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ASSESSING THE READINESS OF CONTRACTORS IN IMPLEMENTING LOW CARBON CONSTRUCTION IN PENANG

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ABSTRACT

Global warming or climate change is becoming the main concerns of humanity as it leads to an increase in Earth's temperature and rise in the oceans' level which is due to the increase of greenhouse gasses in the atmosphere. Greenhouse gasses consists of water vapour, carbon dioxide (CO2), methane (CH4), nitrous oxide (N20), tropospheric ozone (O3) and chlorofluorocarbons (CFCs). Among the gasses, CO2 is the highest and easiest gas to measure as it is emitted from human economic activities with construction industry one of the major contributors of carbon emissions. Low carbon construction is the reduction of carbon emissions from the construction activities during construction process. For the implementation of low carbon construction in our construction industry, the contractors need to be ready and have knowledge to adopt low carbon construction industry. The purpose of this research is to determine the level of contractors' knowledge towards low carbon construction, determining the level of readiness towards low carbon construction and proposing a checklist for the contractors towards low carbon construction in Penang.

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This research employed questionnaire survey to analyse the level of knowledge and readiness of the contractors on low carbon construction. As a conclusion, the implementation of low carbon practices by the contractors in Penang is good, therefore established that G7 contractors implement low carbon practices throughout their construction. However, the results and findings indicated that the average mean score on the level of readiness of contractors towards low carbon construction is 3.59. The result was perceived as moderate. Therefore, it shows that the contractors are in a moderate readiness to implement low carbon construction fully in their construction projects. A checklist was established by summarizing the highest low carbon activities from each category which were sustainable site planning and management, materials and resources, waste management, water efficiency and energy efficiency, and was perceived as good.

Keywords: Climate change, greenhouse gases, carbon emission, low carbon construction, contractors' readiness.

1. INTRODUCTION

In the recent history, climate change has become one of the main concerns of humanity [1]. The changing of atmospheric composition is the cause of global warming or climate change results to increasing earth temperature. The increasing temperature of the Earth's atmosphere and oceans is the due to building up of greenhouse gases in the atmosphere [2]. The increased levels of greenhouse gases in the atmosphere cause the sun's heat to be retained in the atmosphere by absorbing infra-red radiation that should be reflected back into space and is resulted from human activities. Greenhouse gases consist of water vapour, carbon dioxide (CO2), methane (CH4), nitrous oxide (N20), tropospheric ozone (O3) and chlorofluorocarbons (CFCs). The unavoidable fact is the negative effects of greenhouse gases emission and global warming not only impact the environment and economy, but also the human's health. Yale University published greenhouse gasses producers' world ranking, Malaysia was 26th country by final score 84 among 149 countries. Conspicuous progressive in industry and increasing rate of the population are the main cause to the rising rate of greenhouse gasses generation in Malaysia. The pollutant production in Malaysia affects the agriculture, forestry and tourism industry in this country. In additional, the most important effects of greenhouse gasses is on the human health which are heart stroke, respiratory and

cardiovascular problems, respiratory and cardiovascular problems and the risks of death from dehydration or referred to black carbon, ozone and sulphates.

According to Lam et al., 2010; Tsai et al., 2013, many countries has accuse construction industry as the major contributors of carbon emission [3]. Sequestrating and reducing greenhouse gasses production is the solution to climate change [4]. Due to the rising rate of greenhouse gasses, the government was convinced to invest in greenhouse gasses reduction through different programs [1], and one of the programs is sustainable development. The construction industry has developed a sustainable construction in contributing to the effort to achieve sustainable development.

Enhancing and better protecting the natural environment and minimising its impact on the consumption of energy especially carbon-based energy and natural resources are one of the many strategies for sustainable construction that was published in 2000 by the Department of the Environment, Transport and the Regions – DETR in year 2000,, which followed on from the 1999 priorities and this document set out ways that the construction industry could contribute to the achievement of more sustainable development [5]. In additional, to control the rising rate of greenhouse gases production in the world, many activities have been performed by different countries such as United Nations Framework Convention on Climate Change (UNFCC) which is the nonbinding protocol goaled to reduce greenhouse gasses production which is agreed by 150 countries and was adopted by The Kyoto Protocol (KP) in December 1997 by the countries in UNFCC with content of an international treaty to fight climate change by urgent global greenhouse gasses reduction which is similar to UNFCC. However, the countries are listed as Annex 1 and non-Annex 1 where developed countries are bound to reduce the rate of greenhouse gasses according to the related timetables to the specific amount, and in the opposite, the non-Annex 1 countries are not bound to reduce greenhouse gasses. Malaysia, a developing country is listed in in non-Annex 1 and approved the KP at September 2002 and has no obligation for emission reduction; however Clean Development Mechanism (CDM) created a window for non-Annex 1 countries like Malaysia to participate in greenhouse gasses reduction in sustainable offered by KP for Annex 1 countries [1]. It was identified that 70% of the national carbon emission is caused by these urban developments., therefore Malaysia aimed to reduce forty percent (40%) of carbon emission by the year of 2020 as compared with its levels in 2005 at the United Nations Climate Change Conference 2009 in Copenhagen (COP15) and as it is necessary for urban areas in Malaysia experiencing rapid urbanization (70% of urban population with 3% annual rate of increase) to be regulated and minimize its carbon emission to be in line with Malaysian

Government effort at the United Nations Climate Change Conference 2009 in Copenhagen (COP15) (Bernama,2009) as cited in [6].

Therefore, low carbon construction is one of the solutions under sustainable development for carbon reduction in the construction industry. However, low carbon construction is not applied in the Malaysia as it is still in infancy stage; therefore this research is carried out to identify the contractor's readiness towards low carbon construction in Malaysia.

I. THE NEED TO IMPLEMENT LOW CARBON CONSTRUCTION ON CONSTRUCTION SITES

Evidently, Malaysia has relatively high energy consumption and CO2 emission compared to other middle-income developing countries. Commercial and residential buildings comprise about 13% of total energy consumption and 48% of electricity consumption. In additional, it is expected energy-intensive industries in the industrial sector such as chemical, cement and ceramic, iron and steel and food processing to remain the major consumers [7].

Consequently, it is revealed that there is need for construction organizations to establish frameworks for managing and avoiding the carbon-related risks derived from their construction projects. The content of the framework should assist the organization to identify their level construction carbon emissions, explore their mitigation opportunities, and internally and externally report the results of their mitigation efforts. The efforts on the improving productivity in construction processes results in the reduction of carbon emission. However, the contractor plays an important role in the reduction of carbon emission in construction processes as the range of project activities in construction sites are controlled by the contractor. The effects from on-site equipment operations, transportation of material and selection of materials sometimes governed by the contractors at the design phase on carbon emissions are all controlled by the contractor [8]. Hence, contractors play an indispensable role in reducing carbon emissions under their control [3].

II. RESEARCH OBJECTIVES

The research is to achieve the following objectives:

1. To determine low carbon construction practices on site.
2. To identify the level of readiness of contractors in Penang towards low carbon construction.
3. To establish a checklist of low carbon construction implementation for contractors in Penang.

III. LITERATURE REVIEW

A. Global Warming and Green House Gasses

The average global surface temperature has increased over the last century and it is caused by the increasing concentrations of greenhouse gasses contributed by human activities, where it has caused severe climate change, rises in sea level, massive flooding, landscape changes and infectious disease spread [9]. The statement corresponds with the study that stated the impact of greenhouse gasses is large enough to change global climate [4]. Greenhouse gases increases the atmospheric temperature as it absorbs more heat energy than other gasses such as oxygen and hydrogen, therefore trapping more heat within the gasses. The more greenhouse gasses trapped in the atmosphere, the more solar heat is trapped in the gasses and results to increase in atmospheric temperature which leads to climate change. The greenhouse gasses consist of gases like carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), water vapour and some Volatile Organic Compounds (VOCs).

B. Carbon Emission in the Construction Industry

The levels of certain greenhouses gasses in the atmosphere are contributed by human activities. Among all of the gasses, large percentages of CO2 emissions in the world are contributed by construction and building sector [10]. The building sector contributes carbon emission through electricity use were about 8.6 GtCO2, 0.1 GtCO2-eq N2O, 0.4 GtCO2-eq CH4 and 1.5Gt CO2-eq halocarbons (including CFCs and HCFCs) and the direct energy-related carbon dioxide of the building sector were about 3 Gt/yr [7].

In addition, large amount of carbon is generated from the construction industry through planning, design, construction, installation, maintenance, operation, decommissioning, and demolition of buildings. According to a study in the United Kingdom, buildings contributed about 50% of the UK's carbon emissions and construction contributes about another 7% and generate over 40% of all carbon emitted in the United Kingdom [4].

C. Reducing Carbon Emission in Construction

The carbon emission during construction can be reduced on site pollution prevention such as loss of soil, waterway sedimentation, airborne dust generation, water disposal, indoor air quality management during construction, and reduction of environmental impacts from material transportation. In addition, the on-site operation of equipment which accounts for a major portion of construction carbon emissions, and transportation should be controlled, however not effecting cost, time and quality [8].

D. The Theory of Readiness

The theoretical basis for change readiness begins with early studies on creating readiness by reducing the resistance to change. Correspondence to that, change readiness focus on the importance of generating an awareness of the need of change and supporting people's perceived ability to change [11].

Readiness can be present, more or less at the individual, group, unit, department, or organizational level. Readiness can be assessed, theorized, and studies at any of these levels, however organizational readiness is more complex that any of these levels. To successful implement complex changes in the construction environment, organizational readiness for change is considered a critical precursor. Therefore, organizational members' change commitment and change efficiency to implement organizational change is referred as organizational readiness. It followed the term 'readiness' which it is a state of being both psychologically and behaviourally prepared to take action or in other words willing and able to [12].

IV. METHODOLOGY

Research methodology plays an important role to ensure the study is carried out in a systematic manner and corresponds with the objectives and aim of the study. The aspects that is involved in a research methodology are design study, research instrument and data analysis. The research will focus on identification of problem statement and research aim, and the next stage is establishing the research objective. The data collected for this study will be collected through primary and secondary data. For primary data, this research will use questionnaire as a research instrument by applying quantitative method. Quantitative is a simple method to collect and analyse data. As the time to collect data is restricted, therefore questionnaires are the best method to be used and easy to understand. The secondary data is obtained through literature review of journal papers, conference papers, books and web sites browsing. Descriptive analysis is used to analyse the data.

For this research, the population is G7 contractors in Penang registered with CIDB website, and the total number of G7 contractors companies was 296. The sampling method chosen is non-probability sampling, and the sampling frame is the companies which focused on construction as well as building services. The number of companies chosen for this research is 100 G7 construction companies, due to insufficient time and resources to accomplish the whole population.

Research instrument is the method on how the data will be collected, and questionnaires will be used as a research instrument for this study. The contractors are required to respond to 5

point Likert scale of 1 to 5, where 1 is strongly disagree, 2 is disagree, 3 is neutral, 4 is agree and 5 is strongly agree [13] (Douglas et al., 2006). It is easier to identify the level of knowledge and making comparison with the data collected with Likert scale.

This study will be focused in Penang, and the respondents are G7 contractors registered with CIDB in Penang. The questionnaires will be analysed using Statistical Package for Social Science (SPSS) to determine the level of contractors' readiness in Penang on low carbon construction.

V. RESULTS AND DISCUSSION

The implementation of low carbon practices on site by contractors were identified by dividing the practices into five (5) categories which were sustainable site planning and management, materials and resources, waste management, water efficiency and energy efficiency. It was established that the implementation of sustainable site planning and management is good, with the average mean score of 3.93. The implementation of materials and resources were concluded as good, with the average mean score of 3.73. In additional, the implementation of waste management was perceived as good with the average mean score of 3.78. It was established that the implementation of water efficiency was moderate, with the average mean score of 3.62 and the implementation of energy efficiency during construction was identified as good with the average mean score of 3.87. As a conclusion, the implementation of low carbon practices by the contractors in Penang is good as shown in Table 1, therefore established that G7 contractors implement low carbon practices throughout their construction.

Table 1. Implementation of Sustainable Practices

Nos	Implementation of Sustainable Practices	N	Mean	Std. Deviation
1	Sustainable site planning and management	52	3.93	0.801
2	Materials and resources	52	3.73	0.92
3	Waste management	52	3.78	0.892
4	Water efficiency	52	3.62	0.845
5	Energy efficiency	52	3.87	0.775

However, the results and findings indicated that the average mean score on the level of readiness of contractors towards low carbon construction is 3.59, with 20 statements on readiness and the standard deviation of 0.815. The result was perceived as moderate. Therefore, it shows that the contractors are in a moderate readiness to implement low carbon construction fully in their construction projects.

A checklist was established by summarizing the highest low carbon activities from each category which were sustainable site planning and management, materials and resources, waste management, water efficiency and energy efficiency, and the average mean score for the checklist is 3.93, which was perceived as good, as shown in Table 2. Therefore, the implementation of the activities in the checklist is convenient and effective for the contractors.

Table 2. Checklist for Contractors to Implement Low Carbon Construction

Nos	Checklist for Contractors to Implement Low Carbon Construction	N	Mean
1	Properly store and handle materials	52	4.27
2	Use building materials and products that are extracted and manufactured within the region during construction	52	3.83
3	Develop and implement a construction waste management plan (identifies the materials to be diverted from disposal regardless of whether the materials will be sorted on site or co-mingled)	52	3.90
4	Implement water recycling that will lead to reduction in water consumption during construction	52	3.65
5	Monitoring of energy consumption (electricity and diesel consumption)	52	4.00
	Total Mean		**19.65**
	Average Mean		**3.93**

As a conclusion, it can be concluded that the implementation of sustainable practices is good; however, the readiness for these contractors to fully implement sustainable practices is moderate. Therefore, it shows that the contractors did not have the knowledge that implementing sustainable practices during construction process is actually implementing low carbon construction. Due to this, more awareness on the low carbon practices should be shared with the contractors by the government bodies to increase the implementation of low carbon practices.

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