International Journal of Managing Projects in Business

Managing project success using project risk and green supply chain management:
A survey of automotive industry

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Received 19 January 2017
Revised 16 September 2017
Accepted 9 October 2017

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Abstract

Purpose – The implementation of the risk management in the development of new car models can contribute to the improvement of the project management performance and project success. The purpose of this paper is to provide evidence about whether project risk management (PRM) and green supply chain management (GSCM) are positively related to project management performance and the project success.

Design/methodology/approach – Data were collected from 145 project managers in the Malaysian automobile manufacturing industry and analyzed using structural equation modeling.

Findings – The results found that PRM and the GSCM had a positive association with project management performance and the project success.

Originality/value – The effective implementation of GSCM and risk mitigation strategy is strategic solutions to manage sustainable project performance and successful implementation of a project.

Keywords Malaysia, Project management, Automotive industry, Project success, Green supply chain, Project risk management

Paper type Research paper

1. Introduction

Automobile manufacturing firms have applied project risk analysis in production to improve the ability of these firms to minimize uncertainty in supply and demand. To produce an automobile that is well accepted in the market, manufacturing firms must expend resources to develop and design vehicles according to the demands of potential customers. Being over budget, having delayed lead times, political instability, business that does not generate yields and final products that do not match consumer needs have been identified as risks that burden the management of automobile manufacturing firms. To mitigate these risks, automobile manufacturers and vendor companies need to work together in new automobile development projects to ensure that the project is successful. In addition, manufacturing firms should also consider how to comply with the environmental regulations and maintain a positive image of the firm in the market.

Over the last decade, the natural environment and global and environmental problems have become a challenging issue for business organizations affecting their operations.

International Journal of Managing Projects in Business
© Emerald Publishing Limited
1753-8378
DOI 10.1108/IJMPB-01-2017-0007

Business operation activities, such as sourcing, manufacturing and logistics are believed to be responsible for most of these problems (Beamon, 1999). Increasing pressure has been put on business operations through added scrutiny from various stakeholders both inside and outside the organization from government agencies, workers and non-for-profit groups (Sarkis, 2006). Hence, the demands of customers and environmental societies have grown for more environmentally friendly car products.

These challenges and pressure push firms to seriously consider environmental impacts while doing their business. Green becomes a common practice to portray the environmentally friendly image of products, processes, systems and technologies, and the way in which business is conducted (Vachon and Klassen, 2006a, b). However, most of the adopted green solutions, especially in developing countries, continue to be the traditional command-and-control or "end-of-the-pipe" solutions. These are solutions whereby a firm tries to eliminate or reduce negative environmental impacts after they are created rather than adopting proactive approaches to reduce the sources of waste or pollution (Anbumozhi and Kanda, 2005; Walton *et al.*, 1998).

Car manufacturing firms should able to foresee the expectations of customers. Customers can unnecessarily disrupt project execution by insisting on design changes, particularly when these are made late. However, these changes could have been foreseen and therefore incorporated into the design process earlier (Shapiro and Lorenz, 2000). Customers often confound the project process without fully realizing the implications of their behavior for a project's progress and budget (Geyer and Davies, 2000). Aware of these issues, Hobday (2000) suggests that the needs of project managers should outweigh the influence of functional managers and customer directors. Others recommend setting up governance structures that make the costs of late design changes explicit (Ross and Staw, 1986; Miller and Lessard, 2007). Clegg *et al.* (2002), meanwhile, advocate an "alliance culture" fostered by frequent meetings with customers to discuss how to accomplish a future perfect outcome when planning is almost impossible. This approach brings soft skills such as communication, emotional intelligence, leadership, and motivation to the forefront.

Based on research results from German automobile industry, Thun and Müller (2010) have postulated that green supply chain management (GSCM) will become more important for automobile companies. Green practices can improve firm survival and reduce the high-cost problem encountered by automobile manufacturing firms. For example, Xia and Li-Ping Tang (2011) suggested the USA automobile industry consider a Triple-C (cease-control-combine) approach to overcome sustainability supply chain issues and achieve firm sustainable development. Another case in Japan, the reconditioning of used car and remanufacturing has its own trend. Focus of automobile manufacturing firms on a niche segment of used car in emerging market has motivated manufacturing firms to practice a closed loop supply chain management. This can provide benefits in the long run because of greater demand from emerging countries and reduced raw material costs. When exporting used cars, a Japanese manufacturer does not need to pay recycling, reuse and disposing fees (Kumar and Yamaoka, 2007).

The study of green supply chain practices in Asia mostly began around 2000 (Abdolhossein *et al.*, 2012; Chin-Chun *et al.*, 2013; Mahmood *et al.*, 2011; Tritos *et al.*, 2013). To fulfill the demand for eco-friendly cars and comply with local and international regulations, Indian automobile suppliers and manufacturing firms need to replace questionable hazardous material and re-design a green supply chain to reduce energy consumption and emissions (Luthra *et al.*, 2016). Rao (2002) studied the greening of the supply chain in the South East Asian Region, including the Philippines, Indonesia, Malaysia, Thailand and Singapore. While noting that this greening had started to take place, Rao (2002) called for more research to bridge the gaps in this area. The objective of the study was to create insights into greening process and inspire regional businesses, governments and communities to create an atmosphere conducive to the process.

Many researchers have conducted studies on GSCM practices in Asian countries such as China that may have market and social-cultural situation similar with Malaysia. Nonetheless, different industries in different countries are facing different pressures in terms of economic and ecological conditions (Christmann and Taylor, 2001). Rao (2002) supported this argument, stating that the level and mode of implementation of GSCM practices varies significantly in different countries. Therefore, the manufacturing industry in Malaysia differs with other countries due to its characteristics and business culture. Consequently, these differences justify the need to conduct a study concerning green supply chain practices in the Malaysian context with the aim of investigating the notion, challenges and adoption of GSCM practices among manufacturing firms. According to Phuah and Fernando (2015), the effective implementations of GSCM in automotive industry depends on the integration of technical aspects such as green purchasing, green design, green production, green packaging, green labels, reuse, recycle and recovery of material, and reduce energy consumption.

The implementation of the green supply chain is hindered by several non-technical factors such as culture, social impact, type of management skills and control (Sarkis, 2012; Vanalle *et al.*, 2017). Different cultural and communication styles can cause a different understanding of the green supply chain concept and practices especially if the first-tier suppliers directly and second-tier/third-tier suppliers indirectly supply parts and materials to automotive manufacturing firms and involved in logistics and production activities. According to Vanalle *et al.* (2017), studying different country context of green supply chain practices is worthwhile. This is because they found that first- and second-tier suppliers in the Brazil automobile supply chain are neglecting the green aspect in designing products. This will inevitably lead to an increased risk of failure when the automobile is launched in the market, and the companies do not comply with green regulations. In fact, the automotive industry calculates that supplier-dependent sectors and outsourcing activities contributed to 60-80 percent of the total manufacturing costs (van Weele, 2010; Scannell *et al.*, 2000). Besides procurement, production and distribution, there are dozens or hundreds of main and sub-projects involved in developing a new design of an automobile model. Project failure can occur if the automotive companies do not pay attention to environmental and risk aspects in managing their supply chains. Green practices should be an integral part of the management project because they can help to improve project success and reduce negative impacts of social and environmental outcomes (Carvalho and Rabechini, 2017).

GSCM is receiving significant interest from researchers and practitioners of business operations. Recently, the significance of GSCM has been emphasized more due to increasing negative impacts upon the environment. Hence, GSCM is now considered to be an essential management tool to lead manufacturing organizations in improving environment sustainability along with other performance targets. In addition, Pietro (2012) highlighted that GSCM is not only a tool to reduce the environmental impacts of processes and products but also a distinctive strategy to create a competitive advantage and increase environmental performance and social welfare. As the economic perspective shifts to a green economy, a business person should answer this challenge by not only pursuing profitability but also sustainability.

Unfortunately, previous studies on the relationship between green supply chain practices and performance have produced inconsistent results (Eweje, 2011; Azevedo *et al.*, 2011; Tritos *et al.*, 2013). For instance, while some studies have reported a positive and significant relationship (Schnietz and Epstein, 2005), other studies have reported a negative association or an insignificant relationship (Barnett and Salomon, 2006; Mill, 2006). These mixed results might imply the presence of unexamined factors that could possibly influence either the strength or direction of GSCM practices on the outcomes of project performance.

Previous studies have attempted to isolate these factors. Some studies have empirically tested the interactions between internal integration and external integration of supply chain as related to the specific performance gained (Devaraj *et al.*, 2007). Others have reported that internal integration moderated the effects of external supply chain integration on performance. However, the extent of this contingency relationship has focused primarily on the roles of internal customers and supplier integration separately. Thus, another question is raised that adds to the need to examine systematically the interaction of supply chain integration activities on the relationship between green supply chain practices and sustainable performance.

To address this need, this study investigates whether project risk management (PRM) can significantly influence the relationship between GSCM practices and project management performance. Besides investigating the effects of PRM and green supply management on project management performance, this study also investigates the outcomes of GSCM in terms of project management performance. The project success or sustainability concept has increasingly become important in business operations and supply chain management. Research shows that price is no longer the only determinant for successful competition but that ecological, health and welfare benefits are involved collectively (Penker, 2006).

2. Literature review

Malaysia, as a developing country, has collectively realized that, in combination with economic development and an emphasis on exports, investing in environmental protection has become increasingly vital. Capitalizing on this realization is part of the attempt made by the country to compete globally while upholding a "green image." Malaysia has already been credited by the international community for its engagement in ecotourism, but other industries still require large efforts to be brought up to speed on environmental matters (Market Watch, 2011). One of the industries to be focused on is the manufacturing sector because these industries are a major cause of environmental problems in Malaysia (Rusli *et al.*, 2012). To address the problem, Malaysian Prime Minister, Datuk Seri Najib Tun Razak, launched the National Green Technology Policy on July 24, 2009.

2.1 Natural resource-based view (NRBV)

The NRBV emerged from an earlier theoretical contribution of the resource-based view (RBV) (Hart, 1995). The RBV theory takes the standpoint that a firm's resources and capabilities are key sources for a sustainable competitive advantage (Hart, 1995; Shi *et al.*, 2012). Whereas RBV focuses on internal resources and capabilities of a firm to achieve a competitive advantage, NRBV is based on the connection between environmental challenges and firm resources, which is operationalized through interconnected strategic capabilities of pollution prevention, product stewardship and sustainable development (Hart, 1995). The theory of NRBV suggests that a purely internal (competitive) approach may prove inadequate because issues of external (social) legitimacy and reputation are also extremely important. Such an external (legitimacy-based) orientation "in no way jeopardizes competitive advantage and may reinforce and differentiate the firm's position through the positive effects of a good reputation" (Hart, 1995, p. 999). Therefore, according to the NRBV, a firm can gain competitive advantages not only by having internally focused resources and capabilities, but also by generating these resources and capabilities from an external environment such as the natural (or biophysical) environment. In the case of the automotive industry, original equipment manufacturers typically force suppliers to comply with environmental aspects (Thun and Müller, 2010). The knowledge driven by the environmental aspects can be good resource for improving the competitiveness of automotive firms by means of understanding market demands and avoiding the risk of failure through non-compliance with environmental regulations.

Hart (1995) and Shi *et al.* (2012) also explained in detail how the three strategies of NRBV framework lead to competitive advantages through cooperative action. First, the pollution prevention strategy seeks to reduce emissions using continuous people-intensive improvement methods that depend upon tacit skill development through employee involvement and work in "green" teams. Second, product stewardship aims at minimizing the environmental impacts of the entire product life cycle; therefore, this stewardship requires an ability to coordinate functional groups within the firm and integrating the perspective of external resources along the supply chain into decisions of product decisions about product design and development. Third, sustainable development requires the development of a shared vision of the future. Thus, a shared vision provides opportunities for sustainable competitive advantage and performance through involving a shared vision of the future and a focus on collaborative new business processes and competency development. NRBV can provide a suitable foundation for understanding the positive effects of GSCM practices, explaining well how firms can gain superior performance through adopting cooperative green practices. Therefore, NRBV provides the theoretical basis for understanding the effects of GSCM practices on sustainable performance.

2.2 PRM

To secure project success in today's competitive environment, an organization must manage related risks effectively even though various difficulties are experienced (Buchanan and O'Connell, 2006; Shenhar *et al.*, 2007; Srivannaboon and Milosevic, 2006). Commonly, in all organizations from commerce to government, most efforts of managers are expended on managing project risk-related issues. Thus, risk management tools and techniques have been discussed comprehensively in the literature as potential solutions to the business problem (Bstieler, 2005; Cooper *et al.*, 2005; Hillson, 2000, 2003; Jaofari, 2003; Kallman, 2006). Each category of risk includes various specialized methods that may help in dealing with project risk issues, often focusing on schedule, budget or technical areas (Barber, 2005; Bartlett, 2002; Dey, 2002; Elliott, 2001). Methods to manage these various areas include critical path analysis, budget tracking, earned value analysis, configuration control, risk-impact matrices, priority charts, brainstorming, focus groups, online databases for categorizing and sorting risks, and sophisticated Monte Carlo analysis, all designed to make project-based results more predictable.

Scholars in the risk management literature recognize that adapting a project to changes in customer needs can be business critical (Dvir and Lechler, 2004; Miller and Lessard, 2000). To decide whether to respond to a customer's re-design requests, project teams must appraise and manage risks related with adapting changes in detailed designs or construction (Cleland and King, 1983; Cooper and Chapman, 1987; Morris and Hough, 1987). Changes are typically accepted when their prospective benefits to future operations are thought to outweigh the adaptation costs and risk of delays, all issues that are especially significant in projects with integral design architectures (Shenhar, 2001; Floricel and Miller, 2001). From the automotive perspective, the risk can come from global source of raw materials/spare parts that have caused products recall and negatively impact company reputation (Tse *et al.*, 2011). An automotive company needs to ensure that the suppliers involved with a project comply with quality requirements and sustainable compliance.

2.3 GSCM

GSCM is defined as a firm's plans and activities that assimilate environmental concerns into supply chain management to improve the environmental performance of suppliers and customers (Bowen *et al.*, 2001). Although the literature on GSCM has been growing during the last decade due to its increased significance, areas remain that need further research. Environmental performance standards have become incorporated increasingly into contracts and guidelines for supply chain partners (Simpson *et al.*, 2007). A firm's response to the environmental requirements from external stakeholders is determined by its level of commitment to both performance and environmental awareness. In such environment-based scenarios, the supplier-buyer relationship is established both upon cost considerations and the environmental commitment of both entities. Therefore, GSCM involves integrating environmental thinking and entails a comprehensive perspective, including product design, material sourcing and selection, manufacturing processes, delivery of final products to the consumers, as well as end-of-life management of the products (Srivastava, 2007).

The primary aim of GSCM is to shift from services and products that negatively impact the environment to those embracing environmental principles (Curkovic and Sroufe, 2011). Along with the evolution of supply chain management to GSCM concepts, many variations in the definition and terminology of green supply chain have occurred over the years. The consideration of inter-organizational activities related to environmental management is a primary characteristic of GSCM practices. However, finding research that conceptually develops GSCM practices based on a solid theoretical framework remains difficult. This absence of a theoretical framework can explain the broad range of conceptualizations found in the literature. For instance, environmental issues in supply chain practices have been labeled and defined using a variety of terms including green supply (Bowen *et al.*, 2001), environmental purchasing (Carter and Carter, 1998; Zsidisin and Siferd, 2001), green purchasing (Min and Galle, 1997) and green value chain (Handfield *et al.*, 1997). This implies that a wide range of practices can be performed within GSCM. According to Fernando and Uu (2017), the importance of GSCM adoption in manufacturing sector can involve all the stages of the life cycle of a product that influence the agility of GSCM. Green supply chain implementation can only be achieved by cooperative efforts on an inter-organizational level. According to Thun and Müller (2010), the barriers of green supply chain implementation in the German automotive sector occur because different countries have different regulations and environmental acts.

2.4 Project management performance and success

The project management has high uncertainty due to project goals with certain durations and the temporary structure of a project's organizational structure (Brink, 2017). Most companies are aware of the importance of a systematic approach to project management (Miklosik, 2015). The main purpose of using a project management framework is to increase organizational value (Dalcher, 2012). An organization can benefit from using a project management framework by increasing the effectiveness and the efficiency of human effort in the organization. Therefore, project success is measured by its efficiency in the short term and its effectiveness in achieving the expected results in the medium and the long term (Jugdev *et al.*, 2001; Müller and Jugdev, 2012). Therefore, the value of a project can be understood in so far as it satisfies customer needs, aligns the project output with the organization's strategy and gives a return on investment (Thomas and Mullaly, 2008).

The set of measures for the project management performance and success depends on the organization's strategy, technology, the particular industry and the environment in which they compete. Return on investment is the most common measure for evaluating project management investment. Return on investment is defined as net benefits divided by costs. This measure shows the percentage return from a firm's investments. The key to this metric is in placing monetary value on each unit of data that can be collected and used to measure net benefits. Sources of benefits can come from a variety of measures, including contributions to profit, savings of costs, increase in the quantity of output converted to a dollar value and quality improvements translated into any of the first three measures. Cost factors include costs to design and develop and/or maintain the project or project management improvement initiative, costs of resources, costs of travel and expenses, costs to train, and overhead costs, among others.

The ability of a project's output to deliver the expected return on investment is a key to declaring a project's success from the business perspective (Artto and Wikström, 2005). Therefore, project investment success is used to describe the ability to generate a project's return on investment (Zwikael and Smyrk, 2012). Project investment success is indeed more challenging than project management success. Project investment success needs a systems approach to understand and manage the interoperation of the internal and the external environment (Fortune and White, 2006). For instance, Cserhati and Szabo (2014) have found that relational-oriented success factors such as communication, co-operation and leadership are more critical than are task-oriented success factors. In supporting this observation, Müller and Turner (2007) found that more experienced project managers are more interested in developing teamwork and more oriented to investment success. Likewise, in urban regeneration projects, which entail changes in the behaviors and attitudes of citizens, stakeholder management is a critical factor for project success (Yu and Kwon, 2011). Consequently, Golini *et al.* (2015) have found that the PM tools (e.g. critical path method and Gantt chart) used to achieve project management success are different from those needed for project investment success because they are more closely related to stakeholder management such as the stakeholder matrix and the responsibility assignment matrix.

Figure 1 shows the theoretical framework of this study. It includes predictors of project success in the automotive industry, using the above-developed measures.

2.5 Hypotheses

H1. PRM has a positive and significant relationship with GSCM.

H1a. PRM has a positive and significant relationship with GSCM: environmental collaboration with customers.

H1b. PRM has a positive and significant relationship with GSCM: environmental collaboration with suppliers.

H1c. PRM has a positive and significant relationship with GSCM: environmental monitoring by customers.

H1d. PRM has a positive and significant relationship with GSCM: environmental monitoring of suppliers.

H1e. PRM has a positive and significant relationship with GSCM: internal.

H2. GSCM has a positive and significant relationship with project management performance.

H2a. GSCM: environmental collaboration with customers has a positive and significant relationship with project management performance.

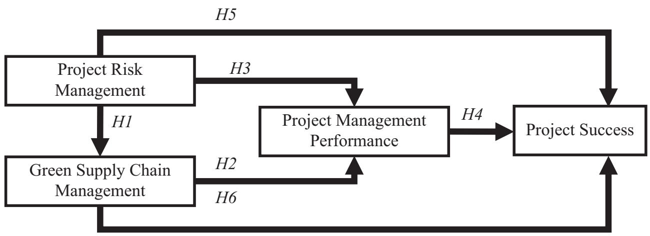

Figure 1.
Theoretical framework

H2b. GSCM: environmental collaboration with suppliers has a positive and significant relationship with project management performance.

H2c. GSCM: environmental monitoring by customers has a positive and significant relationship with project management performance.

H2d. GSCM: environmental monitoring of suppliers has a positive and significant relationship with project management performance.

H2e. GSCM: internal has a positive and significant relationship with project management performance.

H3. PRM has a positive relationship with project management performance.

H4. Project management performance has a positive relationship with project success.

H5. PRM has a positive relationship with project success.

H6. GSCM has a positive and significant relationship with project success.

H6a. GSCM: environmental collaboration with customers has a positive and significant relationship with project success.

H6b. GSCM: environmental collaboration with suppliers has a positive and significant relationship with project success.

H6c. GSCM: environmental monitoring by customers has a positive and significant relationship with project success.

H6d. GSCM: environmental monitoring of suppliers has a positive and significant relationship with project success.

H6e. GSCM: internal has a positive and significant relationship with project success.

3. Method

Survey-based research is used to answer the research questions and hypotheses testing. This study used a cross-sectional design to make inferences from a sample of population. Data were collected just once over a period of one month from the targeted respondents. The population of this study was project managers and leaders working with manufacturing companies either in car manufacturing or car component manufacturing firms within Malaysia (including first-tier and second-tier suppliers). According to the Malaysian Automotive Associations (Proton Vendors Association (PVA), Honda Malaysia Suppliers Club (HMSC) and Toyota Suppliers' Club Malaysia (TSC) directory) in 2015, about 140 vendors were related to the automotive industry in Malaysia. The target respondents comprised those individuals who were project managers or leaders, who led a project in the automobile industry either in car manufacturers or car component manufacturers. The unit of analysis of this study was the project managed by an individual project manager. The sampling method used for this research was the non-probability, stratified sampling method. This sampling method was used because the population was heterogeneous and comprised a mixture of more than one element. The study has carried been out via a web-based survey of 420 project managers and leaders. The questionnaire was designed using a five-point Likert-type scale, and the measurement items were adapted from the previous studies. The metrics for the operationalization of the PRM in this study were adopted from Blos *et al.* (2009), measurements of GSCM were adopted from Laari *et al.* (2016), and the measurement constructs of project success were adopted from Badewi (2016).

4. Results

The sample contact information for this study was obtained from the Malaysian Automotive Association, the Proton Vendors Association (PVA), the Honda Malaysia Suppliers Club and the Toyota Suppliers' Club Malaysia (TSC) website. Those sources provided a list of companies that manufacture and supply car components to local and oversea car assemble companies. Those sources provided contact information for a total of 420 project managers from 140 vendors. The questionnaires were distributed to the project leaders or managers of the organization through e-mail via a Google survey link. Of the 420 surveys circulated, 153 were returned, and 8 incomplete questionnaires were omitted. Therefore, only 145 questionnaires were taken for the analysis, and the effective response rate of the study was 34.5 percent. The non-response rate was 65.5 percent.

The profile of respondents is shown in Table I. Demographic information included gender, age and education. Of the total respondents, 82 percent were male and 18 percent were female. As for the age of respondents, 39 percent were aged between 41 and 50 years old followed by 31 to 40 years old with a percentage of 32 percent. Most respondents held a tertiary degree, comprising 77 percent of the total respondents. In terms of education distribution, 78 percent had an engineering background followed by management that was 17 percent.

In terms of career path, 66 percent of the respondents had become a project manager by default (had been appointed by the management without applying for that position, i.e. he or she had been selected and transferred from another department) and the other 34 percent by choice. About 34 percent of the respondents had between three and five years of working experience, followed by 29 percent of the respondents who had between six and ten years of working experience. In terms of the nationality, 97 percent of the respondents were Malaysian at 97 percent and followed by others Asian at 3 percent. Most respondents used English as their language in workplace, which was 70 percent of the respondents and followed by other language at 30 percent.

About 46 percent of the respondents had worked less than one year on their current project, followed by 22 percent who had worked between one and three years. With respect to working experience, 53 percent of the respondents had worked as project manager in their previous job and industry. Of those who had worked as a project manager in a previous job, 47 percent of them had worked as a project manager in the automotive industry. About 39 percent of the respondents had more than six years of working experience in the automotive industry, followed by between four and six years (28 percent) and between one and three years (21 percent). Details of respondents' profiles can be seen in Table I.

4.1 Profile of companies

Table II shows that the profile of the companies drawn from the respondents of 145 project managers. In terms of the work location, 38 percent operated in Kuala Lumpur, Selangor and Putrajaya, 35 percent operated in the southern region of peninsular Malaysia, and 27 percent were in northern region of peninsular Malaysia. None of the respondents operated in western region in peninsular Malaysia or in Sabah and Sarawak. With respect to what the companies did, 15 percent were from companies that supply struts, absorbers and spring assembly modules followed by the front corner module which was 13 percent. In total, 54 percent of the companies were Malaysian owned, 45 percent were foreign companies from Asia Oceania followed by European companies at 33 percent and American companies at 21 percent. A further description of the companies profiles can be seen in Table II.

4.2 Construct validity

To be valid, the loadings and cross loadings between constructs and its items should be higher than the cross loadings of any other constructs' items. The cut-off value for loadings is 0.5 for significance. If any items have more than 0.5 for two or more factors they are

Description		Frequency	%
Project manager background			
Gender	Male	11	8
	Female	134	92
Age	Less than 25 years	6	4
	25-30 years	17	12
	31-40 years	47	32
	41-51 years	56	39
	More than 51 years	19	13
Education level	Certificate	2	1
	Diploma	22	15
	Degree	112	77
	Masters/MBA	9	6
	PhD	0	0
Education field	Engineering	113	78
	Management	24	17
	Account/Finance	3	2
	Others	5	3
Project manager career plan			
By choice (applied for this position)		49	34
By default (selected by the management)		96	66
Years of work experience before start work as a project manager			
Less than 3 years		21	14
3-5 years		49	34
6-10 years		42	29
More than 10 years		33	23
Respondent Nationality and native language			
Nationality	Malaysian	141	97
	Others Asian	4	3
	American	0	0
	European	0	0
	Others	0	0
Native language	Malaysian (Malay, Chinese and Tamil)	102	70
	English	43	30
	Others	0	0
Years worked on CURRENT projects			
Less than 1 year		67	46
1-3 years		32	22
4-6 years		21	14
More than 6 years		25	17
Respondent working experience in as project manager			
Did you work as a project manager in a previous job?	Yes	77	53
	No	68	47
If YES, was it also related to the automotive industry?	Yes	45	66
	No	23	34
Years of working experience as a project manager in automotive industry including current job			
Less than 1 year		17	12
1-3 years		31	21
4-6 years		41	28
More than 6 years		56	39

Table I.
Demographic profile

(*continued*)

Description	Frequency	%
Proportion of respondents working time for projects work		
Less than 30%	14	10
30-65%	30	21
66-99%	74	51
100%	27	19
Number of projects that respondents had completed		
None	3	2
1-3	44	30
4-6	41	28
More than 6	57	39
Type of projects respondents had completed		
Immovable end date	13	9
Limited resource availability	24	17
Critical to business survival	29	20
Closely linked to "'business as usual' activity"	79	54
The longest time-scale longest running project that the respondents had completed		
Less than 1 year	23	16
1-2 years	58	40
More than 2 years	21	14
The largest budget a respondent had been responsible for in his/her overall working experience?		
Less than RM100K	15	10
RM100K to RM499K	19	13
RM500K to RM1M	65	45
More than RM1M	46	32
The largest incurred cost the respondents had experienced		
Less than RM100K	76	52
RM100K to RM499K	24	17
RM500K to RM1M	16	11
More than RM1M	29	20
The largest project team size that a respondent had managed or led		
1-3 people	23	16
4-7 people	52	36
8-11 people	24	17
More than 11 people	46	32
The largest number of team members or sub-project managers reporting to the respondent on a single project		
0 people	0	0
1-2 people	54	37
3-4 people	38	26
More than 4 people	53	37
The understanding of the stakeholders about the project purpose		
Unclear	12	8
Sponsor was clear; others were not clear	17	12
Majority was clear	35	24
All of them were clear	81	56
The number of the business functions impacted by the changes introduced by the project		
1	10	7
2-3	35	24

(*continued*)

Table I.

Description	Frequency	%
4-6	46	32
More than 6	54	37
The number of business functions supplied resources to a respondent's project team		
1 or "fixed" team	19	13
2-3	33	23
4-6	38	26
More than 6	55	38
The major source of risks to the benefits		
Finance	21	14
Project deadlines or lack of product clarity	87	60
Resource constraints	24	17
Lack of stakeholder "buy-in"	13	9
The major source of constraints on the project		
None	0	0
Time	102	70
Resources	25	17
Business drivers	15	10
Others	3	2
The percentage of completion that a typical project meets on the delivery date from the overall working experience of a respondent		
Less than 25%	4	3
26-50%	19	13
51-75%	16	11
76-99%	94	65
100%	12	8
The percentage of respondents who had taken a project management course before start manage any project		
No	74	51
Yes	71	49
The number of project management training courses attended per year		
0	74	51
1	62	43
2	2	1
3	6	4
4 and above	1	1

Table I.

considered to have a significant cross loading (Hair *et al.*, 2014). Table III shows that all items have factor loading of more than 0.7; hence the issue of cross loading does not exist. In terms of reliability, all items also show a value of more then 0.8, which means high consistency.

4.3 Convergent validity

Convergent validity determines if two measures of a construct that were hypothetically correlated were actually correlated. Average variance extracted (AVE) is used as measurement for convergent validity, and the loading value of AVE must be greater than 0.5 (Hair *et al.*, 2014). Table IV shows all the factors evaluated in this study. This study contained a total of eight variables and all variables have an AVE of more than 0.7; thus, measures of construct that hypothetically correlated were correlated. Composite reliability scores for each construct were determined, and all AVE scores were higher than 0.5 cut-off value and were also acceptable.

Description		Frequency	%
Current work location			
Kuala Lumpur, Selangor and Putrajaya		55	38
Northern region in peninsular Malaysia		39	27
Southern region in peninsular Malaysia		51	35
Western region in peninsular Malaysia		0	0
Sabah and Sarawak		0	0
Type of product the vendors supplied to the original engineering manufacturer (OEM)			
1. Front corner module		19	13
2. Rear Corner Module		1	1
3. Instrument panel module		8	6
4. Struts, absorber and spring assy. module		22	15
5. Bumper module		4	3
6. Front cross member module		3	2
7. Function integrated door module		5	3
8. Fuel tank module		2	1
9. Pedal module		3	2
10. Door trim module		7	5
11. Floor console module		0	0
12. Tires and wheel module		6	4
13. Wiper system		1	1
14. Brake system		3	2
15. Vehicle integrated system		8	6
16. Air bag system		2	1
17. Navigation system		2	1
18. Telematics		1	1
19. Exhaust system		3	2
20. Audio system		2	1
21. Heater ventilation and air-conditioning system		1	1
22. Power and signal distribution system		1	1
23. External lighting system		9	6
24. Safety system		7	5
25. Seat belt system		0	0
26. Engine management system		1	1
27. Body in white module		1	1
28. Engine fuel injection system		1	1
29. Seat module		10	7
30. Alarm system		1	1
31. None of the above		11	8
Company investor background			
Are you working in Malaysian company	Yes	79	54
	No	66	46
If No, which FORIEGN investor is the majority shareholder?	America	14	21
	Europe	22	33
	Africa	0	0
	Middle East	0	0
	Asia Oceania	30	45

Table II.
Profile of companies

4.4 Discriminate validity

Discriminate validity examines whether potentially overlapping measures exist between the correlated constructs. Although no specific value has been identified for discriminate validity, a generally accepted criterion is that a result showing a value of less than 0.85 indicates the probability that discriminate validity occurred. Table V shows that all the values were above 0.9 (> 0.85); therefore, no probability of the overlapping of measures was

Table III. Construct validity

Variable	Dimension	Item	Loading	Cronbach's α
Green supply chain management (GSCM)	GSCM: environmental collaboration with customers	ECC1	0.984	0.981
		ECC2	0.981	
		ECC3	0.981	
	GSCM: environmental collaboration with suppliers	ECS1	0.904	0.926
		ECS2	0.963	
		ECS3	0.933	
	GSCM: environmental monitoring by customers	EMC1	0.938	0.975
		EMC2	0.967	
		EMC3	0.970	
		EMC4	0.984	
	GSCM: environmental monitoring of suppliers	EMS1	0.961	0.975
		EMS2	0.972	
		EMS3	0.964	
		EMS4	0.958	
	GSCM: internal	IGSCM1	0.872	0.905
		IGSCM2	0.935	
		IGSCM3	0.942	
Project management performance		PMP1	0.946	0.975
		PMP2	0.981	
		PMP3	0.975	
		PMP4	0.956	
Project risk management		PRM1	0.929	0.921
		PRM2	0.918	
		PRM3	0.935	
Project success		PS1	0.941	0.925
		PS2	0.820	
		PS3	0.764	
		PS4	0.927	
		PS5	0.921	

Table IV. Results of measurement model

Variable	Average variance extracted (AVE)	Composite reliability
Environmental collaboration with customers	0.964	0.988
Environmental collaboration with suppliers	0.871	0.953
Environmental monitoring by customers	0.931	0.982
Environmental monitoring of suppliers	0.929	0.981
Internal GSCM	0.841	0.941
Project management performance	0.931	0.982
Project risk management	0.864	0.950
Project success	0.770	0.943

present. As all the values were more than 0.9 except for the value of project success that was 0.877 (> 0.85). Hence as per Henseler *et al.* (2015), an analysis of the Heterotrait-Monotrait (HTMT) criterion is required. Table V presents the results of the HTMT criterion test. As all the values of the HTMT criterions were below 0.90 so discriminate validity was established. This adequately confirmed model validity as both convergence validity and discriminate validity were established and the conclusion could be made that the measurement model was acceptable for hypothesis testing.

Table V.
Result of HTMT criterion for discriminate validity

Item	GSCM: environmental collaboration with suppliers	GSCM: environmental monitoring by customers	GSCM: environmental monitoring of suppliers	GSCM: internal	GSCM: environmental collaboration with customers	Project management performance	Project risk management	Project success
GSCM: environmental collaboration with suppliers								
GSCM: environmental monitoring by customers	0.861							
GSCM: environmental monitoring of suppliers	0.745	0.747						
GSCM: internal	0.964	0.962	0.676					
GSCM: environmental collaboration with customers	0.828	0.949	0.518	0.809				
Project management performance	0.461	0.473	0.815	0.443	0.267			
Project risk management	0.631	0.722	0.508	0.678	0.726	0.479		
Project success	0.594	0.584	0.580	0.569	0.492	0.777	0.640	

Note: Black shaded box means cannot be used to measure oneself

4.5 Hypothesis testing

The developed hypothesized model was tested using path analysis. Using the structural model developed in structural modeling by means of smart-PLS, a bootstrapped analysis was executed to test and validate the model. To meet the purpose of this study, a total of 18 hypotheses (including main and sub hypotheses) were tested. For a structural model, model quality is evaluated through the value of the coefficient of determination (R^2). The rule of thumb for interpreting the results is that a R^2 between 0.25 and 0.49 is weak, between 0.50 and 0.74 is moderate and 0.75 and above is substantial (Hair *et al.*, 2014).

The R^2 value of environmental collaboration with customers was 0.361. This shows that environmental collaboration with customers explained 36.1 percent of PRM among the total variance. This means the model quality of environmental collaboration with customers and PRM was close to moderate.

The R^2 value of environmental collaboration with suppliers was 0.445. This shows that environmental collaboration with suppliers explained 44.5 percent with PRM among the total variance. This means the model quality of environmental collaboration with suppliers and PRM was close to moderate. The R^2 value of environmental monitoring by customers was 0.232. This shows that environmental monitoring by customers explained 23.2 percent of PRM among the total variance. This means that the model quality of environmental monitoring by customers and PRM was weak.

The R^2 value of environmental monitoring of suppliers was 0.415. This shows that environmental monitoring with suppliers explained 41.5 percent with PRM among the total variance. This means the model quality of environmental monitoring of suppliers and PRM was close to moderate. The R^2 value of internal GSCM was 0.441. This shows that internal GSCM explained 44.1 percent with PRM among the total variance. This means the model quality of internal GSCM and PRM was close to moderate. The R^2 value of project management performance was 0.718. This shows that project management performance explained 71.8 percent with PRM among the total variance. This means the model quality of project management performance and PRM was close to substantial. For the purpose of hypothesis testing, the determinant of t-values on one-tailed test of statistical significance must be greater than 1.645 when tested at the 95 percent confidence level, p-value < 0.05. Table VI provides a summary of the results of analysis.

H1 predicted that PRM was positively related to GSCM, and *H1a* predicted that PRM was positively related to GSCM: environmental collaboration with customers. The result indicated that *H1a* was statistically significant at $p < 0.05$ and positively related (path coefficient 0.124, t-value $= 4.853$). *H1b* predicted that PRM was positively related to GSCM: environmental collaboration with suppliers. The result indicated that *H1b* was statistically significant at $p < 0.05$ and positively related (path coefficient 0.1092, t-value $= 7.254$). *H1c* predicted that PRM was positively related to GSCM: environmental monitoring by customers. The result indicated that *H1c* was statistically significant at $p < 0.05$ and positively related (path coefficient 0.135, t-value $= 3.565$). *H1d* predicted that PRM was positively related to GSCM: environmental monitoring of suppliers. The result indicated that *H1d* was statistically significant at $p < 0.05$ and positively related (path coefficient 0.100, t-value $= 6.466$). *H1e* predicted that PRM was positively related to GSCM: internal. The result indicated that *H1e* was statistically significant at $p < 0.05$ and positively related (path coefficient 0.100, t-value $= 6.466$). Thus, *H1a-H1e* were supported. The result indicated *H1* PRM was significant with respect to GSCM.

H2 predicted that GSCM was positively related to project management performance. *H2a* predicted that GSCM: environmental collaboration with customers was positively related to project management performance. The result indicated that *H2a* was statistically significant at $p < 0.05$ and positively related (path coefficient 0.212, t-value $= 1.678$). *H2b* (t-value $= 1.145$), which predicted that GSCM: environmental collaboration with suppliers

Hypothesis	Path	SD	t-value (1-tailed)	p-values	Decision
H1a	Project risk management → GSCM: environmental collaboration with customers	0.124	4.853	0.000	Accept
H1b	Project risk management → GSCM: environmental collaboration with suppliers	0.092	7.254	0.000	Accept
H1c	Project risk management → GSCM: environmental monitoring by customers	0.135	3.565	0.000	Accept
H1d	Project risk management → GSCM: environmental monitoring of suppliers	0.100	6.466	0.000	Accept
H1e	Project risk management → GSCM: internal	0.077	8.622	0.000	Accept
H2a	GSCM: environmental collaboration with customers → project management performance	0.212	1.678	0.047	Accept
H2b	GSCM: environmental collaboration with suppliers → project management performance	0.180	1.145	0.126	Reject
H2c	GSCM: environmental monitoring by customers → project management performance	0.063	15.646	0.000	Accept
H2d	GSCM: environmental monitoring of suppliers → project management performance	0.244	0.964	0.168	Reject
H2e	GSCM: internal → project management performance	0.103	1.269	0.102	Reject
H3	Project risk management → project management performance	0.138	1.953	0.026	Accept
H4	Project management performance → project success	0.076	13.151	0.000	Accept
H5	Project risk management → project success	0.110	1.342	0.090	Reject
H6a	GSCM: environmental collaboration with customers → project success	0.223	3.828	0.000	Accept
H6b	GSCM: environmental collaboration with suppliers → project success	0.238	0.506	0.307	Reject
H6c	GSCM: environmental monitoring by customers → project success	0.145	5.302	0.000	Accept
H6d	GSCM: environmental monitoring of suppliers → project success	0.210	1.899	0.029	Accept
H6e	GSCM: internal → project success	0.121	0.255	0.399	Reject

Table VI. Path coefficients and hypothesis testing

was positively related to project management performance, and was statistically insignificant at $p > 0.05$ and was rejected. *H2c* predicted that GSCM: environmental monitoring by customers was positively related to project management performance. The result indicated that *H2c* was statistically at $p < 0.05$ and positively related (path coefficient 0.0.063, *t*-value $= 15.646$). *H2d* (*t*-value $= 0.964$), which predicted that GSCM: environmental monitoring of suppliers was positively related to project management performance was statistically insignificant at $p > 0.05$ and was rejected. *H2e* (*t*-value $= 1.269$), which predicted that GSCM: internal was positively related to project management performance, was statistically insignificant at $p > 0.05$ and was rejected. Thus *H2a* and *H2c* were supported and *H2b*, *H2d* and *H2e* were rejected. Thus, the overall results indicated that *H2* was insignificant to project management performance.

H3 predicted that PRM was related positively to project management performance. The result indicated that *H3* was statistically significant at $p < 0.05$ and positively related (path coefficient 0.138, *t*-value $= 1.953$). *H4* predicted that project management performance was related positively to project success. The result indicated that *H4* was statistically significant at $p < 0.05$ and positively related (path coefficient 0.076, *t*-value $= 13.151$). *H5* (*t*-value $= 1.342$) predicted that PRM was related positively to project success was found to be statistically insignificant at $p > 0.05$ and was rejected. *H6* predicted that GSCM was related positively to project success. *H6a* predicted that GSCM: environmental collaboration with customers was related positively to project success. The results indicated that *H6a* was statistically significant at $p < 0.05$ and positively related (path coefficient 0.223, *t*-value = 3.828). *H6b* (*t*-value = 0.506), which predicts that GSCM: environmental collaboration with suppliers was related positively to project success, was found to be statistically insignificant at $p > 0.05$ and was rejected.

H6c predicted that GSCM: environmental monitoring by customers was related positively to project success. The results indicated that *H6c* was statistically significant at $p < 0.05$ and positively related (path coefficient 0.145, *t*-value = 5.302). *H6d* predicted that GSCM: environmental monitoring of suppliers was related positively to project success. The result indicated that *H6d* was statistically significant at $p < 0.05$ and positively related (path coefficient 0.210, *t*-value = 1.899). *H6e* (*t*-value = 0.255), which predicted that GSCM: internal was related positively to project success, was found to be statistically insignificant at $p > 0.05$ and was rejected. Thus *H6a*, *H6c* and *H6d* were supported and *H6b* and *H6e* were found to be insignificant. The results indicated that *H6* GSCM was related positively to project success.

5. Discussion

Despite the fact that the GSCM concept and implementation has gained the attention of scholars and practitioners in last decade and a consensus was reached on how GSCM can impact financial return, environmental outcomes and the operational firms' improvement in automobile sector in global context such as Germany (Thun and Müller, 2010), USA (Xia and Li-Ping Tang, 2011), Japan (Kumar and Yamaoka, 2007), Brazil (Vanalle *et al.*, 2017) and India (Luthra *et al.*, 2016), limited study has conceptualized the impact of risk management on green supply chains and its impact on project management activities to predict project success. This study has closed the literature gaps that managing risk can assist the company to reduce risk of failure on new car development by implementing green supply chain strategy. It can also improve project managers confidence by adding value to project management activities for project success.

To answer the research problem, this study incorporated project risk as a predictor of GSCM adoption. Project risk was found as the driver of GSCM adoption in the Malaysia automobile industry. In the automobile sector, the project risks can come from additional costs and profit loss via government regulations and market requirements, which can be overcome by frequently conducting risk assessment. Project risk can be caused from product failure and the inability of an automobile firm to accommodate the technical and market requirements on environmental aspects. According to Somsuk and Laosirihongthong (2014), four main drivers of GSCM adoption exist in Thailand; these are government pressure, top management support, customer pressures, cost reduction and employee involvement/motivation. In Brazil, Mauricio and Jabbour (2017) identified critical success factors of GSCM adoption including top management commitment, information management and green product/process design. Cost is an interesting domain, which drives firms to adopt GSCM. Each industry and country have different market requirements and priorities in driving firms to adopt GSCM (Zhu and Sarkis, 2006).

This finding derived from the Malaysia automobile sector may also be different from same industry worldwide and other industries. Future studies can use measurement items and the theoretical model either in the same sector in another country setting or in others industries determine the generalizability. The findings were based on a correlational study to predict the effect of selected drivers. Thus, future study can investigate project risk, project management performance and GSCM adoption based on the differences among types of products that vendors have supplied to an Original Engineering Manufacturer and carbon emission reductions that these firms have experienced.

To ensure that a project can be delivered, meet the scope of work, schedule and within the budgeted cost, PRM is becoming a key component of project management performance and project success. Based on the finding, the main constraints and the major source of risks to the benefits project management are project deadlines or lack of product clarity.

The results of this current survey indicated that PRM that is being implemented was related positively to the successful implementation of GSCM in the automotive industry in Malaysia. Successful PRM not only avoids unnecessary costs for new car model development, but also will assist a company to make efficient use of all resources (Mohanty and Prakash, 2014). Thus, automotive manufacturing firms need to accommodate eco-efficient engineering designs to meet market specifications and requirements.

Malaysia is one of the developing countries that has encouraged industry to practice GSCM for all types of industries. To prepare and manage green technology management at the workplace, a transformative process must occur to change from voluntary to enforced compliance. It is important for a company to implement PRM to influence project management performance that will generate many benefits to a company including reduced costs and time savings among others.

This study confirmed that PRM is positively related to project management performance. The ability of a project leader in managing risk will not only improve the success of a project being completed as planned but also is able to ensure a project can be coordinated with other stakeholders to reduce unnecessary costs, as well as the use of hazardous raw materials. According to Carvalho and Rabechini (2015), project management needs to be embedded in strategic thinking on project risks to ensure the activities of project management go according to plan. Carvalho and Rabechini (2015) suggested that project management risk can use a mapping method of the threats and opportunities especially in developing a new automobile model, which means more eco-efficient production.

This study found that GSCM was partially related with project management performance. This is due to the lack of ability of the automotive manufacturing firms in managing external collaborators to develop success implementation of GSCM. This shortcoming can be solved if a company can communicate with suppliers and customers on how important environmental aspects are for their business survival in the industry. As part of GSCM, the reverse supply chain can be embedded under project management, especially in terms of development of a new car model. Automotive manufacturing firms need to consider reverse supply chain activities to process scrapping and recycling of used parts to build a new car model.

This study found that the project managers who were involved in developing a new car model infrequently attend formal training, attending it was just a once a year. However, the majority of respondents had not attended a project management course before starting to manage any project. This is a training gap that needs to be reduced, and companies need to arrange regular training on project management. Then, project managers can improve their knowledge and expertise in managing a project. Additionally, a company should design the training with current market and technology requirements in mind. For example, this training should include GSCM, reverse logistics, closed loop supply chain, green technology, management control, safety and other relevant project risk in training modules.

Automobile firms should incorporate the concept of eco-innovation in GSCM to reduce dependence on non-renewable materials. According to Fernando and Wah (2017), eco-innovation implementation can assist manufacturing firms in reducing costs of materials, improving products and service designs, improving the production process, reducing waste, and enhancing resource efficiency. In the future, a project's success could be measured by how well project managers can reduce carbon emissions and improve energy efficiency (Fernando and Hor, 2017). GSCM adoption should be clearly linked to a low carbon supply chain in the procurement, material handling, production and distribution to steer the earth away from negative effects of global warming (Fernando and Saththasivam, 2017).

Besides these earth friendly goals, GSCM can reduce the risk of environmental fines, penalties and unacceptable products on the market due to legal and environmental issues.

Government and senior management should evaluate how to motivate stakeholders to seek the benefits that can be derived from PRM and GSCM. This study proves that GSCM implementation or practices do not much influence project management performance in the Malaysian context. Based on hypothesis results, however, GSCM dimensions with respect to customer's collaboration and monitoring shows a positive relationship with project management performance. This means that GSCM implementations with customers have contributed project management performance. But, on the other hand, GSCM implementations with suppliers did not contribute to project management performance. Although this study demonstrates that the PRM implementation or practices did not influence project success, PRM did have an influence on the green supply chain and project management performance, and GSCM also influenced project success.

This study confirmed that project management performance was the strongest predictor of project success. Project management performance practices like planning, execution and control, which are based on the project manager leadership and team work capabilities, assisted the automobile firms in achieving project goals in terms of time, budget, scope, quality and meeting customer expectations. Project management performance can use specific tools to measure how well a project achieves the specific objectives in three phases including: early start, mid-project and complete project. An eco-efficient project based in the automobile sector need to incorporate sustainability domains in project management performance and success indicators for project success. Sustainability domains in project management performance and project success need to cover technical designs for environment, and environmental technologies to ensure that project processes, knowledge, green procurement and partnerships, and social responsibility can be implemented (Carvalho and Rabechini, 2017).

Several studies have been conducted on the effects of PRM and GSCM on project success; however, a limited number of studies exist on project management performance and success. From the theoretical perspective, this study was aimed at highlighting the importance of the dominant actor within PRM and GSCM. Thus, the study extends knowledge through the investigation carried out in the Malaysian automobile industry and as well as of project managers by understanding the effects of PRM on GSCM and project success with respect to the projects in the respondent's companies. From a practical perspective, managerial implications and solutions were deliberated to provide answers to address the concerns of managers who intend to expand their capabilities and performance of their company. PRM will motivate the desire for continuous improvement through GSCM and contribute to the achievement project management performance and success.

New cars that are produced based on technical and market requirements and are environment oriented are becoming key success factors in the market. If automobile manufacturing firms frequently monitor project risk assessment and GSCM adoption to incorporate in design new car models and production, they will able to control costs, and new car sales will continue to grow. Green technology can be commercialized in the upcoming modeling of a new car such as an affordable hybrid or electric car.

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Appendix

Project management performance [1]	
PMP1	Our project teams are able to work together to achieve the project objective successfully
PMP2	We have competent project team members
PMP3	Our project strategy has given more effort to managing the progress of a project
PMP4	We use project management life cycle to guide us in monitoring the progress of a project
PMP5	We always ensure that a project progresses in line with our key project performance indicators
Project success [2]	
PS1	Our project was completed on time.
PS2	Our project was completed within budget
PS3	Our project was meet scope as specified
PS4	Our project was meet quality as specified
PS5	Our project was meet customer expectation
Project risk management [3]	
PRM1	We are able to minimize project risks on additional costs to our new car model development projects
PRM2	We are able to minimize project risks on profit loss to our new car model development projects
PRM3	We frequently conduct risk assessment for our new car model development projects.
GSM: internal [4]	
IGSM1	We have increased the usage of environmentally friendly raw materials/components in our new car model development projects
IGSM2	We have designed our new car model development projects with materials that can be recycled
IGSM3	We have conducted internal environmental audits to ensure that products in new car model development meet the environmental goals
GSM: environmental collaboration with suppliers [4]	
ECS1	We have worked together with our suppliers to take environmental issues into account in our new car model development projects
ECS2	We have collaborated to design the new car model to be more environmentally friendly with our suppliers
ECS3	Our company and our suppliers have a clear mutual understanding of responsibilities of environmental issues in our new car model development
GSM: environmental monitoring of suppliers [4]	
EMS1	We have used environmental impacts as an essential criterion in supplier selection for our new car model development projects
EMS2	We have asked our suppliers for information on their environmental compliance during a pre-audit of new car model development projects
EMS3	We have demanded our suppliers to ensure the environmentally friendly practices of second-tier suppliers who are involved in our new car model development projects
EMS4	We have demanded our suppliers to implement an environmental management system (e.g. ISO 14000, EMAS) for our new car model development projects
GSM: environmental collaboration with customers [4]	
ECS1	We have worked together with our customers to take environmental issues into account in product design for new car model development projects
ECS2	We have developed our products design to be more environmentally friendly with our new car model development projects

(*continued*)

Table AI. Construct of project management performance

ECS3	Our company and our customers have a clear mutual understanding of responsibilities in environmental issues on the product design and the processes in our new car model development projects
GSM: environmental monitoring by customers [4]	
EMC1	Our customers have used environmental impacts as an essential criterion in supplier selection
EMC2	Our customers have asked us for information on our environmental compliance
EMC3	Our customers have demanded us to ensure the environmentally friendly practices of our suppliers
EMC4	Our customers have demanded us to implement an environmental management system (e.g. ISO 14000, EMAS)

Sources: Adapted and adopted from: [1] Mir and Pinnington (2014); [2] Badewi (2016); [3] Blos *et al.* (2009); [4] Laari *et al.* (2016)

Table AI.

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