GREEN CONSTRUCTION ASSESSMENT MODEL FOR IMPROVING SUSTAINABLE PRACTICES OF THE INDONESIAN GOVERNMENT CONSTRUCTION PROJECTS

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ABSTRACT

As an effort to implement the sustainable construction concept in Indonesia, the government, particularly the Ministry of Public Works, took a leader role. Even though the Indonesian construction practitioners have established several notable green movements, such as green buildings and green contractors, the realization to the achievement of proper sustainable construction is far to be seen. Recent studies on the effectiveness of the implementations have shown the need of more holistic approach in delivering the green construction.

Based on the holistic approach of green construction concept, the Indonesian government has developed an assessment model for benchmarking the sustainable practices of government construction projects. The assessment model was developed based on three important aspects of green construction: Green Behaviour and Practices; Green Construction Process; and Green Supply Chains. Seven sustainable principles are used for the development of indicators for each aspect of green construction. Two ongoing government projects were used for piloting the assessment model. In general, it was found that the score of the Green Behaviour and Practices aspect, which related to indirect activities, was relatively higher than two other aspects. Some identified low scored indicators in all aspects were used for improvements in sustainable construction practices of the government projects.

KEYWORDS

Green behaviour, green construction, green process, green supply chains, sustainable construction.

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INTRODUCTION

The terms green, high performance, and sustainable construction, are often used interchangeably. All these terms address the economic, ecological, and social issues of an infrastructure in the context of its community. The terminology defined by CIB is widely used. The seven principles of sustainable construction should apply when evaluating the components and other resources needed for construction. The principles of sustainable construction are relevant across the entire life cycle of construction, from planning to disposal, which referred to as deconstruction rather than demolition. When considering the resources needed to create and operate the built environment during its entire life cycle: land, materials, water, energy, and ecosystems; the seven principles should be the valid basis (Kibert, 2008).

The Indonesian Ministry of Public Works had been launched what it is called a draft of Agenda 21 for Sustainable Construction in Indonesia. The document itself was developed based on the document of the Agenda 21 for Sustainable Construction in Developing Countries (du Plessis, 2002) with the national conditions in mind. The agenda was derived to achieving the three enablers, i.e., technology, institution, and value system enablers. While the government has set an initial and necessary initiatives in implementing sustainable construction in Indonesia, the practitioners has also been beginning to consider sustainable practices, especially in the area of green buildings and green construction. It seems that 'green' terminology is more tempting to be used instead of 'sustainable', and buildings are more controllable compared to other types of construction (Abduh et.al., 2012).

GREEN BUILDINGS IN INDONESIA

One of other prominent movements in green construction in Indonesia is the establishment of Green Building Council Indonesia (GBCI) in 2008. Until now, there are more than 120 corporate members joined this organization, 4 new green building projects and 3 existing building that had received platinum level of certification, and there are more than 20 green building projects that were registered to be assessed the designs. The assessment system that is published by the GBCI is called Greenship rating tools which consists of three rating tools: for new buildings, for existing buildings, and for interior spaces. The rating categories of Greenship for new buildings are appropriate site development; energy efficiency and conservation; water conservation; material resources and cycle; indoor air health and comfort; and building and environment management (Abduh et. al., 2012).

INDONESIAN GREEN CONTRACTORS

Some large contractors, as the main subjects in the construction field, had shown their awareness and stewardships to the environment by declaring themselves as green contractors. They have implemented reduce, reuse and recycle (3R) principles, as well as the reducing the use of energy in their construction projects. International certifications for environment management (ISO 14000s) have been their marketing weapons besides the certification of health and safety management from OHSAS nowadays. The practices of reducing the use of papers, catering waste, the use of air conditioning, the use of water and electricity has been their day to day operation in their project sites. Furthermore, they had their own assessment systems to measure

the level of greenness of their projects. A form-based assessment was used for measuring the following categories: appropriate site; energy efficiency and conservation; water conservation; site environment management; material sources and cycle; and site health and comfort.

INDONESIAN GOVERNMENT'S INITIATIVES

In 2010, the Indonesian government, represented by the Ministry of Environment, has issued a regulation on criterion and requirements for an institution that could publish an assessment system for certifying green buildings in Indonesia. Moreover, the Ministry of Public Works has been developing a standard of green specifications and also rating tools for designing, constructing, and operating green governments' buildings that will be introduced to central and local governments. Moreover, the Ministry of Public Works has been developing a manual to deliver green projects; an assessment model for green construction; a manual to green procurement using design-build delivery system; a standard for green roads; and a green construction supply chains strategy.

HOLISTIC APPROACH FOR GREEN CONSTRUCTION IN INDONESIA

Recent studies on the effectiveness of the implementations have shown the need of more holistic approach in delivering the green construction. The importance of operations during construction in delivering the green or sustainable value of a construction product, such as buildings or other infrastructures, is not addressed adequately and still substantially missing in the available assessment tools for green buildings as well as for green contractors (Abduh and Fauzi, 2012; Carneiro et.al, 2012; Halloway and Parrish, 2013).

Abduh and Imran (2013) introduced three important aspects of green construction to be implemented: Green Behaviour and Practices; Green Construction Process; and Green Supply Chains. Those aspects are actually correspondent with three enablers of sustainable construction, but with terminologies that are easier to be comprehended by construction practitioners.

In principle, implementation of green construction should begin with the individual behaviour and contractor organization practices or called Green Behaviour and Practices (GBP). The big challenge for the contractor to implement this aspect is related to how to manage paradigm shift of the individual and changes in the organization to be greener. To fulfil this green construction aspect, the contractor should have the value system of green adopted and sanctioned. This aspect could measure how well the contractor personnel behave in a green way and how well the contractor organization introduce the green practices policy and also make them as a standard operating procedure.

Other important aspect to be considered in delivering green construction is related to the operations or processes of construction itself at the field. This is a production problem. Therefore, the operations or processes of construction at the field should minimize waste and on the other hand should maximize value to be delivered. This aspect is called as Green Construction Processes (GCP). However, this aspect is also known as lean construction principles. It was suggested that lean construction practices can complement and assist the sustainable construction practices on-site and off-site the construction project (Novak, 2012; Valente et.al, 2013; Ladhad and

Parrish, 2013). This GCP aspect could be addressed by measuring the waste produced by each operation or process of construction in the field and how good is the achievement to the value defined by the succeeding operations or processes and the final customer. In this GCP aspect, waste could be physical or non-physical.

The last but not the least, there is another aspect that is very important to support two previous aspects of green construction, it is called Green Supply Chains (GSC). Since most of the production factors of a construction project are related to the availability of materials or commodities (about 70% of construction cost), the management of construction supply chains is very important. As stated by Glavinich (2008) and Maund and London (2009), the performance of the construction in delivering sustainability value depends mostly on the performance of its supply chain; therefore, the green construction supply chains management is very important aspect to be considered in green construction. The green materials should be managed by a proper green supply chains. Every member of the construction supply chains should contribute to the achievement of green value defined by the final customer.

OBJECTIVES AND METHODOLOGY

The government of Indonesia, represented by the Ministry of Public Works, realised its important role in leading the sustainable construction implementation in Indonesia. Moreover, the government understood that the identified problems of the green building and the green construction assessment systems would lead the green construction practices in Indonesia to improper directions of development. Therefore, the government initiated to develop green construction assessment model for its construction projects. The assessment model was designed to measure the level of sustainable construction practices performed by the contractor in the field and to be used as a benchmarking tool to improve the practices. The assessment model should be suitable for all types of project conducted by the Ministry of Public Works, i.e., roads, bridges, buildings, and water resources infrastructures. Since the assessment model is also a benchmarking tool, it would identify which part of sustainable construction principles, approaches, and applications that need to be further developed by the contractor and supported by the government.

The assessment system was developed based on the holistic approach for green construction in Indonesia as suggested by Abduh and Imran (2013). The government believed that the holistic approach would cover more comprehensive indicators and an ideal approach compared to the available assessment tools, and on the other hand it would identify the deficiencies of current sustainable construction practices by the Indonesian contractors.

The development of the assessment model followed the subsequent procedure:

1. Firstly, suggested practices of green construction from literatures (Glavinich, 2008; Kibert, 2008; and Kubba, 2010), as well as the green construction related indicators of available assessment tools (the Greenship for green buildings and the GreenRoad for roads) were listed and noted as the current applications of green construction in Indonesia.
2. The current applications of the green construction then were classified into three important aspects of green construction as suggested by Abduh and Imran (2013).

3. The classified current applications of green construction then were used in a survey to verify the implementation of those applications. The survey was conducted to on-going construction projects.
4. The verified list of current applications was then grouped into the CIB's seven principles of sustainable construction as stated in Kibert (2008).
5. Moreover, the approach of each sustainable principle related to each application was determined based on the similarity of the applications.
6. The identified approaches were then further developed into indicators which quantitative scales were determined based on qualitative scale for measuring enablers as suggested by the EFQM (2013).
7. The assessment model was then structured using an additive model with the equivalent weights for all indicators in a particular approach and principle (Figure 1).

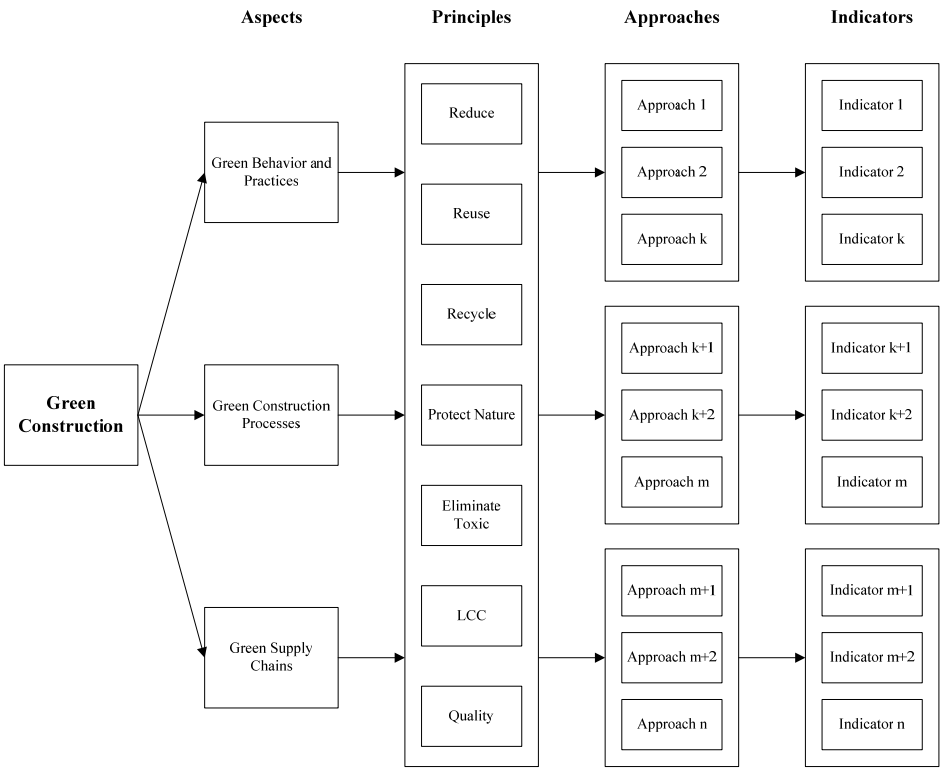

Figure 1: The Structure of the Assessment Indicators

8. The scales used for determining the value of each indicator are:
    - 0, if there is no effort and awareness on such indicator;
    - 1, if there is a plan to address the indicator but the plan is still not integrated to others;
    - 2, if there is an integrated plan to address the indicator;

- 3, if the plan is being executed with some notes to be improved;
- 4, if the execution is done successfully and systematically; and
- 5, if there is further improvement done even though the execution is already successfully and systematically performed.

9. The aggregated score of green construction would be 0 to 5, and then divided into 5 predicates: 0.0 – 1.0: 'Inhibiting'; 1.1 – 2.0: 'Performing'; 2.1 – 3.0: 'Enabling'; 3.1 – 4.0: 'Optimizing'; and 4.1 – 5.0: 'Best in Class'.
10. The assessment model was implemented in a spreadsheet program (MS-Excel) to ease its data acquisition and calculation processes.
11. Two case studies were used to test the assessment model, to validate the model, and to portrait the current practices of the two pilot projects.

THE SURVEY ON INDICATORS DEVELOPMENT

For developing the indicators, a survey was conducted to 7 on-going construction projects in Indonesia, i.e., hotel and apartment, airport, hospital, and government office building projects. The survey was aimed to verify whether the list of suggested applications in green construction (GC) were already implemented and useful in addressing the sustainable construction principles. There were 55 applications listed in the Green Behaviour and Practices (GBP) aspect or any efforts to address sustainable construction principles for indirect works of the project; they included such as using low voltage lamps for the project site, reusing rainwater for personnel activities, planting green vegetation for beauty, reducing the use of papers and plastics for office activities, using local public transportation system for workers, separating project trashes into organic and inorganic bins, and others.

There were 36 applications listed in the Green Construction Processes (GCP) aspect or any efforts to address sustainable construction principles for direct works of the project; they included such as using local material for construction, reducing the idle time, protect vegetation during construction, using certified wood, reducing construction waste, etc. Moreover, there were 18 applications listed in the Green Supply Chains (GSC) aspect or any efforts to address sustainable construction principles related to the procurement of resources of the project; they included practicing green procurement for subs and sups, reducing transportation cost for materials, designing optimal batch for purchasing, limiting the millage for construction equipment, and so on.

Comparing the numbers of listed current applications between the aspects of green construction, the GBP aspect had the highest number applications and the GSC aspect had the lowest number of applications. It can be concluded that the GBP aspect was the most considered and developed aspect compared to GCP and GSC.

Based on the results of the survey, it was found that not all already implemented applications were considered as efforts to address the sustainable construction principles (Figure 2). The respondents did not agree all the listed applications to be recommended as applications to address sustainable construction principles. From this findings, it was clear that the current applications performed by contractors in the field were only applications that were developed by contractors with specific

condition of projects and would not be suitable to be used for others. Different location of project would have different challenges and therefore would need innovation from the contractor in order to cope with the challenges in addressing the sustainable construction principles.

As depicted in Figure 2, not all current applications were recommended to be used by the respondents; about 39% to 47% of current applications in all aspect were not recommended. This finding meant that the list of current applications could not be used as indicators for assessing the GC practices, and therefore the indicators for GC should be developed in other way. The authors proposed the development of the indicators based on the principles and approaches of sustainable construction instead. This is to address the aforementioned finding and to deal with different types of construction projects on which the assessment model will be used.

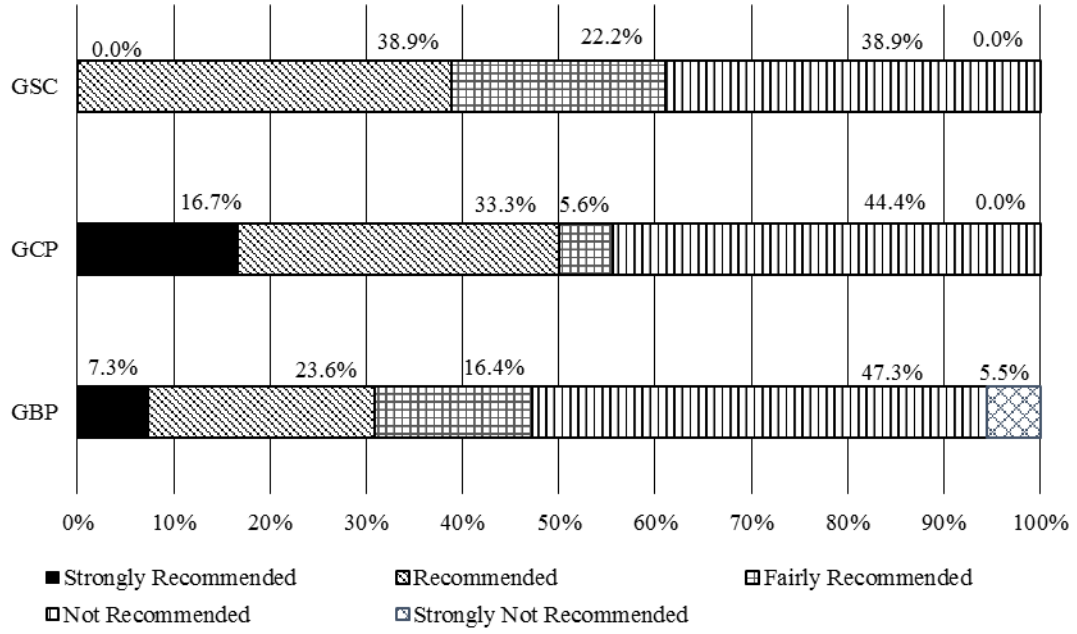

Figure 2: Recommendations from the Survey for Current GC Applications

The developed indicators are provided in Tables 1, 2, and 3. It can be seen that not all of aspects have all seven principles of sustainable construction. The principles, approaches, and indicators listed in those tables were used to form the questions for the assessment model. For instance, for GBP aspect in Table 1, the 'material' indicator, the 'efficiency' approach, and the 'reduce' principle all together formed a question of "What are the efforts of the project in minimizing the consumption of materials that are used for supporting activities of the project (indirect works)?" For GSC aspect in Table 2, the 'material transportation' indicator, the 'energy efficiency' approach, and the 'reduce' principle all together formed a question of "What are the efforts of the project in minimizing the consumption of energy for supporting the transportation of the materials needed by the project (for indirect and direct works)?" For GCP aspect in Table 3, the 'material' indicator, the 'efficiency' approach, and the 'reduce' principle all together formed a question of "What are the efforts of the project in minimizing the consumption of materials that are used to deliver the physical product of the project (direct works)?"

Table 1: Indicators for the Green Behavior and Practices (GBP)

No.	Principles	Approaches	Indicators
1	Reduce	Efficiency	Material
			Human Resources
			Energy
			Water
		Minimize Waste	Indirect Works
			Facility
2	Reuse	Efficiency	Supplies
			Water
			Temporary Facilities
		Minimize Waste	Domestic Waste
3	Recycle	Transformed Waste	For On-site Use
			For Off-site Use
4	Protect Nature	Natural Environment	On-site
			Off-site
5	Eliminate Toxic/SHE	Activities	On-site
			Off-site
		Occupational Environment	On-site
			Off-site
6	Quality	Quality Assurance	Firm Policy
			Organization
			Procedures
		Quality Control	Inspection
			Feedback

Table 2: Indicators for the Green Supply Chains (GSC)

No.	Principles	Approaches	Indicators
1	Reduce	Energy Efficiency	Material Transportation
			Labor Transportation
			Equipment Transportation
		Procurement Process	e-Procurement
2	Protect Nature	Certification	Fabricated Materials
			Natural Materials
3	Quality	Quality Assurance	Supplier Selection
		Quality Control	Inspection
4	Life cycle	Material Life Cycle	Carbon Footprint

Table 3: Indicators for the Green Construction Processes (GSC)

No.	Principles	Approaches	Indicators
1	Reduce	Efficiency	Equipment
			Labor
			Material
			Energy
		Minimize Waste	Physical
			Non-Physical
2	Reuse	Utilization	Material
			Temporary Facilities
		Construction Waste	Material
			Water
3	Recycle	Transformed Waste	On-site
			Off-site
4	Protect Nature	Replacement	Off-site
5	Eliminate Toxic/SHE	Construction Operation	On-site
			Off-site
		Occupational Environment	On-site
6	Quality	Quality assurance	Pre-Planning
			Instructions
			Monitoring and Evaluation
		Quality control	Inspection
			Commissioning

TWO CASE STUDIES

For testing the assessment model, two on-going projects were selected voluntarily. These case studies were also used to portrait the current practices of the selected pilot projects. The first project (further noted as Case-1) was the construction of a new building at the Ministry of Public Works complex in Jakarta; this building applied for GBCI's green building's certification and constructed by one of the largest contractors in Indonesia. The second project (further noted as Case-2) was the 10-km normalization works of a river crossing the Jakarta city; the project would widen the river from currently 8-15 meters to about 60 meters width to reduce the risk of flooding in Jakarta areas and constructed by the first-claiming green contractor in Indonesia. The assessments of both cases were performed by the authors through interviews with their project managers and visual observations in the fields.

The aggregated scores of both cases, at the level of green construction practice and its aspects, are depicted in Figure 3. Based on the figure, the Case-2 was categorized into 'Optimizing', whilst the Case-1 was still considered into 'Enabling'; it means that both contractors had been trying to implement what they believe to be the best applications that could contribute to the achievement of sustainable construction, with some noted of deficiencies. However, the Case-1 did it unsystematically nor integrated. Moreover, Table 4 depicts the low scored indicators

(less than 3; out of 5) of both case studies that show the different capabilities of each contractor and constraints each contractor faced in the particular project.

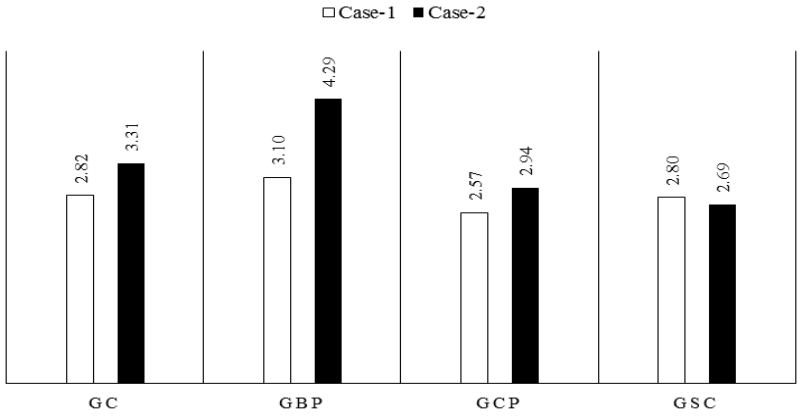

Figure 3. Aggregated Scores of Green Construction Practices of Two Case Studies

Table 4. The Low Scored Indicators of the Cases*

	Case-1	Case-2
GBP	• Water, Efficiency, Reuse • For On-site Use, Transformed Waste, Recycle • For Off-site Use, Transformed Waste, Recycle • Off-Site, Natural Environment, Protect Nature	• Off-site, Activities, Eliminate Toxic/SHE
GCP	• Non-physical, Minimize Waste, Reduce • Material, Construction Waste, Reuse • Water, Construction Waste, Reuse • Equipment, Efficiency, Reduce • Off-site, Replacement, Protect Nature • On site, Construction Operation, Eliminate Toxic/SHE • Off-site, Construction Operation, Eliminate Toxic/SHE	• Non-physical, Minimize Waste, Reduce • Material, Construction Waste, Reuse • Water, Construction Waste, Reuse • Energy, Efficiency, Reduce • Material, Utilization, Reuse • Temporary Facilities, Utilization, Reuse • Off-site, Activities, Eliminate Toxic/SHE
GSC	• e-Procurement, Procurement Process, Reduce • Natural Materials, Certification, Protect Nature • Carbon footprint, Material Life Cycle, LCC	• Labor Transportation, Energy Efficiency, Reduce • Equipment Transportation, Energy Efficiency, Reduce • Natural Materials, Certification, Protect Nature • Carbon footprint, Material Life Cycle, LCC

In general, the Case-2 had better green construction practices than the Case-1. Moreover, from Figure 3 and Table 4, the Case-2, which was conducted by a green contractor, showed superior capabilities in GBP aspect (Score: 4.29) compared to the Case-1 (Score: 3.10), which was conducted by a non-claiming green contractor. Since the contractor of Case-2 is a green contractor, it seems that its behaviour and practices for indirect activities are already becoming part of its businesses. The contractor of the Case-1 had big problems in trying to achieve the indicators of GBP aspect since it did not get used to in implementing them; there were 4 indicators that had low scores. This contractor had no specific policy to be a green contractor in the near future either; it just performs what it believes as the best proprietary practices. The demand from the owner of the Case-1 in addressing more green behaviour and practices for indirect works was inadequate to be a motivator for the contractor yet. However, only one indicator that could not be delivered by the contractor in Case-2, i.e. the efforts of the contractor to eliminate toxic and to implement good practices in safety, health, and environment (SHE) outside the location of the construction site. This was merely due to the vast physical coverage of the Case-2 project (10 km length). Therefore, the contractor could not afford to control all off-site conditions along the location.

For GCP aspect, both cases had some difficulties in addressing the indicators; Case-1 had overall score 2.57 and 7 low scored indicators, whilst Case-1 had overall score 2.94 and 7 low scored indicators. This shows that the GCP aspect was less developed practices for both contractors compared to the GBP aspect. This could be meant that the impacts of construction operations to the environment were still not acknowledged and neglected. Even though both contractors of the cases were considered as the biggest contractors in Indonesia, very well known for their good performances, and their construction technologies should be adequate, yet the lean construction concept was not acknowledged by both. The authors believed that the statement is true since the indicators that could not be delivered by both cases in GCP aspect show the inexistence or inadequate understanding of lean construction practices as mentioned in Valente et.al (2013). Moreover, for the Case-2, the physical characteristics of the construction project had detrimental effect to the contractor in achieving the indicators of energy efficiency, reuse of temporary facilities, toxic elimination, and deliberation of SHE program for the off-site activities.

Compared to the GBP, the GSC aspect had also been problems for both contractors; both cases had scores less than 3.0. However, the Case-2 had more difficulties in addressing indicators of the GSC aspect, this was merely due to, again, the physical characteristics of the Case-2 construction project. However, both cases had not implemented tighter selection process for subcontractors and supplier to accommodate the green supply chains aspect. For the Case-2's contractor, the optimization of embedded energy in delivering labour, materials, and equipment to its very vast location of project was rather impossible and costly. In addition to that, the inexistence of the certification program for materials and fabricated products for construction has been a constraint to the sustainable construction implementation in Indonesia.

CONCLUSIONS

The developed green construction assessment model was aimed by the Indonesian government to be an effort to implement the sustainable construction concept in

Indonesia. The assessment model implemented more holistic approach for green construction by including three important aspects of green construction, i.e. green behaviour and practices, green construction processes, and green supply chains.

Two case studies were used to test the assessment model and demonstrated the benefits that it can deliver for the benchmarking purposes. The findings of the two case studies accentuate that the current practices of green construction in Indonesia still need motivation from the government, strong demands from the owners, construction firm's policy in green construction, awareness of the importance of lean construction concept for construction operation, and supporting to the development of green construction supply chains.

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