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Sustainable Performance Measurement (SPMs) Model: Effects of Product Tecnology and Process Technology

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ABSTRACT

Malaysia as a developing country is in the transformation process of becoming an industrialised nation, as stated in Vision 2020. Manufacturing industry significantly contributes to the national economic growth in Malaysia; however, the manufacturing industry consumes the most natural resources which cause degradation of natural resources. This is against the global efforts that put pressure on world organisations to carry out their business in a more responsible and sustainable manner. As an approach to improve sustainability performance, manufacturing companies should develop technologies that consume less material, while trying to adopt new technologies effectively. However, empirical studies in Malaysian manufacturing industry on technology and Sustainable Performance Measurements (SPMs) are still very limited. Thus, the main purpose of this study is to determine the relationship between technology and Sustainable Performance Measurements (SPMs) model among different sizes of Malaysian manufacturing companies. The target population in this research is 2500 manufacturing companies registered under Federation of Malaysian Manufacturers (FMM). The random sampling method is engaged in the sample selection. A total of 217 observations were collected over 600 sample size, with a response rate of 36.17%. The results of the analysis indicate that product technology does not have any significant effect on SPMs. In contrast, process technology demonstrates a positive relationship with SPMs. In addition, business size does not affect SPMs. Overall, it can be concluded that Malaysian manufacturing companies consider more privilege for process technology implementation to achieve desirable SPMs performance in their business rather than product technology.

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INTRODUCTION

Over the recent years, global pressures dealing with issues such as global warming, scarcity of raw materials and deterioration of human rights have increased (Seuring, 2004; Porrit, 2006). Manufacturing companies are the main sources of producing natural resources consumption, depletion and degradation, along with making toxic by-products and wastes. Hence, environmental laws and regulations, customer demand for sustainable goods and services, and environmental interest groups have required manufacturers to perform their business in a more accountable and responsible manner toward all stakeholders including the environment.

This triggers the emergence of sustainability as an integral part of companies' business strategies in order to obtain economic, environmental and social benefits (Sebhatu, 2009). Generally, sustainability is defined as fulfilling the current needs without jeopardising the ability of future generations to meet their requirements. That is why companies must be responsible for the impacts of their business activities on society and environment, while being accountable to stakeholders at the same time (ACCA, 2005). In order to respond to the increasing awareness of and demand for sustainability, Global Reporting Initiative (GRI), established in late 1997, provided generally accepted sustainability reporting framework. The companies which adopt GRI standards are mandated to report their economic, environmental, social and governance compliance with the guidelines provided.

Some nations like Australia, China, Denmark and the USA have started to derive their own national sustainability standards from the whole or part of GRI guidelines. The stock exchanges of some Asia Pacific countries such as Singapore and Malaysia are also taking serious steps to require or recommend listed companies to disclose sustainability information (GRI, 2013). This geographical area deserves more consideration since about 25% of the global sustainability reports are originated from the Asia Pacific Region (ACCA, 2013). Although sustainability reporting is a voluntary exercise by each company in Malaysia, research on Bursa Malaysia revealed an increase number of listed companies reported over the environmental and social issues since 1999 to 2003, from 25 to 60 companies, respectively. The manufacturing sector had the greatest portion of environmental reports over this 5-year period, comprising 28% of the reporting companies in 1999 and reaching 32% in 2003 (ACCA, 2013).

In addition, the sustainability aspects of physical development of cities are aimed to be met in 10th Malaysia Plan from 2011 to 2015 (Prime Minister's Department, 2010). In 2010, Bursa Malaysia announced Business Sustainability Programme to encourage public listed companies (PLCs) to integrate sustainable practices into their business strategy. This not only enables Malaysian companies to have a better understanding of sustainability but also assists PLCs to gain tangible and intangible benefits from sustainable processes.

It is assumed that observing sustainability guidelines assists manufacturers to gain a competitive advantage by reducing cost, increasing quality, managing risk and enhancing social image (Boons & Ludeke-Freund, 2013; Forsman, 2013). It is believed that sustainable development can be accomplished through technological innovation in conjunction with the measures to improve social and environmental impacts of the company's operations (Manufacturing Skills Australia, MSA, 2008). This innovation comprises of process technology and product technology implementation in manufacturing processes.

To begin with process technology, manufacturing industries are required to be aware of newly available and emerging technologies in the market, while trying to develop technologies that generate more energy and consume less materials (Ball, 2013). For example, in 2012, Adidas introduced a new technology known as "DryDye" that uses no water, 50% less chemicals and 50% less energy than the traditional fabric dyeing process in manufacturing t-shirts. As a result of DryDye implementation, the financial expenses of Adidas decreased by 30%, while the net income attributable to shareholders increased by 6% just within the first half of 2013 (Adidas, 2013). Thus, it can be concluded from Adidas case that new technology provides the company with a competitive advantage. Moreover, social and environmental responsibilities of the company with high technological process are met by reducing chemicals usage and increasing employees' productivity. However, the fact that competitive advantage is resulted from the new technology does not last for a long time due to the quick imitation and thus, a continuous process innovation is a must for companies to be sustainable.

In addition, manufacturing companies play a vital role in sustainability if their product quality is improved and products with more environmental-friendly features are offered through using new technologies. For instance, UMW Toyota Motor recently launched a new product, Komatsu HB205-1 hybrid hydraulic excavator, with the function of saving fuel at an average of 25%, which is equivalent to the same reduction in carbon dioxide emissions (UMW, 2012). This new high technology product assisted Toyota to not only contribute to the environment preservation, but also capture a lot of customers' attention. Nowadays, consumers are more interested in companies which produce environment-friendly products. This will motivate companies to invest more on product technologies that improve sustainability as well.

Although process technology and product technology seem to play a key role in sustainable performance measurement of manufacturing companies in developed context, this effect has not been investigated in an emerging market such as Malaysia. Hence, this research aims to find out the relationship between product and process technology and Sustainability Performance Measurements among manufacturing companies listed in Bursa Malaysia. Therefore, the effect of the size of manufacturing company on this possible relationship is also scrutinised in this study.

LITERATURE REVIEW

The concept of sustainability has been argued by a wide-range of international discussions. In 1972, the terms "sustainability" and "sustainable development" began to be commonly used in the literature (Harell, 2011). International Union for Conservation of Nature and Natural Resources (IUCN, 1991) explained that sustainability is the use of an organism, ecosystem, or other renewable resource at the rate within its capacity for renewal. In the subsequent year, this explanation is supported by Pronk, Jan and Haq (1992) who stated that sustainability involves economic growth that provides fairness and opportunity for the entire world's people without further destroying the world's finite natural resources.

In order to monitor the progress of sustainability performance of firms, Strategic performance measurement system (SPM) is introduced (Gadenne, Mia, Sands, Winata, & Hooi, 2012). Sustainability performance measurements have turned into a more competitive issue in manufacturing industries. Feng and Joung (2011) proposed that sustainable manufacturing is the production process with the minimal level of negative impacts on the environment as well as the minimum energy, cost, and natural resources used throughout its entire lifecycle.

Although sustainable development is investigated internationally, Joseph (2013) indicates that there has been no research conducted in the Malaysian context. Until now, a number of theories have been developed by researchers globally to convey sustainability measurement; however, there is no perfect model that serves all elements of sustainability simultaneously.

Theoretical Framework

The three theories which seem to be relevant about sustainability measurement are discussed in the following subsection.

The first theory applied is called "Resource-Based Theory" (RBT). Resource-based view (RBV) is one of the main trends under (RTB) which discusses the relationship between firm's resources and sustainable competitive advantage. Discussed for the first time in the late 1950s, RBV reflects the vitality of firm to manage resources to achieve sustainable competitive advantage (Alagoz & Akatay, 2008). According to Barney (1991), when firm implements a value creating strategy, which is not simultaneously taken by any other rivals, the firm gains competitive advantage. The potential resources of firm to achieve competitive advantage are represented by four empirical indicators of value, rareness, inimitability and substitutability (Barney, 1991). Another study by Hart (1995) stated that RBV of the firm is viewed based upon the relationship between the firm and natural environment. It explains that if a company attempts to manufacture products that are environmental responsible while constantly produce high level of production waste and emission, the firm is at risk of degrading its credibility and reputation.

"Institutional theory" is the second theory of study which emerged in the 1970s. This theory discusses over the implementation of organisation in social and cultural contexts. It comes to the concern of Delmas and Toffel (2004) that institutional pressures and organisational characteristics are influencing an organisation to adopt environmental management practices. In this study, the achievement of top management in implementing effective policy and culture to gain favourable sustainable performance measurement is identified.

The third is "Stakeholder Theory" discussed by Freeman (1988). Stakeholder theory defines stakeholders as groups and individuals that gain benefits or incur losses from corporate decision making. Stakeholder includes management, local community, suppliers, employees, customers, government, shareholders, financier and also investor. In the research done by Oruc and Sarikaya (2011), the stakeholder theory suggests that firm shall expand and have more sensitive management approach towards benefit and interest of stakeholders in order to achieve long-term sustainability. However, there is little study to support sustainable performance measurement in the stakeholder theory. Another viewpoint by Ilinitch, Soderstrom and Thomas (1998) suggested that environmental issues are becoming substantially important to stakeholders. Phillips *et al.* (2003) further explained that managing stakeholder not only emphasises on maximising shareholders' wealth but also concerns with the interest and well-being of people who are able to assist achievement of an organisation's objectives. In a nutshell, the stakeholder theory argues about the role of stakeholders in managing a firm not only to achieve favourable prospect but also to consider environmental and social issues. Thereby, the impact of management's decision making on the sustainability performance measurement is further determined in this study.

Technology and Sustainability

One way to improve sustainability performance of manufacturing companies is to take advantage of new technologies. As stated by Chakravarthy and Doz (1992), new technology is crucial in sustaining survival of industrial companies. The reason may be because manufacturing industry that implements new technology obtains competitive advantage (Milgrom & Roberts, 1990).

As an evidence, Malaysia's economy expanded by 6.3% in 2007 because of the manufacturing industry being its strongest industrial sector (abed. Rahman, Bennet, & Sohal, 2009). Jabar *et al.* (2009) stated that technology advancement plays a key role in achieving Malaysia's vision to become an industrialised nation by 2020.

According to the Malaysian Industrial Development Authority, MIDA (2008), the efforts have increased to improve Research & Development (R&D) and innovations in the manufacturing industries. After 2013, MIDA offered incentives for high technology companies with 100% income tax exemption of statutory income for a period of five years. Two types of technology called product technology and process technology have attracted a lot of attention recently.

Product Technology

Product technology is defined as the science and art of developing and producing performance products, either by improving existing or designing new products in order to meet the demands and requirements of society (Voncken *et al.*, 2004).

Voncken *et al.* (2004) stated that product technology is increasingly important in manufacturing environment due to customers' high demand for products with high levels of performance and functionality (Voncken *et al.*, 2004). Rosen and Kishawy (2012) argued that designing new environmental friendly products contributes to firm's success in terms of both introduction and mature lifecycle stages of products. However, there is little empirical study available on the impact of product technology on sustainability.

Based on the above discussion, the first hypothesis is suggested:

H_1: *The product technology of manufacturing industries in Malaysia has a positive relationship with sustainability performance measurement.*

Process Technology

As opposed to product technology, where technology is embedded within a product, process technology facilitates the production and delivery of product to consumers (Slack, Chambers, & Johnston, 2013). In other words, process technology is the machinery, equipment and devices that assist manufacturer to transform materials into products which add values to customers (Dedhia, 2012). It is mentioned by Cramer and Zegveld (1991) that process technology requires less water, energy and raw material, and thus reduces waste discharges.

The introduction of both product technology and process technology in the late 1970s have eased firms to gain economies of scale and desired profitability. The concern on product technology is shifted toward process technology, where manufacturing firms are emphasising on even lower cost production as innovation rate in product technology has become slower (Slack *et al.*, 2013). For instance, Samsung Foundry formed Semiconductor R&D Centre to offer process technology in order to meet its customers' process specification and requirements. Another example is Semiconductor R&D Centre which emphasises on process technology development to produce mobile and information technology computing applications that consume energy more efficiently. Therefore, sustainable process technology is important to the current market as the raw materials of the earth are reducing at greater speed (Institute of Sustainable Process Technology, ISPT, 2011).

Having a look on the above-mentioned points, the second hypothesis of this research is proposed as:

H_2: *The process technology of manufacturing industries in Malaysia has a positive relationship with sustainability performance measurement.*

Company Size as Control Variable

Firm size is one of the main characteristics of a firm in evaluating its performance. The size of a firm can be determined by using its total sales generated in monetary units and number of employees hired (Kitov, 2009).

In Malaysia, a guideline is issued by SME Corp Malaysia in judging the firm size. It states that SMEs engaging in manufacturing sectors have to employ full-time employees not more than 200 workers or generate sales turnover of less than RM50 million. More specifically, firms with sales turnover ranging from RM300,000 to less than RM15 million or with full-time employees from 5 to less than 75 persons are classified as small firms. Meanwhile, a firm with sales turnover ranging from RM15 million to less than RM50 million or full-time employees from 75 to not exceeding 200 persons is known as a medium-sized firm [SME Cor. Malaysia, SME (M), 2013]. Therefore, the guideline issued by SME (M) is in line with the result in the research paper done by Kitov (2009) which listed out firm size as determined by firm's sales turnover and number of employees employed.

The debate about the effect of firm size on sustainability practice is still open to discussion. Some studies supported the idea that small firms can perform better in sustainability through closed relationship with external parties (Ernst & Young, 1994; Condon, 2004; Spence, 2012), while other studies highlighted that large firms with abundant resources in terms of technology, labour and capital take advance in sustainability (Watson, Shrives & Martson, 2002; Zadeh & Eskandari, 2012; Hosey, 2013). To support the latter idea, it is proven by Burgess, Ong and Shaw (2007) that large companies engaging in high technology manufacturing industry tend to rely on performance measurement systems because of their advantage on resources to implement more innovation as compared to Small and Medium Enterprises. Therefore, this study aims to use a sample of companies with different sizes to investigate how process technology and product technology relation with social performance measures varies among them.

According to the above-mentioned literature and hypothesis, the research framework on technology and sustainability performance measurement is shown in Fig.1.

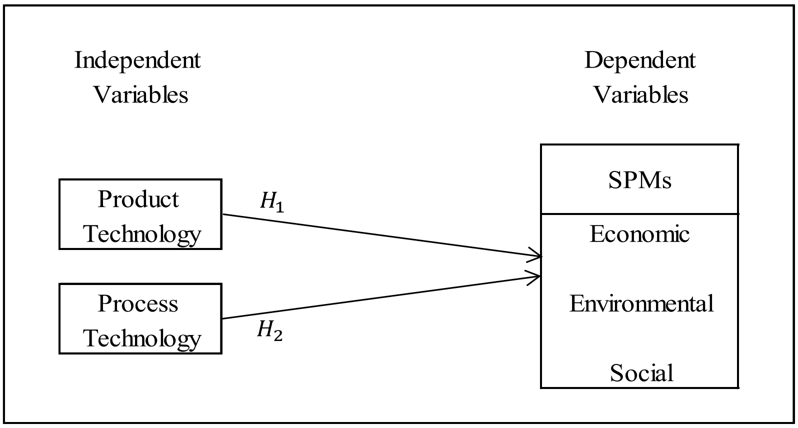

Fig.1: Research Framework on Technology and Sustainability Performance Measurement

RESEARCH DESIGN

Population

The target population of this study comprises of the manufacturing companies of different sizes in Malaysia. The list of these companies was obtained from the Federation of Malaysian Manufacturers (FMM) database. FMM is an officially recognized economic organization which represents over 2,500 manufacturing companies of varying sizes in Malaysia. Since FMM's vision is to assist Malaysian industries to become globally competitive, the FMM database is sufficiently reliable and valid to be used as the population.

Sample Size and Procedure

As suggested by Bolt (1999), minimum sample size of 100 observations is required to achieve adequate and valid results. In this study, a total of 600 manufacturing companies were randomly selected as the sample with an estimated response rate of 25%. Accordingly, the manufacturing company names were arranged alphabetically, and the sample was then chosen through simple random sampling method.

Research Instruments Development

In conducting the research, a closed-ended questionnaire that is also known as fixed-alternative questionnaire was designed and distributed to 600 selected companies through mail with a cover letter to selected companies. This research instrument was chosen because of its ability to provide objective and accurate data for hypothesis testing while it is cost-effective for the large sample sizes and wide geographical areas. Copy of the questionnaire used can be found in the appendix of this study.

This questionnaire is divided into four sections. The first part includes questions on the profile of company and the financial performance. This section requests details of the respondents, contact information, as well as the criteria possessed by technology in affecting sustainable performance measurement. The third part consists of the characteristic of company in relation to product technology and process technology. The questions in the final part of the questionnaire ask about the operation of company in relation to its achievement in economic, social and environmental areas. In designing the questionnaire, the five-point Likert scale was used and elaborated in sections three and four.

In order to ensure the relevancy of the questionnaire, it was submitted to two experienced university lecturers to evaluate the appropriateness of the questions. After amending the questionnaire by referring to the lecturers' feedback, the next step was conducting a pilot test, where the questionnaire was distributed to ten manufacturing companies. The respondents included chief executive officer, chief financial officer and human resource manager who participated in the company's sustainable performance measurement activities. When the comments received from these companies, changes to the questionnaire were made to improve the relevance of the questions. The final modified questionnaire was posted to selected companies with envelope provided for the convenience of the companies to return their responses to the researcher.

Data were analysed by using six statistical methods including descriptive analysis, validity test, reliability test, normality test, factor analysis, multicollinearity and regression analysis.

RESULTS AND DISCUSSION

In this study, there were 217 manufacturing companies participated out of the 600 samples selected, which constituted a response rate of 36.17%. The response rate was considered as high compared to the initial expected response rate of 25%. There were no missing data in the questionnaire due to the initiatives taken by researchers who had contacted every company representative to complete the questionnaire.

The guidelines provided by National SME Development Council (NSDC) are used as references in the classification of the size of companies. According to NSDC, small manufacturing companies consist of 5 to less than 75 full-time employees, whereas medium-sized companies have 75 to 200 full-time employees. Companies with more than 200 full-time employees are categorised as large companies. As shown in Table 1 below, the data consisted of small companies (50.7%), medium companies (17.5%) and large companies (31.8%).

TABLE 1
Size of Companies

	Frequency	Percentage (%)
Small	110	50.7%
Medium	33	17.5%
Large	74	31.8%

Table 2 depicts the distribution of the 217 manufacturing companies which are mainly from the Klang Valley. The areas outside of the Klang Valley include several states of Perak and Sabah. For the purpose of this study, it is assumed that the Klang Valley includes Selangor state, Federal Governments of Kuala Lumpur and Putrajaya (Alatas, 2011).

TABLE 2
Distribution of the Sample Size

	Frequency	Percentage (%)
Klang Valley	135	62.2%
Non-Klang Valley	82	37.8%

Descriptive Analysis

Table 3 below shows the value ranges of minimum, maximum, mean and standard deviation for the independent variables, dependent variables and control variable in the measurement model. The results are stated in value range because there are many statements which were initially designed in the questionnaire with the intention of achieving better understanding for each variable.

The minimum range value of 1 to 2 indicates the attitude of manufacturing companies towards the statements for each variable, where 1 is defined as strongly disagree and 2 is disagree. The maximum value of 5 for the independent variables and dependent variables is defined as strongly agree with the statements, in which the companies have implemented the measurement or concern as a particular statement stated.

Meanwhile, the control variable of business size distributed with a mean of 452.03 and standard deviation of 1,253.249. The result suggested that on average, the manufacturing companies involved are large companies comprising 452 employees. However, the result is not parallel with those in Table 3, which comprise 50.7% small companies that have 5 to less than 75 employees. The variance can be explained by the large standard deviation of 1253.249 along with a minimum value of 2 employees and the maximum value of 10,000 employees.

TABLE 3
Descriptive Analysis of Value Range for All the Variables

Variables	N	Minimum	Maximum	Mean	Standard Deviation
Independent Variables:					
Product Technology	217	1	5	3.65 - 3.74	1.112 - 1.198
Process Technology	217	1	5	3.48 - 3.76	0.921 - 1.028
Dependent Variables:					
Economic	217	1 - 2	5	3.87 - 4.27	0.747 - 0.867
Environmental	217	1	5	3.46 - 4.05	0.801 - 1.027
Social	217	1 - 2	5	3.66 - 4.43	0.673 - 0.815
Control Variable:					
Business Size	217	2	10,000	452.03	1,253.249

Modified Measurement Model

It is necessary to alter the initial measurement model to achieve the required model fit for this study. This is done by inspecting the factor loading of each indicator, where one with a value lower than 0.5 is eliminated from the construct (Awang, 2013). When one indicator is deleted, the model fit analysis is performed to determine whether fit indexes are achieved. After repeating the analysis for several times, the model fit is achieved. The modifications conducted over the indicators of the variables are tabulated in Table 4.

TABLE 4
Comparison of Factor Loadings between Initial and Modified Measurement Model

		Initial Measurement Model	Modified Measurement Model
Construct	**Indicator**	**Factor Loading (λ)**	**Factor Loading (λ)**
Product Technology	Fp1	0.842	0.842
	Fp2	0.891	0.892
	Fp3	0.819	0.819
	Fp4	0.733	0.733
Process Technology	Fpr1*	0.063	DELETED
	Fpr2	0.618	0.605
	Fpr3	0.726	0.742
SPMs	Ec1*	-0.333	DELETED
	Ec2*	0.488	DELETED
	Ec3	0.500	0.416
	Ec4	0.603	0.550
	Enc1*	-0.083	DELETED
	Enc2	0.739	0.749
	Enc3	0.724	0.734
	Enc4	0.703	0.729
	Enc5	0.751	0.769
	Enc6	0.720	0.727
	Sc1*	0.446	DELETED
	Sc2*	0.407	DELETED
	Sc3*	-0.064	DELETED
	Sc4	-0.325	0.346
	Sc5*	0.085	DELETED

In addition, the modification indices (MI) are also examined to determine results of every possible relationship that is not estimated in the model (Hair *et al.*, 2010). Result of the MI for e1 and e2 is 47.077, which is higher than 15. This indicates that Ec3 and Ec4 are correlated because it provides better results of model fit compared to deleting the indicators. Based on the above modifications, the Modified Measurement Model presented in Fig.2 is the fit model.

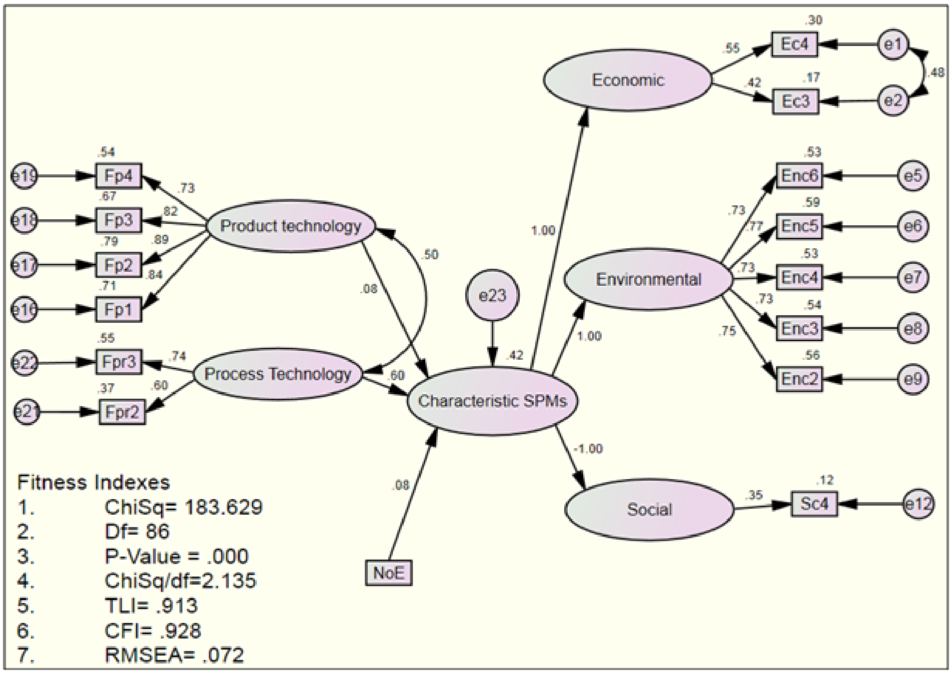

Fig.2: Modified Measurement Model

Model Fit

Table 5 summarises the indices of Goodness-of-Fit (GOF) for the model used in this study. As it is clear, all absolute fit, incremental fit and parsimonious indices fall in either good or acceptable fit range.

In order to provide a clear view on the comparison of fit statistic between Initial and Modified Measurement Model, Table 6 is formed as follows. Therefore, the Modified Measurement Model is used to perform the following tests.

TABLE 5
Fit Indexes for Modified Measurement Model

Fit Indexes	Value	Model fit
Absolute fit		
- RMSEA	0.072	< 0.08, Good fit
- GFI	0.904	> 0.9, Good fit
Incremental fit		
- TLI	0.913	> 0.9, Good fit
- CFI	0.928	> 0.9 Good fit
Parsimonious fit		
- Chisq/df	2.135	< 5.0, Acceptable

TABLE 6
Comparison of Fit Statistic between Initial and Modified Measurement Model

Fit Indices	Initial Measurement Model	Modified Measurement Model
Absolute Fit:		
- RMSEA	0.114	0.720
- GFI	0.710	0.904
Incremental Fit:		
- TLI	0.643	0.913
- CFI	0.679	0.928
Parsimonious Fit:		
- Chisq/df	3.820	2.135

Reliability and Validity Test

As stated in Table 7, Cronbach's alpha for product technology is 0.890 (initial = 0.890), CR value of 0.981 (initial = 0.893) and AVE value of 0.678 (initial = 0.678). These values are above the acceptable cut-off value, thus, indicators in product technology are reliable and valid.

However, process technology improves significantly with Cronbach's alpha value of 0.648 (initial = 0.401), CR value of 0.626 (initial = 0.487), and AVE value of 0.459 (initial = 0.304). Although the value of cronbach's alpha is not greater than 0.7, it is supported by Hair *et al.* (2010) that the value of 0.6 is deemed the lower limit of acceptability. Meanwhile, the value of CR lower than 0.7 causes the data not to be highly reliable, but CR with the value higher than 0.5 can be considered as reliable enough (Bolt, 1999; Hair *et al.*, 2010).

In spite of having AVE lower than 0.5, the process technology construct is sufficiently reliability because of the Cronbach's alpha and CR values (Bolt, 1999). Moreover, the reliability and validity values for SPMs demonstrate remarkable improvement on the value in the Modified Measurement Model, making data for SPMs as both reliable and valid.

TABLE 7
Reliability and Validity Test for the Modified Measurement Model

Construct	Cronbach's Alpha	CR	AVE
Product Technology	0.890	0.981	0.678
Process Technology	0.648	0.626	0.459
SPMs	0.783	0.836	0.418

Normality Test

In order to examine whether the data are normally distributed, two measures are used to determine the distribution of data: skewness and kurtosis. The acceptable range for both measures is +2 to -2. Based on the results of the skewness and kurtosis tests in this research, the data are found to be normally distributed (Table 8).

TABLE 8
Normality Test for the Modified Measurement Model

Statements	Skewness	Kurtosis
Independent Variables:		
Product Technology		
Fp1	-0.779	0.277
Fp2	-0.774	0.129
Fp3	-0.835	0.091
Fp4	-1.089	0.554
Process Technology		
Fpr2	-0.018	-0.690
Fpr3	-0.791	-0.665
Dependent Variables:		
Economic		
Ec3	-0.499	-0.096
Ec4	-0.457	-0.053
Environmental		
Enc2	-0.018	-0.572
Enc3	-0.453	-0.107
Enc4	-0.251	-0.175
Enc5	-0.344	0.046
Enc6	-0.361	-0.206
Social		
Sc4	-0.588	-0.464

Multicollinearity Analysis

Multicollinearity occurs when indicators are strongly correlated in the measurement model, with a coefficient correlation higher than 0.85 (Kline, 2011). As depicted in Table 9, the correlations between all the variables are less than 0.85, without considering the correlation between the same variable. Therefore, the indicators in the study have the ability to provide a proper estimation for the relationship between the variables.

TABLE 9
Coefficient Correlations of the Measurement Model

	NoE	Fpr3	Fpr2	Fp4	Fp3	Fp2	Fp1	Sc4	Enc2	Enc3	Enc4	Enc5	Enc6	Ec3	Ec4
NoE	1.000														
Fpr3	.070	1.000													
Fpr2	.059	.448	1.000												
Fp4	.031	.371	.301	1.000											
Fp3	.022	.335	.260	.658	1.000										
Fp2	.037	.257	.215	.613	.738	1.000									
Fp1	.008	.337	.302	.599	.641	.782	1.000								
Sc4	.047	-.294	-.317	-.175	-.078	-.183	-.210	1.000							
Enc2	.017	.419	.303	.452	.330	.286	.351	-.294	1.000						
Enc3	.121	.360	.266	.229	.183	.133	.093	-.254	.594	1.000					
Enc4	.176	.296	.250	.347	.290	.236	.253	-.238	.503	.517	1.000				
Enc5	.141	.314	.233	.315	.215	.124	.181	-.199	.566	.534	.630	1.000			
Enc6	-.018	.368	.297	.342	.236	.201	.267	-.221	.524	.551	.547	.582	1.000		
Ec3	.082	.196	.255	.271	.295	.250	.199	-.107	.315	.373	.282	.289	.264	1.000	
Ec4	.115	.283	.328	.252	.138	.159	.174	-.246	.400	.418	.369	.461	.350	.591	1.000

Regression Analysis

Regression analysis result for the framework of the study reveals of 0.42. This indicates that 42.4% of the dependent variable (SPMs) is affected by the independent variables, whereas the remaining 57.6% is represented by independent variables other than process technology and product technology.

Equation Model	R^2
$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3\, NoE + \varepsilon$	0.424

Y	Dependent variable
β_0	Axis intercept
β_n	Regression coefficient, n = 1, 2
x	Independent variable
NoE	Control variable
ε	Random non-observable error

The regression coefficients presented in Table 10 indicate that only process technology has a significant and positive effect on SPMs with β value of 0.491 at significant level, 0.01. However, product technology with β value of 0.041 and NoE with β value of 0.000 show non-significant effects on SPMs.

TABLE 10
Summary of the Regression Coefficients

Dependent Variables	Variables	Unstandardised Coefficients	
		β	Standard error
SPMs	**Independent Variables**		
	- Product Technology	0.041^{ns}	0.480
	- Process Technology	0.491***	0.115
	Control Variable		
	- NoE	0.000^{ns}	0.000

*** represents P < 0.001
ns represents non-significant

Results of Hypotheses Testing

Two hypotheses were formulated to predict the relationship between the dependent variable and independent variables while having a control variable. As presented in Table 11, hypothesis tested on the relationship between product technology and SPMs is not supported at the significance level of 0.01. On the contrary, the test result on the second hypothesis reveals that process technology affects SPMs at the significance level of 0.01 with the regression weight of 0.601.

TABLE 11
Results of Hypotheses Testing

Hypothesis	Relationship between Variables	Standardised Regression Weight	Level of Significance	Hypothesis Test Outcome
H_1:	Product Technology → SPMs	0.081	P > 0.001	Not supported
H_2:	Process Technology → SPMs	0.601	P < 0.001	Supported

Discussion of Study Findings

Based on data presented in Table 4-11, it can be figured out that the first hypothesis of this study, which is about the relationship between product technology and SPMs, is rejected. The reason can be explained as the fact that majority of the observations participated in this survey comprises of small companies which suffer from scarcity of resources and capabilities in implementing product technology to enhance SPMs.

As indicated by Hosey (2013), large companies possess sufficient resources that offer them a privilege over the small and medium companies in the industry. As large companies are able to improve environmental characteristic by reducing carbon emission, and also social characteristic through enhancing employee productivity, it would therefore be a heavy burden for small companies to compete with medium and large firms in the manufacturing industry.

However, the results of testing the second hypothesis, revealed a significant and positive effect of process technology on SPMs. This means that the Malaysia manufacturing companies which have process technology in their production process are able to achieve better performance on SPMs. This result is relatively important to the growth and expansion of manufacturing companies, as majority of the small companies are involved in the survey.

CONCLUSION

The main purpose of this study is to investigate how technology influences Sustainable Performance Measurements adopted in Malaysia manufacturing industries. In specific, this study attempted to empirically test and explain the relationship between product and process technology on SPMs among Malaysia manufacturing companies.

The results of the study depict that product technology does not improve Malaysian manufacturing SPMs. This result contradicts with several research done in other countries. It was argued by Rosen and Kishawy (2012) that product technology improves the environmental performance of manufacturing companies while retaining their competitiveness. In addition, Drejer (2004) proposed that product technology has a positive relationship with social performance on the grounds that innovation applied in the performance of the product plays an important role in fulfilling customers' demands.

Moreover, Voncken *et al.* (2004) claimed that product technology shortens the time to market of a new product and assists companies to gain first mover advantages. First mover advantages include superior positions in physical location, patent and customer perceptual (Lieberman & Montgomery, 1998). However, product technology requires continuous innovation and improvement in order to retain market share as the competitors would respond quickly by recognising the error made by the early entrant.

Contrary to product technology, process technology does improve the SPMs of Malaysian manufacturing companies. Since small companies are able to gain advantages from the implementation of process technology, medium and large companies with higher capability are competent to place more comprehensive process technology to facilitate companies achieve higher performance on SPMs.

Other than that, this result is supported by Milgrom and Roberts (1990) who argued that process technology has a positive relationship with the economic and social aspects, which form the two elements of SPMs. Process technology would function well in profit-maximising company as it shortens the production cycles and lowers rejected orders. With shorter production cycles and lower goods return, the employees' productivity and customers' satisfaction will be improved.

Another study done by Cramer and Zegveld (1991) mentioned that process technology enables companies to reduce environmental pollution during the production process. Consequently, manufacturing companies can attain sustainable manufacturing. Having in mind the results of previous studies, it can be concluded that Malaysian manufacturing companies benefit from process technology since economic, social and environmental measurements outweigh the cost incurred from process technology implementation.

IMPLICATIONS OF STUDY

The results obtained from this study are particularly beneficial to researchers, manufacturing companies and policy makers. To begin with, this study provides a reference for researchers to further explore social performance measures in Malaysia due to the scarcity of research papers on this particular topic. As for manufacturing companies, the findings of this study suggest that these companies provide a budget for implementing process technology to boost their SPMs. Last but not least, evidences of this study encourage policy makers to motivate manufacturing companies with limited capital to have process technology in their activities. This can be achieved by offering tax incentives and low interest fund/loan to facilitate companies with this process.

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