integrated delivery process, design charrates and community engagement, effective environmental compliance and involvement of green building consultants were agreed by more than half of the respondents.

Table 2: Importance of Success Factors

Category	Factors	Weighted Average	Agree (%)	Rank
A. Cost	A1: Innovative financing and adequate finance	21.2	69	6
B. Project Management	B1: Effective collaboration within participants	23.4	83	1
	B2: Selection of companies relative to project size	16.4	35	14
	B3: Selection of an integrated and collaborative delivery process	20.4	62	8
	B4: Design charrettes and community engagement	20.4	55	8
	B5:Innovative management approaches	19.4	48	10
C. Technology and Human Resources	C1: Skilled project participants	21	79	7
	C2: Support from senior management	21.4	72	5
	C3: Early involvement of the project participants	22.8	79	3
	C4: Commitment of all project participants	23.2	79	2
	C5: Use of advanced machinery and innovative technologies	17.4	41	13
	C6: Effective feedback and troubleshooting	22	76	4
D. Green Building Codes and Certification Standards	D1:Effective environmental compliance and auditing programs	18.2	55	12
	D2: Early involvement of LEED professional	19.2	52	11

4.2. FAILURE FACTORS

Similar to success factors, respondents were asked to rate each failure factor on a scale of 1 to 5 with 1- strongly disagree, 2- disagree, 3- neutral, 4- agree and 5- strongly agree where the numbers 1 to 5 were assigned as weights for each option. Table 3 lists all the failure factors and their importance as perceived by the green building experts. The weighted average of each factor has been calculated and listed along with the percentages of respondents who have chosen the option ‘agree’ or ‘strongly agree’. The overall rank of each factor is listed in the last column. It can be noted that cost related factors like high premium cost and lack of government incentives have a higher percentage of acceptance than other categories. Lack of collaboration, setting ambitious project goals, and lack of management and time to implement green practices were considered the most important in the project management category. Lack of interest from client and market demand and resistant to change to green practices were agreed by more than half the respondents in the technology and human resources category. Respondents also believed complex and different green building codes can also be a great challenge in pursuing green building projects as it can cause confusion in terms of which standard to adopt and which technology to pursue.

Table 3: Importance of Failure Factors

Category	Factors	Weighted Average	Agree (%)	Rank
A. Cost	A1: High premium cost	24.6	75.6	1
	A2: Lack of government incentives	21.6	69.5	2
B. Project Management	B1: Lack of collaboration within project team	20.6	55.6	5
	B2: Setting ambitious project goals	18.8	64.8	9
	B3: Lack of a flexible procurement and bidding process	17	45.7	13
	B4: Lack of management and time for green practices	20	58.4	6
C. Technology and Human Resources	C1: Lack of green building expertise	18.4	50	10
	C2: Lack of interest from client and market demand	21	69.5	3
	C3: Lack of interest from project participants	19	49	8
	C4: Resistance to change to green practices	19.4	54	7
	C5: Lack of information regarding green technologies	17.4	44	12
D. Green Building Codes and Certification Standards	D1: Complex green building codes and regulations	20.8	52.7	4
	D2: Conflicts in LEED credits or process selection	18.4	41.7	10

4.3. COMPARISON: MATURE VS DEVELOPING GREEN BUILDING MARKETS

Previous sections listed the importance of success and failure factors by all the participants. This section will compare the responses from the mature and developing green building markets to identify the change in perception in different green building markets. Table 4 lists the ranking of certain success factors in both the markets. Most of the success factors were perceived similarly in both the markets. Ranks of success factors with major differences are listed in the table. Developing green building markets consider the cost related factor, innovative financing methods and adequate financial budgets important for project success. Mature green building markets perceive project management factors like skilled project participants and early involvement of project participants as key factors of success. Developing green building markets rates design charrates and use of advanced technology and machinery higher than mature markets. From the results, it can be understood that developing green building markets emphasize more on project cost and innovative technologies whereas mature green building markets focus more on project management related factors.

Table 4: Comparison of Success Factors

Factors	Rank in Mature Markets	Rank in Developing Markets
Innovative financing methods and adequate financial budgets	8	1
Design charrettes and community engagement	10	6
Skilled project participants	6	9
Early involvement of the project participants	3	6
Use of advanced machinery and innovative technologies	14	11

As for the failure factors, Table 5 shows that cost related failure factors like high premium cost and lack of government incentives were perceived important in both the types of markets. Lack of collaboration within project team was also considered an important failure factor in both the markets. On the other hand, other project management related factors like setting ambitious goals, lack of management and time

to implement green practices, and lack of interest from client and market demand were perceived differently. It is interesting to find that developing green building markets perceive setting ambitious goals as an important factor of failure whereas mature markets do not. Similarly, lack of interest from project participants is given more importance in developing green building markets than mature green building markets. In mature green building markets, lack of management and time to implement green practices is considered more important than in developing green building markets. This shows that while developing green building markets focuses on issues related to project design and execution, mature green building markets are emphasizing more on the operational stages of the project.

Table 5: Comparison of Failure Factors

Factors	Rank in Mature Markets	Rank in Developing Markets
High premium cost	1	1
Lack of government incentives	2	2
Lack of collaboration within project team	4	4
Setting ambitious project goals	12	6
Lack of management and time to implement green construction practices	5	10
Lack of interest from client and market demand	3	3
Lack of interest from project participants	8	4
Complex green building codes and regulations	6	6

5. CONCLUSIONS

This study compares different success and failure factors in two different green building markets. Results show interesting perceptions of the two markets. Overall, project management and human resources factors were considered as key success factors whereas cost and project management factors were considered as key failure factors. While respondents were in agreement with the success factors, certain respondents' responses to failure factors were conservative. The authors think that the reason behind the conservative responses is to show their lack of involvement in many failure projects. Developing green building markets focused more on issues related to cost, design and execution of green building projects and mature green building markets emphasized more on project management, human resources and operational issues. It is a direct indication of the evolution in development of mature green building markets and the rise of green building trends in developing green building markets. This study contributed to the identification and perception of success and failure factors in two different green building markets. In addition, it assists practitioners in the industry to strategize and effectively plan their green building projects.

Despite getting responses from green building experts from around the world, getting equal number of respondents from both the markets was not possible. This could have caused a certain skew in the final results. This study used a simple ranking of factors based on weighted average and an agree percentage measurement to identify the importance of factors. To make the analysis more robust, future work will focus on applying various statistical analysis techniques and case study validations to supplement the results and avoid anomalies if existed. In addition, impact of success and failure factors on various project performance metrics will also be considered to help practitioners focus on issues related to individual project requirements.

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