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DETERMINING CRITICAL SUCCESS FACTORS RELATED TO PROJECT MANAGER IN LOW CARBON CONSTRUCTION: A REVIEW

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Abstract: The construction sector heeded the calls towards greener and more sustainable industry in the country. However, despite the advent made in sustainable development, not much had been done to determine the critical success factors of low carbon construction in Malaysia. This studies attempts to review the literatures in relation to critical success factors by project manager in low carbon construction. By examining literature review carried out by researchers in countries around the world, it is shown that there are five number of critical success factors for low carbon construction related to project manager. The five critical success factors are competence of project manager, timely decision, abilities in troubleshooting, practise of incentive system and possession of technical knowledge. Research findings in this study will act as a stepping stone to guide the developers and project managers towards achieving success in low carbon construction in the country.

Keywords: Critical success factors, low carbon construction, project manager, project success.

Introduction

Beginning of 10th Malaysian Plan is considered an important era for construction industry in Malaysia as recorded total of 68,394 contractors as of March 2013 and total of 6770 number of projects worth RM 112.5 billion in the year 2012 (CIDB, 2013). Besides that, sufficient effort by the developer for construction of green or low carbon building also visibly and total of 254 number of projects certified as green buildings in Malaysia as of 15 October 2014 (Green Building Index Sdn Bhd, 2014). According to Ho & Fong (2007), low carbon building refers to building which uses about 30 kWh/m^2 to 20kHh/m^2 and fitted with high level of building insulation such as energy efficient window, low level of air infiltration and heat recovery ventilation. Hong & Fong (2007), also added that in tropical countries, low carbon builders are practising the usage of passive solar building design techniques, besides involved in effort of reduction of energy usage for air conditioning and water heating. According to Construction Industry Development Boards (2014), low carbon buildings are constructed;

i) to protect the environment by using eco-friendly material during construction
ii) strictly following rules and regulation based on conservation of environmental,
iii) proper usage of waste management to reduce construction wastage,
iv) prevent the wasteful overuse of material, water and energy,
v) maintaining and protecting greenery and variability among living organism from all sources,
vi) prioritised project safety and workers health
vii) ensuring welfare of workers and
viii) managing social problem due to construction

Malaysia involvement in sustainable development started since the launch of four important policies commencing in the 80's which are National Energy Policy 1979, National Depletion Policy 1980, Four Fuel Diversification Policy 1981 and Fifth Fuel Policy 2000 (Chua & Oh, 2011). However, the total amount of carbon dioxide emission in Malaysia is increasing at higher rate each year. According to World Development Indicator (2010), carbon dioxide emission has increased from 160,266 kilo tonnes to 208,267 kilo tonnes from the year 2003 to 2008. Therefore, as one of the corrective measures, the National Green Technology Policy was launched on 24th July 2009 in Malaysia concomitant with the sustainable development in the country where the country committed to achieve 40% reduction of carbon emission intensity per GDP (Gross

Domestic Product) by year 2020 through the announcement in Copenhagen on 17 December 2009 by the Malaysia Prime Minister. Besides that, Malaysian Government also launched the Low Carbon Cities Framework and Assessment System in September 2011(Kettha, 2011)

Based on the research carried out by Spence & Helen Mulligan (1995), sustainable development in construction industry in 21st century will be an uphill task. Abidin (2010) further elaborated that sustainable development still in infancy stage in Malaysia where builders are struggling to penetrate the construction market. As already sufficient research carried out by researchers around the world such as De Wit (1998) in conventional construction, new critical success factors related to low carbon construction focusing on project manager need to be identified for success of low carbon construction. Lam *et al.* (2009), attempted research on the potential barriers on green construction where fifteen potential barriers identified which divided to economic, technological and policy. Besides that, Li *et al.*, (2011) listed down critical project management factors for delivering green building project in Singapore through previous literature. There are total of nineteen factors identified which grouped in five elements which are, human resources , technical and innovation, support from designer and senior management, project manager's competence and finally coordination of designers and contractors oriented factors.

This research also attempts to develop a framework or model which will determine critical success factors in low carbon construction in Malaysia as much needed as global emphasis of environmental awareness exist. Therefore, there are several questions which inspired this research such as what is the critical success factors related to project manager which determine success for the low carbon construction in Malaysia and what is the theoretical framework of critical success factors related to project manager.

Sustainable Development Globally

US Green Building Council (2004), mentioned that buildings in United States contributed 39 percents of overall carbon dioxide emission in United States. While United States Environmental Protection Agency (1998), further explained in the report titled 'Characterization of Building Related Construction and Demolition Debris in the United States', that building related construction and demolition debris accounting 136 million tons per year or 60% of total non industrial waste generation in the United States in the year 1996.

The United States Green Building Council (USGBC) was founded in the year 1993 which helps to contribute to green construction certification by establishing Leadership in Energy and Environmental Design (LEED) program. According to LEED (2014), 274 projects or 36.5 million of square footage are certified in United States as of October 2014. Besides LEED, a joint green rating tool program between Environmental Protection Agency of United States and United States Department of Energy called Energy Star was established. Energy Star uses nearly 40% less energy than average buildings and emit 35% less $C0^2$ (US EPA, 2013).

In Europe region, United Kingdom has committed to reduce carbon emission to 26% by 2020 and by no less than 80% by 2050 under the Climate Change Act 2008. Besides that, according to The Climate Change Act, government also needs to establish five years of carbon budget until the year 2050 (Innovation and Growth Team from UK construction industry 2010). While based on the report released by The Environmental Transformation Fund in September 2008, the original UK Climate Change programme was launch in the year 2000 to reduce UK emissions by 20% by the year 2010. Besides that, the report also stated that there are several programmes launch by the UK government to curb the emission of carbon dioxide towards achieving sustainability in construction such as 'The Review of the UK Climate Change Programme' aimed to reduce

emissions by 12 million tonnes of carbon by 2010. While based on the explanation given by Morrell (2010), the chairman of Steering Group, Innovation and Growth Team from United Kingdom construction industry, construction process developed 10% of overall proportion of total United Kingdom carbon dioxide emission.

In United Kingdom, BREEAM assessment system being used to recognise measure of performance and rating system for building in term of building environmental performance. Until September 2013, BREEAM already certified over 4179 buildings around United Kingdom since BREEAM launched in 1990 as of 2013. Projects are accessed based on nine categories which are management, energy, transport, health and well being, water, materials, waste, land use and ecology and pollution (BRE Global Limited, 2013).

While in Australia, an independent research based and a non-profit organization called 'Climate Works Australia', explained that building in Australia accounted 18% of Australian greenhouse emission in 2010 where residential building accounts for 58% and commercial building accounts for remaining 42% of total emission (Climate Works Australia (2010). Meanwhile as one of the effort, Australian Government has pledged to provide 20% of the nation's energy from renewable energy source by the year 2020 and expecting to increase the percentage in future aligned with the Howard government which introduced a Mandatory Renewable Energy Target (MRET) scheme in 2001 which requires 20% of electricity supply from renewable energy sources by year 2020 (Parliament of Australia, 2013). While in term of certification procedure, The Carbon Reduction Institute was established in Australia to promote a low carbon economy in Australia. The Carbon Reduction Institute provides certification for overall carbon reduction activities. Some other sustainable development event which took place in Australia is the launching of Australian Carbon Tax on 1st July 2012 and the remark given by the International Energy Agency (IEA) Executive Director Maria Van Der Hoeven in the year 2006 on the report titled' Energy Policy of IEA Countries: Australia 2012 Report' regarding effort taken by Australia to increase and improve low carbon energy in the country (International Energy Agency, 2012) .The main objective of formulation of The Australian Carbon Tax by Julia Gillard's government on 1st July 2012 was to enforce companies emitting over 25000 tonnes of carbon dioxide annually to buy carbon permits as a corrective action to reduce greenhouse gas emission in Australia by 80% in 2050 (Carbon Reduction Institute, 2012). According to report titled 'A Clean Energy Future for Australia by the Clean Energy Future Group in 2004, Australia's greenhouse pollution can be greatly reduced by the year 2040 by combination of several energy efficiency technologies such as wind turbines, solar thermal, solar photovoltaic, biomass combustion, fuel cells, geothermal, wave energy and tidal energy (Saddler, 2004). In Australia, there are 779 projects certified by Green Building Council of Australia (GBCA) as of October 2014 (GBCA, 2014).

While in Asian continent, China also involving in reduction of emission of carbon dioxide and increase the activities of sustainable development. China has created its own green rating system. In the 2011, China Housing Industry Association, Tsinghua University, Chinese Academy of Building Research and other institutes established China Green Housing Rating System which named 'Three Star Rating System' to assess the building sustainability and to improve the design quality of building. The rating system is managed by the Ministry of Housing and Urban Rural Development and building certified by the China Green Label Office at the China Green Technology Centre (Institute for Building Efficiency, 2013). Besides that, green buildings in China also rated through by another international green building rating system managed by the US Green Building Council named LEED.A look on the scenario of sustainable development in China shows that as of July 2009, there were 30 buildings that have achieved green building certification under LEED Green Building Rating System. There are another 10 buildings have been certified under

other green building certification system while 210 buildings are pursuing to get certification once construction process completed (Crachilov *et al.,* 2009). The Government National Development and Reform Commission launched a pilot project to construct low carbon cities in five provinces which are Guangdong, Liaoning, Hubei, Shanxi and Yunan. Besides that, there are eight low carbon cities involved which are Tianjin, Chongqing, Shenzhen, Xiamen, Hangzhou, Nanchang, Guiyang and Baoding (Xintian *et al.*, 2012). Xintian *et al.* (2012) has elaborated that China has created Urban Development Model Evaluation System to help cities realizing the low carbon city construction which will lead the developer towards a solid basic for the implementation stage of low carbon city construction. One of the examples of eco-city is Dongtan Eco-City, located on Chongming Island at the mouth of Yangtze River designed by London based company named Arup. The project was funded by both UK and Chinese government. Electricity formed the main source of energy supply where all heat and fuel are to be provided by renewable means. All the buildings will able to save energy by using energy efficient equipment and system inside the building. Energy is supplied through grid and electricity. Buildings in Dongtan Eco-city were constructed combining traditional and modern technologies and have capabilities to reduce 70% of energy consumption (Hald 2009).

India which formed a part of Asian region together with China, also on the move towards reducing emission of carbon dioxide and stepping towards sustainable development. India has a relatively low carbon footprint due to 400 million people who still lack of access to electricity and 456 million of people in 2005 were still living at US$1.25 a day. But still, emission of carbon dioxide in India may increase in coming year as the Indian economy is all set to flourish where per capita GDP bound to double up in 10 years of time frame as indicated in India's 11th Five Year Plan for 2007 until 2012 (Energy Sector Management Assistance Programme Report, 2011). India has emitted 1.6 billion tons of carbon dioxide in the year 2005 and expected to release five to six billion tons of carbon dioxide between year 2025 and 2030 (Mckinsey, 2009). As a counter measure, India has committed to reduce the carbon intensity of its economy by less than 24% beginning year 2005 to 2020 in Copenhagen. Besides that, the Indian government has introduced the national solar mission with targets of installing 20,000 MW of solar capacity in India by the year 2020 (Makhijani & Ochs, 2010).

Based on the estimation given by Sathaye *et al*. (2010), Indian cities have annual energy growth rate of 10% where more energy consumed in the non-residential and commercial sectors. Most of the non-residential and commercial buildings which are newly constructed have higher energy usage than the existing buildings. In India, there are many growing cities and one of the eco-city which is known is Bhopal city. Bhopal city was expected to release emission around 2.5 million ton CO^2 in 2005. The total of emission expected to rise 6 times around 14.2 million to CO^2 by the year 2035. But as the city is equipped with energy efficiency improvements, development of renewable energy and other regulation and policy to promote sustainable development, it is expected to reduce 40% of Greenhouse Gases by the year 2035 (Deshpande *et al.*, 2011).

Sustainable Development in Malaysia

Malaysia similar to efforts by other countries of the world such as Australia and United Kingdom also have taken drastic steps by ensuring commitment into legal obligation to achieve transition of low carbon construction over the next 40 years (CIDB, 2012). As there are various green building rating schemes across the world such as Green Star, LEED and BREEM (Kibert, 2007), Green Building Index was introduced by Green Building Index Sdn Bhd since certification of Malaysian Energy Centre as first green certified building on 24 July 2009. In Malaysia, according to Green Building Index Sdn Bhd (2014), there are total of 254 number of projects certified as green buildings out of 621 number of projects applied for green certification as of 15

October 2014. Total of 621 numbers of projects consists of 320 non-residential new projects, 248 residential new projects, 18 industrial new projects, 19 non- residential existing projects, 3 industrial existing project and 13 township projects. Besides that, there are other foreign green rating system that have issued certification to buildings in Malaysia which are by The US Green Building Council (LEED) from United States and BCA Green Mark from Singapore.

Based on the explanation given by Hezri & Hasan (2006), there are two factors or reasons which influenced Malaysia to move towards sustainable development. First, Malaysia with a good economic stability which leads the Group 77 is driven to explore sustainable development concomitant with the diplomatic influence of the country among developing nations in the world. Secondly, Malaysia started stepping into sustainable development since the allegation of uncontrolled forest clearing by the international community in Sarawak (Brosius, 1999). Meanwhile, Malaysian also launched several national policies such as National Energy Policy (1979), National Depletion Policy (1980), Four Fuel diversification Policy (1981) and Fifth Fuel Policy (2000) as measures to curb the emission of CO^2 and as an effort towards sustainable development in the country. Launching of National Green Technology Policy (NGTP) in 2009 further diversify the effort of sustainable development in the country. As a subsequent effort, the Green Building Index Sdn Bhd (2014) also able to establish Green Building Index (GBI) system through the Malaysian Architect Association and the Association of Consulting Engineers Malaysia (ACEM) in the same year. The Green Building Index (GBI) system is to evaluate the Malaysian buildings based on six main criteria which are Energy Efficiency, Indoor Environmental Quality, Sustainable Site Planning and Management, Material and Resources, Water Efficiency and Innovation. Pusat Tenaga Malaysia or Malaysia Energy Centre is officially Malaysia's first Green Building Index (GBI) certified building. Pusat Tenaga Malaysia was certified on 24 July 2009 under the "Certified" GBI rating which counts in between 50 to 65 points.

Since the launching of Green Technology Policy and Low Carbon Cities Framework and Assessment System on 24 July 2009 and September 2011 respectively, Putrajaya, Cyberjaya and Iskandar Development Region (IDR) are chosen to be developed as green or low carbon cities and as a guidance for the development of other townships in the country. Rizzo & Glasson (2011) mentioned that Iskandar Development Region (IDR) which covers an area of about 2,216.3km^2 was developed in 2006 to become a fully evolved state and as an unify connection point between Singapore and Indonesia. Initially, as reported by Ho & Matsuoka (2011), Iskandar Development Region (IDR) was chosen by group of Malaysian and Japanese low carbon research group as the first research opener in low carbon city development in the country. The research team consists of researchers from University Teknologi Malaysia, Iskandar Regional Development Authority, Kyoto University, Okayama University, National Institute for Environment Studies and Science and Technology Research Partnership for Sustainable Development. The research period is expected for 5 years beginning from the year 2011 to 2015 where results of the research findings will be used for the developments of other cities and region in Malaysia and worldwide. Ho & Matsuoka (2011), also added that the research still in preliminary study in the year 2012 which involves the process in identifying the amount of carbon emission of Iskandar Malaysia and mitigation measures towards achieving low carbon region. Malaysia is still in initial stage in term of sustainable development if compare with other developing countries (Hezri, 2005), due to economic development and lack of control of its rain forest (Hezri & Hasan, 2006).

According to Construction Industry Development Board, (2013), there are several methods used for green practises for low carbon construction in Malaysia such as 5S method, environmental management system and on-

site environment best management practises (BMP). 5S practises referring to 5 principles of housekeeping practises which are cleanliness, standardise, discipline, organize and orderliness. Organizing is referring to grouping of material to three groups of usage frequencies which are low, medium and high. Orderliness refers to process of ensuring materials have clearly designated name and place. Cleanliness refers to process to ensure construction site clean and free of accident. Standardise refers to maintaining standard operating procedures at all time. Finally, discipline refers to process which ensures self discipline through continues practise. Meanwhile, environmental management system refers to sets of process and practises to monitor environmental impact by builders during construction process. Contractors in Malaysia also practises on-site environmental best management practises (BMP) to monitor environmental impact during construction process through related practises such as on-site housekeeping, waste management practises, dust and mud control, erosion and sediment control, noise and vibration control, pest and vector control, workforce management, energy efficiency and lastly water efficiency.

Critical Success Factor

Based on definition given by Rockart & Bullen (1981), critical success factor refers to limited number of areas in which satisfactory results will ensure successful competition performance for the individual, department or organization**.** Friesen & Johnson (1995), described critical success factors as the things an organization must do well is to achieve its strategic goals which represent those managerial and enterprise area that must give special and continual attention for high performance. Leidecker & Bruno (1984) considered critical success factors to be those factors that allow a firm to successfully compete in particular industry. Meanwhile, Boynton & Zmud (1984) stressed about the importance of critical success factors for the project manager to ensure success for an organization. Boynton & Zmud (1984), also added on the importance of critical success factors in improving risk management implementation action, increment of production output by staff motivation, enhancement of company position in market and increment of source of customer base. Rockart & Bullen (1981) has presented five key sources in critical success factors which are industry, competitive strategy and industry position, temporal factors environmental factors and managerial position.

Critical Success Factor in Low Carbon Construction

This study discussed about the critical success factors for low carbon construction which are based on project manager in construction process.

Factors Related to Project Manager

Factors related to project manager referring to critical success factors which generated through project manager in a project which may influence the success of low carbon construction. There are a total of 5 number of critical success factors identified by authors related to project manager which are;

i) Competence of Project Manager
ii) Timely Decision
iii) Abilities in Troubleshooting
iv) Practise of Incentives System
v) Possession of Technical Knowledge

Competence of Project Manager

Competencies of skills by Project Manager in low carbon construction are essential for success. Hwang & Ng (2012) supported that the competencies of skill by project manager will ensure the success of green construction. Hwang & Ng (2012) elaborated that project manager must effective in schedule and planning management in green construction. Hwang & Ng (2012) also included that competency in communication management by project manager is vital for success of green construction as project manager need to be detailed when planning the project. Besides that, effective communication management is important in green construction

as project manager need to ensure information is communicated to all the parties including green specialists and architects. According to Odusami (2002), communication was ranked the most important and critical skill for a project manager to achieve success in a project. In low carbon construction, communication plays key factor in educating other team members by the project manager in waste recycling where demolition and construction waste were to be separated in waste stream such as plastic, concrete and timber. Therefore, communication is important in conveying green intent of project to team members in low carbon construction.

Besides that, project manager needs to equip with project management competencies skills with clear understanding of resources efficiency in low carbon construction (HM Government, 2011). Additionally, coordinators such as architect or project manager also need to equip and competent with essential low carbon construction skill such as commissioning, ensuring delivery low carbon design and metering and monitoring (RIBA, 2008). Robichaud & Anantatmula (2011) also agreed that proper communication among the project team during construction of green buildings will contain the construction cost.

The project manager also needs to frequently visit the site to ensure sustainable practise to be implemented on site (Tagaza & Wilson, 2004). They also added that to achieve the objective of sustainable practices, project manager must follow strategy such as "environmental policing". According to HM Government (2011), the success of implementing green related theories and policies is depending on the availability of skilled people. This phrase suits well for project manager in low carbon construction sector.

Timely Decision

Besides the existence of competent project manager, Isik *et al.* (2009) also highlighted that all project related matters need to be reviewed as soon as possible while a proper long term effective solution identified for the issue. This will ensure the operation of construction project without major obstacle towards success. Gushgar *et al.* (1997) also pointed out that project manager need to take proper decision in limited time, information and resources.

Chan & Kumaraswamy (2002) stated that in low carbon construction time plays crucial role for success in low carbon construction. Therefore, delay in decision making increase cost and damage the time related clauses in specification of low carbon project (Arditi & Pattanakitchamroon, 2006). Shenkar *et al.* (1997) also clarified that project managers are accountable for long term success for the project based on the decision taken. Bass (1999) mentioned that project manager must avoid late decision making attitude while attending to problems as problem may become chronic when left unattended. Time also considered prime project objective in Singapore especially in low carbon construction (Ofori & Kien, 2004). While Zimmerer & Yasin (1998) have stated that project tend to face failures due to lack of project manager in taking effective timely decision and followed by corrective action to constraint time and cost in a project. Besides that, they also stressed that project manager must quickly make effective decision for client related issues to avoid disputes or confrontation with stakeholders in advance stage of construction.

Abilities in Troubleshooting

The project managers must know the proper method and techniques to troubleshoot problem encounter during the construction process. Pinto & Slevin (1989) mentioned in their research work regarding the importance of possessing troubleshooting skill by project manager in the construction project. Munns & Bjeirmi (1996) elaborated that there are several key point which are vital to ensure success in construction process including appointment of proper project manager to troubleshoot construction related issues in project. According to Hwang & Tan (2010), there are several common obstacles in low carbon construction such as lack of communication, knowledge and interest among

team members regarding green related items. As a solution Hwang & Tan (2010) added that, project manager or coordinator may arrange special green awareness training by professional such as architect and engineer or arrangement of tool box meeting regularly may troubleshoot the problem. Besides that, project manager needs to regularly visit green construction to trouble shoot problems at site related to sustainable practises where workers tend to forego time consuming sustainable practises in limited time given to complete the project. The project manager must be able to troubleshoot all the problems and obstacles encounter in the project as Brown (1983) has said that an effective project manager refers to project manager which has the ability to work closely with quality, willing to carry the responsibility, easy handling of crisis and problems and able to make proper decision in solving problems. According to Fotwe & McCaffer (2000), in term of problem solving, project manager needs to combine the traditional construction knowledge to come out with new perceptive project management techniques.

Practise of Incentives System

Munns & Bjeirmi (1996) also stressed the importance of rewarding activities practised in the project for the project participant by the project manager to boost the motivation level. This may also lead the project participant to work harder towards success in low carbon construction. Kerr & Slocum (2005) have agreed that rewards system implemented in project may function as a tool controlling behaviour of project team members and to strengthen the relationship with the employees and the superiors. While Lawler (1995) said that rewarding system may influencing the project by six ways which are;

i. Attracting and ensuring the existing employees
ii. Help boosting the motivation level of employees
iii. Help workers to work harder to enhance the skills and knowledge of low carbon construction
iv. Revealing corporate culture
v. Strengthening the structure
vi. Determining pay costs.

While Laufer *et al.* (1981) also supported the incentives system such as implementation of financial incentives to workers may help to motivate the workers to drive the productivity to greater height. Hwang & Tan (2010) explained that incentives such as bonuses provided to staff for achievement appreciation such as successful completion of green certification or completion of difficult stages in construction processes in low carbon construction. Kossbiel (1994) added that incentives system may help the employees to move from uncooperative position to cooperative position at higher level. Ward *et al.* (1991) said that incentives system tends to improve the performance of employees as works is a tool to extract outstanding level of performance from the employees. Shr & Chen (2003) said that incentive system also tend to fasten the project progress to finish ahead of project schedule. Bubshait (2003) also concluded that incentives system are linked with basic objectives of project which cost, time and schedule.

Possession of Technical Knowledge

While, Eisenberg *et al.* (2002) said that there are two main reasons which create obstacles during green construction which are, lack of technical expertise and unfamiliarity with the products, materials, system or design. The project manager which leads the overall construction team needs to be possessed with high technical knowledge of the overall construction activities. According to Ahadzie *et al.* (2008), the project manager must possessed with knowledge of technical aspect of the industry to an extent that the project manager understands the product and service being built and delivered. Iyer & Jha (2005), have also mentioned that through their research studies conducted on the factors affecting cost performance of Indian construction project, it is revealed that project manager needs technical capability during execution process in a project. Goodwin (1993) has pointed out that possession of technical knowledge is essential

Table 1: List of critical success factors in low carbon construction related to project manager from previous literature

List of Sources	Competences of Project Manager	Timely Decision	Abilities in Troubleshooting	Practise of Employees Incentives	Possession of Technical Knowledge
Hwang & Ng (2013)	X				
Odusami (2002)	X				
Tagaza & Wilson (2004)	X				X
Arditi & Pattanakitchamroon, (2006)		X			
Chan & Kumaraswamy (2002)		X			
Ofori & Kien (2004)		X			
Robichaud & Anantatmula (2011)	X		X		
Hwang & Tan (2010)			X	X	
Eisenberg *et al.,* (2002)					X
Meryman & Silman (2004)					X
RIBA (2008)	X				
HM Government (2011)	X				

for successful project manager. He added that project manager needs technical knowledge related to construction activities to comply with project requirement in term of budget, schedule and specification. Project manager mastered with technical knowledge may easily resolve problems related to technical aspects during design and implementation stage in the project. Besides that, any suggestion and remarks given by consultant during project execution may easily understand by technical possessed project manager while ensuring proper solution taken by project team under the supervision by project manager. Although, Sahlin (1998) had play down the needs of technical knowledge for project manager, he finally agreed about the importance of technical knowledge skills to analyse the project report by the project team members. Tagaza & Wilson (2004), pointed out that one of the main barrier in green building construction will be the technical constraints encounter during the construction processes. Besides that, Meryman & Silman (2004) further explained that, one of the technical barriers during low carbon or green construction is the unwillingness to change the conventional way of specifying existing materials and processes by the project team members. A technically knowledgeable project manager may ease the situation through proper motivation to team members.

Discussion

Low carbon construction started to gain popularity since the 1980's in USA, United Kingdom, Australia and developing countries such as Malaysia, Singapore, India and China. Awareness regarding low carbon construction started to rise sharply among major countries in the world since the alarming raise of carbon dioxide emissions into atmosphere through various activities by countries around the world which causes green house effects. As part of several efforts taken by governments around the world to reduce carbon dioxide emission and promote energy efficiency, construction of low carbon buildings are considered by construction

related organization to achieve optimum energy efficiencies by effectively using the resources of energy, water and raw materials. Besides that, identification of critical success factors related to project manager for low carbon construction through this study will encourage the project managers and developers in Malaysia to start building low carbon units rather than conventional units which may compromise its design in term of environmental aspects.

Figure 1 illustrates the theoretical relationships between the list of critical success factors related to project manager and the success of low carbon construction. After the literature reviews have been completed, the critical success factors have been examined, identified, selected, and synthesized. The factors related to project manager are being represented by these variables: (1) Competence of Project Manager, (2) Timely Decision, (3) Abilities in Troubleshooting, (4) Practise of Incentives System, (5) Possession of Technical Knowledge

Conclusion

Construction activities involving low carbon constructed units are started to increase around the world. World leading nations such as United States and United Kingdom pledged to increase low carbon construction and reduce conventional constructions to significant figure in 10 years. While in Malaysia, government initiative in embracing sustainable development is visible through the formulation of several environmental policies and establishment of low carbon cities across the country. Besides that, effort taken by private developers to build and certified large number of green buildings in Malaysia reflected the passion and responsibility of the developers in environmental preservation. Furthermore, in future, this study suggests that identification of the critical success factors related to project managers which are competence of project manager, timely decision, abilities in troubleshooting, practise of incentives system and possession of technical knowledge may steer Malaysia construction industry towards great achievement in low carbon construction as par as leading nations in the world.

Research Limitation and Future Study

The current study has some limitations while creating path for future research. This study has evaluated the current literature contributed by researchers related to the critical success factors in perceptive of project manager on low carbon construction around the globe. As the overall topic is large, future researchers in Malaysia should take the opportunity to explore further on the other group of undisclosed critical success factors such as related to project team, client, equipment and external factors in low carbon construction. Besides that, findings from this study should be used for reference by project manager to drive low carbon construction in the country towards success as there is no proper critical success factors framework available as a guideline for developers and project managers in Malaysia. Future researcher should also try to help the government to boost the success rate of low carbon construction in Malaysia by providing data obtained through research for evaluation process and further development of existing low carbon cities across the country such as Project Iskandar and Cyberjaya which

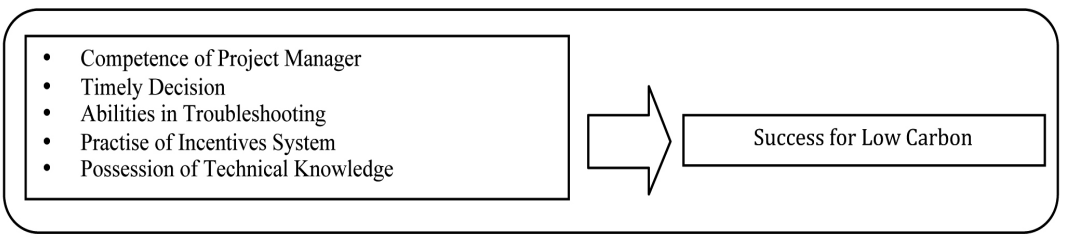

Figure 1: Critical success factors related to project manager which influenced success for low carbon construction

may help the government in its long term plan of achieving sustainable development in Malaysia.

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