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Determining Critical Success Factors in Low Carbon Construction

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ABSTRACT

Malaysia started its involvement in sustainable development intensively by establishment of green rating tool, Green Building Index and the launching of Low Carbon Cities Framework and Assessment System in the year 2009 and 2011 respectively. However, research studies regarding the critical success factors of low carbon construction are less and not sufficient in Malaysia which plays an important role in achieving success in sustainable development and low carbon related project. This studies attempts to review the literatures in relation to critical success factors of low carbon construction. Previous studies conducted by researchers had revealed that there are six groups of critical success factors for low carbon construction which are factors related to project, project manager, project team, material and equipment, client and external factors.

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INTRODUCTION

Malaysia took decision to join the United Nation Framework on Climate Change in July 1994 (Ho and Fong, 2007) as a decision to uphold its position to control the emission of carbon dioxide into atmosphere. Malaysia involvement in low carbon construction geared towards greater stage since the establishment of Low Carbon Cities Framework and Assessment System in September 2011 by the Malaysia Government. Subsequently, Malaysia started to developed several low carbon cities in Malaysia such as Iskandar Development Region, Cyberjaya and Putrajaya (Kettha, 2011) as indicated in the Low Carbon Cities Framework and Assessment System. As an initial effort towards low carbon construction, Malaysia also had established its own green rating tool; Green Building Index (GBI) in the year 2009 while giving certification to Malaysian Energy Centre as the first green building in Malaysia on 24 July 2009 (GBI, 2015) and launching of energy related policies to enhance its development and contribution towards the success of low carbon construction. Besides that, the success of low carbon construction also depending on the identification of critical success factors of low carbon construction

The objective of this paper is to identify critical success factors in low carbon construction which will ensure the success of low carbon construction.

Sustainable Development in Malaysia:

Sustainable development in Malaysia started to grow since the establishment of green rating tool, Green Building Index, (GBI) in the year 2009. After few years of establishment of Low Carbon Cities Framework and Assessment System, several low carbon cities such as Iskandar Development Region, Cyberjaya and Putrajaya started to be developed across the country. Those low carbon cities are equipped with fundamental low carbon facilities such as proper infrastructure and communication network. Cyberjaya for instance connected with five major highways, home for 35 multinationals companies from around the world and first Malaysian city equipped with cctv connected to the Malaysia Emergency and Response System. Besides that, Wisma Shell which is the one of the first building in Malaysia accredited with the Leadership in Energy and Environmental Design (LEED) also placed in Cyberjaya (Siong,2006). Furthermore, these low carbon cities also contributed USD 20 billion in the year 2005 where estimated 60% of Johor's total GDP of USD 33.4 billion (Iskandar Region Development Authority, 2007). According to Green Building Index Sdn Bhd (2015), as of 15 Januari 2015, there are total of 281 projects certified as green building in Malaysia where consists of 135 non residential new construction, 125 residential new construction, 6 industrial new construction, 7 non residential existing building, 2 industrial existing building and 6 township.

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Sustainable Development Globally:

Countries around the world such as United Kingdom and Australia already contributed sufficient efforts towards sustainable development in their respective countries. United Kingdom had pledged to reduce carbon emission to 26% by year 2020 (UK Innovation and Growth Team, 2010). Besides reduction of emission of carbon dioxide, United Kingdom also implemented several programmes related to low carbon construction such as programmes to ensure all houses to be zero carbon beginning 2016, carbon emission reduction up to 13% for non-domestic buildings and proper sustainable transportation system which reduce emission by 14% by year 2020 (UK Innovation and Growth Team, 2010), Furthermore, existence of UK green rating tool, BREEAM also played important role in implementation of sustainable development where already certified 200,000 buildings until mid of 2012 (BREEAM,2015).

While, Australia also contributed towards sustainable development through Mandatory Renewable Energy Target (MRET) scheme in 2001 which required 20% of electricity supply from renewable energy source by year 2020 (Parliament of Australia, 2013).Besides that, introduction of the Australian Carbon Tax in 2012 which enforce companies to buy carbon permits helps to reduce emission of carbon dioxide (Dopita and Williamson, 2010)

In Asia, China has started creating own green rating tool named Three Star Rating in the year 2011 to evaluate buildings for green certification (IBE,2013) besides having several pilot project such as Tianjin, Chongqing and Shenzhen (Xintian *et al*, 2012). Chinese authority also pledged to reduce emission of carbon dioxide by 40 to 45% by the year 2020 (Los Angeles Times, 2009).

India has also taken steps towards sustainable development by creating low carbon cities such as Bhopal City which able to reduce 40% of greenhouse gases by the year 2035 (Deshpande *et al*, 2011). India also pledged to reduce intensity of carbon dioxide by 24% beginning year 2005 to 2020 (Energy Sector Management Assistance Programme Report, 2011).

Critical Success Factors:

Critical Success Factor referring to term for the element which is needed for an organization or project to achieve its target or objective. Critical Success Factor is very essential to ensure success for a manager or organization. According to Rockart and Bullen, (1981), critical success factor referring to limited number of areas in which satisfactory results will ensure successful competition performance for the individual, department or organization. Boynton and Zmud (1984) said that critical success factors as the elements needed to ensure success for a manager or an organization.

Based on the previous researchers such as Belassi and Tukel (1996), the critical success factors can be categorized into 6 categories which are factors related to project, project manager, project team members, material and equipment, client and external factors as shown in table 1 below. The factors below formed the design of the questionnaire used for the pilot survey.

Table 1: Categories of Critical Success Factors for Low Carbon Construction.

Factors Related to Project
1) Manageable construction cost from initial to final phase of project
2) Acceptable quality from overall result of the project
3) Proper project schedule before commencement of project
4) Better process checklist to monitor construction process
5) Adequate top management support for smooth process of construction
6) Flexible contractual term for smooth project progress
7) Proper method of procurement before project start
8) Proper construction method during construction process
9) Well integrated objectives of project
10) Initial green aspect finalised before project start
11) Well focused energy modelling before commencement
12) Effective project management throughout project process
13) Proper project stage implementation monitoring process
14) Effective financing method until the end of project construction
15) Simplify work processes for highly technical matter in construction process
16) Effectiveness of approval process in all stages of project by project authorities
Factors Related to Project Manager
1) Existence of competent project manager in project
2) Short term tactical review followed by long term effective decision by project manager
3) High abilities in troubleshooting by project manager in project
4) Incentive system for employees by project manager in project
5) Higher technical knowledge possessed by project manager in project
Factors Related to Project Team
1)Coordinated project participant in project
2) Good characteristic of project team
3) Experienced project team involved in project executions
4) Utilised resources available for project by project team
5) Proper relationship with all team members in project until completion of project
6) Proper green consultation from project team throughout construction process

7) Proper work related training for project team to involve in construction process 8) Proper recruitment of project team to involve in project 9) High level of communication between project team in project 10) Effective project team involvement in utilisation stage in project 11) Adequate information flow among project team during construction of project 12) Better green design innovation from project team for the project 13) Proper green design features included by the project team for the project 14) Awareness of green rating tools by project team for smooth process of green certification at project completion stage 15) Effective cooperation between project team throughout project process
Factors Related to Material and Equipment
1)Durability of building material for construction usage 2) Effectiveness of computer software to smoothen construction process 3) Usage of latest equipment to evaluate construction process 4) Execution of life cost analysis (LCA) on green materials before implementation of project
Factors Related to Client
1)Competent client in overall process of construction 2)Committed client in ensuring success of the project 3) Willingness of client to accept final project 4) Effective client involvement from planning to production phase 5) On time payment by client for completion of each stages of production
Factors Related to External Factors
1)Stability in national economy during construction process 2)High green environment requirement by regulators 3) Flexible government policies towards low carbon or green construction 4) Stability in national politics during construction process

Research Methodology:

This pilot research study is based on quantitative research adopting questionnaire. Based on the literature review, there are total of 6 main categories of critical success factors which were identified that have an impact on the success of low carbon construction. The six main categories are factors related to project, project manager, project team members, material and equipment, client and external factors. Questionnaire was designed to identify the most important critical success factors impacting the success of low carbon construction. Factors were expressed on the Likert scale of 1 (strongly disagree) to 5 (strongly agree). Besides that, open ended questions were provided to respondent inside the questionnaire for additional comments.

Data Analysis and Result Discussion:

Profiles of Respondents:

The survey involves total of 30 participants which represents 2 experts with this research topics and 28 contractors which have previous experience in low carbon construction. For the pilot study, the return rate is 100% because the questionnaires were personally administrated.

Table 2: Designation of Respondents.

Respondent Designation	Frequency	Percentage of Total	Cumulative percentage
Executive	11	36.7	36.7
Senior Executive	4	13.3	50
Manager	5	16.6	66.7
Senior Manager	6	20	86.7
Executive Director and above	2	6.7	93.4
Expert	2	6.7	100.0
Total	30	100.0	

Table 3: Respondents Working Experience in Property Industry.

Years of Experience	Number of Respondents	Percentage
1-5	14	46.7
6-10	5	16.7
11-15	4	13.3
16-20	1	3.3
21-25	2	6.7
26-30	3	10
31-35	0	0
36 and above	1	3.3
Total	30	100

Table 4: Respondents Working Experience in Low Carbon Construction.

Number of Projects	Frequency	Percentage	Cumulative Percentage
1-3	20	66.7	66.7
4-6	10	33.3	100
7-9	0	0	0
10 and above	0	0	0
Total	30	100	

Table 2 referring to group of respondent designation consists of Executive; 36.7%, Senior Executive; 13.3%, Manager; 16.6%, Senior Manager; 20%, Executive Director and above; 6.7% and finally the Expert represent 6.7% of the total respondents. As shown in table 3, majority of respondents, that is 46.7% have working experience in property industry between 1 to 5 years while only one respondent above 30 years of experience.

Table 4 shows that most of the respondents which are 66.7% have experience involving 1 to 3 numbers of low carbon projects while 33.3% of the respondents have experience working in 4 to 6 numbers of low carbon projects.

Questionnaire collected through this pilot study survey were analysed using the Statistical Package for Social Science (SPSS) software. In this pilot survey, Cronbach's coefficient alpha used to determine the reliability of the five-point scale used in the survey.

Internal Reliability:

As shown in table 5 above, factors related to project scores the highest value of cronbach's alpha (0.913) while factors related to material and equipment scores (0.744).

Table 5: Reliability Statistic for Categories of Critical Success Factors of Low Carbon Construction.

Categories of Critical Success Factors	Cronbach's Alpha	N of items
Factors Related to Project	.913	18
Factors Related to Project Manager	.785	5
Factors Related to Project Team	.865	15
Factors Related to Material and Equipment	.744	4
Factors Related to Client	795	5
Factors Related to External Factor	795	4

Conclusion and Recommendation:

Low carbon and sustainable development started to gain its momentum across the developed countries. Therefore, identification of critical success factors is vital to ensure success for low carbon construction. In this research study, questionnaire designed based on the list of 51 numbers of critical success factors obtained from various literature sources. Respondents who participated in this pilot research studies completed the survey by answering questionnaire based on five point Likert scale. Through the data obtained from the questionnaire answered, reliability test was conducted and found within the acceptable range of 0.664 to 0.984 (Cronbach, 1951). There are limitations in this research study as only reliability test was conducted for this paper as it is pilot research study. Future research should be focused on obtaining data from larger scale of respondents to conduct other test such as factor analysis and regression analysis to get more specific information regarding the research study.

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