THE DEVELOPMENT OF GREEN CONSTRUCTION SITE INDEX

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Special Dedication
for My Professor, My Supervisor and My Father

Prof. Dr. Hj. Fadil Othman, Dr. Khairulzan Yahya and Ir. H. Sumantri

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ABSTRACT

The development of construction industry in Indonesia has been substantially contributing to the enhancement of social and economy of the country. However, its expansion may also give negative effects to the environment if the practices of implementing the construction project neglected the rules and regulations of sustainable construction concept. The aim of this study is to develop Green Construction Site Index (GCSI) with the consideration of assessing the staff commitment level on the implementation of the sustainable construction practices. Therefore, Project Organizational Commitment Index (POCI) is also developed. Data were collected by on site direct observation, distribution of questionnaire and interview with key personnel and project documentation review. All the data were tabulated and analyzed by using descriptive elaboration method. The development of GCSI and POCI was based on the opinion and validation of selective experts in the importance of sustainable elements in construction by using Average Index Analysis. Evaluations of GCSI and POCI have been conducted toward ten selected construction projects in Indonesia. The findings have revealed that the overall GCSI value of all ten construction projects was 3.39 which indicated that level of sustainability was in a good category. Meanwhile, the POCI value of all the projects was 3.31 showing that the commitment level of staffs in implementing the sustainable construction project practices was also in a good category. The result shows and proves that the establishment of GCSI and POCI were able to be used to assess level of sustainability construction project in the perspective of project progress and level of staff commitment. It shows that the capability of GCSI and POCI in assessing level of sustainability construction project, based on sustainability concept of construction project. In conclusions, GCSI and POCI are beneficial and suitable to be used in measuring level of sustainability in construction project by respective construction stakeholders like government bodies, local authorities and contractor.

ABSTRAK

Pembangunan industri pembinaan di Indonesia telah memberi sumbangan yang besar kepada peningkatan sosial dan ekonomi negara. Walau bagaimanapun, kemajuan ini juga boleh menyebabkan terjadinya kesan-kesan negatif pada alam sekitar, jika terdapatnya amalan-amalan projek pembinaan yang tidak mematuhi peraturan dan undang-undang berkenaan konsep kelestarian dalam pembinaan. Matlamat kajian ini adalah untuk membangun *Green Construction Site index* (GCSI) dengan mengambil kira tahap komitmen kakitangan terhadap pelaksanaan projek pembinaan secara lestari yang diukur menggunakan *Project Organizational Commitment Index* (POCI) yang turut dibangunkan dalam kajian. Pengumpulan data dan maklumat telah dijalankan dengan beberapa cara termasuklah kaedah pemantauan di tapak bina, kajiselidik dan temubual pemain utama industri serta penelitian dokumentasi projek. Data-data yang diperolehi telah dianalisis menggunakan kaedah penghuraian deskriptif. Selanjutnya pembangunan GCSI dan POCI dibuat menggunakan kaedah Index Purata (Average Index) berdasarkan pendapat dan validasi pakar-pakar yang dipilih bidang pembinaan. Bagi tujuan penelitian GCSI dan POCI yang dibangunkan, sepuluh projek pembinaan di Indonesia telah dipilih untuk dianalisis tahap kelestarian projek pembinaan tersebut. Hasil kajian menunjukkan bahawa nilai keseluruhan GCSI bagi kesemua sepuluh projek yang dinilai adalah 3.39. Ini menunjukkan tahap kelestarian keseluruhan projek adalah dalam kategori yang baik. Sementara itu, nilai POCI pula didapati sebanyak 3.31, yaitu menunjukkan tahap komitmen pekerja-pekerja ke arah pelaksanaan projek pembinaan secara lestari adalah juga dalam kategori yang baik. Keputusan menunjukkan bahawa kedua-dua GCSI dan POCI boleh digunakan untuk menilai aktiviti-aktiviti kelestarian projek pembinaan dari perspektif prestasi projek dan komitmen pekerja. GCSI dan POCI terbukti mampu menilai tahap kelestarian sesuatu projek pembinaan berdasarkan konsep kelestarian projek pembinaan. Kesimpulannya, GCSI dan POCI amat bermanfaat dan sesuai dijadikan sebagai alat pengukur tahap kelestarian projek pembinaan bagi pihak-pihak berkaitan seperti badan-badan kerjaan, pihak berkuasa tempatan dan kontraktor.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF EQUATION

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

The steadily increase of social and economy of Indonesian has stimulate the stable development of construction industry in many areas. The growth of the construction industry has triggered many supporting system related construction industry that compel the government to control those industries to follow rules and regulations in order to protect both the industries and the environment from possible negative impact generated by tight competition among the industries.

As the demand of housing, for example, increases the activities of the construction industry will also multiply. The multiplier effect sometime force the construction industry to disregard the negative implication exposed to the environment. As a result, the deterioration of the environment has become the central issue and the construction industry will be blamed to be responsible that create that situation.

Therefore, both the construction industry and the government should be working together and function dependently in resolving the adverse impact of the development to the environment. To develop this mutual understanding, both sides, besides law and order, need a tool that function as a controlling system to fulfill any requirement toward the achievement of sustainable green construction concept.

The negative impact of the construction industry to the environment has been realized as one of the world's problem because it is taken place in many countries. Many scholars appreciate the existence of this industry; however, although the establishment of an infrastucture for the development of economy influenced by construction industry that directly shared to the development of a nation (Firmawan *et al.*,2012a), Bossink and Brouwers (1996) claimed that it generates severe impacts to the environment. A considerable number of studies concerning environmental problems associated with construction activities has been carried out (Shen *et al*., 2005; Tam and Lee, 2007; Ofori and Ekanayake, 2004, Gangolells *et al*., 2009); such as the fact that resource depletion, considerable amount of waste and high energy consumption are needed by construction industry (Kim *et al*., 2006) that lead the industry becomes one of the biggest environmental polluters (Yahya and Boussabaine, 2006). Most of the findings concluded that in order to serve the industrial activities, high number of raw materials is consumed by construction industry such as soil, aggregates, sand and water to manufacture goods such as bricks, cement, plasterboard, metals (steel and iron), timber, concrete and plaster that generate large quantity of construction waste that has significant negative impacts to the environment.

The negative impact of the construction waste to the environment becomes more serious as the quantity of solid waste increases, while the availability of land to dump the waste decreases. As a result, the exhausted landfill and severe ecological impact increases. High demands of infrastructure and building projects, particularly commercial and dwellings are the key contributors to the construction waste generation (Begum *et al.*, 2009a). The construction waste can be accounted for more than 50% of UK's landfill area (Ferguson 1995) and in 2001, 44% of the solid waste disposed at municipal landfill sites in Hong Kong is C&D waste (Poon, 2001a).

The design, material handling, operational and procurement are among the major sources of construction waste generation (Ofori and Ekanayake, 2000). However, the most frequent causes of the construction waste generation are design changes and leftover scrap (Ofori and Ekanayake, 2000), type of building, design, size of project and site management (Masudi *et al*., 2011). In addition, the lack of utilizing the environmentally friendly construction materials resulted in poor

sustainability in the Indonesian construction sector (Siagian, 2005) and the status of waste management in the Indonesian construction industry is very limited to disposal only; minimum efforts are made to actually manage, reuse and recycle waste materials (Suprapto and Wulandari, 2009).

The construction waste related problems can also be observed from management perspective as Tam (2008b) and Gavilan and Bernold (1994) conclude that reducing waste is the utmost important measure in waste management plan. In contrast, in Malaysia, contractors put less emphasis on awareness as shown by lack of waste record-keeping and illegal practices of waste disposal (Masudi *et al*., 2011 and Begum *et al*., 2009). The contractors regard the waste and its impact to the environmantal least important, but duration and cost as the most important. (Poon *et al.,* 2004). In the same case, Alwi (2003) documented that one of the main problems suffered by the Indonesian construction industry is productivity; particularly waste management and the key contributing factors were the characteristic of contractors, inadequate management strategy and organizational focus. Meanwhile, Poon *et al.*, (2001a, 2001b) and Tam (2008) put great emphasis on sound and proven the waste management plan during on-site operational phase of the construction, including effective measures in reducing waste such as waste segregation and applying prefabricated building system.

Accordingly, the construction waste management has to be carefully maintained to achieve high productivity in regard to some consideration as some scholars suggested. Green construction practice seems to be the solution for the problems associated with the waste generation (Ervianto *et al.*, 2011) and institutions are expected to play a major role in determining the waste management practice (Nitivattananon and Borongan, 2007). Therefore, the construction waste generation must be quantitatively measured for assessing environmental performance of construction project (Lau *et al*, 2008 and Masudi *et al*, 2011).

1.2 Problem Statement

The quantitative measurement is a significance indicator that can be implemented as a benchmark for contractors' performance. The benefits of the benchmark are to develop good planning on resources and environmental management, to reduce the wastes generated in all stages of construction project (Poon *et al.,* 2001b) and to achieve more sustainable and innovative practices in industry (Jalali, 2006). A quantitative measurement called waste index calculations has been used to anticipate the quantity of waste in order to establish the awareness of waste minimization. Hong Kong, for instance, has established the "construction waste index" and "wastage level".

However, the construction waste index is not accountable, project size-dependant and does not reflect the overall productivity and the environmental performance of a construction project. The waste index calculation illustrates a very generic approach in waste quantification (Poon *et al.*, 2001b; Jalali, 2006; Masudi *et al.*, 2011); as a result, simplified approaches were employed which resulted in type of building and size of project as the main factors for construction waste generation.

Thus, a specific and accurate approach is required to assess quantitatively the waste reduction performance in respect to the productivity of the construction project. In this perspective, efficient consumption of materials is considered the pillar of the construction waste minimization and the overall project productivity. The quantitative approach is applied by catering the need for benchmarking of the waste generation rate in order to achieve an additional efficiency and productivity of the construction industry. In addition, prefabrication or Industrialized Building System (IBS) is popularly recognized as the solution for minimizing construction waste generation (Poon, 2001b). Recently, considerable extent of IBS system is adopted in Indonesian construction industry. Nevertheless, further studies must be carried out to assess quantitatively the effectiveness of IBS towards efficiency of the material use, the waste generation and the overall productivity.

It can be summarized that the importance to quantitatively measure the construction waste generation is to understand the real problem caused by the

construction industry and to determine the mitigation actions as the quantification provides an essential means for evaluating the exact amount of the waste and therefore, resulting a proper decision for their reduction and sustainable management (Poon *et al.*, 2001b; Jalali, 2006; De Silva, 2008). Moreover, the construction waste reduction requires characterization and quantification of waste (Jalali, 2006; Martinez-Lage *et al.*, 2009). However, the accurate quantity and the type of waste, which is anticipated about 5-10% of materials purchased, are unidentified (Bossink and Brouers, 1996; Poon *et al.*, 2001b, 2009; Jalali, 2006). As a consequence, waste management decisions are often based on guesses and simplified conclusions made by site personnel (Jalali, 2006).

In the near future, the management decision based on bias information input should not be taken into account. The accurate and reliable record of onsite problems should be taken into consideration as part of the controlling mechanism that flow in two ways system. Therefore, it is believed that the Indonesian construction industry needs to strive for the establishment of a quantitative measurement tool that is capable of assessing the performance of an ongoing construction project from several aspects and perspective and to immediately present the result to be employed for making a significant decision to mitigation efforts.

1.3 Research Aim and Objectives

The aim of this study is to develop Green Construction Site Index as quantitative assessment tool to measure the implementation of green construction concept. The Green Construction Site Index is expected to be applied as a standardized reference by both the construction industries and the authority; so that, both parties may develop mutual understanding upon conserving the environment.

The Objectives of the study are:

i. To classify factors that associated with the green construction concept
ii. To develop a framework of the Green Construction Site Index (GCSI) and Project Organization Commitment Index (POCI)

iii. To investigate the efficiency, productivity, awareness and organization commitment of an ongoing construction projects

1.4 The Scope of Research

This study was undertaken to provide a quantitative assessment tool in construction site and evaluate an on-going project from which two aspects are scored and transformed into index. The two aspects consisted of the performance of a construction project measured by its efficiency, productivity and awareness and the degree of commitment of the personnel within an organizational structure of a construction project. Furthermore, the index obtained by an ongoing project shall be used as an input to the managerial level to make a decision upon an existing state of a project.

Ten construction projects participated in this study – categorized into three types; Non Commercial, Non Residential Building; Commercial, Residential Building; and Commercial, Non Residential Building. The data were collected in three ways: on site observation, interview with key personnel and review of the project documents.

This study merely focused on the construction project site located in Indonesia by conducting the following limitation:

i. All projects participated in this study were state own entreprise.

ii. The types of the building project involved this study were Non Commercial, Non Residential Building; Commercial, Residential Building and Commercial, Non Residential Building.

iii. The assessment of construction waste management were conducted during the ongoing construction phase only, not full life cycle of building construction project.

iv. This study is focused on the on site construction waste management not include factories that the precast material elements were produced.

1.5 Research Outputs

The output of the study is as follow:

i. The formulation of Green Construction Site Index as quantitative assessment tool to measure the implementation of green construction concept

ii. The method used to do assessment using Green Construction Site Index Application.

The benefits of the research output;

For contractors:

i. Financial benefits might be generated as the tool works simultaneously with the construction process, so whenever the construction process and product are identified doing improper execution, the management might take an immediate action to avoid more losses.

ii. Social benefits will be rewarded to the construction industry when the outcome proves to be technically properly and environmentally acceptable by both the government and the community.

iii. Environmental benefits will be produced when the tool is used as part of the controlling mechanism to evaluate every step of the construction process.

iv. Organization benefits will be earned once the community appreciates with the sustainable green construction product offered by the construction industry.

v. Quality benefits will be generated when the previous four benefits are achived

For Authority:

i. A controlling mechanism tool that has an ability to do assessment, evaluation and directly provide recommendation to an ongoing project

ii. Authorities are expected to formulate policies and regulation with thorough enforcement in order to encourage environmental awareness, promote better productivity and apply more responsible practices

iii. The growth of more productive construction industry in Indonesian that put emphasis its practice on reducing waste generation and improving efficiency, reducing cost of opening new landfills and preserving natural resources.

6.2.2. For Authorities

In line with the development of the construction industry in Indonesia, the government should supervise any construction project to achieve sustainable green construction concept. To do so, the need of a tool to control and recommend an ongoing project is imperative. As a new method that will be implemented in Indonesia, The Green Construction Site Index is an option to be considered.

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