

Measuring Green Performance for Malaysian Automotive Industry

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Abstract

The purpose of this study is to examine the green performance measurement for Malaysian automotive industry. In this study, by using the structural equation modelling technique, four of green performance measures were developed and verified. From the findings of the survey, the results of the study indicated that the green performance for environmental performance, economic performance, operational performance, and innovation performance were valid and reliable. It was shown that green performance measurement assist in improving performance for Malaysian automotive industry. The green performance measurement contributes to assist the Malaysian automotive industry in order to maximize productivity, implementing energy saving approaches, and increase the performance evaluation.

Keywords: Automotive Industry, Economic Performance, Environmental Performance, Performance, Reliability Analysis, Structural Equation Modelling

Introduction

Malaysia has long been involved in the development of the automotive industry with a different emphasis over time and the attempt to increase performance with various new initiatives in managing processes and operation management which indirectly play an important role in helping the development of the local automotive industry (Habidin et al., 2014; Habidin et al., 2016). Thus, to assist National Automotive Policy (NAP) in achieving one of its objectives which is to develop high value-added manufacturing activities in niche areas, further research is very important to find the new green techniques particularly for enhancing quality initiatives in the Malaysian automotive industry.

Then in 2006, the (NAP) was introduced in order to promote the competitiveness of the Malaysian automotive industry to advocate a strategic partnership between PROTON, PERODUA and other national car projects which would allow them to increase their

competitiveness, long-term viability, access to the latest technology such as R&D activities and enable Malaysia to play the role of regional hub for the industry by increasing their exports (MITI, 2009; Habidin & Yusof, 2012). Thus, the researcher is aware that the measurement of Green Performance (GPM) needs to be explored more deeply for searching new green techniques to improve the industry's performance especially in the Malaysian automotive industry.

Green Performance (GPM) refers to the result of the initiatives, activities, techniques, and rules of environmental implementation (Zhu et al., 2008). GPM plays an important factor as guidance to the organization for achieving performance and creating new opportunities and chances to improve their performance. Several previous studies have been reviewed to explore the measurement for GPM (Chiou et al., 2011; Green et al., 2012). This study has important implications for improving GPM in Malaysian automotive industry.

More companies are going green as they realize that they can reduce pollution, reduce cost of operation and management and increase profits simultaneously (Hart, 2007). In this line of study, green activities play important roles in practice and innovation to increase the GPM. The GPM is not just a good strategy improvement tool but it is useful for managing in environmental risks and cost. Organizations need to be smart to take a chance in competitive advantage through the strategic management of green challenges (Esty & Winston, 2009). The organizations realize that they have to accept their responsibility to do no harm to the environment particularly in their practice, products and production processes. Therefore, the aim of this study is to examine the green performance measurement for Malaysian automotive industry.

Literature Review

Performance Measurement Systems (PMS)

In order to ensure improvement performance especially in the quality initiatives for industry, performance measurement should be designed based on the current studies with different results and different performance. The performance measurement involves the most prevalent techniques by understanding how they are adapted and used as a strategic measurement in organization (Epstein, 2008).

There might be different green initiatives applied in different performance measurement improvements. The performance measurement for this study is known as GPM. GPM refers to the result of an organization's management of its environmental aspects (The International Marine Contractors Association (IMCA), 2004). There are a few studies proven which give positive GPM results especially in the manufacturing process with better performance in all aspects on environmental management (Constantini & Mazzanti, 2012).

Green Performance (GPM) Measures

Recent studies have mentioned that GP and GI efforts have improved its GPM through various strategies; initiatives achieved and created opportunities to the company (Rennings, 2000; Wagner, 2007; Zhu & Sarkis, 2004; Chien & Shih, 2007; Zhu et al., 2008; Chiou et al., 2011; Comoglio & Botta, 2012). These studies consist of four different of GPM measures such as environmental, economic, operational and innovation as consequences for this study.

Environmental Performance (ENP)

Environmental Performance (ENP) relates to the ability of manufacturing plants to reduce air emissions, effluent waste, and solid wastes and the ability to decrease consumption of hazardous and toxic materials (Chien & Shih, 2007; Zhu et al., 2007; Wagner, 2007; Zhu et al., 2008, Fuzi et al., 2015). Such differences may result from significantly better implementation of GP and GI and improvement for all types of ENP in the automotive industry.

Operational Performance (OP)

Operational Performance (OP) has become an essential need for the industry to have the competitive advantage. OP relates to the manufacturing plant's capabilities to more efficiently produce and deliver products to customers (Chien & Shih, 2007). OP improvements can be listed as increasing amount of goods delivered on time, decreasing inventory levels and increased product line (Zhu et al., 2008). Thus, it can be concluded that operational performance can optimize cost and performance for the automotive industry.

Economic Performance (ECP)

Economic Performance (ECP) is usually assessed in terms of the achievement of the *economic* objectives of the industry. ECP relates to the manufacturing plant's ability to reduce costs associated with purchased materials, energy consumption, waste treatment, waste discharge, and fines for environmental accidents (Zhu et al., 2007; Zhu et al., 2008). In addition to reduce the environmental risks, economic performance and assessment for the organization is also carried out in areas related to its assets, liabilities and overall market strength to make sure that the industry finances are always on the right track to avoid the high cost (Rennings, 2000). Therefore, ECP can be considered as an important measure to increase the industry's competitive advantage and their image.

Innovation Performance (IP)

The Innovation Performance (IP) is highly competitive to assess and improve industry's innovation capabilities. IP can define as measures for industry to develop a new ideas and behaviour to produce product and processes (Rennings, 2000; Montabon et al., 2007). In addition, a successful organization that turns its focus to innovation is looking for achievements and show the quality and quantity of ideas and the efficiency and effectiveness of IP (Chiou et al., 2011). Table 1 shows the green performance measures and their measurement items.

Table 1

Green performance measures and their measurement items

Green Performance Measures	Items	Authors
Environmental Performance (ENP)	<ol style="list-style-type: none"> 1. Reduction of air emissions. 2. Reduction of effluent waste. 3. Reduction of solid wastes. 4. Reduced in consumption for hazardous/harmful/toxic materials. 5. Reduced in frequency for environmental accident. 	Chiou et al. (2011); Zhu et al. (2010); Green Jr et al. (2012)
Economic Performance (ECP)	<ol style="list-style-type: none"> 6. Reduced in cost of materials purchasing. 7. Reduced in cost for energy consumption. 8. Reduced in fee for waste treatment. 9. Reduced in fine for environmental accidents. 	Zhu et al. (2008); Zhu et al. (2010); Green Jr et al. (2012)
Operational Performance (OP)	<ol style="list-style-type: none"> 10. Increased amount of goods delivered on time. 11. Increase in product quality. 12. Improve capacity utilization. 13. Reduction in inventory. 14. Reduced the defect rate. 	Zhu et al. (2008); Zhu et al. (2010); Green Jr et al. (2012)
Innovation Performance (IP)	<ol style="list-style-type: none"> 15. Improved the level of customer satisfaction in relation to product design and development. 16. Improved the number of product is easy to recycle, reuse, and decompose for conducting the product development or design. 17. Improved frequent introduction of new product ideas into production process. 18. Improved probability of success for new products being tested. 	Chen et al. (2006); Nunes and Bennett (2010); Chiou et al. (2011)

Nowadays, environmental management is predicted to be the most important performance indicators for the competitive advantage of firms in the future. Brio and Junquera (2003) found that focusing on environmental management actions turns into a competitive advantage for the company while it increases GPM levels similar to those of larger companies. According to Nunes and Bennett (2010), the implementation of environmental management refers to the development of the idea in the market and monitoring is the activity that should provide feedback to the company about its GPM in order

to enhance the learning of innovating in a sustainable way. For this study, the GPM measures are presented in order to improve their performance especially in environmental management within the automotive industry.

Methods

In this study, one of the objectives was to measure the GPM for Malaysian automotive industry. The survey methodology consists of the pilot study, population and sampling of the study, and statistical analysis.

Pilot Study

Pilot study refers to a research project which is conducted on a limited scale to get a first impression and clearer idea of what the researcher needs to know based on the objectives and to identify the potential problems which may affect the quality and validity of the results (Maxwell, 2005). The pilot study was collected using questionnaires distributed to 50 Malaysia automotive suppliers such as metal, plastic, rubber, engine/transmission, electric/electronic manufactured. After the questionnaires were returned, it was discovered that only 26 respondents responded to the questionnaire, with an average response rate of 52%. The pilot data for this study was analysed using SPSS statistical software.

Cronbach alpha refers to a specific measure of internal consistency reliability, whereas exploratory factor analysis, principal component analysis, and confirmatory factor analysis address construct validity (Andrew et al., 2011; Fuzi et al., 2013; Habidin et al., 2013). The reliability results of the pilot data indicated that all the constructs were appropriate and reliable for the automotive industry as the Cronbach alpha results for all constructs were more than 0.80. Leech, Barrett, and Morgan (2005) indicate that the value of Cronbach alpha should be 0.70 and above (acceptable) and the items in the scale are necessary for a reliable measurement. Cronbach alpha was used in this study to assess whether the 18 items of GPM were summed to create the reliability for each variable. The result of the reliability test for each element is shown in Table 2.

Table 2

Pilot results of reliability analysis for GPM measures

	Green performance	
Environmental Performance (ENP)	5	0.898
Operational Performance (OP)	5	0.935
Economic Performance (ECP)	4	0.910
Innovation Performance (IP)	4	0.868

Population and Sampling

To achieve the objectives of the study, the samples were selected from the list of PROTON and PERODUA automotive suppliers. These lists of automotive suppliers consist of electrical, electronic, metal, plastic, rubber, and other automotive parts. The information of the company such as classification of company, mailing address, email address, office and fax number, and direct hyperlink to companies' website can be obtained from the Proton Vendor Association (PVA) and Kelab Vendor Perodua (KVP) website. The final number of respondents which had been collected was 230 respondents.

Statistical Analysis

In this study, the survey instrument was analysed using two statistical software packages. Firstly, the Statistical Package for the Social Sciences (SPSS) for window Version 21.0 was used to perform the required statistical analysis of the data from survey. Secondly, Structural Equation Modelling (SEM) AMOS Version 21.0 was used.

Secondly, SEM AMOS Version 20.0 was used. The researcher utilized SEM as it is not just a statistical technique but also a process involving several stages: (a) initial model conceptualization, (b) parameter identification and estimation, (c) data-model fit assessment, and (d) potential model modification. In addition, SEM consists of six stages as recommended by the Hair et al. (1998), namely (1) develop a theoretically based model, (2) construct a structural model, (3) choose the input matrix type, (4) assess the identification of the model, (5) evaluate model estimates and Goodness-of Fit, and (6) model interpretation and modification.

SEM is a method for measuring relationship among latent variables in conducting analyses. It is used to specify, estimate, and evaluate models of linear relationships among a set of independent variables in terms of generally smaller number of dependent variables (Shah & Goldstein, 2006; Habidin, 2012; Habidin et al., 2015). This method is found to be better compared to other multivariate techniques such as multiple regression, path analysis and factor analysis.

Results***Exploratory Factor Analysis (EFA)*****EFA on green performance measures**

EFA with varimax rotation from 18 items of GPM measures was done on a random sample (n=230) of Malaysian automotive companies to produce basic details on each GPM such as Environmental Performance (ENP), Economic Performance (ECP), Operational Performance (OP), and Innovation Performance (IP). The results of KMO and Bartlett's Test for GPM measures was 0.938 greater than 0.7. This indicates that the current data was suitable for principal component analysis. Similarly, Bartlett's test of sphericity was significant ($p < 0.001$), indicating that the correlation was adequate among the items to proceed with the analysis.

Four factors contributed 82.453% of the total variance. This indicates that the four latent factors were associated. The last column of cumulative percentage shows that the variance explained by the extracted solution was also 82.453%, similar to the initial solution. Hence, no change of the variation explained by the initial solution was lost because of latent factors which reflected the suitability of the method in getting the GPM measures. Table 3 shows the results of KMO and Bartlett's Test and total variance explained.

Table 3

KMO and Bartlett's test for GPM measures

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.938
Bartlett's Test of Sphericity	Approx. Chi-Square	4089.675
	Df	153
	Sig.	0.000
Total variance explained		82.453%

For GPM measures, 18 items were fit for four factors as recommended. The first factor was classified as ENP which was provided by five items (ENP1, ENP2, ENP3, ENP4, and ENP5). The second factor was categorized as ECP which included five items (ECP1, ECP2, ECP3, ECP4, and ECP5). Then, the third factor was classified as OP which comprised of four items (OP1, OP2, OP3, and OP4). Lastly, the fourth factor was categorized as IP which comprised of four items (IP1, IP2, IP3, and IP4). From the EFA results, it can be summarized that four factors of GPM were recognized as 18 items and no item was suggested for removed because the factor loading is more than 0.5 (Hair et al., 1998) as accepting values.

Reliability Analysis

For this study, the reliability was analysed using SPSS reliability analysis for GPM measures. The latter method was implemented and the internal consistency was conducted on 18 items of GPM measures. The value of alpha must be at least greater than 0.7, indicating that the reliability values of the each construct and measure were received (Cronbach, 1951). Table 4 shows the reliability analysis for GPM measures.

Table 4

Results of reliability analysis for GPM measures

Measures	No. of items	Alpha (α) values	Item for deletion	Alpha (α) if item is deleted
GPM				
Environmental Performance (ENP)	5	0.945	None	0.945
Economic Performance (ECP)	4	0.942	None	0.942
Operational Performance (OP)	5	0.932	None	0.932
Innovation Performance (IP)	4	0.935	None	0.935

The analysis result showed that all the constructs and measures for this study were accepted because the value of alpha was greater than 0.7. This means that all the items were reliable and accepted for further analysis.

Confirmatory Factor Analysis (CFA)**Green performance measures with four factors**

The confirmatory factor analysis was tested and the results exhibited that GPM measures with four factors consisted of ENP, ECP, OP, and IP. The diagram is presented in Figure 1. The CFA result demonstrated a good fit. Statistics of χ^2 was 227.720 (degree of freedom = 129, $p < 0.001$), with a ratio of χ^2/df at 1.765 which was less than 3.0, exhibiting a good fit. The Goodness of Fit (GFI) was 0.900 and the Adjusted Good Fit (AGFI) was 0.867. The Comparative

Fit Index (CFI) was 0.976; the Tucker Lewis coefficient (TLI) was 0.971. The score was very close to 1.0, signifying a perfect fit. The Root Mean Square Error of Approximation (RMSEA) was 0.058 and less than 0.08 and this reflected a good fit. The Canonical correlation (rc) indicated a value of less 1.0, implying that the discriminant validity was acceptable.

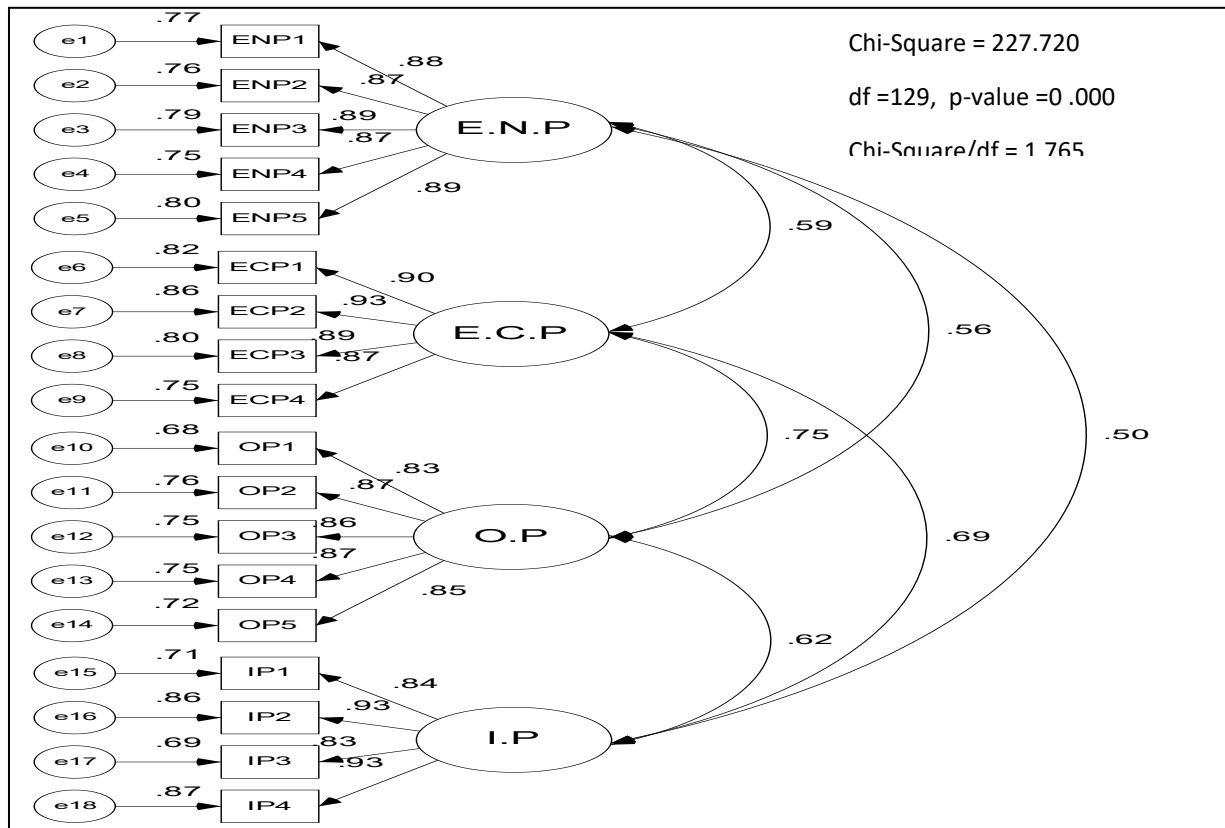


Figure 1. The output path diagram for four factors GPM model

Table 5 shows the steps and results for each analysis. In summary, the value of Cronbach alpha indicated there was strong reliability for each instrument. In contrast, the result of EFA and CFA indicated that items and constructs in this study exhibited both convergent and discriminant validity. The measurement model was evaluated in this study to ensure the validity of latent variables in GPM measures.

Table 5
Summary of EFA, reliability and CFA results

	Before analysis GPM	After analysis GPM	Remarks
EFA	4 factors 18 items	4 factors 18 items	No items of GPM has been eliminated
Reliability	-	> 0.7	Acceptable
CFA	4 factors 18 items	4 factors 18 items	Acceptable

Through the measurement model of GPM measures, four factors of model analysis as measurement model demonstrated a good fit and proved that this model is valid and reliable

for the Malaysian automotive industry. All observed variable was significant at $p < 0.001$. The results of the study indicated that the latent variables of GPM were valid and reliable. All factors of endogenous variable of GPM had the correlation value which was closely related to the value of canonical correlation (rc) of less than 1.0 which means that the discriminant validity was accepted. Finally, GPM was represented by four observed endogenous variables namely, ENP, ECP, OP, and IP. Thus, the researcher suggested that Malaysian automotive industry need to constantly monitor perfectly all green practices to measure GPM as performance measurement to reduce environmental impacts, and enhancing profitability.

Conclusions

This study focuses on measuring the GMP for Malaysian automotive industry. The key contributions of this study by using the SEM technique, four for GMP measures were developed and verified. The result of this study is reliable, as the initiatives of the GMP measures for the Malaysian automotive industry are becoming important not only for environmental management decisions, but also for all types of routine management activities such as product and process design, cost savings which focus on maximizing productivity, implementing energy saving approaches, and increase the performance evaluation. For future agenda, this study focused on the relationship between green practices, green innovation, and green performance for Malaysian automotive industry.

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