

The Effects of Supply Chain Strategies on Supply Chain Performance of Malaysian Manufacturing Companies with Moderation of Six Sigma and Lean Production

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Abstract

Since researchers and practitioners alike have focused on the importance of superior supply chain performance, this study examined which supply chain strategies are more likely to enable manufacturers achieve superior supply chain performance, and whether lean production and Six Sigma can play a moderating role and leverage the effects of mentioned strategies on supply chain performance. This research is a descriptive exploratory project in which primary data was collected from 80 Malaysian manufacturing companies. Data were analyzed by applying bivariate correlation and multiple regressions and indicated that two strategies (many suppliers and few suppliers) can have positive and strong effects on achieving superior supply chain performance, but vertical integration strategy. In addition, outputs show that lean and Six Sigma can be considered as a strong moderator just for improving the impact of vertical integration on superior supply chain performance.

Key words: Supply chain performance, supply chain strategies, lean production, and Six Sigma



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INTRODUCTION

Due to the fact that there is a strong rivalry between supply chains instead of companies, and no one has been studying the effects of supply chain strategies on supply chain performance in the presence of six sigma and lean, this research was conducted. In deed, no research has been found that even considers the impact of the strategies on supply chain performance without any moderating variables like six sigma and lean as two of the most helpful and applicable methods. However, no previous study attempts to empirically demonstrate the relationship among supply chain strategy, supplier-firm partnerships, supply chain, and SME performance (Sukwadi et al., 2013). Later on, Singh et al. (2015) stated to date, previous studies have not been able to reveal the performance differences as they relate to the various supply chain strategy models that organizations apply. So this research model was developed applying four of the most significant concepts, supply chain performance, supply chain strategies, six sigma, and lean production.

These days, one of the most important debates among scientists and practitioners is evaluating organizations' supply chain performance. Olfat et al. (2012) stated that three main levels of performance should be evaluated: Strategic, Process, and Implementation, in which the effect of strategic level (0.98) would be more significant. In addition, financial, knowledge, responsiveness, and cooperation are some helpful factors for assessing every mentioned level. Informing, steering, and controlling are three basic indicators for measuring supply chain performance (Jafarnejad et al., 2015).

Supply chain strategies should be considered as one of the most important drivers of supply chain performance and companies' success. Supply chain strategy includes all activities and cultures of the members operating within a supply chain and should be followed by every organization's competitive strategy. In order to be successful, every organization's competitive and supply chain strategies should be matched (Jafarnejad et al., 2015).

Both scientists and practitioners have been focusing on Six Sigma for many years to allow companies to be perpetually successful. Firstly, it was implemented by Motorola in the 1980s. Motorola itself reports over \$17 billion in saving from implementing Six Sigma (Beckman & Rosenfield, 2008). Then, Toyota developed and applied Six Sigma. The purpose of Six Sigma is to reduce cost by reducing variability in the processes, which leads to decreased defects (Naslund, 2008).

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The term “lean” was first coined by John Krafcik. After that, lean production system was introduced by Taiichi Ohno after the Second World War that was implemented in Toyota. Lean manufacturing has had a major influence on the competitive structure of a number of manufacturing industries and its broader counterpart, lean thinking, and is influencing a range of industries outside the manufacturing sector (Beckman & Rosenfield, 2008).

LITERATURE REVIEW

In these days hyper competitive environment, researchers and practitioners strive to reveal helpful guidelines by which manufacturers can achieve superior supply chain performance. So, the effects of supply chain strategies should have studied as strong drivers of the performance. But, no research has been found focusing on the area. However, no previous study attempts to empirically demonstrate the relationship among supply chain strategy, supplier–firm partnerships, supply chain, and SME performance (Sukwadi et al., 2013). Later, Singh et al. (2015) emphasized that previous research have not been able to reveal the performance differences as they relate to the various supply chain strategies. There for, this study framework was designed to fill research and literature gap: the effects of supply chain strategies on supply chain performance. More importantly, it is decided to insert six sigma and lean production as moderator to release more helpful guidelines for researchers and managers.

Supply chain Performance

As these days there is a strong rivalry between supply chains instead of organizations, supply chain performance and its measurement is quite important and has been focused by managers and researchers. Jafari and Fathi Almas (2011) considered technical and cost point of view for supply chain performance. The more accessible and correct information and useful tools for managers, the more cost reduction for companies. In fact, there is an interaction between technical and money matters in supply chain management. Base on the model, External variables are included as financial (income), and operational (on time delivery rate) and internal variables are financial (cost), and operational (cycle time). In addition, they stated supply chain should be considered as various processes applying for maintaining and leveraging market share in which every process includes several activities that can be evaluated by some factors.

To achieve maximum competitive advantage through the supply chain, the supply chain must be performing at its best or anything it has gained will be short-lived (Kushwaha, 2012). Singh et al. (2015) stated that companies have to select and pursue strategies associated with higher performance.

Kushwaha (2012) has focused on paint companies and clarified by strategizing supply chain practices, managers would achieve superior supply chain performance through lower cost and higher value for customers. Superior supply chain performance would be achieved through maximizing customer satisfaction and minimizing inventories and manufacturers’ costs in which supply chain strategies, inventories, and logistics are considerable enablers. Firms are under heavy pressure to improve supply chain planning and performance because of factors such as increasing uncertainty and competition (Chae, 2014).

As supply chain and operational performance enjoy a noticeable overlap, we can also consider and study operational performance as well. There is a causal relationship between operations strategies and operational performance which lead to sustainable competitive advantage (Samarrokhi et al., 2014). Operations strategies have been addressed by researchers and practitioners as they believe that operations strategies can be considered as strong drivers of companies’ successes (Smamrrokhi et al., 2015). One of the most applicable measures for operations strategies is competitive priorities, which can evaluate operational performance as well. The competitive priorities framework can also be thought of as way to conceptualize and measure operational performance, or even competitiveness (Miguel & Ledur Brito, 2011).

Jafarnejad et al. (2015) stated SCOR (supply chain operations reference) is a reference method for business and supply chain evaluation which has many advantages including a framework of standard processes

relationship, standard measures for assessing processes performance, description of a standard management process for fixing supply chain, management methods leading to the best performance, and recognition of software applications which lead to the best implementations. This is precisely the motivation behind standardization initiatives such as the supply chain operations reference (SCOR) model (Levi et al., 2000). In order to show the supply chain SCOR model is using the five parts named plan, source, make, deliver, and return (Jafarnejad et al., 2015). The five processes were divided into twenty-six processes groups (level two). In the third level, applications' specifications, factors, the best implementations, and software specifications would be considered. Later, in the fourth level, supply chain processes should be conducted.

Evaluation of the supply chain is particularly critical for these managers, because they spend most of the organization's money (Heizer & Render, 2009). They also revealed three formulas based on assets committed to inventory for measuring supply chain performance:

- Percent invested in inventory = $(\text{Total inventory investment} / \text{Total assets}) * 100$
- Inventory turnover = $\text{Cost of goods sold} / \text{Inventory investments}$
- Weeks of supply = $\text{Inventory investments} / (\text{Annual cost of goods sold} / 52 \text{ weeks})$

As managers should compute how well their manufacturing site have been performing and prefer to apply the most applicable formulas, it is decided to measure manufacturers' supply chain performance by inventory turnover, and percent invested in inventory. By this means, regarding Heizer and Render (2009), Toyota (13), Nissan (150), and Dell (90) should be considered as the benchmark companies for inventory turnover. They also emphasized that the more inventory turnover, the higher performance. Percent invested in inventory should be compared with 20%, and companies stand below this amount are enjoying high supply chain performance like Toyota (5%).

Supply chain strategies

Supply chain strategy, in somehow, specifies supply chain structure which is sometimes called supplier strategy, operations strategy, or logistics strategy (Jafarnejad & Amoozad Mahdiraji, 2012). They also enhanced supply chain strategies and included network design decisions based on inventories, logistics, operations facilities, and information flow. Samarrokhi et al. (2014 & 2015) proved that operations or manufacturing strategies have been playing an important role for manufacturers to achieve higher performance and sustainable competitive advantage. Due to the fact that supply chain strategies are the most important part of operations strategies, they should have a strong effect on supply chain performance.

Tyssen et al. (2011) stated supply chain and organization strategies should be matched in case of enjoying sustainability and released a framework as shown in figure 1. In general we can distinguish - following markets and competition theory - three decisive factors which determine the business environment and consequently the strategy of a corporation: Demand (e.g. customers, target groups, etc.); Supply (e.g. competitors, employees, suppliers, etc.); and the General Environment (e.g. regulations, society, natural resources, etc.) (Tyssen et al., 2011). A firm must identify the strategic objectives of the supply chain that are critical to contributing to meeting the firm's broader strategic objectives (Massow and Canbolat, 2014).

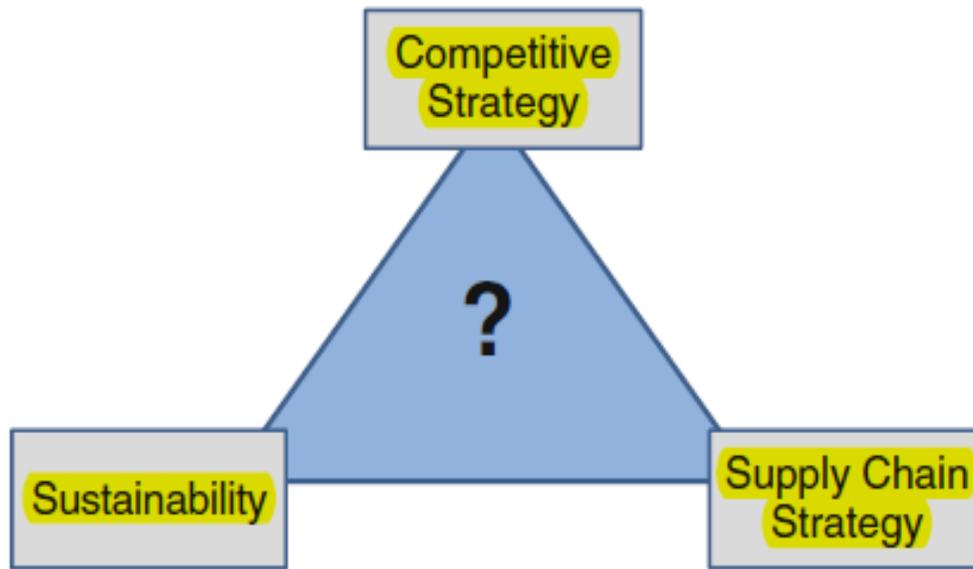


Figure 1: Source: Tyssen et al. (2011).

Chopra and Meindl (2007) divided supply chains into responsive and efficient as two opposite points of an axis. Every supply chain needs a particular strategy with its own specifications. Indeed, Chopra and Meindl (2007) clarified a responsive supply chain should: response to demand quickly, differentiate products, increase profit, have flexible capacity, lower lead time, and select a reliable, flexible, and quality supplier. In contrast, an efficient supply chain should: offer lower cost, increase performance, decrease profit, lower lead time while considering cost, and select suppliers based on cost and quality. Moreover, Jafarnejad et al. (2015) noted two points about supply chain strategies:

1. No supply chain strategy would be reliable and applicable forever.
2. There is no unique supply chain strategy specified for a competitive strategy.

For goods and services to be obtained from outside sources, the firm must decide on a supply chain strategy (Heizer & Render, 2009). They also revealed the following categories for supply chain strategies:

1. Many suppliers
With the many-suppliers strategy, a supplier responds to the demands and specifications of a “request for quotation”, with the order usually going to the low bidder.
2. Few suppliers
A strategy of few suppliers implies that rather than looking for short-term attributes such as low cost, a buyer is better off forming a long-term relationship with a few dedicated suppliers.
3. Vertical integration
By vertical integration, we mean developing the ability to produce goods or services previously purchased or actually buying a supplier or distributor.
4. Keiretsu network
Some manufacturers have found a middle ground between purchasing from few suppliers and vertical integration.
5. Virtual companies
Virtual companies have fluid, moving organizational boundaries, that allow them to create a unique enterprise to meet changing market demands.

Six Sigma

Organizing in many companies, six sigma is accepted as an effective tool for improving processes continuously. The approach has proved itself highly effective in terms of delivering cost saving and increased customer satisfaction (Bendell, 2006). Six Sigma could also be described as an improvement program for reducing variation, which focuses on continuous and breakthrough improvement (Andersson, Eriksson, & Torstensson, 2006). Also, Bendell in 2006 introduced terms “Black Belts” referred to full-time engineers and managers’ improvement and “Green Belts” referred to part-time improving them. These improvements should be achieved project-by-project. Even though Six Sigma focuses on cost reduction and customer satisfaction through eliminating variations, sometimes cost reduction does not end in customer satisfaction.

DMAIC and DFSS are two methodologies that are applied to develop a Six Sigma program. Managers may apply the five phases of DMAIC that come from: define, measure, analyze, improve, and control to enjoy perfect Six Sigma. DFSS is another method for implementing Six Sigma including define, measure, analyze, design, and verify (DMADV).

In other words, Six Sigma allows companies to manufacture 3.4 defects out of one million products. For applying perfect Six Sigma, the most important issues are whole organization commitment, top managers’ involvement, preparing suitable infrastructure, and organizational training. Also, Andersson, Eriksson, and Torstensson in 2006 emphasized that there are two methodologies for Six Sigma implementation: one for existing processes and another for new processes.

Naslund (2008) revealed the characteristics of a company implementing Six Sigma:

1. Bottom-line results expected and delivered;
2. Top management leadership;
3. A disciplined approach (DMAIC);
4. Rapid project completion;
5. Success measurement;
6. Infrastructure;
7. Focus on customers and process; and
8. Statistical approach for improvement.

Dahlgaard (2006) clarified six steps of applying Six Sigma by Motorola:

1. Identify physical and functional requirements of the customers;
2. Determine the critical characteristics of products;
3. Determine for each characteristic, whether controlled by part, process, or both;
4. Determine the maximum rate of each characteristic;
5. Determine process variation for each characteristic; and
6. If a process capability (C_p) is less than two then redesign materials, product, and process as required.

Lean Production

John Krafcik has introduced the concept of “Lean” for the first time. Lean can be summarized as the systematic pursuit of perfect value through the elimination of waste in all aspects of the organization’s business processes (Bendell, 2006). Companies want to be perpetually successful should focus on eliminating waste as well as increasing value-added (VA) activities. VA activities thus refer to the actual production process (whether manufacturing or service) and could simply be explained as activities that the customer is willing to pay for (Naslund, 2008).

Among the several quality management concepts that have been developed, the lean concept, as in lean manufacturing, lean production, etc. is one of the more wide-spread and successful attempts (Andersson, Eriksson, & Torstensson, 2006). They, also, illuminated several lean production advantages, cut costs, provided competitive advantages, reduced work-in-process, increased inventory turns, increased capacity, reduced cycle-time, and achieved customer satisfaction. The lean system was introduced at first

for manufacturing sectors, but nowadays, it is also applied to service provider companies. While the concept of lean operations were originally applied to manufacturing systems, they can also be applied to service operations in areas such as capacity management, process flow, and material support (Beckman & Rosenfield, 2008). They also released some helpful methodologies for those applied in lean production:

- Producing product anywhere customers exist;
- Maintaining production at a constant level to the degree possible;
- Reducing lot size as much as possible;
- Achieving short and predictable lead times;
- Striving for a linear flow of production to the extent possible;
- Positioning suppliers to supply frequently and in small lots as dictated by specific assembly requests;
- Limiting number of suppliers and interacting with them in material management, quality, and design;
- Integrating design cycles with manufacturing, using concurrent engineering, and reducing development lead times as much as possible;
- Reducing variability, improving supplier consistency, machine reliability, and demand predictability;
- Reducing demand variability by managing it; and
- Engaging the workforce in the processes.

Di Pietro et al. (2013) illustrated how the adoption of a holistic approach and integration between internal and external aspects of service functions can be more effective. Also, Womack and Jones in 1996 (as cited in Bendell, 2006) and Andersson et al. (2006) specified characteristics of lean organizations:

1. The elimination of waste (or Muda);
2. The identification of value stream;
3. The achievement of flow through the process;
4. Pacing by a pull (or kanban) signal; and
5. The continuous pursuit of perfection.

In fact, lean producers continuously focus on zero defects, zero inventories, and declining costs. In other words, by the lean approach companies can identify and decline non-value-added activities within their organizational processes. Lean production focuses on eliminating waste as much as possible in a business value stream, which encompasses all activities that should be done for producing a product or delivering a service. Andersson, Eriksson, and Torstensson (2006) identified the major issues contributing to eliminating non-value-added activities as excess production, excess processing, delays, transport, inventory, defects, and movements. They also illustrated several approaches for eliminating waste, value stream analysis, total productive maintenance, Kaizen costing and cost analysis, engineering and change management, and document management. Waste or Muda can be happen in every activity, department, or division. Waste can be part of production and distribution activities and can also appear in related activities, such as design, inventory management, and work assignments (Beckman & Rosenfield, 2008). Therefore, managers should identify, analyze, and try to eliminate waste in every activity and the whole value stream. Beckman and Rosenfield (2008), in their operations strategy book, mentioned different types of waste as those categorized by Ohno:

1. Overproduction ahead of demand;
2. Unnecessary processing steps;
3. Waiting for the next processing step;
4. Unnecessary transport of materials;
5. Excess inventories;

6. Unnecessary movement of workers;
7. Production of defective parts or services; and
8. Production of goods or services that do not meet customer needs.

Companies can benefit from lean operations as much as possible by applying and implementing it through the whole supply chain. The conditions for including suppliers in a successful lean program are the same as for implementing it at a single producer: variation and lot sizes must be reduced across the entire supply chain, lead times must be shortened, and requirements must be leveled (Beckman, & Rosenfield, 2008).

One of the most popular companies that use lean production system is Toyota. Its net profits are more than double those of its next closest competitors, Nissan and Honda, and nearly triple those of GM and Ford (Beckman & Rosenfield, 2008). Also, Toyota engaged its suppliers in lean production systems by shortening delivery lead times, frequenting communication of schedules, and by minimizing of delivery lot sizes.

RESEARCH METHODOLOGY

Framework and hypotheses

Regarding the previous discussion, this research examines whether supply chain strategies have serious effects on supply chain performance or not. In this way, the authors also test if lean production and Six Sigma can be considered as effective moderators. The framework related to the study is shown in Figure 2.

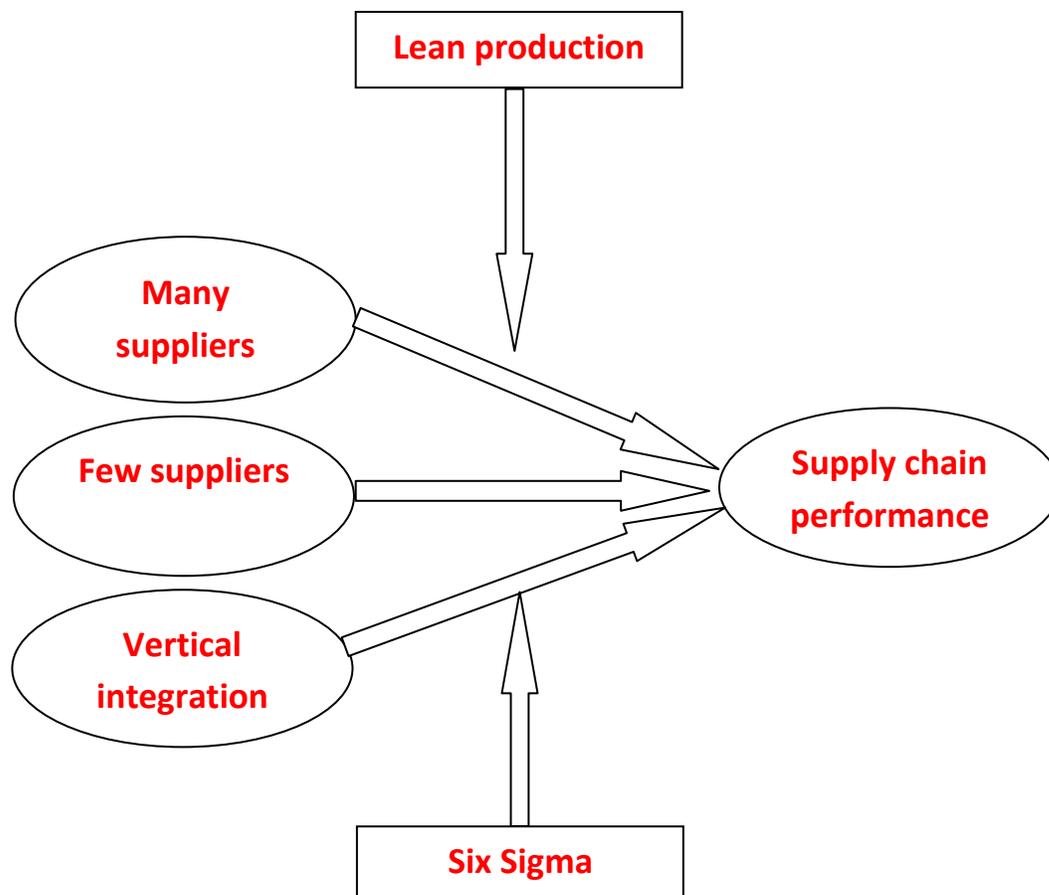


Figure 2: Research framework

Hypotheses of the research are obviously concluded from the model. Firstly, the effects of every supply chain strategy on supply chain performance should be considered (H1-H3). Secondly, the effects of supply chain strategies on supply chain performance in the presence of lean production as moderator would be examined (H4-H6). Finally, six sigma will be inserted in the effects of supply chain strategies on supply chain performance (H7-H9). So, the following hypotheses must be considered and tested:

- H1. Many suppliers strategy is a strong factor for improving supply chain performance.
- H2. Few suppliers strategy is a strong factor for improving supply chain performance.
- H3. Vertical integration strategy is a strong factor for improving supply chain performance.
- H4. The positive relationship between many suppliers strategy and supply chain performance would be stronger in manufacturing companies applying lean production.
- H5. The positive relationship between few suppliers strategy and supply chain performance would be stronger in manufacturing companies applying lean production.
- H6. The positive relationship between vertical integration strategy and supply chain performance would be stronger in manufacturing companies applying lean production.
- H7. The positive relationship between many suppliers strategy and supply chain performance would be stronger in manufacturing companies applying Six Sigma.
- H8. The positive relationship between few suppliers strategy and supply chain performance would be stronger in manufacturing companies applying Six Sigma.
- H9. The positive relationship between vertical integration strategy and supply chain performance would be stronger in manufacturing companies applying Six Sigma.

Operational procedure-Measurements

All mentioned concepts are evaluated by valid variables and questions. Due to the fact that no questionnaire was found that cover measuring all of concepts and variables, a questionnaire was designed by the authors using few parts of others, but several supply chain researchers and practitioners were asked to review and redesign it. By this means, supply chain performance is measured by computing percent invested in inventory, inventory turnover, and weeks of supply that was conducted by Chief Operating Officers (COO) of Malaysian manufacturing companies before answering the questionnaire.

Simultaneously, the COOs were asked to response to how much their company had been following the supply chain strategies, many suppliers, few suppliers, and vertical integration. Also, based on Andersson et al. (2006), for understanding whether the companies are pursuing lean production, the following variables were measured:

- Eliminating all production waste
- Reducing lot size
- Shortening lead time.

Regarding Naslund (2008), this study chooses the following variables for measuring Six Sigma:

- Having less than 3.4 defects out of one million products
- Applying a DMAIC approach
- Having rapid project completion (three to six months).

The questionnaire applied a five point Likert scale from strongly disagree to strongly agree. For example, for measuring Six Sigma, every COO was asked to what extent he/she is producing a good containing fewer than 3.4 defects out of one million, across three factors. These scores were then averaged to determine whether the company was applying Six Sigma or not.

RESEARCH DESIGN

This study is a descriptive-exploratory research based on a causal approach, in which, secondary data was collected through previous research, articles, and books. Primary data were collected from a structured questionnaire - partly designed by the authors - from Malaysian manufacturing companies. A

pilot study was conducted and some questions were later revised based on feedback from researchers and industrial experts.

Hair et al. (2010) stated it would be better if researchers survey 15 samples for every independent variable. Because of the presence of five independent variables, at least 75 samples should be examined; however, it was decided to expand it to 80 units in order to leverage the research reliability and validity. Hence, all data were collected from 80 COOs of Malaysian medium and large manufacturing companies with at least 150 employees and an operating history of more than five years. Roughly 60% of the respondents were over 40 years of age and had more than 10 years of work experience. SPSS-16 (multiple regressions) was used to analyze the data.

Reliability and validity

Cronbach's alpha test was conducted for evaluating the reliability of the concepts and variables, all of which fell between 0.7 and 0.9, indicating a satisfactory level of reliability (many suppliers: 0.865, few suppliers:0.873, and vertical integration:0.786). Four researchers and two COOs revised and validated the variables and concepts in terms of the face method (Corbin & Strauss, 2008). In addition, for the validity test, exploratory factor analysis (EFA) (Habing, 2003) was conducted. All Eigen values stood greater than one and all KMOs fell in an appropriate range, between 0.6 and 0.9, (many suppliers: 0.812, few suppliers: 0.781, and vertical integration:0.723).

ANALYSIS AND DISCUSSION

Even though it is obvious that supply chain strategies have serious impacts on supply chain performance, current research clarifies which strategies guarantee the most significant positive performance. Later on, we examine whether lean and Six Sigma can be considered as a strong moderator for the effects and would leverage the supply chain performance or not. So, in the first step, descriptive statistics and bivariate correlation applying Pearson coefficient was conducted. The output illustrated that supply chain performance and various supply chain strategies are highly related (Table 1).

Table 1. Descriptive statistics and correlation matrix

	MEAN	STDEV	1	2	3	4
Supply chain performance	2.8	1.18	1			
Many suppliers	2.75	1.22	0.841	1		
Few suppliers	2.71	1.27	0.882	0.762	1	
Vertical integration	2.83	1.14	0.796	0.810	0.812	1

As the second step, a multiple regression analysis was conducted without considering moderator variables, lean and Six Sigma. The R-square value of 0.892 illustrated that 89% of the dependent variable, supply chain performance, can be explained by independent variables, supply chain strategies. Based on Model Summary and ANOVA tables, p-values of many suppliers and few suppliers strategies fell less than 0.05; but, the p-value for vertical integration was greater than 0.05 (0.743), indicating that this strategy cannot be considered as a driver of supply chain performance. Besides, regression coefficients for many suppliers and few suppliers became 0.421 and 0.467, and in turn, regression equation is as shown below:

$$\text{Supply chain performance} = -0.341 + 0.421 (\text{many suppliers}) + 0.467 (\text{few suppliers})$$

Later on, the effects of all supply chain strategies on supply chain performance with moderation of lean and Six Sigma were analyzed. The output is summarized in Table 2.

Table 2. Multivariate regression analysis

	B	Sig.	Δ (R-Square)
Many suppliers	0.712	<0.01	
Lean production	0.728	<0.01	
Six Sigma	0.703	<0.01	
Many suppliers X Lean production	0.053	N/S	0.001
Many suppliers X Six Sigma	0.076	N/S	0.001
Few suppliers	0.733	<0.01	
Lean production	0.740	<0.01	
Six Sigma	0.725	<0.01	
Few suppliers X Lean production	0.042	N/S	0.002
Few suppliers X Six Sigma	0.062	N/S	0.001
Vertical integration	- 0.489	<0.01	
Lean production	0.502	<0.01	
Six Sigma	0.524	<0.01	
Vertical integration X Lean production	0.189	<0.05	0.027
Vertical integration X Six Sigma	0.212	<0.05	0.022

Regarding regression output, the following findings were released:

Many suppliers and lean production/Six Sigma: Even though the many suppliers strategy would guarantee manufacturers high supply chain performance, lean or Six Sigma can not leverage this impact (B= 0.053 & 0.076, Sig= N/S & N/S, and Δ (R-Square)=0.001 & 0.001). Consequently, hypothesis one was supported, but hypothesis four was rejected.

Few suppliers and lean production/Six Sigma: Although the few suppliers strategy can be considered as a strong predictor of supply chain performance, lean production and Six Sigma does not have any effects on this impact (B=0.042 & 0.062, Sig= N/S & N/S, and Δ (R-Square)=0.002 & 0.001). Therefore, hypothesis two was supported, but hypothesis five was not.

Vertical integration and lean production/Six Sigma: Even though vertical integration has no serious effect on supply chain performance, lean production and Six Sigma leveraged the vertical integration strategy impact on supply chain performance. Indeed, lean production and Six Sigma are strong moderators of the causal relationship (B= 0.189 & 0.212, Sig<0.05, and Δ (R-Square)=0.027 & 0.022).

Regarding outputs of regression analysis, manufacturers can rely on many suppliers and few suppliers strategies to achieve a satisfactory level of supply chain performance. More importantly, although lean production and Six Sigma were suggested as two strong approaches promising manufacturing companies to get higher supply chain performance, they can not increase the effects of many and few suppliers strategies on supply chain performance anymore. Moreover, the vertical integration strategy would never guarantee manufacturers will enjoy a high level of supply chain performance. However, they can leverage the effects of vertical integration by applying lean or Six Sigma to have a noticeable supply chain performance.

CONCLUSION

Since manufacturing companies would not compete with rivals unless enjoying superior supply chain performance in today's hyper competitive environment and no studies were conducted that examine the effects of supply chain strategies on supply chain performance with presence of lean production and Six Sigma, 80 Malaysian manufacturing companies were surveyed to extract a useful model enabling manufacturers to achieve considerable supply chain performance. The finding proved that manufacturing companies implementing many suppliers and few suppliers are more likely to get superior supply chain performance, but vertical integration is not strong enough to promise manufacturers a noticeable level of supply chain performance. More importantly, this research showed that lean production and Six Sigma cannot improve the effects of many suppliers and few suppliers on

supply chain performance as strong moderators. On the contrary, lean production and Six Sigma are strong enough to leverage the effect of vertical integration on supply chain performance. Although the current research focused on manufacturing sectors, management scientists can survey service-providers for the future studies clarifying whether service and manufacturing sector companies behave in the same manner or not. Since the data was collected from Malaysian manufacturing companies, future research should examine companies from other developing countries like Iran.

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