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Supplier Sustainable Integrity Using a Split-half Method: Empirical Evidence from Malaysia

Yudi Fernando[1], Anderes Gui[2], Ika Sari Wahyuni-TD[1,3], Yong Won Seo[4], and Hasnah Haron[1]

[1]Faculty of Industrial Management, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Pahang, Malaysia
[2]School of Information Systems, Bina Nusantara University, Jakarta, 11480, Indonesia
[3]Faculty of Economics, Kampus Limau Manih, Universitas Andalas, 25163 Padang, Indonesia
[4]College of Business and Economics, Chung-Ang University, Seoul, 06724, Republic of Korea

Abstract

The objective of this study is twofold accordingly. First, it aims to explore the measurement items of sustainable supplier integrity drivers. Second, it purports to investigate the relationship between drivers and supplier sustainable integrity. Furthermore, this study collected data from manufacturing firms in Malaysia. The targeted respondents were procurement managers and other decision-makers in the manufacturing companies. This study examined using a split-half method. First half data set was examined using exploratory factor analysis (EFA). The supplier assessment, supplier collaboration, and supplier codes of conduct were identified as drivers of sustainable supplier integrity. The other half of the data set used to develop a theoretical model. It was then established to test the model assessment and hypothesis testing. Thus, this study may shed light on finding answers on the importance of supplier codes of conduct. This is as the strongest driver in the theoretical model of the study. The possible reason behind this is because the manufacturing firms should inform supply chain network on essential of supplier codes of conduct to avoid corporate fraud and leverage business sustainability.

Keywords: split-half method; sustainable supplier integrity; supplier assessment; supplier collaboration; supplier codes of conduct

Corresponding Author:
Yudi Fernando
yudi@ump.edu.my

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1. Introduction

In the past, it might be worth pointing out that many of supply chain studies mostly focus on how to manage the effective and efficient supply chains (Walters, 2006; Gunasekaran et al., 2004). However, since then, the shifted business paradigm in the supply chain has changed the business focus on the sustainability aspect. This is included on how the environmental and social impacts considered in supply chain management (Shaharudin et al., 2019; Koberg & Longoni, 2019). Environmental and social outcomes of business performance are closely associated with the sustainability indicators (Fernando et al., 2019; Fernando & Chukai, 2018). According to Fernando and Saththasivam (2017), EMS ISO 14001 manufacturing firms which adopted green supply chain agility has improved the performance of a firm environmentally and socially. It is also argued that the manufacturing firms' inability to manage ethical standard and integrity will impact to poor product quality, and it will slow the growth of a company.

The manufacturing firms should be able to comply with their entire supply chain with fairness, ethical standard, quality, honesty, and integrity. The ethical compliance should include and closely monitor starts from the first-tier until third-tier level suppliers. If the manufacturing companies unable to monitor their supplier compliance with the ethics and integrity standard, it will impose penalties and will damage company reputation. Ali et al. (2017) postulated that individual, firm certification is never sufficient to compete in the era of the inter-supply chain. All players in the supply chain should ensure the integrity of procurements, manufacturing processes, storage, and distribution. The ethical compliance and integrity should be practiced in daily business operation. There are three domains of risks that face by the manufacturing companies, including human trafficking, forced labour, and slavery. In order to comply with the integrity standard, the supply chain professionals can refer to the Institute for Supply Management (2016); however, standards and guidelines cannot cover every situation in day to day business operations. The right way to select the suppliers is key to manage supplier integrity with business sustainability orientation.

A strategy of manufacturing companies is now more focus towards the triple bottom line, the simultaneous achievement of environmental, social, and financial performance. This is because of the pressure from the regulators, customers, shareholders, and also the supply chain partners. The companies are aware of the compliance of the emissions reporting requirements, which is one of the aspects to be responsible for the environmental and social stewardship. With the increasing cost of energy, the risk of all the rise and shortage of even primary natural resources like water, the companies should have a broad view regarding sustainability as possible. There are three justifications of the novelty of this study. First, the focus is timely to investigate the supplier sustainable integrity, especially in developing countries. According to Hawkins et al. (2014), developing countries are often characterized as a lacking structure to ensure business integrity and a sustainable sourcing strategy in developing nations remains unknown. The green aspects that have been practiced by Asian manufacturing firms attracted scholars' attention as many manufacturing plants have become concentrated in the region (Fernando et al., 2016). Second, existing business scandals of low integrity and inability to comply with the ethical standard indicate that the current mechanism used is not sufficient enough. It requires an additional manufacturing strategy in ensuring the integrity of the supply chain (Ali et al., 2017). Unethical behaviours in the buyer and supplier relationship are closely related to pressure for achieving success balances of power (Carter 2000). Thirdly, there is a limited study report on examining the impact of ethical behaviour between buyer and supplier. The data should be collected from the management of procurement (Kaynak & Sert, 2012). As a result, this study aims to investigate the drivers of supplier sustainable integrity. Therefore, in an attempt to bridge the gap in the literature, this research proposed the theoretical model of supplier sustainable integrity.

2. Literature Review

Seuring and Müller (2008) defined supply chain as the flow material, information, and capital of the supply chain, which can work along with sustainable development. The performance of the supply chain can be measured by using the profit and impact on ecological and social system (Pagell & Wu, 2009). Supplier sustainable integrity should be substantially integrated with the sustainable development concept in the supply chain. Hence, there are three domains that should exist in sustainable supplier integrity, such as social equity, environmental integrity, and economic prosperity. The supplier governance mechanism is between coordination and collaboration, which need to cope with evolving internal and external context. According to Marsh (2009), corporate integrity is a firm awareness of ethical principles and practices. In this study, the definition of supply chain integrity (SCI) was adopted from Castillo et al. (2018). SCI is defined as:

> *The dedication to maintaining integrity in supply chain activities and the recognition of the systemic and strategic implications of maintaining integrity in supply chain processes and flows (Castillo et al., 2018).*

Adopting a good concept from the business ethics in the supply chain context will assist companies to maintain the business integrity for along the supply chain activities. The firms need to form a dedicated team to ensure the supply chain comply with the ethical standard and integrity. Castillo et al. (2018) postulate that SCI consists of structural and moral perspectives that support the improvement of sustainable supply chain practices. The firms are suggested to find suppliers who meet the ethics and integrity standards. Castillo et al. (2018) further explain that structural SCI is referred to as the sustainability decision. The business decision should promote the triple bottom line to achieve firms' performance. Meanwhile, moral supply chain integrity can be described as the attentiveness to ethics and implications for the stakeholders, including the community where the company is located. Those two elements of structure and reliable supply chain integrity are vital as it is consistent and rational with the explanation of corporate integrity.

3. Method

This study derived the measurement constructs from a systematic review of the sustainable supply chain (Koberg & Longoni, 2018) and supply chain integrity (Castillo et al., 2018). A Five-Likert scale was utilized in this study (1- Strongly Disagree to 5 – Strongly Agree). The targeted respondents were companies listed in Malaysia External Trade Development Corporation (MATRADE). The electronic survey was distributed to 2800 companies in the manufacturing sector. The unit analysis is organization, and stratified random sampling was utilized as a sampling technique. Stratified random sampling was used based on the strata of decision making in companies (top management) (Fernando & Wah, 2017). Stratified random sampling technique is commonly used in the strategic level of supply chain management studies. There are two statistical techniques that used in this study such as IBM SPSS Version 23 and PLS-SEM version 3.2.8. The data was analyzed into a split test. Half data were analyzed using Exploratory Factor Analysis (EFA) with IBM SPSS 23 and another half for model development and assessment using PLS-SEM version 3.2.8.

4. Results

Table 1 shows the profile of respondents. The data were collected from 480 manufacturing firms. More than 500 employees have the highest category participated in the survey, which are 268 respondents, with a percentage of 52.4%. Other than that, this analysis also showed that the highest respondents also came from the company that has been established for more than 20 years, which is 193 respondents and the percentage of 37.8%. In the statistical data also provided the highest respondents came from American owned companies with 219 respondents (42.9 percent).

The data were divided into two sections with the split-half method. The purpose of the split-half method assessment is to examine the internal consistency of a test propose instrument constructs. The proposed instrument constructs are derived from a systematic review of the sustainable supply chain (Koberg & Longoni, 2018) and supply chain integrity (Castillo et al., 2018). The validation of the measurement constructs needs

Table 1: Profile of Respondents.

Profile	Category	Frequency	Percent
Employees	100 - 200 employees	5	1.0
	201 - 300 employees	157	30.7
	301 - 400 employees	81	15.9
	More than 500 employees	268	52.4
Length in business	Less than 5 years	4	.8
	5 - 10 years	141	27.6
	11 - 15 years	172	33.7
	16 - 20 years	1	.2
	More than 20 years	193	37.8
Ownership	Malaysian jointly owned	35	6.8
	Malaysian Owned	190	37.2
	American Owned	219	42.9
	European Owned	64	12.5
	Asia Owned	3	.6

a psychometric assessment. The split-half method is assumed to be parallel. It means that the parallel will have equal correct scores and error variances. An estimate of half-test reliability will be obtained if half-test scores are correlated (Bardhoshi & Erford, 2017). There are two types of tests that have been conducted in this study. Firstly, an exploratory factor analysis (EFA) and follow from the structural model and path analysis (N = 240) have been used in this study. The possible reason using this model is as such EFA is to validate the measurement constructs. Also, the objective of using a structural model with path analysis is to examine the link from independent variables to the dependent variable. Table 2 shows that the KMO and Bartlett's test. The value of KMO is 0.822, x^2 =2825.900, and the degree of freedom equal to 55***. It indicates that adequate data for EFA test (Tabachnick & Fidell, 2001).

Table 2: KMO and Bartlett's Test for Supplier Sustainable Integrity.

KMO	x^2	df
0. 822	2825.900	55***
***p < 0.000		

Furthermore, Table 3 above provides the results of factor analysis for drivers of supplier sustainable integrity. The EFA with Varimax rotation was extracted for drivers of supplier sustainable integrity yielded with three components, namely; supplier codes of conduct (41.560%), supplier collaboration (16.810%), and supplier assessment (14.255%). The Extraction Method was utilized as a principal component analysis, and rotation method has generated Varimax with Kaiser Normalization. Three drivers are explained

Table 3: Factor Analysis for Drivers of Supplier Sustainable Integrity.

Construct	**Codes**	**Component**		
		X1	**X2**	**X3**
Supplier codes of conduct (X1)	SCC2	**.860**	.167	.099
	SCC1	**.840**	.186	.124
	SCC3	**.820**	.132	.239
	SCC4	**.796**	.174	.250
Supplier collaboration (X2)	SC3	.102	**.840**	.109
	SC2	.166	**.815**	.048
	SC4	.100	**.782**	.132
	SC1	.249	**.753**	.076
Supplier assessment (X3)	SA2	.174	.124	**.857**
	SA1	.158	.074	**.825**
	SA3	.199	.109	**.779**
Eigenvalues		4.572	1.849	1.432
Total variance (71.392%)		41.560	16.810	13.018
Note: Bold and underline loadings indicate the inclusion of that item in the factor				

for 71.392% of the total variance. Besides, Table 4 depicts the anti-image matrices to assess the sampling adequacy. The Measures of Sampling Adequacy (MSA) is represented of (^{a}) in anti-image correlation. This study found that data is sufficient and complied with the MSA requirement (>.07).

Moreover, the commonality for the model of supplier sustainable integrity is illustrated in Table 5 below. This is because this study uses principal component analysis as an extraction method. As can be seen in Table 5, there are two indicators which are initial and extraction. Initial communities are used to examine the variance in each variable accounted for by all constructs. Furthermore, the aim to conduct extraction communities are to estimate of the variance in each variable accounted for each construct. The initial was consistent for all measurement items, and extraction indicates that all values surpassed the cut-off value (>. 05). There is no issue in the data, and all construct items are fit well with the factor solution.

The drivers of sustainable supplier integrity (Figure 1) showed the plot in rotated space, which indicates a visual representation of the loadings plotted in 3-dimensional spaces. Based on the component loadings, the results confirmed the validation of three drivers of sustainable supplier integrity.

Table 4: Measures of Sampling Adequacy.

		SA1	SA2	SA3	SC1	SC2	SC3	SC4	SCC1	SCC2	SCC3	SCC4
Anti-image Covariance	SA1	.566	-.198	-.115	.029	.011	-.017	-.021	.022	.014	-.032	-.052
	SA2	-.198	.465	-.219	.033	.021	-.068	-.002	-.030	.034	-.040	-.005
	SA3	-.115	-.219	.528	-.088	-.042	.087	.004	-.001	-.045	.025	-.019
	SC1	.029	.033	-.088	.480	-.206	-.049	-.067	-.004	-.052	.035	-.047
	SC2	.011	.021	-.042	-.206	.452	-.143	-.022	-.062	-.002	.065	-.026
	SC3	-.017	-.068	.087	-.049	-.143	.416	-.231	.034	-.017	-.046	.028
	SC4	-.021	-.002	.004	-.067	-.022	-.231	.501	-.015	.049	-.046	-.005
	SCC1	.022	-.030	-.001	-.004	-.062	.034	-.015	.398	-.167	-.105	-.034
	SCC2	.014	.034	-.045	-.052	-.002	-.017	.049	-.167	.386	-.081	-.083
	SCC3	-.032	-.040	.025	.035	.065	-.046	-.046	-.105	-.081	.355	-.160
	SCC4	-.052	-.005	-.019	-.047	-.026	.028	-.005	-.034	-.083	-.160	.406
Anti-image Correlation	SA1	**.834**[a]	-.386	-.210	.055	.023	-.036	-.040	.046	.029	-.072	-.108
	SA2	-.386	**.771**[a]	-.441	.070	.046	-.154	-.003	-.069	.081	-.098	-.011
	SA3	-.210	-.441	**.782**[a]	-.175	-.085	.185	.007	-.002	-.099	.059	-.040
	SC1	.055	.070	-.175	**.830**[a]	-.442	-.109	-.137	-.009	-.121	.084	-.107
	SC2	.023	.046	-.085	-.442	**.792**[a]	-.329	-.045	-.147	-.005	.161	-.059
	SC3	-.036	-.154	.185	-.109	-.329	**.754**[a]	-.506	.085	-.043	-.121	.067
	SC4	-.040	-.003	.007	-.137	-.045	-.506	**.805**[a]	-.033	.110	-.110	-.011
	SCC1	.046	-.069	-.002	-.009	-.147	.085	-.033	**.861**[a]	-.427	-.280	-.084
	SCC2	.029	.081	-.099	-.121	-.005	-.043	.110	-.427	**.854**[a]	-.219	-.209
	SCC3	-.072	-.098	.059	.084	.161	-.121	-.110	-.280	-.219	**.838**[a]	-.422
	SCC4	-.108	-.011	-.040	-.107	-.059	.067	-.011	-.084	-.209	-.422	**.883**[a]

Table 5: Results of Communalities.

	Initial	**Extraction**
SA1	1.000	.711
SA2	1.000	.780
SA3	1.000	.658
SC1	1.000	.635
SC2	1.000	.694
SC3	1.000	.728
SC4	1.000	.639
SCC1	1.000	.756
SCC2	1.000	.778
SCC3	1.000	.747
SCC4	1.000	.727

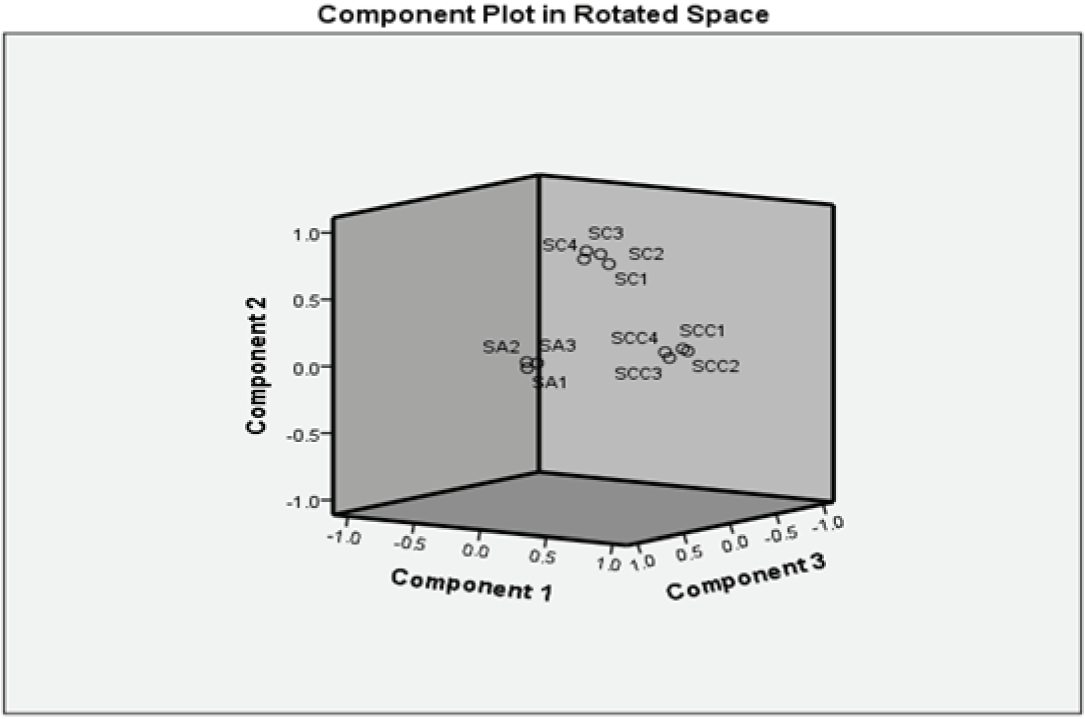

Figure 1: Drivers of Sustainable Supplier Integrity Plot in Rotated Space.

5. Hypothesis Development

Based on the EFA findings, this study found that there are three drivers of sustainable supplier integrity. Thus, this study has conceptualized drivers of supplier sustainable integrity based on three drivers in a theoretical model. Figure 2 shows that supplier assessment, supplier collaboration, and supplier codes of conduct are the drivers of supplier sustainable integrity. Firms' ability to comply with supplier sustainable integrity can determine the future of the business itself. This study utilizes the resource-based view (RBV) as the underpinning theory. RBV explains sustained superior firm performance by focusing on the differential ability of firms to develop new capabilities (Barney, 2001). The supplier assessment, supplier collaboration, and supplier codes of conduct will improve firm ability to achieve supplier sustainable integrity. Integrity and business ethics are essentially bringing a positive impact on the entire supply chain. Besides, it is also important for the sake of having a good supply chain information flow as the supplier is the first in the flow of any supply chain business flow and it can affect the other activities if the information given were manipulated or untrusted one. Therefore, the proposed hypotheses are stated as follows:

H1: The higher level of supplier assessment will be the higher level of supplier sustainable integrity

H2: The higher level of supplier collaboration will be the higher level of supplier sustainable integrity

H3: The higher level of supplier codes of conduct will be the higher level of supplier sustainable integrity

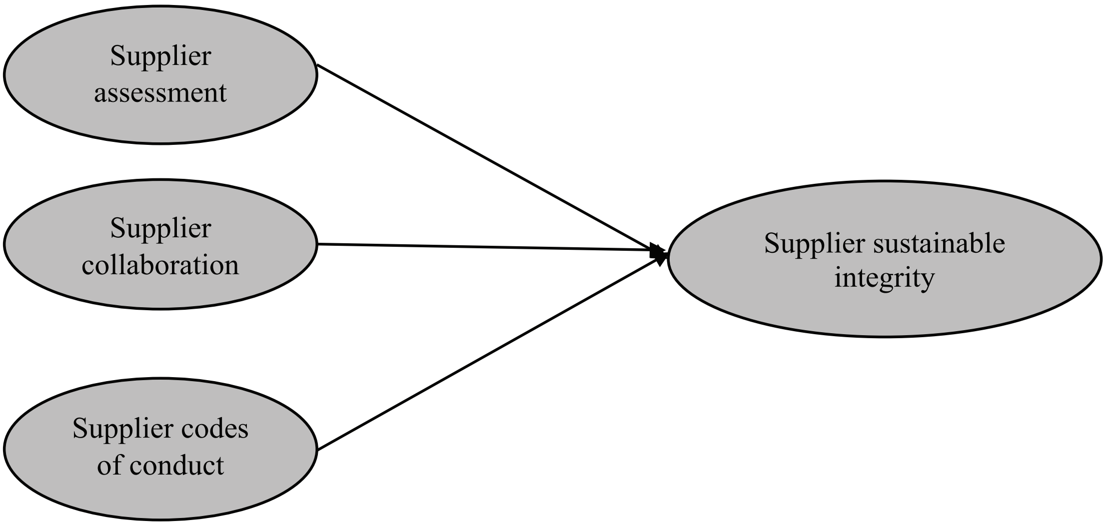

Figure 2: Theoretical Model.

The results of the measurement model (Table 6) is another half data set was tested using PLS-SEM (N = 240). Loadings and CR have achieved a satisfactory outcome. The average variance extracted (AVE) values have presented at the desired level (>0.50). Thus, all indicators of construct validity are acceptable (Hair et al., 2014).

The output of heterotrait-monotrait (HTMT) analysis was conducted to test the discriminant validity requirement. The cut-off value of HTMT should be higher than the HTMT 0.90 (Gold et al., 2001). Table 7 shows that all values lower than 0.90. The findings show that the discriminant validity is established in the model.

The path analysis was examined to test the hypothesis. This study uses a one-tailed test to decide the significant level of acceptance. The cut-off t-value of acceptance is greater than 1.645. The path from supplier assessment to sustainable supplier integrity is significant and related (β = 0.082; t-value = 2.250; Q^2 = 0.403). Thus, H1 is accepted. The link from supplier collaboration is examined to sustainable supplier integrity. The result provides a significant and positive relationship with p-value less than 0.001. Hence, the H2 is accepted (β = 0.206; t-value = 5.334; Q^2 = 0.429). The H3 is examined to investigate the relationship between supplier codes of conduct and sustainable supplier integrity. The result was a positive and significant related with p-value less than 0.001. Thus, the H3 is accepted (β = 0.535; t-value = 13.416; Q^2 = 0.534). The blindfolding procedure was examined to obtain Q^2 value. The latent variable in the theoretical model shows

Table 6: Results of Measurement Model Evaluation.

	Loadings	Composite Reliability	Average Variance Extracted (AVE)
SA1	0.854	0.883	0.716
SA2	0.857		
SA3	0.828		
SC1	0.814	0.922	0.748
SC2	0.842		
SC3	0.832		
SC4	0.780		
SCC1	0.868	0.890	0.668
SCC2	0.870		
SCC3	0.865		
SCC4	0.856		
SSI1	0.864	0.872	0.695
SSI2	0.834		
SSI3	0.800		

Table 7: Results of Heterotrait-monotrait Test.

	(1)	(2)	(3)	(4)
Supplier Assessment (1)				
Supplier Codes of Conduct (2)	0.496			
Supplier Collaboration (3)	0.324	0.452		
Sustainable Supplier Integrity (4)	0.448	0.778	0.537	

that PLS-SEM has sufficient predictive relevance ($Q^2 > 0$; Hair et al., 2017). The supplier code of conduct is the strongest driver of sustainable supplier integrity. This can be seen from the greater value of standardized beta, t-value, and Q^2. Thus, three drivers are good predictors of sustainable supplier integrity (Figure 3).

Table 8: Results of Hypothesis Testing (One-Tailed).

Hypothesis	Path	Std. Beta	SD	Q^2	T-Value	P-Value	Remarks
H1	SA -> SSI	0.082	0.036	0.403	2.250	0.012	Accepted
H2	SC -> SSI	0.206	0.039	0.429	5.334	p<0.001	Accepted
H3	SCC -> SSI	0.535	0.04	0.534	13.416	p<0.001	Accepted

6. Discussion

In this study, there are substantial drivers of sustainable supplier integrity, which consists of three main drivers, namely; supplier assessment, supplier collaboration and supplier codes of conduct. In term of the method, this study used a split-half method to identify

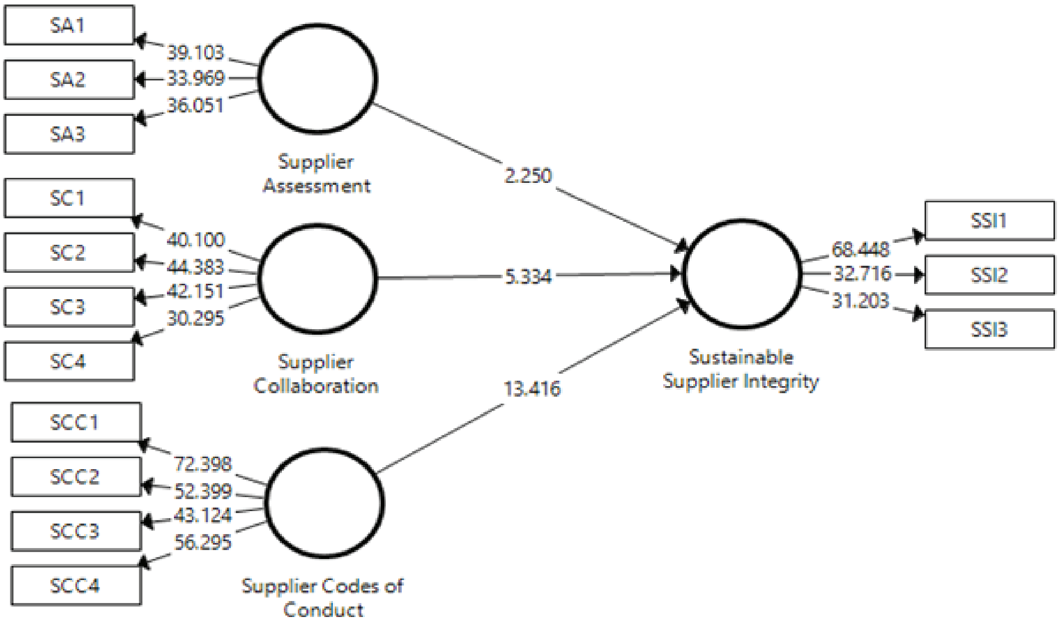

Figure 3: Structural Model with PLS-SEM.

the construct items when the existing measurements are not established. Besides, a split-half method allows scholars to split the data into two sets with a different type of tests and statistical software. The positive relationship between supplier assessment and supplier sustainable integrity is in line with Castillo et al. (2018). Blome et al. (2017) postulated that integrity should be rewarded in the organization. The companies are expected to monitor, control, and evaluate the integrity performance of suppliers to strengthen the positive business outcome of supplier sustainable integrity. Supplier integrity can assist the companies in reducing the uncertain risks in quality of materials. A positive relationship between supplier collaboration and supplier sustainable integrity has an impact on sustainable supply chain integration. The collaboration with integrity among networks in the supply chain can improve best practices and business model. The collaboration with integrity will trigger products and service quality and strong brand positioning. Thus a positive relationship between supplier collaboration and sustainable supplier integrity was supported by Castillo et al. (2018). The collaboration with integrity will come from the supplier collaboration program (Blome et al., 2017). The aim of the supplier collaborative program is to develop a critical part of business ethic and integrity. The relationship between supplier codes of conduct and supplier sustainable integrity was positively significant.

Moreover, the managerial implication for this study concludes that codes of conduct are immensely important in providing the best ethical practices. The result was supported by Castillo et al. (2018). According to the Institute for Supply Management

(2016), understand of principles and standards of ethical supply management, conduct will increase awareness and acceptance of ethical conduct and emphasize the role of ethics when formulating decisions. The significant of supplier codes of conduct can impact regulatory compliance. For example, the supplier sustainable integrity can assist the manufacturing firms to comply with ISO 14001 and ISO 5001 on environmental and energy management practices (Jasmi & Fernando, 2018; Fernando et al., 2018; Fernando & Hor, 2017).

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