

## Drivers and barriers in the adoption of green supply chain management in construction projects: A case of Indonesia

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### ABSTRACT

*The concept of Green Supply Chain Management (GSCM) is attracting attention to the construction industry to minimise adverse environmental effects. However, its application is not common in developing countries like Indonesia. Based on contractors' and construction design consultants' point of view, the current study attempts to identify the drivers and barriers to adopting GSCM in construction projects in Central Java Province, Indonesia. The research study used previous literature, observation, questionnaires, and in-depth interviews with experts on drivers and barriers to implementing Green Supply Chain Management in construction. Data were analysed using SPSS and evaluated by the ordinal regression analysis method. Based on testing in ordinal regression analysis, seven factors were identified as drivers or barriers to the adoption of GSCM in construction projects in Central Java Province, and four of them affect significantly. The driving factors that significantly affect the adoption of GSCM include government regulations on environmental protection and pressure from the supply chain stakeholders. On the other hand, the barrier factors include the shortage of suppliers who implement GSCM practices in the construction area and inadequate knowledge and awareness about the impact of construction activities on the environment. This work could give the policymakers' insight into the barriers and drivers to GSCM, thus enabling them to develop strategies in implementing GSCM in the construction industry.*

**KEYWORDS:** Barrier, Construction industry, Driver, Green Supply Chain Management (GSCM).

### INTRODUCTION

The global community currently accepts sustainability as providing a competitive advantage and increasing construction process performance in the construction sector (Hussain *et al.*, 2019). The construction industry leads to various environmental impacts; therefore, it is appropriate for the community to adopt different construction management concepts like Green Supply Chain Management (GSCM). Green Supply Chain Management is a process

that uses environmentally friendly inputs and converts these inputs into reusable outputs at the end of their life cycle, thus creating a sustainable supply chain (Penfield, 2007). The GSCM includes green purchase, green production, green logistics, reuse, recycling, and reduction (Chun, Hwang, & Byun, 2015). Green construction has been a challenge to developing countries because of unanticipated obstacles (Hwang & Ng, 2013). Most construction projects in Indonesia have not implemented GSCM in construction projects because of several factors that influence its adoption. According to Zhang and Zheng (2010), some factors that affect the existing greening practices in the construction sector are enablers, and others are barriers.

Some published articles have provided a detailed and systematic exploration of the various green supply chain phases and supply chain stakeholders. They addressed the relevant issues, the drivers for implementing such practices, and the barriers stakeholders face in implementing these practices (Akdağ & Bledek, 2017). The previous study by Malviya & Kant (2015) revealed that integrating GSCM into supply chain management (SCM) has nowadays appeared as a universal approach to environmental management. GSCM is anticipated to be the best approach to handling construction and demolition wastes (Elizar, Wibowo, & Koestalama, 2015; Faniran & Caban 1998). The Green Supply Chain is categorised by integrating eco-friendly thinking into supply chain management, starting from project initiation, project design, material sourcing, manufacturing processes, product delivery, and end-of-life management of the product (Ojo, Mbohwa, & Akilabi, 2014).

The study by Wibowo, Handayani, & Mustikasari (2018) developed the Green Supply Chain Management framework in the construction industry. However, researches identifying drivers and barriers to GSCM implementation in Indonesia are still limited. Therefore, because of inadequate information about incorporating GSCM in Indonesia's construction projects, this study's main objective is to explore the significant drivers and barriers in implementing GSCM in Central Java Province, Indonesia. The research could help policymakers know the strategies in minimizing problems associated with GSCM implementation on construction projects.

## THEORETICAL BACKGROUND OF GREEN SUPPLY CHAIN MANAGEMENT

### Supply Chain Management in Construction Projects

The supply chain in construction projects is very complex, making the supply network system that occurs in the production process complicated. A study shows that poor supply chain design could increase project costs by 10% (Chopra & Meindl, 2004). Other studies show that the construction supply chain pattern can contribute to the efficiency of project implementation (O'Brien, Formoso, & London, 2008; O'Brien, London, & Vrijhoef, 2002; Winch, 2001). The main parties involved in a construction supply chain include the project owner, contractor, sub-contractor, suppliers, and consultant (Vrijhoef & Koskela, 2000).

### Green Supply Chain Management in Construction

Green Supply Chain Management (GSCM) is identified as a new concept, which becomes a critical business value driver that could enhance environmental sustainability (Dadhich *et al.*, 2015; Luthra, Garg, & Haleem, 2016). GSCM could be defined as the 'practice of integrating sustainable practices into upstream and downstream supply chain management, including product design, material sourcing, and selection, manufacturing processes, delivery of the final

product to the consumers as well as end-of-life management of the product after its useful life' (Srivastava, 2007). The construction industry's green supply chain implementation framework includes green initiation, green design, green material management, green construction, and green operation and maintenance (Ghobakhloo *et al.*, 2013; Wibowo *et al.*, 2018).

### Drivers and Barriers of GSCM Implementation in Construction Projects

The implementation of green practices is associated with drivers and barriers. Walker & Jones (2012) categorised driver and barrier factors for companies implementing eco-friendly practices as external or internal.

#### *Drivers to green practices (External and Internal)*

**External drivers** are pressures organisations face outside entities like government, competitors, supply chain stakeholders, and end consumers. External drivers applicable to the construction industry can be recognised as follow;

- **Government green-related regulation:** Governments have issued regulations globally regarding reducing environmental impacts caused by construction projects. For example, setting environmental standards for materials and technology (Shi *et al.*, 2013), applying strict fines for environmental disobedience and accidents (Tam *et al.*, 2006; Qi *et al.*, 2010), and the imposition of landfill taxes (Jaillon, Poon, & Chiang, 2009; Pitt *et al.*, 2009). A study by McGraw-Hill Construction also highlights the influence of governments in institutionalizing green construction projects around the world (World Green Building Council, 2013).
- **Stakeholder pressure.** The specific needs and expectations of stakeholders can encourage green practices of other stakeholders in the supply chain. A study by Robin and Poon (2009) shows that this pressure is hierarchical, usually flowing from the developer to the supplier. Implementing green practices is one of the most critical requirements of developers for contractors in project tenders, shifting away from conventional cost-based delivery systems (Qi *et al.*, 2010).
- **Competitor pressure.** This can have an impact on corporate green practices. Ofori, Gang, & Briffett (2000) stated that competitor pressure is one of the main drivers of green practices in the Singapore construction sector. Likewise, evidence in other sectors shows the effect of competition on the development of corporate green practices (Zhu, Sarkis, & Lai, 2007).
- **End-consumer Pressure.** The end consumer is the owner of the building/apartment. Consumers only deal directly with developers. This indicator is only relevant to be discussed with the developer. However, there is not much previous research that examines developers' consumer pressure regarding green practices in the construction sector. It was a significant driver of green practices in other sectors, such as manufacturing (Sarkis, Zhu, & Lai, 2011).

**Internal drivers** are pressures that emerge within the organisation to implement green practices. Apart from being part of their environmental commitments, the company's goal of implementing green practices also achieves clearly stated business benefits (Varnäs *et al.*, 2009). Some of the fundamental drivers identified for the construction sector are outlined as follows:

- Environmental commitment. The company's commitment to protecting the environment has been proven to encourage green practices in many cases. The adoption of green practices is usually seen as a voluntary obligation consistent with community values as a corporate commitment (Hsu & Hu, 2008; Hsu *et al.*, 2013).
- Enhance reputation/brand image. The importance of enhancing brand image and reputation is a reliable driver for companies to adopt green practices because reputation is expected to attract additional investors and buyers. Zhang, Shen and Wu (2011) explained that developers in China who have a good reputation in implementing green practices have attracted many high-income people and got higher selling prices. Likewise, Shi *et al.* (2013) highlighted the increasing enthusiasm among contractors to implement green construction practices to enhance the organisation's reputation.
- Reduce costs. Construction companies realise the potential of reducing costs through green practices. However, this requires high initial capital for green equipment and technology. For example, a contractor can reduce costs associated with transportation, labor requirements, installation time, and waste management (Carris *et al.*, 2012).
- Enter foreign markets. Opportunities to enter foreign markets are a significant driver of green practices. The company applies environmentally friendly practices to meet foreign governments' low carbon regulatory requirements and foreign clients' demands and partners' environmental expertise (HM Government, 2013).

### *Barriers to green practices (External and Internal)*

**External barriers** are obstacles beyond the company's control. Barrier factors that affect the implementation of green practices in the construction sector include;

- Shortage of green professionals. Implementing green procedures requires experts in the green industry. Previous studies have explained that the absence of experts in these fields can be a significant barrier to green practices in the construction sector (DBIS, 2013; Ofori *et al.*, 2002).
- Shortage of green suppliers. Companies rely on green materials provided by suppliers to implement green practices. Companies have difficulties doing green practices if the material is unavailable in a standardised supplier and distribution network. Collaboration with suppliers with delivery commitments, flexible payment terms, and reasonable prices are expected to improve green practices (Shi *et al.*, 2013).
- Tight and inflexible stakeholder deadlines. Developers are expected to complete the project faster (from design to delivery), especially if the demand for green practices is estimated to exceed the company's capacity. Implementing green practices in the construction sector requires a process and a longer time than traditional practices (Hwang & Tan, 2012). The deadlines given by stakeholders to developers are often stringent and inflexible. It requires a rapid material supply process to compromise with all supply chain stakeholders' green practices.
- Lack of stakeholder engagement/collaboration. Stakeholders' tendency to maintain their competitive advantage can prevent other stakeholders' initial involvement to share ideas and best practices at the conceptual stage. Liu, Low and He (2012) stated that poor communication between stakeholders arising from lack of involvement is a significant barrier to implementing green practices.

**Internal barriers** are resource-based challenges that arise within the organisation. Two main barriers relevant to the implementation of green practices in the construction sector are;

- The high cost of implementation. Supplementary costs incurred for implementing green practices pose significant challenges for all stakeholders. It was also considered in the study of the implementation of green practices in the construction industry and other sectors (Seuring & Muller, 2008; Liu *et al.*, 2012; Zhang *et al.*, 2011).
- Lack of Knowledge and awareness. Previous studies on green construction practices explain that the lack of knowledge and awareness about green practices and their benefits is a significant barrier that stops companies from implementing green practices (Sourani & Sohail, 2011; Zhang *et al.*, 2011). Bon-Gang (2018) revealed that lack of awareness could be due to inadequate research about the indoor air quality of eco-friendly buildings.

### Conceptual Framework of Implementation GSCM in Construction Project

This study aims to identify driver and barrier factors in the application of green practices in construction projects. Thipparat (2011) developed a model to evaluate the implementation of GSCM practices in several contracting companies in Singapore. Five criteria and twenty-one sub-criteria were built on the model. The criteria consist of internal environmental management, environmentally friendly purchases, collaboration with customers, eco-design, and investment recovery. Elbarkouky and Abdelazeem (2013) examined the drivers and barriers to GSCM implementation in developing countries with a case study in Egypt. The study compares the GSCM implementation's weaknesses in developing countries' international and local construction companies and seeks solutions. In this study, the driving factors for implementing GSCM in Egypt are ISO 14001 certification and market competition. Simultaneously, the main drivers were lack of regulation, lack of government support, and lack of social pressure.

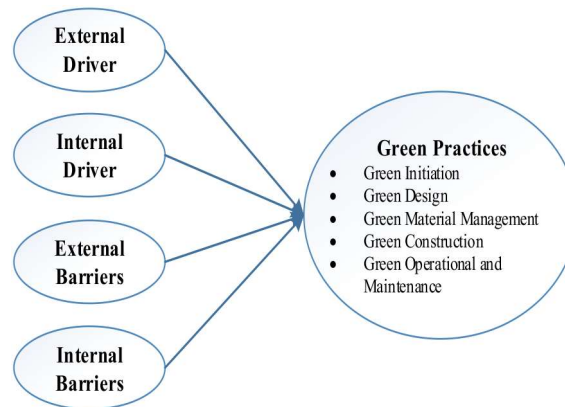
Kim, Woo, Rho, and Chung (2016) researched contractors' and suppliers' understanding of environmental management capabilities by assessing contractor evaluations and supplier evaluations' consistency. From the two evaluation results, the supplier gets the worst score on the relationship of goods with the second level supplier and the best score on the relationship of goods with the contractor. Balasubramanian and Shukla (2017a) conducted a study to develop, validate, and implement a multidimensional GSCM framework for the United Arab Emirates construction industry. The results confirmed the nine constructs' validity and reliability and the assessment framework factors interconnected through hypothesis testing. This construction includes external drivers, internal drivers, external barriers, internal barriers, green core practices, facilitation of environmentally friendly practices, environmental performance, economic performance, and organisational performance.

Wibowo *et al.* (2018) investigated the 'factors for Implementing Green Supply Chain Management in the Construction Industry'. Their study developed a framework consisting of five concepts, twenty-two dimensions, and eighty-two elements as a model of GSCM based on Project Life Cycle (PLC) in the construction industry.

The current study aims to identify drivers and barriers in GSCM implementation by referring to the framework in the construction industry (Wibowo *et al.*, 2018) and driver and barrier indicators in GSCM implementation (Balasubramanian & Shukla, 2017b). Expert opinions are considered to improve the model that was prepared. This research involved researchers in the construction management field, architects, contractors, and stakeholders. This model is expected to be a reference for project stakeholders to determine the right improvement strategy



for GSCM implementation. It is expected to increase efficiency and minimise environmental impact. This study's variables that influence green practices are green initiation, green design, green material management, green construction, and green operations and maintenance (Wibowo *et al.*, 2018). This study's empirical model refers to Balasubramanian and Shukla (2017b) and Wibowo *et al.* (2018), as shown in Figure 1.



**Figure 1: Empirical Model**

The hypothesis that is built based on the empirical model in this study is explained as follows.

- a) The influence of external drivers on green practices. Previous research on external drivers' impact on green practices found that external drivers would strongly influence proactive companies and vice versa on reactive companies (Hsu *et al.*, 2013; Lee, Kim, & Choi, 2012).

**Hypothesis 1:** External drivers can encourage the adoption of Green Supply Chain Management in construction projects

- b) The influence of internal drivers on green practices. Previous research on the effect of internal drivers on green practices found that companies that apply green practices only from internal pressures may not be sustainable in the long term (Hsu *et al.*, 2013; Lee *et al.*, 2012; Varnas *et al.*, 2009).

**Hypothesis 2:** Internal drivers can encourage the adoption of Green Supply Chain Management in construction projects

- c) The influence of external barriers on green practices. An impact assessment caused by external or internal barriers in adopting green practices can help the construction sector prioritise the steps needed to minimise barriers (Balasubramanian & Shukla, 2017b).

**Hypothesis 3:** External barriers can hinder the adoption of Green Supply Chain Management in construction projects

- d) The influence of external barrier factors on green practices. In construction projects, if the impact of internal barriers on adopting green practices is high, stakeholders must focus on

the strategies for increasing the company's knowledge and awareness of environmental protection and the obligation to adopt green practices (Balasubramanian & Shukla, 2017b).

## RESEARCH APPROACH

### Data Collection

The study was conducted in Central Java Province, Indonesia. To understand the potential drivers and barriers to the adoption of GSCM in the construction industry, we used different data collection techniques, namely questionnaires, observation, and in-depth interviews. We conducted both online and offline surveys to gather a variety of views. Data collection combining online and on-site surveys help generate perfect results (Zhu, Sarkis, & Lai, 2008). The researchers conducted field observations by directly visiting construction projects.

To obtain more relevant information, questionnaires were distributed to fifty (50) people. These included contractors and consultants (designers and those in operation and supply chain divisions). The respondents' profiles are presented in Table 1. The questionnaire consisted of three parts. The respondents' data is completed in the first part. The second part contains brief theories related to the statements in the questionnaire. The third part contains statement items that the respondent will fill in according to their point of view and environmental construction conditions. The statement items consist of twenty-three statements. Out of the twenty-three statements, ten statements were to identify how significant the adoption of Green Supply Chain Management in a construction project, eight statement items to determine how influential the driving factors are in adopting Green Supply Chain Management in a construction project. Five statements items to identify how significant barrier factors are in adopting Green Supply Chain Management in a construction project. Besides, in-depth interviews were conducted with academic researchers in the construction management field, Architects, and Project managers. The purpose of performing the interview was to get a clear picture of various factors that influence the adoption of GSCM in the construction industry. According to Barriball and While (1994), interviews are most appropriate because they allow the interviewees to extract relevant information and additional important points that they may not previously consider. Moreover, interviews provide clearer understanding of phenomena to determine the motivations and actions that lead stakeholders to behave in specific ways (Myers, 2011).

**Table 1: The Respondents' profile**

Categories		Number	Percentage (%)
Gender	Male	38	76
	Female	12	24
Age	20-29	39	78
	30-39	9	18
	40-49	1	2
	Over 50	1	2
	Contractors	20	40
Profession	Design Consultants	30	60
	Less than 3 years	22	44
Years of Experience (years)	3 - 5	18	20
	5 - 10	8	16
	Over 10 years	2	8

## Research Variables

This research has both the dependent variable and the independent variable. The dependent variable, Y, was Green Practices. On the other hand, thirteen (13) independent variables that influence Green Supply Chain Management adoption in construction projects were used. The independent variables included both internal and external drivers and both internal and external barriers. External drivers include government regulations on environmental protection (X1), pressure from the supply chain stakeholders (X2), pressure from competitors (X3), and pressure from the end consumers (X4). Internal drivers include a commitment to protect the environment (X5), desire to create a good reputation (X6), efforts to reduce costs (X7), and desire to enter the global market (X8). External barriers include the shortage of greening experts in construction areas (X9), shortage of suppliers who implement GSCM practices in the construction area (X10), and inadequate collaboration between stakeholders (X11). Internal barriers include the high costs of implementing Green Supply Chain Management (X12) and inadequate knowledge and awareness about the impact of construction activities on the environment (X13).

## Data Analysis

Data were analysed using an ordinal logistic regression model. Ordinal logistic regression analysis is one of the statistical methods that describe the relationship between a response variable (Y) with more than one predictor variable (X), where the response variable is more than two categories and the measurement scale is graded (Lemeshow & Hosmer, 2000).

## PRESENTATION OF RESULTS AND FINDINGS

### Validity and Reliability Tests

We conducted validity and reliability tests on the measurement data obtained from the questionnaires using the Statistical Packages for Social Science (SPSS) computer program. Validity means that the measuring instrument used can measure the desired concept (Suliyanto, 2006). The validity test examined each variable used in this study, where all research variables contain 13 statements that the respondents must answer. The criteria used in determining the validity of the statements are the level of confidence =95% ( $\alpha = 5\%$ ) and degrees of freedom ( $df = n - 2 = 50 - 2 = 48$ ), it is known that  $r_{table} = 0.2787$ . If  $r_{cal} > r_{table}$  and the 'r' value is positive, then the statement item is said to be valid (Ghozali, 2008). Based on the analysis that was done, the validity test results show that all indicators used to measure the variables have a greater correlation coefficient than 'r' table; therefore, all indicators are declared valid, as seen in Table 2.

Reliability is a tool for measuring a questionnaire. A questionnaire is reliable if a person's answer to a question is consistent or stable over time (Ghozali, 2008). The reliability test is the level of stability of a measuring device in measuring an event. The higher the reliability of a measuring instrument, the more stable the measuring device is. A construct is reliable, if it gives a Cronbach's alpha value  $> 0.70$  (Cronbach, 1951; Ghozali, 2008). As seen in Table 3, all the variables have a large Cronbach's alpha above 0.7, thus acceptable (Cronbach, 1951). All the measuring concepts of each variable from the questionnaire are reliable; therefore, further items in each of these variable concepts are suitable for use as a measuring tool.



**Table 2: Validity test results**

Variable	r Cal	r Table	Description
X1	0.275	0.2787	Valid
X2	0.279	0.2787	Valid
X3	0.332	0.2787	Valid
X4	0.389	0.2787	Valid
X5	0.471	0.2787	Valid
X6	0.374	0.2787	Valid
X7	0.335	0.2787	Valid
X8	0.414	0.2787	Valid
X9	0.465	0.2787	Valid
X10	0.316	0.2787	Valid
X11	0.441	0.2787	Valid
X12	0.31	0.2787	Valid
X13	0.616	0.2787	Valid
Adoption of GSCM	0.407	0.2787	Valid

**Table 3: Results of reliability test**

Cronbach's alpha value	Cronbach's alpha value-based on standardised Items	No. of items
0.720	0.727	14

### Adoption of GSCM in the Construction Industry

The research has examined several supply chain conditions in construction projects in Central Java, Indonesia, by summarising raw data. After conducting interviews and distributing questionnaires to several stakeholders in the construction supply chain, the research concludes that none or few construction projects have adopted the Green Supply Chain Management concept in their supply chain correctly. Among the 50 respondents, none of them complied with characteristics of the adoption criteria number 4, as seen in Table 4.

**Table 4: Adoption of GSCM in a construction project in Central Java**

Value	Adoption criteria	Annotation	No. of respondents
10.0 – 17.5	1	Not yet adopted	21
17.6 – 25.0	2	Adopted, not done well	23
25.1 – 32.5	3	Adopted, well done	6
32.6 – 40.0	4	Adopted, very well implemented	0
<b>Total</b>			50

### Factors Affecting GSCM Adoption in Construction Projects

Factors that influence significantly or insignificantly were identified through ordinal regression analysis. Simultaneous testing in ordinal regression analysis indicates whether factors or independent variables influence Green Supply Chain Management adoption in construction projects. This simultaneous testing uses the Wald test (see Table 5).

**Table 5: Influential partial test results**

Variables	Estimate	Wald	Sig.
[Adopt GSCM = 1.00]	-87.176	4.437	.035
[Adopt GSCM = 2.00]	-77.947	3.747	.053
[X1=1.00]	-38.251	7.108	.008
[X1=2.00]	-17.086	2.648	.104
[X1=3.00]	0 <sup>a</sup>	.	.
[X2=1.00]	5.527	.817	.366
[X2=2.00]	-6.968	3.667	.045
[X2=3.00]	0 <sup>a</sup>	.	.
[X3=1.00]	6.745	.920	.337
[X3=2.00]	7.462	1.361	.243
[X3=3.00]	0 <sup>a</sup>	.	.
[X4=1.00]	-4.039	.121	.728
[X4=2.00]	-21.283	1.449	.229
[X4=3.00]	0 <sup>a</sup>	.	.
[X5=1.00]	124.392	4.535	.033
[X5=2.00]	104.980	4.127	.042
[X5=3.00]	104.141	4.129	.042
[X5=4.00]	0 <sup>a</sup>	.	.
[X6=1.00]	-89.705	5.225	.022
[X6=2.00]	-72.882	4.175	.041
[X6=3.00]	-91.462	4.184	.041
[X6=4.00]	0 <sup>a</sup>	.	.
[X7=1.00]	-51.006	2.193	.139
[X7=2.00]	-22.342	.750	.386
[X7=3.00]	-44.268	1.758	.185
[X7=4.00]	0 <sup>a</sup>	.	.
[X8=1.00]	-15.373	1.004	.316
[X8=2.00]	-2.521	.026	.873
[X8=3.00]	-8.739	.326	.568
[X8=4.00]	0 <sup>a</sup>	.	.
[X9=1.00]	-24.126	5.384	.020
[X9=2.00]	-12.521	3.981	.046
[X9=3.00]	-13.503	2.634	.105
[X9=4.00]	0 <sup>a</sup>	.	.
[X10=1.00]	-10.843	2.885	.049
[X10=2.00]	8.725	1.375	.241
[X10=3.00]	0 <sup>a</sup>	.	.
[X11=1.00]	7.766	1.723	.189
[X11=2.00]	-11.163	2.843	.192
[X11=3.00]	-3.601	.238	.626
[X11=4.00]	0 <sup>a</sup>	.	.
[X12=1.00]	-12.582	1.436	.231
[X12=2.00]	-3.008	.086	.769
[X12=3.00]	.648	.004	.951
[X12=4.00]	0 <sup>a</sup>	.	.
[X13=1.00]	-60.648	5.232	.022
[X13=2.00]	-14.277	.630	.427
[X13=3.00]	-23.218	1.251	.263
[X13=4.00]	0 <sup>a</sup>	.	.

It was concluded that there is at least one variable that influences the dependent variable. The variables that influence the adoption of GSCM in construction projects have a significance value ( $p\text{-value}$ )  $< \alpha=0.05$  because it is a tolerable error limit, so it was decided to reject  $H_0$ .

### Partial Testing to Know Factors that Significantly Influence Dependent Variable

Partial testing in the ordinal regression analysis was carried out to determine which factors influence it. The partial testing was carried out with the G Test, as seen in Table 6. It was observed that seven variables affect the dependent variable i.e. government regulations regarding environmental protection (X1), pressure from the supply chain stakeholders (X2), commitment to protect the environment (X5), desire to create a good reputation (X6), shortage of greening experts in construction areas (X9), shortage of suppliers who implement GSCM practices in the construction area (X10) and inadequate of knowledge and awareness about the impact of construction activities on the environment (X13).

**Table 6: Partial test results for variables that have Significant Influence**

Variables	Estimate	Wald	Sig.
[Adopt GSCM = 1.00]	-32.097	157.865	.000
[Adopt GSCM = 2.00]	-27.199	112.204	.000
[X1=1.00]	-3.991	9.662	.002
[X1=2.00]	-.697	.335	.562
[X1=3.00]	0 <sup>a</sup>	.	.
[X2=1.00]	-1.793	2.311	.128
[X2=2.00]	-.338	.106	.745
[X2=3.00]	0 <sup>a</sup>	.	.
[X5=1.00]	8.914	3.702	.044
[X5=2.00]	6.870	2.567	.109
[X5=3.00]	7.352	2.729	.099
[X5=4.00]	0 <sup>a</sup>	.	.
[X6=1.00]	-5.088	2.229	.135
[X6=2.00]	-1.728	.281	.596
[X6=3.00]	-3.379	.975	.323
[X6=4.00]	0 <sup>a</sup>	.	.
[X9=1.00]	-.776	.204	.651
[X9=2.00]	.518	.094	.759
[X9=3.00]	-1.355	.646	.422
[X9=4.00]	0 <sup>a</sup>	.	.
[X10=1.00]	-3.860	5.626	.018
[X10=2.00]	-2.075	1.908	.167
[X10=3.00]	0 <sup>a</sup>	.	.
[X13=1.00]	-32.633	389.528	.000
[X13=2.00]	-29.961	481.423	.000
[X13=3.00]	-29.841	.	.

Of the seven variables, there are four influential driver factors and three barrier factors that influence the adoption criteria of Green Supply Chain Management in construction projects.

The partial test was carried out only on seven independent variables that affect the dependent variable. It was performed using the Wald test. The confidence level used is 95% or a significance level of 5%, and  $k$  is the number of independent variables. The variable that influences the adoption of GSCM in construction projects has a significance value ( $p\text{-value}$ )  $< \alpha$

equal to 0.05 because it is a tolerable error limit; it was decided to reject H0.

Four variables affect the dependent variable, namely X1, X5, X10, and X13.

The hypothesis used is as follows:

$$H_0: \beta_i = 0$$

$$H_1: \beta_i \neq 0; i = 1, 2, \dots, k$$

The rejection area is if the value of p-value < alpha ( $\alpha$ ).

### Regression Model

The regression model and logit function are obtained from the dependent variable's estimated value and the influential independent variables based on the partial test shown in Table 6.

The regression obtained is presented in equation 1.

$$\bullet \quad P(Y \leq 1|X) = p1 = \frac{e^{(-31.097 - 3.991X_1 + 8.914X_5 - 3.860X_{10} - 32.633X_{13})}}{1 + e^{(-31.097 - 3.991X_1 + 8.914X_5 - 3.860X_{10} - 32.633X_{13})}} \quad (1)$$

$$\bullet \quad P(Y \leq 2|X) = p2 = \frac{e^{(-27.199 - 3.991X_1 + 8.914X_5 - 3.860X_{10} - 32.633X_{13})}}{1 + e^{(-27.199 - 3.991X_1 + 8.914X_5 - 3.860X_{10} - 32.633X_{13})}} \quad (2)$$

Transform in logit form as follows.

$$\bullet \quad \log\left(\frac{\pi_1}{1-\pi_1}\right) = -31.097 - 3.991X_1 + 8.914X_5 - 3.860X_{10} - 32.633X_{13} \quad (3)$$

$$\bullet \quad \log\left(\frac{\pi_2}{1-\pi_2}\right) = -27.199 - 3.991X_1 + 8.914X_5 - 3.860X_{10} - 32.633X_{13} \quad (4)$$

### Model Interpretation

Influential factors were used again for a partial test analysis in ordinal regression to determine the driver and barrier factors that significantly influence the adoption of GSCM in construction projects in Central Java. Table 7 shows four factors with a significant effect. These factors are government regulations regarding environmental protection (X1), commitment to protect the environment (X5), shortage of suppliers who implement GSCM practices in the construction area (X10), and inadequate knowledge and awareness about the impact of construction activities on the environment (X13). Based on the odds ratio values in Table 7, it can be seen that the effect of the factor of commitment to protecting the environment (X5) is far more significant than the influence of the other variables.

**Table 7: Calculation of significant variable odds ratio**

Variables	Coefficient	Odds Ratio
X1	-3.991	0.018
X5	8.914	7435.343
X10	-3.860	0.021
X13	-32.633	$6.725 e^{-15}$

## DISCUSSION

The research identified seven (7) drivers and barriers in adopting GSCM in the construction industry in Central Java, Indonesia, as seen in Table 8. Out of these seven factors, four influence significantly, i.e., government regulations on environmental protection, commitment to protect the environment, shortage of suppliers who implement GSCM practices in the construction area, and inadequate knowledge and awareness about the impact of construction activities on the environment. Regarding the point of government regulations, it has been seen that governments worldwide have tried to put tight measures to reduce adverse environmental impacts caused by the construction industry, for example, setting standards for environmentally friendly materials (Zhu, 2007). Zhang *et al.* (2011) complimented that governments impose high taxes and enormous penalties for those who do not abide by the government's rules and regulations. According to Qi *et al.* (2010), commitment to protect the environment is crucial, and the managers in the organisation could do this to encourage the application of green practices.

**Table 8: Drivers and Barriers in adopting GSCM in the construction industry**

Internal drivers	External drivers	Internal barriers	External barriers
Commitment to protect the environment (X5)	Government regulations on environmental protection (X1)	Inadequate knowledge and awareness about the impact of construction activities on the environment (X13).	Shortage of greening experts in construction areas (X9)
Desire to create a good reputation (X6)	Pressure from the supply chain stakeholders (X2)		Shortage of suppliers who implement GSCM practices in the construction area (X10)

Internal drivers that do not affect Green Supply Chain Management's adoption are efforts to reduce costs (X7) and the desire to enter the global market (X8). Based on in-depth interviews with several respondents, the business factor in reducing costs does not affect because most respondents (contractors and design consultants) consider the project's costs and benefits in the short term or not in all construction project phases. It has led to the view that adopting GSCM does not reduce project costs. The business factor of increasing the market by entering the global market also does not affect GSCM in Central Java, Indonesia. This is because, for most construction projects, the focus is still on entering the national market. However, based on other countries like Singapore, Hong Kong, and United Arab Emirates, their major focus in practicing GSCM is to enter the global market. Singapore has been widely viewed as a leader advocating for sustainability in the global construction community with its efficient initiatives (Bon-Gang, 2018).

External driver factors that do not influence GSCM adoption are pressure from competitors (X3) and pressure from end consumers (X4). The issue of pressure from the competitors does not affect the greening practices because there are inadequate green practices among the contractors, consultants, and suppliers. On the other hand, the issue of pressure from end-use consumers does not exist in Indonesia because most customers are not aware of green practices.

The internal barrier factor that does not affect GSCM adoption is the costs of implementing Green Supply Chain Management (X12). Based on in-depth interviews with several



respondents, this factor does not affect GSCM practices because most respondents (design consultants and contractors) of construction projects do not yet know what implementation costs must be incurred to adopt the GSCM concept. The external barrier that does not affect Green Supply Chain Management's adoption is the lack of collaboration between stakeholders (X11). This is because of inadequate awareness among the stakeholders about the implementation of green practices. This is coherent with the study conducted by Qi *et al.* (2010) and Liu *et al.* (2012) that some stakeholders tend to share little knowledge about implementing green practices.

## CONCLUSIONS AND RECOMMENDATIONS

This study attempted to identify the drivers and barriers in implementing Green Supply Chain Management (GSCM) in the construction industry. The study contributes to the existing literature and will help decision-makers formulate new strategies that could lead to sustainable supply chain management in the construction sector. Based on the findings, the following conclusions emanated from the study.

The test results in the ordinal regression analysis showed that seven factors influence Green Supply Chain Management's adoption in construction projects in Central Java, Indonesia. Of the seven factors, four are driver factors, and three are barrier factors. The external drivers are government regulation regarding environmental protection and pressure from stakeholders. At the same time, the internal driver factors are the effort and commitment to protecting the environment and the desire to create a good reputation. External barrier factors that influence are the shortage of greening experts in construction areas and the shortage of suppliers who implement GSCM practices. In comparison, the internal barrier factors that influence are inadequate knowledge and awareness about the impact of construction activities on the environment.

After partial re-testing, it was observed that four factors significantly influenced the adoption of Green Supply Chain Management in construction projects. These include government regulations on environmental protection, commitment to protect the environment, availability of suppliers who implement GSCM practices in the construction area, and inadequate knowledge and awareness about the impact of construction activities on the environment. Furthermore, the study came out with the following recommendations for future research. Many variables used in this study have not been explored entirely both from interviews and literature. Therefore, further research could examine more factors influencing Green Supply Chain Management's adoption in construction projects in developing countries.

Further research could try to use other methods to analyse the factors that influence the adoption of Green Supply Chain Management in construction projects, other than ordinal regression analysis. The ordinal regression method is still limited by the number of samples that researchers obtain.

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