International Journal of Construction Management

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tjcm20

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To cite this article: J. A. Bamgbade, Mohammad Mehdi Hosany, W. A. Ajibike & C. S. Chai (2023): Green supply chain nuances in East Malaysian construction industry, International Journal of Construction Management, DOI: 10.1080/15623599.2023.2179470

To link to this article: https://doi.org/10.1080/15623599.2023.2179470

Published online: 21 Feb 2023.

INTERNATIONAL JOURNAL OF CONSTRUCTION MANAGEMENT
https://doi.org/10.1080/15623599.2023.2179470

Green supply chain nuances in East Malaysian construction industry

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ABSTRACT

The antecedent influence of technology innovation, regulatory regimes and stakeholders' pressure on green supply chain management have been investigated disparately, with mixed results. This study aimed to explore the potential and specific effects of these selection pressure among sampled construction organizations in Sarawak Malaysia using the Triple Embeddedness Framework as an underpinning theory. Using a self-report online survey instrument, we sampled 350 contractors in Sarawak, and 114 responses were received after repeated reminders. However, after removing seven incomplete responses, only 107 usable surveys were considered for data analysis, denoting a response rate of 30.6%. Data screening was then carried out using SPSS version 23, while SmartPLS version 3.2 was used to assess the measurement and structural models. The findings suggest that regulatory pressure and technology orientation positively relate to the contractors' green supply chain management. There is also a significant mediation of technology orientation in customer, regulatory pressure and green supply chain management relationships. This study contributes to the construction project supply chain body of knowledge by channelling the Triple Embeddedness Framework toward green supply chain management by providing empirical grounds from the hypothesized relationships. Stakeholders' unification is also suggested for sustainable upstream and downstream integration.

ARTICLE HISTORY
Received 17 March 2022
Accepted 28 January 2023

KEYWORDS
Green supply chain management; customer pressure; regulatory pressure; technology; Malaysian contractors

Introduction

Construction entities are criticised for excessive environmental pollution due to their high resource consumption and waste from on-site and off-site activities. The industry's massive contribution to environmental degradation through the exploitation of physical and biological resources makes it a vital sector requiring sustainability practices at all levels of project realisation (Bamgbade et al. 2019; Shen and Tam 2002). With the increasing discussion about construction firms' adoption of practices targeted at considering environmental protection in their supply chains, researchers, as well as other construction stakeholders, have suggested the strength of regulatory framework indices directed at the contractors/supplier in predicting effective green supply chain management (GSCM) practices (Gardas et al. 2019; Geng 2019). Since supply chain involves various processes from material purchase to the final project delivery, construction firms must carefully manage each subcategory based on clients' demands by employing sustainable methods at the right condition.

Others have also hinted that construction entities are faced with a host of disruptions in the realisation of the GSCM practices, leading to overwhelming barriers (Ting et al. 2020). Although construction product manufacturers and suppliers are encouraged to innovate and improve green technology for carbon reduction, evidence has shown that quite an infinitesimal achievement was recorded without mandatory regulatory standards and punitive measures (Yuan and Zhang 2020). This study attempts to broaden the understanding of GSCM practices among the contractors operating in East Malaysia. Specifically, it considers how technology innovation, regulatory regimes and stakeholders' pressure drive GSCM practices. These are essential predictors when GSCM is viewed from an attitudinal perspective through sustainability moves targeted at firms' financial viability and socio-environmental improvements (Mathiyazhagan et al. 2013; Min and Galle 1997). These considerations were also motivated by calls for research to explore the broader interaction effects of other relevant constructs for a robust GSCM implementation model (Irfan et al. 2021; Touboulic and Walker 2015).

Owing to their influence on construction delivery, construction clients are getting more concerned about environmental protection, especially in developed countries. The regulatory authorities in emerging economies consistently push for strict compliance with environmental laws to reduce their carbon footprints (Melanta et al. 2013). Since GSCM adoption is still evolving in the developing world, attention is consistently focused on construction firms due to their excessive CO_2 emissions. Another mitigation direction for the industry is to invest heavily in green technology and innovations to increase firms' performance and competitiveness (Weng and Lin 2011). To address these concerns, this study focuses on the salient roles of contracting firms' technology orientation (TO) as an interaction construct in effective GSCM practices (Tseng et al. 2019). Technology orientation was conceptualised in this study as the construction firms' will and capabilities for the optimal usage of technological knowledge to respond to their clients' needs and create new product ideas (Gatignon and Xuereb 1997). Studies, particularly Batra et al. (2015), have noted the need to reconsider the critical roles of technology orientation in a firm's performance objectives and competitiveness.

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We then initiated an empirical study to sample the opinions of the construction firms in Sarawak, Malaysia ($N = 107$). This affords us to contribute to the literature on green practices within the construction industry. The steps involved include adopting and validating the measuring scales for GSCM, technology orientation, regulatory and customer pressure. We also examined the predicting capabilities of regulatory pressure (RP), customer pressure (CP) and technology orientation (TO) in explaining the outcomes of GSCM practices within the context of the Malaysian construction industry. Importantly, our model reinforces these links by observing the importance of technology orientation as a mediating construct.

Literature review - theory and hypotheses development

Stakeholder's theory has been popular in GSCM over the years. Its prominence is unconnected to the emphasis it places on the effects of companies' activities on both the internal and external parties while also addressing corporate social responsibility in meeting various stakeholders' expectations (Freeman 1984). However, emerging theoretical models are integrating different theories and disciplines to address sustainability in firms and other social systems. For instance, the Triple Embeddedness Framework (TEF) of industries established the isomorphic pressures that institutions exert on firms to ensure that their actions are desirable and appropriate within some socially constructed system of norms, values and beliefs. In his exposition, Geels (2014) draws a co-evolution relationship between organisations and their environments in such a way that the socio-political and economic environments exert selection pressure on firms. The firms simultaneously influence these environmental dimensions through their strategic responses, signifying an extension of firms' sustainability commitments from a broader social standpoint (Chang et al. 2017). The triple embeddedness framework is relevant to this study due to its emphasis on the consumers, policymakers, social movements, and civil society's pressure on the firms-in-industries towards re-orienting them on sustainability and radical innovation to address their major challenges. Our model conceptualises GSCM, based on TEF, as pressure-driven attainment that requires compliance with the environmental protection agenda to gain public recognition, government support and access to external capital (Geels 2014).

The idea of cutting production waste, which is core to GSCM, was first addressed in the literature in the early twentieth century and was not initially proposed for environmental protection. Rather, it was mainly for economic reasons because uncontrolled waste generation was viewed as an indication of economic loss (Ibrahim 2016; Sarkis et al. 2011). Discussions on environmental issues began to develop in the period that followed since construction waste has had enormous effects on the environment globally. Consequently, the relationship between waste-generating industries and the environment became a dominant discussion among economists and environmentalists. Unlike the narrative and conceptual build-up on GSCM, recent research has shown increasing interest from scholars and industrial practitioners in more empirical cases (Luthra et al. 2011).

Green supply chain management in the construction industry

The extant literature gave various inconsistent definitions of green supply chain management. However, a general definition can be adduced from the array of literary permutations, especially construction industry-specific. Ahi and Searcy (2013) offered a construction industry-specific conceptualisation of GSCM as a multiple-step action starting from the design stage to the end of the building life by integrating concern about environmental protection, economic benefits and social improvement into the conventional supply chain network, in order to minimise and eliminate the negative impacts of the supply chain on the environment.

In most emerging economies, there are few effects of regulations geared toward environmental protection due to the low capacity and incompetence of the SME contractors. While the emergence of the construction supply chain is to significantly improve the construction life-cycle towards sustainability achievements, the initiative is yet to garner the expected impact on the industry (Mojumder and Singh 2021; Wibowo et al. 2018).

Technology orientation, client and regulatory pressures for GSCM

Several firms in the AEC industry are reluctant to integrate green innovation and eco-friendly concepts such as GSCM due to its perceived cost ineffectiveness (Ajibike et al. 2021; Huang et al. 2012). However, due to incessant client demands for environmentally friendly products, contractors are under intense pressure to adopt and implement GSCM to mitigate environmental degradation. Such awareness is expected to provoke green purchasing and distribution, green manufacturing processes and lean thinking in construction project delivery. However, client demands without a strong policy might be counter-productive. Arguments are emerging regarding circumstantial implementation of green practices, mainly at the client's behest or when policy circumvention is almost impossible (Hovav et al. 2021). A sustained GSCM practice can be achieved with stringent regulatory regimes (Trujillo-Gallego et al. 2021). Where compliance is non-negotiable, implementation becomes the key performance indicator for organisations to remain competitive (Min and Galle 1997).

The push for green practices is intense to such an extent that several corporate clients demand evidence of environmental regulations certification (such as ISO14001) from their suppliers as part of the bidding process. At the same time, most regulatory bodies are strengthening awareness through incentives to reduce the burden on firms. For instance, the Malaysian government provides various supports, such as import duty exemption on energy conservation equipment not produced locally to promote energy-efficient products in the construction sector (Muhammad et al. 2010; Ohueri et al. 2022). Regulatory authorities in other developed countries are constantly organising green practices training for suppliers to claim Continuing Professional Development (CPD) points and improve their environmental performance (Hutchison 2017). Invariably, there is always evidence of improved environmental regulations compliance where client satisfaction and competitiveness are the suppliers' core values (Bamgbade et al. 2018; Park et al. 2020).

It goes without saying that the supply chain requires companies to recognise and adapt to emerging technologies. Studies about the novel blockchain in construction have established its strength in improving contract payment, smart contract asset management, procurement, and supply chain management (Ahmadisheykhsarmast and Sonmez 2020; Dakhli et al. 2019). Regulatory push factors (mostly environmental policies) are strong catalysts of ecological innovations, especially in an environmental-sensitive industry with a constant emphasis on carbon dioxide reduction. Other empirical pieces of evidence have also suggested a relaxed regulatory environment to balance the conflict between management and technology innovation such that companies in the supply chain can be easily licensed to explore rather than being restricted by regulatory red tapes (Moshood et al. 2020; Zhu et al. 2020).

Consideration of the firm's technology maturity as regards their willingness to follow the tech trajectories required for green supply chain delivery is also germane. Since tech-oriented firms reflect the extensive capacity for technology investment, their green supply chain achievements will require movements towards carbon reduction tech innovation. Wei and Wang (2021) opined that this tech innovation underscores the firm's continuous R&D in production processes, energy use and raw materials to reduce carbon emission levels for the overall sustainable economy requirements.

H1. CP relates positively to GSCM.

H2. CP relates positively to TO.

H3. RP relates positively to TO.

H4. RP relates positively to GSCM.

H5. TO relates positively to GSCM.

The mediating role of TO and RP

The extant literature provides extensive evidence of the strength of customer pressure on GSCM practices (Chavez et al. 2016; Hoejmose et al. 2014; Laari et al. 2016). While some empirical studies suggest a positive link between these constructs, others disagree with such findings and infer that certain intermediaries are necessary to strengthen the relationship. For instance, Tatoglu et al. (2020) decouple customer pressure and environmental management practices in organisations, citing variations in multinational buyers in a developed economic context. Their findings emphasised the propelling strength of a customer-focused culture in place of pressure. This view questions the direct influence between customer pressure and GSCM while suggesting intermediation possibilities.

Other authors (Mc Loughlin et al. 2021; Moosa and He 2021; Riyadi 2020) offer evidence that environmental technologies are vital in the indirect influence of customer pressure on supply chain sustainability and eventual firm environmental performance. These technological tools, devices and knowledge are perfect input passages to incorporate sustainability into supply chain management. Suppliers can easily reconfigure existing operational capabilities, win more contracts, and better match the competitive market when green technologies are deployed appropriately (Hoejmose et al. 2014). We also contend that regulatory coercion should impact suppliers' technology orientation to practice GSCM. This hypothetical nuance was driven by the unprecedented benefits of tech-innovations utilisation, such as blockchain and Internet-of-Things, in the supply chain (Cousins et al. 2019).

These empirical evidences are merged in the conceptual model shown in Figure 1.

H7. TO positively mediates the relationship between CP and GSCM.

H8. TO positively mediates the relationship between RP and GSCM.

Research methodology

Sample and data collection

As indicated in the research methodology flowchart (Figure 2), this study employs a quantitative research approach to deliver its objectives. The sample for this study is from a list of contractors on the Construction Industry Development Board (CIDB) website. We conducted a cross-sectional survey with the contractors (G1 to G7) in Sarawak. The survey was conducted using a Google form. In determining the sample size for this study, we used power analysis as Hair Jr et al. (2017) recommended that the minimum sample size be based on the constructs with the highest number of predictors. Cohen (1992) initially developed a statistical power analysis to determine sample size by considering statistical power of 80%, the minimum R^2 value, the level of significance and model complexity. For this study, the minimum sample size to achieve these requirements is 85. From the sampled 350 contractors, 114 responses were received after repeated reminders. After removing incomplete responses, the study obtains 107 usable surveys, denoting a response rate of 30.6%. Since this response rate is above the required minimum sample size suggested by Cohen (1992), this study has fulfilled the minimum threshold of 85 based on power analysis.

Regarding ethical considerations, this study was granted ethical approval to conduct this survey by Swinburne's Human Research Ethics Committee (SUHREC) of Swinburne University

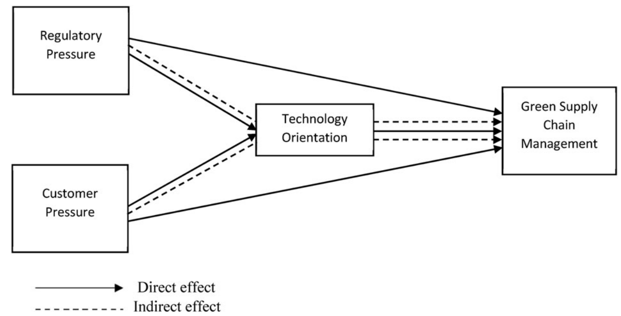

Figure 1. Conceptual model (with both direct and indirect relationships).

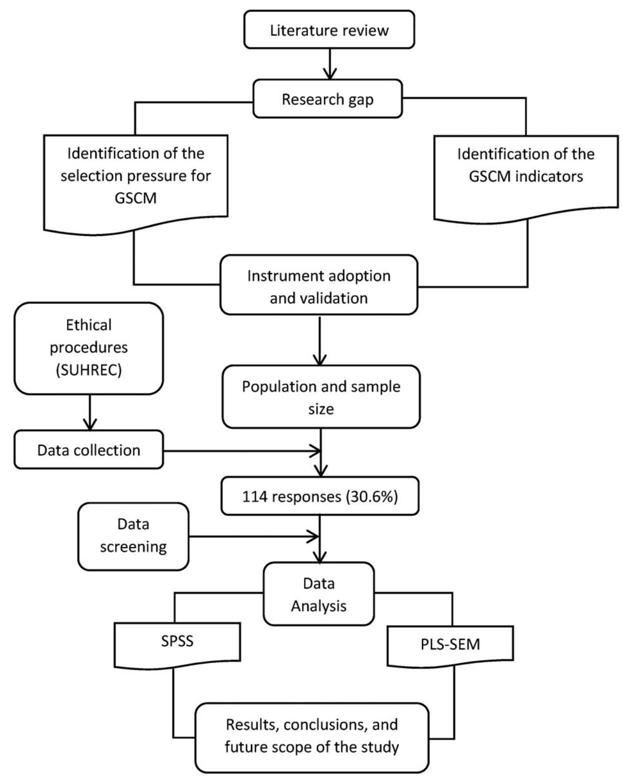

Figure 2. Research methodology flowchart.

of Technology, Sarawak Campus (SHR Project 2019/084). The questionnaire copies were sent online to the sampled firms, accompanied by a cover letter explaining the study's purpose and assuring them that their responses would be treated with maximum confidentiality throughout the research.

As for the measures of the latent variables, all the measures were adopted from the literature with sound validity and reliability. The items for each construct were rated on an ascending 5-point Likert scale, ranging from 'strongly disagree' to 'strongly agree'. The latent variables were also modelled reflectively since any of the items can be removed without changing the real meaning of the latent variables (Diamantopoulos and Riefler 2011). For instance, customer pressure was measured using the three indicators adopted from Min and Galle (1997). The five items for regulatory pressure were adopted from Christmann and Taylor (2001). Technology orientation was measured with indicators adapted from Gatignon and Xuereb (1997), while the items for GSCM were adopted from Zhu et al. (2010). The items covered green supply chain practices such as internal environmental management, green purchasing, and eco-design adopted by the sampled contractors.

Data analysis

As depicted in Table 1, the demographic profile of the responding firms shows that the firms possessed adequate years of experience and staff strength to respond to this study. Among the responding firms, the small and medium-grade contractors (G2, G3, G4, and G5) have the highest representation. Most of the respondents are AEC professionals (construction managers, 17.8%; contract managers, 20%; engineers, 19%; project managers, 19%; and quantity surveyors, 14%). The demographic analysis also indicated that the highest percentage of respondents (57.9%) had above 10 years of work experience. Only 14% had work experience between one to five years.

Table 1. Sampled firms and respondents.

Firm and respondents characteristics	Frequency	Percentage
Firm Age		
<1 year	9	8.4
1–5 years	27	25.2
6–15 years	48	44.9
More than 15 years	23	21.5
Company Size		
< 10 employees	7	6.5
10–49 employees	37	34.6
50–249 employees	45	42.1
More than 250 employees	18	16.8
Firm Grade		
Grade 1 (G1)	11	10.3
Grade 2 (G2)	17	15.9
Grade 3 (G3)	22	20.6
Grade 4 (G4)	18	16.8
Grade 5 (G5)	18	16.8
Grade 6 (G6)	13	12.1
Grade 7 (G7)	8	7.5
Position in the Firm		
Construction Manager	19	17.8
Contract Manager	20	18.7
Engineer	19	17.8
Executive Director	6	5.6
Finance Executive	1	9
Project Manager	19	17.8
Project Supervisor	4	3.7
Quantity Surveyor	14	13.1
Technical Officer	5	4.7
Work Experience		
1–5 years	15	14
6–10 years	30	28
More than 10 years	62	57.9
Environment Department		
Yes	10	9.3
No	67	62.6
Maybe soon	29	27.1

Table 2. Full collinearity testing.

TO	REG	CP	GSCM
2.505	2.779	2.654	1.824

Note: The displayed VIF values are based on the regression analysis of the three latent variables on the random (dependent) variable, TO, technology orientation; REG, regulatory pressure; CP, customer pressure; GSCM, green supply chain management.

The Partial least squares modeling technique was adopted for data analysis as there are 5 first-order constructs in this study. These include GSCM practices as the criterion variable, with its identified drivers (regulatory pressure, customer pressure, and technology orientation) as the predictors. Structural equation modeling (SEM) was used in this study because the study's model is complex with multiple variables and advanced elements such as the mediator variable and hierarchical components. PLS-SEM is superior to SPSS regression analysis when mediation analysis is involved, as is the case with this study (Henseler et al. 2016).

It should be noted that the data for this study was from a single source, and this may cause common method variance in estimating the construct's reliability and validity, as well as inaccuracies in the path coefficient estimates. To resolve this, the suggestion of Kock et al. (2012) was followed by testing full-collinearity. This was done by creating a random variable while all the remaining latent variables (acting as predictors) were regressed against the random variable. The results (Table 2) show that all the Variance Inflation Factor (VIF) values are equal to or greater than 3.3, indicating that single-source bias does not affect our data.

Results

Measurement model

Under this assessment, it is necessary to confirm the indicator loadings, assess the internal consistency reliability (composite reliability), the convergent validity and the heterotrait-monotrait (HTMT) ratio of the correlations (a better replacement to the discriminant validity assessment according to Henseler et al. (2015). Following Hair et al.'s (2010) rule of thumb, indicator loadings above 0.5 are acceptable. The item reliability was confirmed since all the item loadings in this study were higher than 0.5 (see Table 3).

For the assessment of the internal consistency reliability, Hair Jr et al. (2014) recommended that the composite reliability should be higher than 0.7. The composite reliability for all the constructs in this study was higher than 0.7, satisfying the rule of thumb. In checking the convergent validity in this study, the Average Variance Extracted (AVE) was checked to ascertain that they are all above 0.5, following Fornell and Larcker's (1981) specification. This was achieved as all the AVE's were above 0.5 for all the constructs. The measurement model evaluation is shown in Table 3.

The next assessment under the outer model is the discriminant validity, under which three different approaches were reported in the previous studies. The first approach deals with the observation of the cross-loading of the indicators in terms of the proper loading of the indicator on their construct, i.e. the

Table 3. Measurement model evaluation and constructs descriptive statistics.

Variables	Items	Standardised factor loading (λ)	AVE	CR
Green supply chain management	GSCM1	0.732	0.572	0.946
	GSCM2	0.700		
	GSCM3	0.729		
	GSCM4	0.712		
	GSCM5	0.727		
	GSCM6	0.801		
	GSCM7	0.838		
	GSCM8	0.800		
	GSCM9	0.754		
	GSCM10	0.756		
	GSCM11	0.797		
	GSCM12	0.740		
	GSCM13	0.737		
Regulatory Pressure	Reg1	0.770	0.675	0.912
	Reg2	0.869		
	Reg3	0.847		
	Reg4	0.806		
	Reg5	0.812		
Customer Pressure	CP1	0.884	0.751	0.900
	CP2	0.868		
	CP3	0.847		
Technology orientation	TO1	0.818	0.673	0.925
	TO2	0.803		
	TO3	0.843		
	TO4	0.905		
	TO5	0.779		
	TO6	0.767		

Table 4. Discriminant validity (The HTMT ratio).

		1	2	3	4
1	CP				
2	GSCM	0.702			
3	Reg	0.819	0.707		
4	TO	0.664	0.818	0.699	

indicator loadings must also be higher within their respective constructs than in other constructs within the model (Hair et al. 2014). The second approach utilises Fornell and Larcker's (1981) criterion, where the square root of the AVE for each construct is expected to exceed the inter-correlation of the construct with other constructs within the model. Since the aforementioned traditional approaches are associated with unacceptably low sensitivity with respect to discriminant validity assessment, an alternative criterion (heterotrait-monotrait ratio (HTMT) test) was introduced by Henseler et al. (2015).

This test was able to adequately estimate the actual correlation between constructs, such that if the correlation between any two constructs is close to 1, discriminant validity is lacking in the model. If the value between the constructs is below 0.90, then discriminant validity is adequately established. As indicated in Table 4, we are able to confirm discriminant validity in this study because all values were below 0.90.

Structural model and interaction effect

Having confirmed the validity of the results of the measurement of the model, the structural model was evaluated. In this study, the R^2 value for GSCM and technology orientation were 0.632 and 0.416, implying that the model explains 63% and 41% of the variance in the willingness of the construction firms to adopt green supply chain management in complying with the regulatory authorities and technology, respectively are explained by the three latent variables in the model. As indicated in Table 2, all the direct paths are significant.

The interaction effect hypothesis was also estimated with PLS-SEM 3.0 software using a bootstrapping procedure. The result (Figure 3) shows that the mediating effect of technology orientation on the relationship between customer pressure and green supply chain management is significant [standardised beta (β) = 0.135; $t = 1.936$, $p = 0.053$]. The findings suggest that technology orientation mediates the impact of customer pressure on construction firms to engage in green supply chain management. By implication, the technology orientation of the construction firms could cushion the effects of customer pressure on contractors' engagement with green supply chain management. We also hypothesised that the path between regulatory pressure and

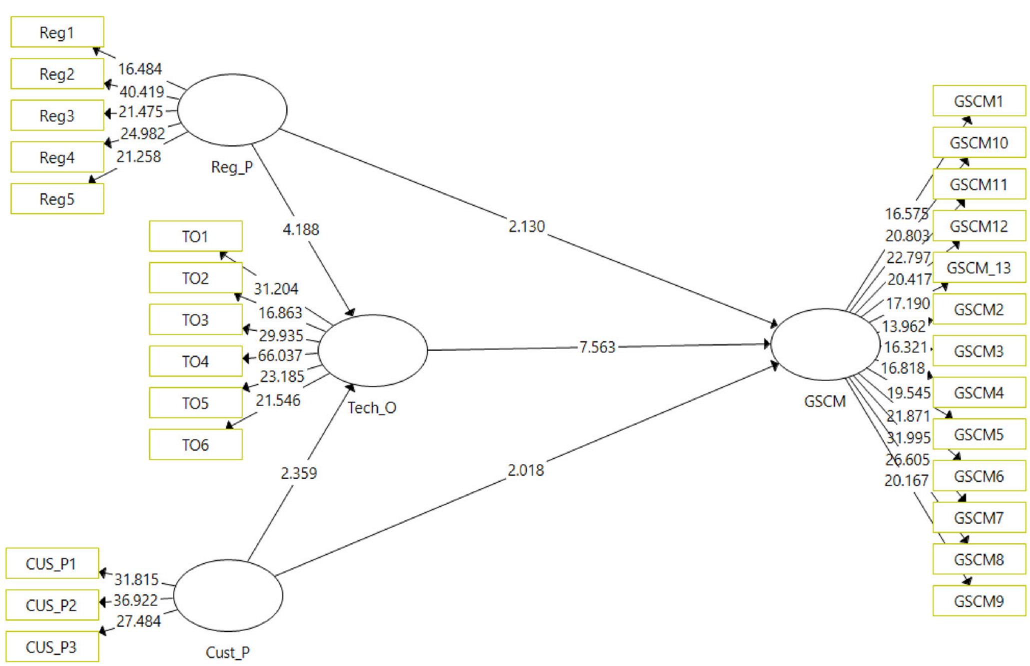

Figure 3. Structural model.

Table 5. Hypotheses testing.

Hypotheses	Relationship	Std β	SE	f^2	VIF	T Stat	Sig.	Decision
H1	CP -> GSCM	0.162	0.084	0.030	2.741	1.936**	0.053	Supported
H2	CP -> TO	0.244	0.100	0.031	2.639	2.455***	0.014	Supported
H3	Reg -> GSCM	0.176	0.086	0.023	2.962	2.046***	0.041	Supported
H4	Reg -> TO	0.435	0.102	0.131	2.639	4.262***	0.000	Supported
H5	TO -> GSCM	0.552	0.077	0.508	1.713	7.163***	0.000	Supported

Note: 95% confidence interval with 5,000 bootstrapping subsamples was used in this study.
**Significant at 5%; and ***significant at 1% (One-tailed).

Table 6. Indirect effects.

Hypotheses	Relationship	Std β	SE	T Stat	Sig.	Decision
H6	CP -> TO -> GSCM	0.135	0.058	2.309	0.021	Supported
H7	Reg -> TO -> GSCM	0.240	0.067	3.562	0.000	Supported

Table 7. The f^2 values.

	GSCM	TO
CP	0.030	0.031
Reg	0.023	0.131
TO	0.508	

GSCM would be stronger with the interaction effects of TO. While the direct linkage was significant, the interaction term captured a better degree of a supplier's adoption of green practices through regulatory instrumentalism (Tables 5 and 6).

Following Stone (1974) and Geisser (1975), Stone–Geisser Q^2 (cross-validated redundancy) was also applied to ascertain the model adequacy of the latent construct in this study. This procedure is useful in ascertaining an additional model fit. In this instance, the SmartPLS3 blindfolding procedure was performed. The predictive relevance of the model is achieved with a Q^2 value greater than zero (Chin 2010). In this study, the Q^2 value was 0.331 (for GSCM), 0.390 (for Reg), and 0.241 (for TO), which are greater than 0, implying that this study's model has high predictive relevance.

The structural model was also assessed by determining the variations in R^2 to observe the substantive impact a predictor variable has on green supply chain management. The effect size f^2 can be calculated following Chin (1998) thus:

$$f^2 = R^2 included - R^2 excluded/1 - R^2 included$$

The R^2 included and R^2excluded from the structural equation is the value of the R^2 given in the criterion variable when one predictor is included in or excluded from the equation, respectively. Going by the recommendation of Cohen (2013), the f^2 values of 0.02; 0.15 and 0.35 are regarded as small, medium and large effects on the endogenous latent variable, respectively. The f^2 estimate for the predictors in this study is shown in Table 7. In this study's model, the f^2 values are greater than 0.02 and 0.35, which indicates a significant effect on the endogenous constructs.

This study also tested for predictive performance using the PLS predict analysis (Table 8). As proposed by Shmueli et al. (2019), this test indicates that the items of a particular construct can predict that criterion variable. This PLS Predict was assessed using cross-validation with a holdout sample-based procedure at either the construct or indicator level to check for predictive relevance. As for the criterion variables, the corresponding Q^2 from the PLS predict analysis were all greater than 0. The Q^2 predict for GSCM is 0.438, while that of OT stands at 0.379, suggesting a satisfactory predictive relevance.

Discussion

This study is novel in its attempt to investigate the influence of selected pressure exerted on construction firms to stimulate GSCM practices. The rationale is to create more avenues to reduce the excessive environmental pollution the construction industry is known for. In order to achieve this aim, seven direct and indirect hypotheses were developed based on a rigorous review of previous studies. Consistent with the first hypothesis, which holds that CP will affect GSCM, the bootstrapping

Table 8. PLS-predict.

PLS				LM			PLS-LM		
	RMSE	MAE	Q^2_predict	RMSE	MAE	Q^2_predict	RMSE	MAE	Q^2_predict
GSCM1	0.714	0.547	0.271	0.727	0.555	0.244	−0.013	−0.008	0.027
GSCM2	0.799	0.585	0.197	0.823	0.606	0.148	−0.024	−0.021	0.049
GSCM3	0.75	0.55	0.188	0.757	0.562	0.172	−0.007	−0.012	0.016
GSCM4	0.761	0.581	0.275	0.77	0.566	0.257	−0.009	0.015	0.018
GSCM5	0.652	0.501	0.274	0.665	0.511	0.245	−0.013	−0.01	0.029
GSCM6	0.782	0.617	0.255	0.791	0.622	0.237	−0.009	−0.005	0.018
GSCM7	0.765	0.595	0.28	0.795	0.611	0.222	−0.03	−0.016	0.058
GSCM8	0.73	0.557	0.231	0.757	0.573	0.174	−0.027	−0.016	0.057
GSCM9	0.73	0.553	0.207	0.766	0.571	0.128	−0.036	−0.018	0.079
GSCM10	0.71	0.551	0.214	0.751	0.569	0.122	−0.041	−0.018	0.092
GSCM11	0.766	0.582	0.226	0.805	0.606	0.147	−0.039	−0.024	0.079
GSCM12	0.694	0.524	0.299	0.712	0.527	0.261	−0.018	−0.003	0.038
GSCM13	0.712	0.538	0.263	0.721	0.557	0.244	−0.009	−0.019	0.019
TO1	0.703	0.538	0.253	0.71	0.546	0.238	−0.007	−0.008	0.015
TO2	0.662	0.51	0.283	0.684	0.537	0.234	−0.022	−0.027	0.049
TO3	0.654	0.489	0.265	0.673	0.489	0.222	−0.019	0.00	0.043
TO4	0.672	0.523	0.325	0.692	0.541	0.284	−0.02	−0.018	0.041
TO5	0.775	0.597	0.219	0.803	0.606	0.161	−0.028	−0.009	0.058
TO6	0.737	0.579	0.241	0.745	0.577	0.223	−0.008	0.002	0.018

technique result indicated a statistically significant relationship between the latent variables. This implies that the more pressure exerted by the consumers/clients, the better for green supply chain management adoption in construction contract administration. This supports the findings of the previous studies where consumers' environmental awareness was highlighted as a driving factor for green supply chain adoption (Cheng and Zhang 2022). The second hypothesis assumes that CP will significantly influence the TO of the sampled contractors, which the structural model result supported with a small effect size of 0.031. By implication, contractors' technology orientation can be enhanced by the client's insistence on green supply chain. This aligns with Cao et al. (2015), where customers' demands for more diversified and adaptable housing influence the developers' technology adoption. In H3, we assumed that regulations would affect GSCM adoption among the East Malaysian contractors, and in agreement with previous studies (Hutchison 2017), the result supported the hypothesis, albeit with a small effect size (0.023). The hypothesis that placed regulatory pressure as an antecedent to technology orientation was also supported with an 0.131 effect size. This was confirmed by the study conducted by Bamgbade et al. (2018), where government intervention was ranked as one of the prominent predictors of sustainability technology adoption among Malaysian contractors. A similar significant result was found in the case of TO's influence on GSCM, which aligns with Wei and Wang (2021), where a strong correlation was established between suppliers' technology adoption and green supply chain delivery.

Our study also investigated the mediating role of TO in the established direct links between the selected pressures (CP and Reg) and GSCM. These significant indirect effects are unexpected as previous studies have shown the mediating strength of TO in improving sustainability achievements (Aslam et al. 2022; Heenkenda et al. 2022). With the statistically supported findings of these mediation paths, we are able to establish empirical evidence to the effect that environmental technologies can indirectly push GSCM achievements when customer pressure is applied. It also signals the TO's intermediating impacts on regulatory pressure – GSCM path. This study has made significant contributions to the body of literature by extending previous studies on GSCM practices by exploring regulatory and client pressure on GSCM under the Triple Embeddedness Framework (TEF), where GSCM is projected as pressure-driven attainment

The next section will focus on the specific implications of the findings.

Study implications

This study's findings have several implications for future studies in green supply chain management within the built environment. First, it offers managerial implications for construction corporations by emphasising the critical roles of the socio-political and economic pressure groups (such as regulators, civil societies and social pressure groups and trade bodies) in driving green purchasing and distribution and manufacturing processes in construction project delivery. The onus of achieving a green supply chain and delivering value also rests on unified stakeholders (clients, designers, manufacturer, main contractors, and subcontractors) so that sustainable upstream and downstream integration is achieved not only to satisfy the demand of their internal and external stakeholders but also for environmental protection. Second, constant upstream and downstream policy reformation and environmental framework addressing socio-environmental sustainability will go a long way in driving manufacturers and other project stakeholders to think green. This study established this by implying that selected pressure exerted on the firms induces stable GSCM practices in the construction industry. Third, the ASEAN member countries should build a cross-border mechanism to reward and punish errant behaviour violating the sustainability policy. This should be extended to the regulators to apply stringent penalties against environmental violations.

Furthermore, while some prior studies on GSCM practices have addressed selected pressure influence on its adoption and successes (e.g. Chavez et al. 2016 suggest that customer pressure influences customer-centric GSCM implementation; Jasmi and Fernando 2018 also concluded that regulation pressure is a relevant driver persuading the maritime companies to adopt GSCM), ours is the first study that addressed these factors in a systematic and integrated manner. By combining and extending these contributions in an emerging nation's context, we have demonstrated a pervasive yet understudied niche within the construction industry setting. Our proposed model is important given the dire global impacts of environmental degradation. It also points to the fact that compliance with environmental practices is expected to generate analogous benefits for the adopting firms, irrespective of their commitment to sustainable practices. Our theoretical framework complements the previously empirically established relationships in other climes and augments such by reminding supply chain researchers that regional-based strategies are foolproof for green practices and cleaner production.

Conclusion

Drawing on the triple embeddedness framework, which establishes the co-evolution of firms and their environments, this study established how selected pressure is exerted on the construction firms and how their simultaneous strategic responses can evoke GSCM in the construction industry. The emphasis here is on the influence of the social-political and economic pressure groups, and regulatory regimes, including emerging technologies absorption, on green SC from material purchase through the final project at delivery. The outcomes of this study's framework provide a nuanced understanding of how and why firms can better contribute to supply chain sustainability occasioned by multi-directional pressure. The underlying rationale is the construction stakeholders' environmental protection concerns and the government's consistent call for carbon footprint reduction.

Previous studies on the drivers of GSCM practices in most emerging countries (Malaysia inclusive) are largely observed within the manufacturing industry, contributing to reduced profitability, low product quality and other competitive advantage problems in their construction industries (Chiou et al. 2011). This study fills this gap by providing some interesting findings. At the outset, the results support all the hypothesised direct links between the three strategic drivers (i.e. CP, Reg and TO) and GSCM practices. The implication is that as construction firms become more customer-focused, abide by environmental regulations, and innovate in technology adoption and usage; they tend to conveniently implement GSCM practices. Although similar findings have been reported in some developed countries, ours is the pioneer study to apply these constructs and confirm them in the GSC setting, where a series of interconnected stakeholders are involved in delivering sustainability benefits within the supply chain. Suffice it to mention that the indirect effects of TO are also significant in both directions, thereby strengthening the initially established connection between CP, Reg and GSCM.

Our findings also point to the fact that there is a need to continuously enforce environmental rules and regulations on the construction supply chain players by strengthening relevant regulations such as the Environmental Quality Act 1974 (No. 127 of 1974). Higher grades of construction firms and multinational organizations should also be encouraged to partner with SME contractors on innovative technologies that support sustainability achievements. This will be beneficial since innovation allows firms to maintain competitiveness.

Limitations and direction for future studies

Like most models, we do recognise that there are limitations to this study. One is utilising self-reported data from the sampled contractors, resulting in social desirability biases. But several steps have been taken to address such biases. One is that the respondents were notified in the survey instrument cover letter to respond with all honesty and that their identity is not required. Second, the common method variance bias risk was addressed using full collinearity analysis (Kock et al. 2012). To further generate a more robust finding on contractors' response towards the upstream and downstream green supply chain practices, a broader stakeholder's perspective is suggested to be considered subsequently. This will compare the results drawn from different professionals' and clients' perspectives. Again, stakeholders' peculiarities could call the modalities and the process of GSCM delivery to question. Third, since this study utilised single-respondent surveys, a mixed method is suggested to further enhance the outcomes. A mixed-method research design will combine data collection techniques such as secondary data, interviews, focus group discussions, case studies, and quantitative surveys. Fourth, future studies should reinvent the relationships to observe how these constructs transmute within a different social-economic and institutional spheres. Lastly, since this study considers the technology orientation of the sampled firms, with the ever-evolving nature of technology use, future studies should consider statistical approaches that allow multi-directional examination of technology usage to determine how different supply chain stakeholder is adopting green technology in project delivery.

Disclosure statement

No potential competing interest was reported by the authors.

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