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The driver and barrier of implementation green supply chain management (GSCM) in construction projects

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Abstract. Climate change due to rising greenhouse gas emissions and resource depletion is one of the major challenges of the twenty-first century. Construction waste is not only associated with energy use and waste of materials in the construction process but also other activities that do not add value such as repair, waiting time and delays. Concepts such as waste and value are not well understood by construction personnel. They often do not realize that many activities they carry out do not add value to the work. These issues contribute to a reduction in the value of construction productivity and could reduce company performance. The aims of this GSCM study on the construction sector are to identify: (i) the drivers of stakeholders to implement green practices and (ii) the barriers faced by stakeholders in the implementation of these practices. The research methods are literature study and fields observation, where the experts were asked about their opinions related to barriers and drivers to implement the Green Supply Chain Management (GSCM) in construction. The results showed that each phase of GSCM has barriers and drivers. The barriers and drivers are involved in Green Initiation, Green Design, Green Material Management, Green Construction and Green Operation and Maintenance.

1. Introduction

Since Kyoto Protocol has been announced in 2005, the issue of sustainability has been highlighted as an important regulation around the world [1]. Climate change, the rising fuel and energy prices as well as constraints about resources and waste generation have triggered irremediable loss have become business environment challenges currently that have to be faced [2].

To overcome this problem, green products (goods and services) are now a concern. Production systems have becoming customer oriented to meet customers' demands with high quality on time. As well as in the construction industry, it is imperative to handle each phase, starting with the design of the building to the destruction. Resource efficiency must be achieved as well as considering aesthetics or building use. As an alternative solution, the design of green building should reduce the use of raw materials at an early phase, so that it will produce a high amount of recycled materials for sustainable structures. If the design phase is taken into consideration, architectures and civil engineers are the actors who responsible in making buildings "green". However, when the entire construction industry is considered, all suppliers and other subcontractors are included in the entire supply chain. For this reason,



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to make the total production line sustainable, the green supply chain model will be useful for connecting each step with each type of actor in the supply chain [3].

Green supply chain management (GSCM) produces sustainable systems with the help of waste management directives. GSCM is expected to be able to manage construction and demolition waste, by reduce the raw material in the source or recover those materials as much as possible. GSCM that can be considered as integrating environmental concerns into supply chain management (SCM) has nowadays appeared as a holistic approach to environmental management [4]; with the environmental effect of a product/project that usually occurs at all phase of its life cycle, the focus of the entire supply chain makes sense [5, 6]. GSCM emphasizes the effectiveness, efficiency of implementing green practice to reduce environmental impact [7, 8] through the ability to manage drivers and barriers to the green practices' implementation [9–11].

In Indonesia, research correlated to the GSCM application in the construction industry is still very limited. On the other hand, there is not yet a performance assessment system that can measure the implementation of sustainable construction that involves the entire supply chain of a construction project as a whole. The current system is still partial, as developed by the Green Building Council Indonesia (GBCI) which uses the GREENSHIP Green Building Rating System assessment tool to assess the ranking of buildings towards the achievement of the concept of environmentally friendly buildings. One of the reasons why the GSCM has not been implemented in detail is because the number of construction projects with a green concept is still very limited [12]. Therefore, this study aims to determine the factors of drivers and barriers to GSCM implementation in construction projects.

2. Theoretical Background of Green Supply Chain Management

2.1. Supply chain management concept

Supply chain is a term that describes a network of organizations from upstream to down-stream that have different processes and activities to produce value for the consumers in the form of products, both goods and services [13]. Supply chain can be viewed as the “set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer” [14]. Whereas, SCM could be defined as a network of facilities and distribution options that performs the functions of procurement of materials, the transformation of materials into intermediate and finished products, and the distribution of the finished products to end customers [15]. Another SCM definition, given by [14], is known as “the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole”.

2.2. Green Supply chain management

Nowadays, the environmental issue is being concerned in many areas. Environmental pollution and climate change have turned out to be one of the greatest challenges. Supply chain traditionally starts from the cradle to the grave, which means from raw materials until the end products reaching the customer. However, today the environmental issues force processes to change and comes up with new operations such as recovery options [3]. So, by entering the specific goal of minimizing the environmental impact in the supply chain, the concept of SCM has turned into GSCM. It has emerged as an environmental management approach with environmental impacts of a product occurring at all its lifecycle stages [6]. There is some description of GSCM. GSCM is concern with climate change, natural resources consumption and energy consumption [16]. GSCM integrates environmental approach in the supply chain, in all of the manufacturing stages including product design, material selection,

manufacturing process and delivery of the finished product to customers [17]. GSCM should run environmentally friendly purchasing, including select the materials that do not have negative impacts on the environment, less amount of material and more renewable and recyclable resources [18]. GSCM has purpose to eliminate or reduce the bad impact on the environment and also waste from resources that were used in the transformation process of a material into a finished product [5].

2.3. Green Supply chain management in construction

Recently, SCM in the construction industry is growing rapidly around the world. Supply chain in the construction is diverse, highly complex, and disintegrated; involving various stakeholders who participate in dyadic relations [19]. On a large construction project, for example, the number of entities who involve in the chain can be hundreds. In addition, this construction sector is illustrated by one-off contracts and a failure to develop long-term relationships among stakeholders [20]. Construction also has a big effect, yet indirect, on other industries. It is because construction requires materials from other industries to construct infrastructure or buildings. Thus, the model of supply and demand in the construction industry has significant contribution to economic growth [21].

A wide-ranging framework of GSCM assessment which comprises nine constructs (i.e., external and internal drivers, external and internal barriers, core and facilitating GSCM practices, economic, environmental and organizational performance implications) was developed by [22]. This study found that green practices implementation has affected a positive impact on the environmental, economic and organizational performance for all stakeholders, while the extent of the implementation of green practices depends on the relative strength of the drivers and barriers. A conceptual framework for GSCM implementation in the construction industry was developed by [12]. By employing the GSCM perspective, this research contributes to developing GSCM standard in the construction industry. Results showed that GSCM consists of five concepts (i.e., green initiation, green product design, green material management, green construction, and green operation and maintenance).

3. Conceptual Models

This research is a continuation of previous studies in the field of GSCM which aims to identify drivers and barriers in the implementation of green practices on construction projects. A model to evaluate the implementation of GSCM practices among contractors in Singapore was developed by [23]. The model consists of five criteria and is derived into 21 sub criteria. The criteria used are internal environmental management, green purchasing, cooperation with customers, eco-design, and investment recovery. Drivers and barriers to applying GSCM in developing countries, with case studies in Egypt were identified by [24]. This study also compares international and local models of construction companies in developing countries in implementing GSCM to identify faults/ weaknesses and providing solutions. In this study, the main driving factors for the application of GSCM in Egypt were ISO 14001 certification and market competition. While the main barriers are lack of regulation, lack of government support, and lack of social pressure.

The next study was conducted by [25] which aims to test the shared understanding of supplier environmental management capabilities between contractors and suppliers, by assessing consistency between contractor evaluation and supplier evaluation of these capabilities. From the two evaluation results, the supplier gets the worst score on the item relationship with the second-tier supplier, and the best score on the item relationship with the contractor. Research in the United Arab Emirates that aims to develop, validate, and implement a multidimensional GSCM framework for the construction industry was conducted by [22]. The results of the study confirm the validity and reliability of the nine constructs and the underlying factors, as well as the assessment framework. The nine constructs are interconnected

according to the framework arranged and proven by testing the hypothesis. These constructs include external drivers, internal drivers, external barriers, internal barriers, core green practices, facilitating green practices, environmental performance, economic performance, and organizational performance.

In 2018, [12] developed the GSCM implementation framework for the construction industry by describing the concepts, dimensions, and elements of GSCM. This study resulted in a framework consisting of 5 concepts, 22 dimensions, and 82 elements as a unified evaluation model of GSCM in the construction industry. The concept is green initiation, green product design, green material management, green construction, and green operation & maintenance.

This study refers to the GSCM implementation framework model in the construction industry resulting from the research of [12] about the elements used in other studies. Expert opinions are taken into consideration to further refine the model compiled. In addition, this study will also produce models to the level of indicators and make measurements to be able to compile a composite index which is an evaluation value of the application of GSCM in the construction industry. From the results of this evaluation, project stakeholders can determine the right strategy to make improvements in the application of GSCM which ultimately is expected to improve efficiency and minimize environmental impacts. The variables that influence green practices in this study are green initiation, green design, green material management, green construction, and green operation and maintenance [12]. Whereas, drivers and barriers refer to [22]. The research variables are depicted in Table 1.

Table 1. Research variables

Dimensions	No	Variables	Definition
<i>Green Initiation</i>	1	The concept of eco-business in construction activities	Eco-Business is a concept in the business world where companies do business not only oriented to profit or profits, but also pay attention to how the impact of the business activities they do [26]
	2	Analysis of environmental impacts on the design that has been made	The green design process must begin with an assessment of the design that has been made whether or not it has a negative impact on the environment [26].
<i>Green Design</i>	3	Planning to use an energy-efficient lighting system	One form of application of green design in GSCM adoption is to make provisions or standards regarding lighting installations in the construction sector [27].
	4	Comprehensive waste management planning	There need to be rules regarding waste management in the project area so that the resulting waste does not have the chance to pollute the environment and can be utilized properly [28]
<i>Green Material Management</i>	5	Environmental criteria in making goods purchase decisions	During material purchasing activities, there are several environmental considerations, one of which is the determination of environmental criteria in selecting materials or products that do not pollute the environment [29].
	6	Environmental criteria to make tender selection decisions	During the activity of selecting a purchase tender, there are several environmental considerations, one of which is the determination of environmental criteria in the pre-qualification stage, for instance, choosing a tender that applies the environmental management system (EMS) or ISO 14001 certification [29].

Dimensions	No	Variables	Definition
<i>Green Construction</i>	7	Public transportation for employees in the construction environment	The use of public transportation is useful to reduce the number of private vehicle employees that pollute the air around the project [30].
	8	Trucks transporting goods/materials and public transportation with energy-efficient fuels	Materials transported by vehicles must also be considered fuel, you should use fuel-efficient fuel [30].
<i>Green Operation and Maintenance</i>	9	Machinery/equipment with energy-saving fuel or energy sources	Fuels used for machinery and equipment in all construction activities should use energy-efficient fuels [28].
	10	Carry out recycling activities of the remaining materials of construction activities	Material left over from the project work should not be thrown away because it will only become waste [29].
<i>External Drivers</i>	11	Government regulations on environmental protection	Governments around the world have announced some regulations to decrease environmental effects due to construction activities, for example, setting environmental standards for materials and technology [31] applying large penalties for non-compliance with rules and accidents and applying landfill tax [32].
<i>External Drivers</i>	12	Pressure from the supply chain stakeholders	Specific requirements and expectations from the stakeholders can encourage other GSCM practices in the supply chain. These pressures usually flow from developers to suppliers in the supply chain [33].
	13	Pressure from competitors	Pressure from competitors can encourage the adoption of the company's green practices. Studies in Singapore show that competitor pressure is one of the main drivers of green practices in construction sector [29]. However, there is also evidence in other sectors that shows the effect of rivalry in the development of corporate green practices [31].
	14	Pressure from end consumers	The final consumer in the construction sector is the tenant/building owner as a result of construction activities. Because they are only directly involved with developers, the pressure from the consumer as a driver of adoption of green practices is relevant to the developers only [28].
<i>Internal Drivers</i>	15	Commitment to protect the environment	The company commitment could protect and encourage the application of green practice. The top of management develops a vision and mission that have an environmental issue and green supply chain management [35].
	16	The desire to make a good reputation/image	The need to develop brand image as well as reputation is a powerful driver for companies for the implementation of green practices. It is expected to attract more buyers and investors. For example, there was a previous study which stated that developers in China who had adopted green practices, their reputation

Dimensions	No	Variables	Definition
			and image had increased and attracted many high-income people to collaborate with these developers [32].
	17	The desire to reduce costs	Construction companies are now aware of the potential for cost reduction, although the initial capital costs will be higher due to the high costs of procuring equipment and technology that supports green practices [32].
	18	The desire to enter the global market	Joining the global markets is a driver for green practices' adoption. For example, the company applies green practices to fulfil the carbon regulatory requirements of foreign governments and the demands of foreign clients who increasingly demand to adopt green practices [32].
<i>External Barriers</i>	19	Availability of experts in greening in the construction area	Professional experts with an expertise in the field of the green industry are required to the implementation of green practices. Several researchers have found that this variable has become one obstacle to adopting green practices [29].
	20	Availability of suppliers that implement GSCM practices in the construction area	Green materials provided by the suppliers are considered as a dependent factor to implement green practices since the companies tend to be reluctant for the implementation if the materials are not available on their distribution networks [28].
	21	Collaboration between stakeholders	Stakeholders tend to hold on to their knowledge of green practices. However, sometimes they tend to prevent being involved with other stakeholders to share ideas and best practices [30; 36; 37].
<i>Internal Barriers</i>	22	The cost of implementing green supply chain management	The additional costs incurred to implement green practices are now considered as a challenge for all stakeholders. It has been stressed by several studies in the construction sector and other sectors as well [32, 37].
	23	Knowledge and awareness of the impact on the environment	This variable can be a barrier for companies to stop them in investing their resources and their time green practices' implementation [32].

4. Discussion

This study refers to [12] and [22]. A GSCM-forming concept consisting of **green initiation, green designs, green material management, green construction, and green operation and maintenance** was proposed by [12]. The Novelty from this research is proposing green initiation as a separate concept in GSCM implementation on construction projects. This considers that the construction project design initiation is a very crucial stage because it will determine the direction and the next stage. Furthermore, drivers and barriers in GSCM implementation on construction projects refer to [22] who have succeeded in identifying these factors in developed countries. Research regarding drivers and barriers in the implementation of GSCM on construction projects in developing countries is still very limited. This is due to limited environmentally friendly development projects in developing countries.

Differences in conditions for GSCM implementation in developed countries and developing countries are explained as follows. The level of awareness of owners, welfare disparities, customer drivers, local people education, and global players (investors) is a differentiating factor for the successful GSCM implementation in both categories of countries. In developed countries, people in general, have been aware of the importance of environmentally friendly development and the impact of development on environmental sustainability. This encourages the owner to be more careful in determining the design, the use of construction materials, the selection of material transportation equipment, energy use and others. Thus, building environmentally friendly drives by customers. For example, Singapore and Dubai which have a limited area, customers can drive the idea of the construction project. This is because most consumers are foreign nationals whose level of awareness is high in the environment, so contractors will be more concerned about the green issue.

However, in developing countries, welfare disparity between regions results in a low awareness and role of the owner/customer in determining environmentally friendly development. In order for the community to be aware of the environmental impact of a construction project, education needs to be done to the local community regarding the impact of design and material selection. On the other hand, the role of higher education as a research centre in each region can drive the emergence of green building ideas. For example, Indonesia as a developing country where there is considerable disparity in welfare between provinces has an impact on the selection of designs, materials, and construction processes that are highly dependent on the budget.

5. Conclusion

This research states that there are factors of drivers and barriers in implementing GSCM on construction projects. These factors are influenced by the level of awareness of owners, welfare disparities, customer drivers, local people education, and global players. Subsequent research will sharpen the identification of drivers and barriers for GSCM implementation so that appropriate strategies can be drawn up and validate models developed in construction projects in various regions.

Acknowledgments

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