
# Measuring the innovation performance of Malaysian automotive industry

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## Abstract

Innovation is an important element in the manufacturing industry as it assists the organization to become more competitive in the market. To obtain some insight into the innovation performance of Malaysian automotive industry, this study examined three innovation performance measures of environmental innovation, employee innovation, and technology innovation. As many as 400 questionnaires were distributed to top management in the Malaysian automotive industry and a total of 229 completed questionnaires was obtained representing a response rate of 57.25%. The results of the factor analysis verified and validated all three innovation performance measures.

**Keywords:** automotive industry, employee innovation, environmental innovation, innovation performance, structural equation modelling, technology innovation

## Introduction

The Malaysian automotive industry is an important industry to the sector economy. The sector's contribution to the economy is large and closely related to manufacturing and services industries (Habidin, Zubir, Fuzi, Latip & Azman, 2015). Malaysian automotive industry began with the import of vehicles which then progressed to assembly operations and the development of the automotive component industry.

Generally, automotive industry is the most actively involved industry with multiple practices such as quality effort, low production cost, continuous improvement activities, development of supply chains, and adoptability advanced technology. These practices are adopted in this industry in order to achieve World Class Manufacturing (WCM) which emphasizes the systematic and effective practices in manufacturing process. Besides, the organization's capabilities should provide world class performance element in their management process to achieve WCM, such as reducing cost (Kennedy & Widener, 2008; Johansson & Siverbo, 2009; Habidin, Zubir, Conding, Jaya & Hashim, 2013), higher quality (Ittner & Larcker, 1995), higher motivation (Towry, 2003) and safety (Nachiappan, Anatharaman & Muthukumar, 2009). By these issues, this paper aims to assess for measuring of innovation performance for Malaysian automotive industry.

## Literature review

*Innovation performance (IP)*

Innovation is seen as an economic need which can provide a return value to an organization in the short and long term (Wang & Ellinger, 2011; Basu, 2013). Innovation is an important element in the manufacturing industry which assists the organization to become more competitive in the market (Weerawardena, O'Cass & Julian, 2006; Baneerjee & Srivastava, 2012). The word innovation is also found in corporate mission of most organizations. Innovation can occur in three circumstances, namely product, process and ideas which can change equipment, so the new system is seen from the perspective of the individual, management and customers as a whole (Rogers, 1995).

In addition, according to Hung (2009), organizational innovation is a combining process for the new ideas, systems, products, and technology. Damanpour (1991) added that the implementation of organization innovation requires top management and employees who are skilled and knowledgeable in new products and technologies. This knowledge can be disseminated to the lower level, in line with the total productive maintenance and kaizen event which emphasize the training and work in groups (Ahuja & Khamba 2008; Hashim, Habidin, Conding, Zubir & Jaya, 2013).

Innovation Performance (IP) involves some internal factors such as knowledge, skills, capability, management, and culture. Meanwhile for the extrinsic factors, there are competitor, customers, legislation, technology, and economy (Husain & Gunasekaran, 2002; Prajogo & Sohal, 2003). Indeed, to better explain about this IP, Table 1 below shows a summary of the definitions of IP from various authors.

**Table 1. Definitions of IP**

| Dimension | Definitions |
|---|---|
| Innovation Performance | Innovations are manifested in a new product, service, technology and administrative practice (Zaugg & Thom, 2003; Brenner & Broekel, 2011; Liu, 2012). |
| | IP is the result of the innovative activities implementation with the quality ideas and effective implementation (Hung, 2009). |
| | Innovation is seen as a process which results from various interactions among different actors (Doloreux, 2004; He & Wong, 2012). |
| | Innovation requires a comprehensive network to accelerate the information dissemination and need information and resources that can be trusted (Dewick & Miozzo, 2004). |
| | Suggested that innovation is equated with the adoption and application of new knowledge and practices, including the ability of an organisation to adopt or create new ideas and implement these ideas in developing new and improved products, services, and work processes and procedures (Bates & Khasawneh 2005). |
| Therefore, in this study IP defined as the measure of the innovation level, impact from various practices adopted, external factors and internal factors. It can also be divided into a number of measurements to obtain a more comprehensive result. | |

Hence, based on previous research, IP is divided into several parts. According to Ryan (2004) IP was divided into four areas, namely incubation, evaluation, process innovation, and strategy and structure. Li, Zhao and Liu (2006) stated that from the perspective of technological innovation, there are three areas of employee training, employee motivation and organization control. However, it is quite different with Inauen and Schenker-Wicki (2011) which describe the IP from different perspectives. IP can be grouped into five different groups: new product, new method of production, new sources of supply, exploitation of new market and new ways to organize business. Therefore, based on previous studies, this study will be divided into three areas of IP to suit the environment for automotive industry. It is divided into an environmental innovation, employee innovation, and technology innovation.

Environmental innovation is recognized as a result of an organized work plan in TPM and KE practices (Hashim, Habidin, Conding, Zubir & Jaya, 2012). On the other hand, employee innovation is emphasis on improvements which have been made by the employee, training and work ethics of employees. All equipment used by the employee will usually be related to technology; therefore technology innovation is emphasized in this study. The three measurements are also in line with previous studies (Yamin & Otto, 2004).

**Table 2. Measurement element of innovation**

| Authors | Types |
|---|---|
| Yamin and Otto (2004) | Administrative innovation, product innovation, process innovation |
| Gopalakrishnan and Bierly (2001) | Administrative and technical innovations, product and process innovations, radical and incremental innovations |
| Prajogo et al. (2004) | Product innovation, process innovation |
| Li et al. (2006) | Employee training, employee motivation, organization control |
| Wang and Ellinger (2011) | Individual innovation, organizational innovation |

*IP measurement*

a. Environmental Innovation (EI)

Environmental innovation (EI) is one of IP measurement based on innovation processes which emphasize the green elements that affect the organizational climate (Carrio'n-Flores & Innes, 2010; Habidin & Yusof 2012; Savitskaya & Podmetina, 2013). In the 21st century, most organizations strive to make innovations on the equipment used or produced. Innovations made by the organizations have to commensurate with green practices which assist to save the environment and create a conducive atmosphere in the work place. Besides, organizations need to ensure no waste during the innovation process such as waste of energy, raw materials, breakdown or accident which can affect the environment (Conding, Habidin, Zubir, Hashim & Jaya, 2012; Pehrsson & Svensson, 2013; Habidin, Fuzi, Desa, Hibadullah & Zamri, 2014).

In line with that, looking back to the industrial history of the world, over the last 30 years the world's automotive industry does a radical change of management processes and products. Organisational management practices such as TQM/Lean, JIT, TPM, KE, and lean practices are a major contributor to these changes (Hung, Lien, Yang, Wu & Kuo, 2011; Habidin & Yusof, 2013). These management practices emphasize the green elements which lead to changes in EI. It also assists the automotive industry in developing countries to keep pace with the country's leading car manufacturers such as Japan, United States, and Germany.

b. Employee Innovation (EMI)

Innovation is a driver of competitive advantage with a combination of resources which creates higher-order competencies which can be referred as capabilities. Organizational capabilities have been defined as a firm's collective physical facilities, skills of employees and firm capacity to deploy its assets, tangible or intangible to perform a task or activity to improve performance (Bakar & Ahmad, 2010; Fuzi, Habidin, Desa, Hibadullah & Zamri, 2013; Askary, Kukunuru & Robert, 2014).

Fitriah and Wafa (2006) found that manufacturing firms have a high inclination towards the business orientations whereby entrepreneurial orientation and innovative capability affect innovation. In addition, Hung et al. (2011) stated that soft factors such as Employee innovation (EMI) in innovation, management commitment, customer focus, entrepreneurial characteristics, organizational context and the external environment are strategic factors which influence firm's effectiveness. Therefore, EMI provides a great impact to IP and it becomes one of the measurement items to measure the IP in the organization practices.

c. Technology Innovation (TI)

Generally, large organizations will have greater funds to innovate on products or services. High technology based industries such as machinery is expected to have higher innovation. Regions that are hubs of science and technology are more likely to supply inputs for organization operating in the region, leading higher IP (Centidamar & Ulusoy, 2008). However, Kanter (1984) has stressed that innovation is not only merely defined as TI but also organizational learning and change processes in supporting and stimulating innovations.

In other words, the organization which owns the most advanced technology but still lack skilled employees will not be able to carry out the processes of innovation with effectively (Wang & Ellinger, 2011; Meeta & Gupta, 2014). The concept of an organization should emphasize continuous learning system for improving employee's skills in performing the innovation practice. Therefore, the term IP is connected with organizational learning practices.

## Methodology

The purpose of this study was to examine the IP measurement. Questionnaire surveys are commonly used by researchers to obtain research data. A questionnaire includes all techniques of data collection in which each respondent was asked the same set of questions in a predetermined order, prior to quantitative data analysis (Saunders, Gebelt & Hu, 1997). The methodology would be explained including the data collection, validity and reliability analysis, and statistical analysis.

*Data collection*

All the data in this research was collected through the use of questionnaire. The questionnaire was mailed to the Executive Manager, Director of Operations/Manufacturing or the person with the equivalent position in the organization. The Executive Manager, Director of Operations/Manufacturing was the best officer to self-report the decisions made regarding the manufacturing practice and the results of the quality program implemented. As many as 400 questionnaires were distributed to top management in the Malaysian automotive industry and 229 completed from received giving the response rate 57.25%
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a. Validity and reliability analysis

Leady and Ormrod (2003) argue that validity of a measurement instrument is the extent to which the instrument measures what it is supposed to measure. In this study, validation of the instrument was concluded in the following procedures: (i) content validity and (ii) construct validity. A construct is considered to have content validity if the constructs contain measurement items that cover all important aspects of the constructs being measured (Cooper & Shindler, 2001). The content validity establishes the representative sampling of a whole set of items which measures a concept, and reveal how well the dimension and elements of the concept have been delineated (Sekaran, 2003).

The reliability refers to the stability and consistency of the results derived from research to the probability that the same results could be obtained if the measures used in the research were simulated. Essentially, reliability is concerned with the consistency, accuracy, and predictability of specific research findings (Hurum, 2005). Besides that, reliability is the extent to which a measurement of a single variable or sets of variable are consistent with what they are intended to measure (Hair, Anderson, Tatham, &

Black, 1998). Meanwhile, reliability is a general term denoting consistency of measurements derived from repeated observations of the same subject under the same circumstances. Therefore, the test on reliability of measurement is very important as a prerequisite to build validity (Schwab 1980), to determine the stability and consistency (Sekaran, 2003) and allow a high degree of correlation among items that comprise the measure (Zakuan, 2009; Habidin, 2012).

b. Statistical analysis

SEM is derived from multivariate techniques, which objectives are to expand the researcher's explanatory ability and statistical efficiency. According Qiu (2008), SEM is a method similar to multiple regressions, but may be used as a more powerful alternative to multiple regression, path analysis, factor analysis, time series analysis, and analysis of covariance. SEM is a multivariate statistical approach that allows researchers to concurrently examine both the measurement and structural components of a model by testing the relationships "among multiple independent and dependent constructs" (Gefen, Straub & Boudreau, 2000).

To meet the requirement of specifying the measurement model and identifying the indicator measuring each construct, factor analysis was conducted. First, the Exploratory Factor Analysis (EFA) was used to identify tentative items, as well as to suggest items for deletion and places where item should be added. Conducting EFA on a single summated scale indicated whether all items within the summated scale load on the same construct or whether the summated scale actually measures more than one construct. In this study, EFA was conducted on IP measures. At this stage, convergent validity was tested in which for each construct, item loading higher than 0.4 was accepted (Hatcher, 1994).

The second way in factor analysis was the confirmation on developed factors or constructs. In this study, the Confirmatory Factor Analysis (CFA) was conducted based on a step which is multiple factor first order confirmatory. CFA is the most comprehensive method to test and examine how well the data set fit the measurement structure. The next stage in the analysis was to test the measurement model, in which the IP measure were tested based on multiple factor (first order confirmatory).

## Results and discussion

*Exploratory Factor Analysis (EFA)*

EFA with varimax rotation from 11 items of IP measures was done on random sample (n=229) of Malaysian automotive companies to produce basic details on each IP. They were Environmental Innovation (EI), Employee Innovation (EMI), and Technology Innovation (TI). Sampling adequacy measure of Kaiser-Meyer-Olkin (KMO) was 0.895, which was greater than 0.7, thus indicating that the present data was suitable for principal component analysis. Similarly, Bartlett's test of sphericity was significant ($p < 0.001$), signalling that correlation was adequate among these items to proceed for analysis as shown in Table 3.

**Table 3. KMO and Bartlett's test for IP measures**

| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | 0.895 |
|---|---|---|
| Bartlett's Test of Sphericity | Approx. Chi-Square | 2747.977 |
| | Df | 55 |
| | Sig. | 0.000 |

Variance explained by initial solution for IP steps was determined. Three factors in initial solution have Eigen values greater than unity as described in Table 4. The three factors taken into account accounted for 83.576% of the total variance. This indicated that the influence of three latent variables were associated. Cumulative variables explained by the three factors in extract solution provided a percentage of 83.576% which was similar to the initial solution. Hence, none of the variation explained by the initial solution was lost due to latent factors implying the suitability of method to extract the IP measures.

**Table 4. Results of total variance explained for IP items**

| Com | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Var | Cum % | Total | % of Var | Cum % | Total | % of Var | Cum % |
| 1 | 6.931 | 63.010 | 63.010 | 6.931 | 63.010 | 63.010 | 3.939 | 35.807 | 35.807 |
| 2 | 1.175 | 10.683 | 73.693 | 1.175 | 10.683 | 73.693 | 2.681 | 24.369 | 60.176 |
| 3 | 1.087 | 9.883 | 83.576 | 1.087 | 9.883 | 83.576 | 2.574 | 23.400 | 83.576 |

* Note: Com=Component, Var=Variance, Cum=Cumulative

*Confirmatory Factor Analysis (CFA)*

The analysis involves testing the measurement model, where IP measures on multiple factor. James, Mulaik, and Brett (1982) suggested a basic model measurement test as a base for the full structural model fit. If the measurement model is acceptable, then one can proceed to structural model testing. An authentication measurement model was conducted to evaluate the value of construct validity by using maximum probability method. CFA was based on the comparison of variance-covariance matrix obtained from the samples which were derived from the model.

*CFA for IP measures-multiple factors*

The confirmation level with First Order Confirmatory with Multiple Factors tested was IP with EI, EMI, and TI. The diagram is presented in Figure 1 and Table 5.

**Table 5. CFA: Multiple factor for IP**

| Factor | x2 | df | x2/df | p-value | GFI | AGFI | CFI | TLI | RMSEA |
|---|---|---|---|---|---|---|---|---|---|
| IP | 74.240 | 41 | 1.811 | 0.001 | 0.947 | 0.914 | 0.980 | 0.973 | 0.060 |

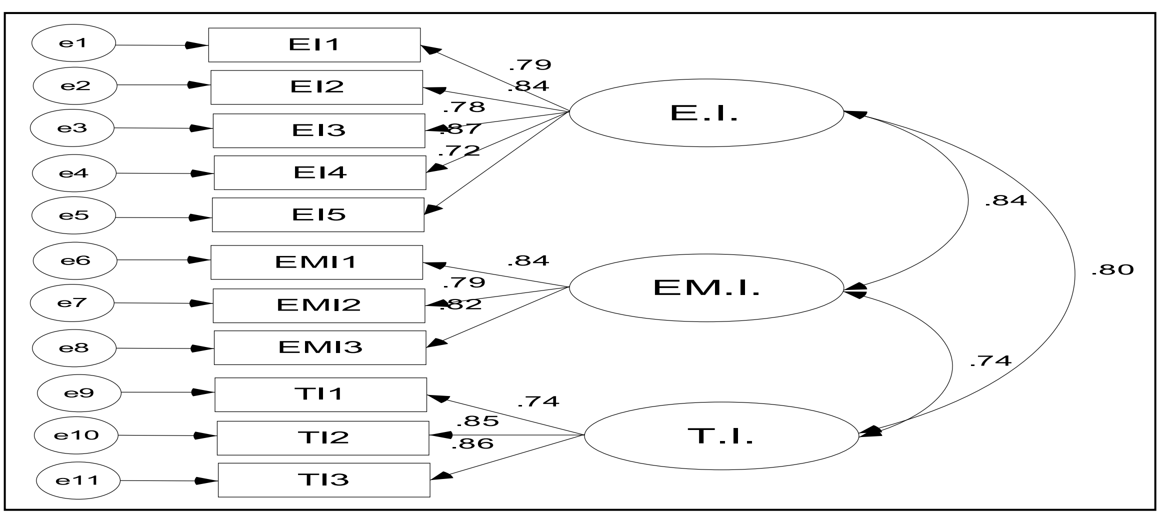


**Figure 1**. *Output path diagram for three factors IP model*

The CFA result demonstrated a good fit. Statistics of $\chi 2$ was 74.240 (degree of freedom = 41, $p < 0.001$), with ratio of $\chi 2/df$ was 1.811 which was less than 3.0 exhibiting a good fit. The Goodness of Fit (GFI) was 0.947 and Adjusted Good Fit (AGFI) was 0.914. The Comparative Fit Index (CFI) was 0.980, Tucker Lewis coefficient (TLI) was 0.973. The score was very close to 1.0, signifying perfect fit. Root mean square error of approximation (RMSEA) was 0.060 and less than 0.08 and this reflected good fit. Canonical correlation (rc) indicated a value of less 1.0, implying that discriminant validity was acceptable. Since Cronbach's alpha value for each factor above 0.70, all factors are accepted as being reliable for the research (Ismail et al. 2015; Muhammadin et al., 2015; Omar et al. 2015).Therefore, the results were shown that IP measures (EI, EMI, and TI) were acceptable for Malaysian automotive industry.

## Conclusions

The result of the three factors analysis of innovation performance (IP) measures , namely, environmental innovation (EI), employee innovation (EMI), and technology innovation (TI) showed that the measurement model for IP measures had a good fit and the model was valid and reliable for Malaysian automotive industry.

**Acknowledgement**

The researches would like to acknowledge the Ministry of Higher Education (MOHE) for the financial funding of this research thought Fundamental Research Grant Scheme (FRGS), and Research Management Centre (RMC), UPSI for Research University Grant (RUG).

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