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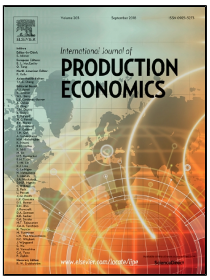

The effects of supply chain management on technological innovation: The mediating role of guanxi

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The effects of supply chain management on technological innovation: The mediating role of guanxi

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ABSTRACT

This paper investigates the relationships between supply chain management (SCM) practices (i.e. strategic supplier partnership, customer relationship, information sharing, information quality, postponement, internal operations) and technological innovation (TI) in a R&D manufacturing setting in Malaysia, with guanxi being the intervening variable. A conceptual model was developed and tested using data collected from 197 Malaysian manufacturing firms for the study. Data set was examined and hypotheses were tested by employing Partial Least Squares-Structural Equation Modelling (PLS-SEM) analysis. The results revealed that internal operations, postponement, strategic supplier partnership, and guanxi have positive and significant relationships with TI; while guanxi mediates the relationships between four SCM practices (i.e. strategic supplier partnership, information quality, postponement, and internal operations) with TI. Findings show that through proper implementation of SCM practices, firms are able to achieve better TI performance. These findings are useful for decision-makers when formulating SCM strategies and focusing on practices that will help them achieve greater TI. This paper also contributes to existing operations management research by empirically validating guanxi as the mediator between SCM practices and TI. From a developing nation perspective, this paper identifies the important relationships that exist between SCM, guanxi and TI. The findings will be of interest to both emerging and other developing nations.

KEYWORDS: Supply chain management, guanxi, technology management, innovation management, manufacturing firms, Malaysia.

1.0 INTRODUCTION

In today's competitive business world, organizations strive to gain competitive advantage by improving their business processes. An integrated supply chain (SC) is a sound strategy to enhance the competitive position of a firm. Blackwell and Blackwell (1999) emphasised that supply chains compete against one another and at the same time promote environmental sustainability. Both academics and industrial practitioners have dedicated much attention to the development and improvement of supply chain management (SCM) for this reason.

Ideally, the SCM philosophy embraces the functions of logistics, operations and materials management, marketing, purchasing, and information technology to generate an effective SC strategy that subsequently leads to an improvement of organizational performance (Devaraj *et al*., 2007), quality performance (Fynes *et al*., 2005), and competitive advantage (Li *et al*., 2006). The research conducted on SCM is also strongly related to the characteristics of the product, as Christopher and Towill (2000) conceived that to be effective, the strategies of SC must be well matched with the characteristics of the product, the surroundings and the competitive strategies of the company. In line with this, Bechtel and Jayaram (1997) pointed out that SCM issues must be considered for research concerning new product development (NPD) (i.e. product innovation). Qi *et al*. (2009) concluded that when strategies of SC are well matched with product characteristics, firms will have the ability to attain a better organizational performance.

Despite the popularity and benefits of SCM on company performance, there exist only few articles that deal with SCM and technological innovation (TI), especially in Malaysia, the context of this study. To the best knowledge of the authors, there are no commonly accepted sub-elements of SCM, and the associations between each SCM dimension and TI have produced inconsistent results in previous research studies (Lau, 2011). Furthermore, limited empirical evidence has demonstrated how different SCM practices simultaneously affect TI

(i.e. product and process), nor has past research paid attention to the mediating effect of guanxi between the different types of SCM practices with TI. There is a need to examine the relationships between SCM, guanxi, and TI that has been recognized as of value (Goffin *et al*., 2006).

Therefore, the main aim of this paper is to identify the relevant SCM practices that significantly relate with TI. Past studies highlight improvement in innovation performance resulting from Total Quality Management (Lee *et al*., 2010; Lee *et al*., 2013); however, studies on the association of SCM with innovation performance, especially when guanxi acts as a mediator, have remained sparse. To narrow the gap in the literature, our study purports to examine if each SCM dimension can ultimately improve the TI of firms, via the development of a close guanxi relationship with its key supply chain partners from a developing country's business environment.

The remainder of this paper is structured as follows. The next section (literature review) discusses the role of SCM practices on TI. With this, a conceptual framework is developed for further testing. The subsequent sections present the methodological details and statistical outcome. Finally, the conclusion, encompassing discussions, implications, research limitations, as well as future recommendations is presented.

2.0 LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

2.1 SCM practices

SCM incorporates a set of methods that effectually integrate suppliers, producers, distributors and customers for the purpose of enhancing competitive position of individual firms in the long-run (Chopra and Meindl, 2001). In simple terms, it is a set of activities carried out in a firm to stimulate effective management of its SC (Li *et al*., 2006).

There are numerous definitions of SCM in the literature. SCM, according to Donlon (1996), comprises of partnership with suppliers, outsourcing, compression in cycle time, continuous flow in process, and sharing in information technology. Following this, six elements of SCM practices were identified by Tan *et al*. (2002), which includes the integration of SC, information sharing, characteristics of SC, the management of customer service, geographical distance and the ability of JIT. The SCM concept as identified by Min and Mentzer (2004) includes vision and goals, effective information exchange, sharing of risks and rewards, collaboration, effective integration and streamlining of processes, long-term connection and SC stewardship. Li *et al*. (2005) have also endeavour to develop and validate a model for SCM and came up with six dimensions of SCM, which are information quality, strategic supplier partnership, information sharing, internal lean practices, customer relationship and postponement. Although SCM is portrayed in various perspectives, it has the same ultimate goal of enhancing organizational performance.

Six SCM practices comprising of strategic supplier partnership, customer relationship, information sharing, information quality, postponement, and internal operations were chosen for this research (Perry and Sohal, 2000; Li *et al*., 2005; Petrovic-Lazarevic *et al*., 2007; Chong *et al*., 2011). It is essential to note that there are other SCM factors, such as cross-functional teams (Chen and Paulraj, 2004), visions and goals, SC leadership (Min and Mentzer, 2004), JIT/lean ability and geographical proximity (Tan *et al*., 2002), which are not captured in this study. This was mainly due to the concern that the survey instrument would become lengthy and the limitations in the measurement instruments needed to be taken into consideration as well.

2.2 Technological innovation

Innovation is being described as the extent to which a company jointly works with its SC partners to come up with processes, products or services which are new (Cao and Zhang, 2011). In another definition given by the European Commission (1996), innovation is defined as (i) a continuous renewing and expansion of the product and services range and related markets; (ii) exploring and establishing new ways to produce, supply and distribute; (iii) introducing a change in management, organizing work and the conditions of work and workforce skills. Kaufman *et al*. (2000) believed that firms are able to enhance their ability to be involved in process and product innovations, provided they carefully manage their relationship with both suppliers and customers. Ulusoy (2003) concludes that customers are the most influential, followed by the R&D Department, trade exhibitions and the company management in terms of new product ideas. If a firm is able to tap into the abilities of joint innovation with its SC partners, it will improve the absorptive capacity of firms, thus introducing new products and services at a more frequent and faster speed (Cao and Zhang, 2011). Indeed, innovation is a fundamental pillar to building competitiveness in the global arena.

There are various ways in which innovation has been categorised by past researchers. For Mavondo *et al*. (2005), this is process, product and administrative innovation; while Chuang (2005) categorized innovation into process and administrative. Most of the previous studies (Prajogo and Sohal, 2001; Cooper, 1998; Damanpour and Gopalakrishnan, 2001; Chuang, 2005; Chong *et al*., 2011) have emphasized mainly on product and process innovation, which have been used to signify TI. TI, according to Ng *et al*. (2012), serves as a mechanism to develop new products, processes, and management systems, or the continuation of delivering old products, processes and management systems at a lower cost. It occurs when there is a new/changed process/process being introduced into the marketplace. The entire process of TI integrates the fruits of labor as a result of designing, researching, market intelligence, and active involvement of management in creating an innovative process of production or when

developing an innovative product (Ibrahim *et al*., 2012). Hence, the two common forms of TI encompass product and process innovations, which will be used to represent TI in this study.

Product innovation, as defined by Damanpour and Gopalakrishnan (2001), is to generate products and services that are new, so that the needs and expectations of customers can be achieved. Process innovation incorporates the changes in techniques, tools, and software used, so that new and enhanced production and delivery methods can be implemented (Bi *et al*., 2006). Instead of the general innovation performance term, TI is used in our study. This is because: (i) TI is believed to possess the capacity to increase performance, resolve a firm's difficulties, improve its value and help the firm gain competitive standing (Cooper, 1998); (ii), to generate new high-end products, the manufacturing companies have been relying strongly on TI (Bi *et al*., 2006); and (iii) regardless of whether it is a single or multiple technologies, the changes in the current processes and products are related to TI (Bi *et al*., 2006). Therefore, both product and process innovation made up the elements of TI, which becomes the focal point of this research study.

3.0 HYPOTHESES DEVELOPMENT

3.1 Strategic supplier partnership and TI

Strategic supplier partnership (SSP) is described as establishing a relation between the suppliers and the firm in the long run (Li *et al*., 2005). Simatupang and Sridharan (2002) defined it as a SC collaboration, in which more than two autonomous firms work together to plan and implement SC operations to achieve a common goal. IBM, Procter and Gamble, Hewlett-Packard and Dell have all formed long-term collaborative connections with their component suppliers, and this has led to a reduction of transaction costs and an increased in joint competitive advantage (Sheu *et al*., 2006). Such collaboration allow firms to share risks (Kogut, 1988), assess their complementary resources (Park *et al*., 2004), incur a lower

transaction cost, improve productivity (Kalwani and Narayandas, 1995), and enhance firm performance in terms of profit and competitive advantage (Mentzer *et al*., 2000).

Building a close relationship with suppliers and customers is the starting point in establishing a successful SC that is more responsive and reactive to demand changes. Close collaboration with supply chain members can improve the capability of a firm to capitalize on market opportunities at a quicker pace. Problems can be resolved faster and the speed of new products brought to the market can also be enhanced.

Petersen *et al*.'s (2005) research found that the selection of the "right" supplier for integration is positively related with new product team effectiveness. As suppliers with the right abilities are selected to work on the project, the decision-making process by the project team during the new product development stage will be more effective, thus producing better products. Another study conducted by Cao and Zhang (2011) on US manufacturing companies concluded that SC collaboration can enhance collaborative advantage (i.e. process efficiency, offering flexibility, business synergy, quality and innovation) and has an influence on firms' bottom-line performance. In summary, it can be concluded that through close collaboration with suppliers, firms can produce synergy which will enable them to expand their total gain. This is achieved through the production of more competitive products with innovative processes in the long-term, generating higher profits, thus transforming the individual businesses and the SC to becoming more competitive. With this, the first hypothesis is established:

H1. Strategic supplier partnership has a positive and significant relationship with technological innovation.

3.2 Customer relationship (CR) and TI

As defined by Li *et al*. (2005), customer relationship incorporates dimensions such as handling complaints, satisfying customers, and building a long-term relationship with them. According to Bayraktar *et al*. (2009), establishing a close customer relationship is as essential as establishing a close supplier relations. Frohlich and Westbrook (2002) also highlight the significance of establishing close customer partnerships in order to create customer value.

According to Srivastava *et al*. (1999), there are three main processes to create customer value:

i. develop new solutions and/or reinvigorate the present solutions that customer desires - accomplished through a well-developed management process;
ii. continuously improve the acquisition of inputs and transform these into desirable customer outputs - executed through a SCM process that includes acquiring physical and informational inputs. In other words, information regarding customer requirements that are shared with their suppliers can promote product innovation (Chong *et al.*, 2011);
iii. create and leverage close connections with the marketplace, such as customer relationship management process, which will help firms to identify customers, build relationships, and shape perceptions.

A key goal of SCM is to constantly implement processes that provide better value in quality to customers. This requires the company to offer a distinctive range of products and service features that allows the chain to be different from other competitors (Kaplan and Norton, 2000). When developing a new product, it is crucial to acquire information from potential buyers at an early stage and to acquire it continuously. This allows the customers to communicate the product and service attributes that would be of value to them, thus allowing for changes to be implemented during the development stage (Goffin and New, 2001). Bhattacharya *et al*. (1998) suggests including customers in new product development teams resulting in improved manufacturing efficiency and agility, and a faster and more reliable service delivery (Narasimhan and Jayaram, 1998). Therefore, with close customer relationships

established, firms are able to incorporate TI in their products and are first to market, thus gaining first-mover advantage. Hence, our second hypothesis is:

H2. Customer relationship has a positive and significant relationship with technological innovation.

3.3 Information sharing (IS) and TI

Information sharing can be described as communicating accurate, adequate and timely information that is of quality between partners in the SC (Li *et al*., 2005). It is also described as the degree to which a firm shares information that is relevant, precise, comprehensive and classified with its SC partners in a timely manner (Sheu *et al*., 2006). When information obtained is shared with partners in the chain, better decisions can be made on the ordering, capacity allotment, collaborative forecasting and replenishment of production/material; thus enhancing customer response and ensuring optimization of SC dynamics (Huang *et al*., 2003).

High degree of information sharing can be achieved by establishing close relations with SC partners which depends upon the degree of connectedness between them. Connectedness refers to being dependent on one another for information or assistance which promotes coordination among individuals, departments, or even between firms (Cheng, 2011). When the communication patterns between partners are healthy and strong, there will be an increase in the sharing of meaningful information (Mohr *et al*., 1996). The stronger the dependency between members of an inter-organizational relationship, the lower the dysfunctional conflict will be, and higher the levels of shared understanding and bond between partners as there exists a common self-interest to work together (Menon *et al*., 1996).

Pereira (2009) discovered that sharing of valuable information between SC partners can help improve the inter-organizational coordination and product quality of the manufacturing

firms. The greater the intensity of information being shared, the greater the competitive advantages gained. As stated by Zhou and Benton (2007), information sharing supports the manufacturing technology and up-and-coming IT applications in SCM. For example, Cisco's virtual manufacturing model which is driven by information sharing, enables the company to concentrate on its core competencies and innovation (Zhou and Benton, 2007). Harland *et al*. (2004) also found that the acquisition, sharing, and dissemination of knowledge (e.g. technology, process or market information) between SC partners allows innovation to occur, leading to long-term SC competitiveness. As a company shares information, such as proprietary information, internal issues on changes, knowledge of core business processes etc., it will improve its adoption rate of the latest technology, resulting in technological competitiveness.

H3. Information sharing has a positive and significant relationship with technological innovation.

3.4 Information quality (IQ) and TI

According to Monczka *et al*. (1998), accurate, timely, adequate, and credible information exchanged can be termed as information quality. The attributes of business information quality are defined as four distinct categories by Lee *et al*. (2002), namely intrinsic, contextual, representational and accessible. Lee and Strong's (2004) refer to five forms of information quality which are accessibility, availability, relevancy, timeliness and accuracy. It is generally well accepted that information quality, together with the appropriate use of information, can lead to business advantages as shown in various business decision-making outcomes attained at the different levels of organizational management. One of which is found in Sellitto *et al*.'s (2007) study, where the perceived benefits of RFID adoption have the potential to improve an

organization's information quality, increasing business responsiveness and decision-making capability across the whole SC.

On the contrary, there are also examples found cited in past studies (McAdam and McCormack, 2001; Mason-Jones and Towill, 1997) on the dysfunctional effects of delayed/inaccurate information that is moving along the SC. Even information that has the potential to reach competitors, suppliers and customers are found to be distorted by organizations in a deliberate manner (Mason-Jones and Towill, 1997, 1999). This, according to Berry *et al*. (1994), is due to the fact that information disclosure is linked with the loss of power. As a result, organizations appear to be more reluctant to provide more than the minimal information. Information needs to be treated as top priority and ensured that it flows through the chain with minimum distortion and delay. Thus, it can be concluded that the stronger a firm's information quality, the greater the improvement in information management and activity coordination, increasing the likelihood of firms to be more creative and innovative in their processes and products to meeting end consumer needs. This lead to our fourth hypothesis:

H4. Information quality has a positive and significant relationship with technological innovation.

3.5 Postponement (PPN) and TI

Postponement is the practice to move one or more activities or operations (such as to source, make and deliver) to a later part in the SC. *Place postponement*, as described by van Hoek *et al*. (1999), refers to the upstream positioning of inventories in centralized manufacturing or distribution operations, to delay the downward or forward movement of goods. *Form postponement* refers to delaying any activity that determines the form and function of products to a later point in the chain until customer orders have been received, hence postponing the

point of product differentiation. *Time postponement* entails postponing the forward movement of goods until the orders from customers have been received.

Postponement enables an organization to remain flexible when developing various versions of the products (Wadhwa *et al*., 2006), enabling SC costs to be lowered. The most compelling benefit would be the reduction in the amount and value of inventory held, thus lowering holding costs (Beamon, 1998).

Applications of postponement strategy were explored by Chaudhry and Hodge (2012) from the perspective of textile and apparel sector using a case study approach. Their findings indicated that the choice of postponement strategy depends on the downstream demand, the nature of the product, and the SC structure. It is essential that postponement match the market demands, the type of products, and the structure or constraints within the manufacturing and logistics system (Pagh and Cooper, 1998). Generally, it is only wise to adopt postponement for innovative products (Fisher, 1997; Fisher et al., 1994); products that have high monetary density, highly specialized and broad in range; markets that have a long delivery time, low delivery frequency and high uncertainty in demand (Pagh and Cooper, 1998). With this, we hypothesized that:

H5. Postponement has a positive and significant relationship with technological innovation.

3.6 Internal operations (IOP) and TI

According to Perry and Sohal (2000), for a company to improve on its operational efficiency and hence attain superior operational performance, quality and reliability of internal operations needs to be in place. Internal operations is simply defined as activities associated with flexible production systems and internal logistic flows, enabling firms to respond to market changes faster.

It has been well supported in the literature that the internal departments, such as R&D, engineering, finance and marketing are frequently included as members in the new product development teams (e.g. O'Marah, 2002). For the simultaneous development of new products and processes, the involvement of manufacturing personnel is vital (Swink, 1999), especially in the early phases and in the testing and evaluation of the prototypes. Past empirical studies have shown that the effectiveness of the purchasing department positively affect both production and logistics activities, customer service and organizational performance (Das and Narasimhan, 2000). Purchasing's early participation allows them to communicate with other departments and undertake the necessary planning, such as supplier selection and examining project needs (Wynstra *et al*., 2001). Schilling and Hill (1998) further commented that by developing strategic coalitions with key suppliers, the purchasing personnel have access to the technology needed to develop the products.

Mabert and Venkataramanan (1998) stated that the two vital elements of SCM are inbound and outbound logistics. One of the benefits of involving logisticians at the beginning stages of the new product development process is so that they can point out the advantages and disadvantages of different product options with regards to the cost-efficient methods in attaining the appropriate service levels (Tracey, 2004). Another reason is due to the growing importance of the postponement philosophy (Johnson and Anderson, 2000), as this has shown to reduce the costs in SC effectively while at the same time enhancing customer service. Thus, in order for SC integration to be successful, every firm is required to effectively coordinate its internal activities first. When there is continuous improvement in the production system and that the current production level is up-to-date, it is believed to ease the production of new products using the latest technological processes. Hence, our next hypothesis is:

H6. Internal operations is positively and significantly related with technological innovation.

3.7 Guanxi

Typically described as 'personal networks', guanxi is a distinct method of Chinese social relationships. The word guanxi is made out of two Chinese characters, which are "guan" (which means "pass" or "fortress), and "xi" (which means inter-connected). Generally, the term means interpersonal connections with the implication of continued exchanges of favour (Peng and Luo, 2000). This inculcates the bond shared by the exchange partners (Luo, 1997), such as with customers, competitors, new entrants, and in particular for the study of supply chain, its key suppliers. It is a "set of 'personal connections' which one can draw upon to secure resource or advantage when doing business or in the course of social life", as defined by Davies (1995, p.155). In our study, we define guanxi as a subset of relationships that work in accordance to the norms and reciprocity (Cheng et al., 2012). Such guanxi relationships, which are based on mutual trust and are largely win-win in nature, is important in business, particularly in the Chinese culture (Abramson and Ai, 1999; Cheng et al., 2012).

In most Chinese firms, guanxi preserves and retains inter-organizational relationships (Xin and Pearce, 1996; Peng and Luo, 2000) and guanxi networks are known to be the most essential informal institution in the Chinese-speaking context (Parnell, 2005; Jia and Lamming, 2013). Guanxi and political networks are preferred by Chinese firms when dealing with operational challenges and local competition (Li et al., 2008; Huo et al., 2014). As suggested by previous studies, guanxi is developed in the unpredictability of a foreign direct investment (Abramson and Ai, 1999) and provides an insurance against uncertainty and assistance when problems arise (Fan, 2002). Lee et al. (2001) also established that close relationships with its business partners positively affects a firm's decision-making uncertainty. All these points to the fact that guanxi is an essential basis for business. It is not only applicable to China, but also applies to the 'Chinese commonwealth' in general, in which it is a network of entrepreneurial

connections outside of China tied closely by tradition (Luo, 1997; Kao, 1993; Lobo *et al*., 2013).

In a country with various ethnic groups, religions and language differences (Waller and Fam, 2000), Malaysia is a country that is surrounded by a huge Muslim community and an economically powerful Chinese population. The diverse population composition comprising of Malays, Chinese and Indians, presents a useful research opportunity to examine how such cultural diversity use guanxi for business dealings in a Malaysian business environment. One such study was conducted by Ngau (2006), where the importance of interpersonal relationships in business dealings has been found to be strong among Malaysian businesses and that guanxi has been highly valued as a tool to gain competitive advantage in a Malaysian business practice.

Business practices and management concepts are different in various parts of the world (Hofstede, 1993). It is said that the Americans emphasizes more on profit; the French on technology leadership, the Germans on quality of products and the Japanese on market share (Fontaine and Richardson, 2005). As contended by Jia and Rutherford (2010, 2016), a buyer-supplier relationship in an international context increases the chances of SC relational risk, in which different countries shares different cultures. Nevertheless, Jacob (2005) highlighted that Malaysian managers are different from their Western counterparts on some facets. While managers from the West may consider a problematic situation as something that should be changed, the Malaysian managers may view it as something that should be tolerated. Such disparity is mainly attributed to the central ethic values held between the Eastern and the Western paradigms. Even in a multi-racial society, Malaysians more converge than diverge in terms of cultural values, as mentioned by Fontaine and Richardson (2005). This was further supported in Ngau's (2006) study that Malaysians embraces a more collectivist culture rather than an individualistic culture, and that guanxi plays an essential role when carrying out business dealings in the Malaysian environment.

Considered as a melting pot of different races, religions and culture, the Malaysian community is like one big family. The concept of Muhibbah (i.e. a feeling of friendship or closeness in Malay), which is similar to guanxi, is ever so prevalent in the present-day Malaysia (Isa, 2017). Such culture is intricately woven into the social fibre of every Malaysian and deeply embedded in the business dealings of Malaysia (Isa, 2017). Several past studies have established that guanxi is an absolute necessity when doing business (Tsang, 1998; Fock and Woo, 1998). Guanxi networks have been found to contribute to firm's growth (Park and Luo, 2001); exhibiting better financial performance (Lobo *et al*., 2013); and positively influencing firm's accounting and market performance (Luo and Chen, 1997). From the myriad of these past studies, guanxi is henceforth recognized as an important catalyst for business success among the alliance partners (Cui & Jiao, 2011). This introduces our next hypothesis, which is:

H7: Guanxi has a positive and significant relationship with technological innovation

3.8 Mediation

As reported by Peng et al. (2008) and Lu (2012), China remains one of the top few nations that relies heavily on individual or organizational networks (i.e. guanxi) when conducting their business operations, stressing on the importance of networks based on trust and reciprocity, providing a healthy ground to invest in the relationship between SC involvement and new product development performance (Feng & Wang, 2013). Such a relationship building strategy is considered as informal, has a long-term orientation, and is based on the interaction of face and renqing (i.e. affection), in which it denotes the degree of closeness among individuals in the guanxi network (Xin and Pearce, 1996). According to Chen and Chen (2004), the quality of guanxi needs to be incorporated as a main indicator of relationship quality and is thus

associated with the quality of relationship as a main indicator of partnership performance (Jia and Rutherford, 2010).

There is a strong belief that guanxi or relationship is highly valued in the networking between suppliers and manufacturers, as goals and aspirations between different parties are harmonized and aligned, at the same time encouraging open-minded discussion of opposing views. As and when it is implemented successfully, it will have significant implications for developing SC partnership, assisting managers to be more responsive and quick to critical changes and emerging business challenges, especially in Asian context (Wong et al., 1999). Leung et al. (1996) in their study of 150 chief executives in Hong Kong also concluded that guanxi is extremely vital to trade successfully in China, in particularly in the negotiation process. In the same vein, Chatterjee et al. (2006) also discovered that guanxi is an essential element for Chinese managers in their business dealings, in which deals are sealed because of close connections, knowing the other party for a long period, and cultivating mutual trust via connections in different task environments.

Past empirical work on guanxi in the SC literature has been rare and only a handful of studies can be found. In the study of Lee and Humphreys (2007), the authors demonstrated that guanxi networks facilitate access for gathering information about a domestic market that is often hard for foreign investors to penetrate. Meanwhile, Park and Luo (2001) also consent that information sharing occurs among business community and government authorities via guanxi utilization, leading to a stronger firm performance in terms of higher sales growth.

In line with this, Lee and Humphreys (2007) also highlighted that there is a linkage between supply management (i.e. supplier development, strategic purchasing, and outsourcing) and guanxi; while a buyer-seller relationship that is built on guanxi-style are strongly linked with lower degrees of perceived uncertainty regarding the business environment and enhanced performance outcomes (Abramson and Ai, 1997). By surveying the manufacturers in Hong

Kong, Cheng et al. (2012) further validated that supply risk can be managed via relational approach (i.e. guanxi) in the Chinese business community, in that buying firms form close guanxi networks with their main suppliers when they perceive supply risk. With the application of SEM analysis, Cheng *et al.*'s (2012) study also found out that both supplier trust and communication are improved with guanxi development between buyer and supplier, which in turn positively influence supplier performance.

Despite the significance of guanxi in business, past empirical studies of guanxi acting as a mediator between SCM and firm performance, in particularly innovation performance, remains fairly rare. Nevertheless, guanxi has been found to enhance the buyer-seller relationship in the SC (Luo et al., 2014). Additionally, Li *et al.*'s (2007) study on the relations between supplier development and buyers' competitive advantage also established that trust and joint actions appeared to be two of the most vital elements for improving operational efficiency. Thus, in our study, it is proposed that guanxi network can strengthen the efficiency and effectiveness of buyers and sellers, at the same time reducing transaction costs (Lovett et al., 1999). With the implementation of good guanxi, both buyers and suppliers can benefit from the resource invested in the SCM practices which in turn decrease volume uncertainty, increase transaction frequency, and gradually put pressure on firms to improve on their innovative capability in both their processes and products in order to survive in a heighten competitive globalized market. The following are the set of hypotheses in relation to the above discussion:

H8a: Guanxi mediates the relationship between strategic supplier partnership and technological innovation.

H8b: Guanxi mediates the relationship between customer relationship and technological innovation.

H8c: Guanxi mediates the relationship between information sharing and technological innovation.

H8d: Guanxi mediates the relationship between information quality and technological innovation.

H8e: Guanxi mediates the relationship between postponement and technological innovation.

H8f: Guanxi mediates the relationship between internal operations and technological innovation.

3.9 Control variables

Firm size (i.e. number of employees) and age of firm have both been included as control variables for this study. Figure 1 illustrates the research model.

<<Take in Figure 1>>

4.0 RESEARCH METHODOLOGY

This section discusses the research methodology including procedures of collecting the data, operational measures used for the variables and the statistical analyses conducted.

4.1 Sample and data collection

To investigate the model shown in Figure 1, we developed a survey questionnaire with items included from previous studies. Three credible professors in the field of SCM verified the

content validity of the measures, resulting in the wording of some questions modified to avoid further confusion. The Malaysian manufacturing firms were chosen due to its substantial contribution to the nation's gross domestic product (GDP) (i.e. contributing 25% to the nation's GDP), total exports (i.e. contributing more than 60%) and employability (i.e. employing 1,028,147 as of October 2015) (Department of Statistics Malaysia, 2015). The Federation of Malaysian Manufacturers (FMM Directory, 2014) directory containing more than 2,000 companies was utilized as a sampling frame for this research. Established by the Malaysian government, FMM has prominent representation from both manufacturing and service industries with experience close to 40 years. Hence, the sample selected is considered to validly represent the population.

A sum of 600 questionnaires were mailed out to the firms randomly selected, with the request that the survey be completed by a person responsible for SCM/logistics activities in their firms. A total of 212 companies responded (response rate of 35.3%) and of these, 15 surveys were found to be incomplete, leaving a total of 197 samples to be usable. The response rate in this study is deemed acceptable according to Sekaran (2003), as low response rate can be anticipated from mail surveys. This was further supported by Rao (2002) and Vachon and Klassen (2006), who reported a rather low response rate of 10 percent and 23 present respectively in their green supply chain studies. When comparing with other such studies, we can conclude that the response rate in our study is considered satisfactory.

In order to examine the representativeness of the sample, a comparison based on company size was conducted. Using number of employees, the companies were divided into two sample groups: those having fewer than 200 employees are categorised as small and medium sized firms (44.7% of the sample); while those having more than 200 employees are considered as large firms (55.3%) (Hoang *et al*., 2006). Table 1 depicts the rest of the details pertaining to the company characteristics of our survey respondents.

<<Take in Table 1>>

4.2 The research instrument

The survey instrument consisted of three main segments consisting of items relating to the six practices of SCM; guanxi and TI. These are discussed below.

4.2.1 SCM practices

A sum of 35 items were utilized to measure the six SCM practices namely: strategic supplier partnership (SSP), customer relationship (CR), information sharing (IS), information quality (IQ), postponement (PPN) and internal operations (IOP). In general, items were selected as they have been agreed and commonly referred to in the SCM literature (e.g. Li *et al*., 2005; Chong *et al*., 2011; Petrovic-Lazarevic *et al*., 2007). Sample items include: "*We actively involve our key suppliers in new product management*" (SSP), "*We frequently interact with customers to set reliability, responsiveness, and other standards for us*" (CR), "*Our trading partners share business knowledge of core business processes with us*" (IS), "*Information exchange between our trading partners and us is reliable*" (IQ), "*Our production process modules can be re-arranged so that customization can be carried out later at distribution centers*" (PPN), "*The current production level is up-to-date*" (IOP).

4.2.2 Guanxi

Guanxi was operationalized from Cheng *et al*. (2012), which was later utilized in Luo *et al*.'s (2014) study. Four items were used to measure guanxi. Sample items consists of "*You and your suppliers have many social interactions*".

4.2.3 Technological innovation

Items measuring TI were adapted from Prajogo and Sohal (2003), Singh and Smith (2004) and Hoang *et al*. (2006). For this construct, a sum of nine items were developed to measure the elements of product and process innovation. Sample items include: "*The use of latest technological innovations in new product development is high compared to our major competitors*" (product innovation), and "*The technological competitiveness of our processes is high compared to our major competitors*" (process innovation).

For all three constructs, a seven-point Likert scale ranging from 1 = 'strongly disagree' to 7 = 'strongly agree' was used as measurements for these items. The details of the measurement items are shown in the Appendix.

5.0 ANALYSIS

To assess the model shown in Figure 1, Partial Least Squares-Structural Equation Modelling (PLS-SEM) was carried out. Confirmatory factor analysis (CFA) and structure model was performed in the two-stage PLS-SEM modelling process (Lin and Lee, 2004; 2005; Lee *et al*., 2010; Hair *et al*., 2005), where bootstrapping method was used with 5,000 sub-samples to attain the inferential statistics (Okazaki *et al*., 2012). For PLS analysis, Chin *et al*. (2003) mentioned that multivariate normal distribution, large sample sizes, and intervals scales are not needed, proving this method to be more superior than other analysis techniques - this is supported by Lee *et al*. (2013). PLS-SEM is perfectly capable of testing small sample sizes. As Peng and Lai (2012, p. 469) states, "PLS only requires a sample size of 10 times the most complex relationship within the research model that is the larger value between (1) the construct with the largest number of formative indicators if there are formative constructs in the research model (i.e. largest measurement equation (LME)); and (2) the dependent latent variable (LV) with the largest number of independent LVs influencing it (i.e. the largest structural equation (LSE))". As this study has a sample size of 197, which is substantially greater than the proposed sample size of 60, PLS is more preferred when compared to covariance-based SEM (i.e. AMOS, LISREL etc). Scott and Walczak (2009, p. 226) further added that "the iterative algorithm of a series of ordinary least square analyses in PLS is able to avoid problems of inadmissible solutions and factor indeterminacy".

As proposed by Lee *et al*. (2013); Chan *et al*. (2010); and Ringle *et al*. (2005), the data analysis is carried out in two ways. The first is to verify the validity and reliability of the data through the use of CFA; and second is to perform the structural analysis so that the linkage between SCM, guanxi and TI can be examined. The steps involved are further elaborated below.

<<Take in Figure1>>

5.1 Common method variance

Harman's one-factor test is conducted to examine the common method variance. The findings showed that the largest factor reported was 40.4%, which is less than 50 percent of the variance. In other words, the issue of a single factor that appears to be a dominant factor does not exist. Hence, with regards to the common method variance bias, there is no significant issue that arises (Lee *et al*., 2014; Foo *et al*., 2018).

5.2 Analysis of Measurement Model

To establish construct validity, the measurement model was performed on the constructs of SCM, guanxi, and TI. A total of 33 items relating to SCM practices (i.e. after deleting two items from the original battery due to poor factor loadings) were included in the model. For guanxi, a total of three items were included, after deleting one item due to low loading. For TI, eight items were used (after removing one indicator due to low factor loading) to measure both product and process innovation.

The reliability, discriminant and convergent validity of the measurement model were also examined. Convergent validity, as proposed by Fornell and Larcker (1981), is used to examine the measurement model based on three main criteria. First, the value should exceed 0.50 for all indicator factor loadings (λ) in order to be acceptable (Kline, 1998). Second, the internal consistency on the indicators that measure a given factor should exceed a value of 0.60 for composite reliability (Bagozzi and Yi, 1988). Third, a value greater than 0.50 should be reported for the average variance extracted (AVE) for every construct (Gorla *et al*., 2010). In addition, Cronbach alpha's value, in accordance to Nunnally and Bernstein (1994), needs to exceed 0.7 to establish the reliability and validity of the variables.

Results reported in Table 2 show that the λ-values for all items are well above 0.50, as suggested by Kline (1998); Meanwhile, the AVE reported for every factor was greater than 0.5, which according to Kline (1998) implies that both convergent validity and reliability are sound. The scales were shown to revolve around the acceptable limits, and that the composite reliability (CR) and Cronbach Alpha for each latent construct were greater than 0.60 and 0.70 respectively. This indicates that the measurement is good (Bagozzi and Yi, 1988).

Following suggestions from Chin (1998), which is consistent with that of Wang and Scheepers (2012), as TI is operationalized as a second order factor, the convergent validity of the first order factors (i.e. product and process innovation) is determined by how strong the first order factors loads on the second order factor TI. All TI dimensions load highly on their second order constructs as indicated in Table 3. The values of AVE, CR and Cronbach Alpha on the second order construct (TI) are also reported in Table 3. From the findings itself, it can be concluded that convergent validity and reliability have been achieved.

<<Take in Table 2>>

<<Take in Table 3>>

In order to test for discriminant validity, Deng *et al*. (2014, p.218) proposed to compare the "square root of AVEs and the correlation between any two constructs". Table 4 reports the results in that the values of square root of AVEs are greater than the correlation values. Therefore, it can be concluded that discriminant validity has been achieved (Fornell and Larcker, 1981; Schaupp *et al*., 2010).

<<Take in Table 4>>

5.3 Analysis of the structural model

The summary results of the structural model analysis are illustrated in Table 5. Utilizing the Smart PLS 2.0 software, the hypotheses were examined through PLS-SEM. This analysis permits the investigation of the linkage between SCM and TI. A statistical analysis was conducted on the structural parameter values in order to ensure the validity and accuracy of the hypotheses. The path coefficients (β), the squared multiple correlations (R^2) as well as the predictive relevance of endogenous variables measured using Stone-Geisser's Q^2 value are shown in Table 5. The result revealed that 61.99% of the variance in TI is explained by the six SCM practices and guanxi. Meanwhile, Q^2 is reported to be 0.3460, which according to Cohen (2013) indicates a medium predictive relevance.

The results indicate SSP (β = 0.1467; $p< 0.05$), PPN (β = 0.1238; $p< 0.10$), IOP (β = 0.2636; $p< 0.01$), and guanxi (β = 0.1986; $p< 0.05$) to be significantly and positively related to TI. Thus, the hypotheses H1, H5, H6 and H7 are supported. However, the findings do not support the hypotheses H2, H3, and H4 because the respective path coefficients are found to be insignificant in the predicted directions. Table 5 and Figure 2 illustrate the results of the hypotheses testing.

Control variables such as firm age and size of firm have also been examined and found to have no significant influence on TI (refer to Table 5).

<<Take in Table 5>>

5.4 Mediating effects of guanxi

To test the mediating effects of guanxi, this study uses the state-of-the-art PLS-SEM method (Zhao *et al*., 2010; Preacher and Hayes, 2008). In agreement with Nitzl et al. (2016) and following Hew et al. (2018), such an approach was used in establishing the mediating roles of

guanxi. The entity variable for this research comprised of SSP, CR, IS, IQ, PPN and IOP and guanxi was hypothesized to intervene the linkage between the SCM dimensions and TI. Under this approach, the mediator has to be included into the model in order to assess the direct and indirect effects (via guanxi) of the predictors. Referring to Table 6, mediation could only be established if the indirect effect is significant, otherwise one can conclude a non-mediation. Full mediation happens when the direct effect is insignificant, while partial mediation occurs when the direct effect is significant.

<<Take in Table 6>>

<<Take in Figure 2>>

From Table 6 and Figure 2, the result show that guanxi has a complementary (partial) mediation between SSP and TI, PPN and TI and IOP and TI, whereby both the direct and indirect effects are pointing at the same direction and are significant. Meanwhile, guanxi was found to have an indirect-only (full) mediation between IQ and TI, where the direct effect is not significant but the indirect effect is. This confirms that the mediation effects of guanxi exists between SSP and TI, IQ and TI, PPN and TI, and IOP and TI, therefore H8a, H8d, H8e, and H8f are supported.

6.0 DISCUSSIONS

The aim of this research investigates the associations between SCM practices, guanxi, and a firm's TI, focusing on the manufacturing sector in Malaysia. Firstly, the results proposed that internal operations, postponement, strategic supplier partnership as well as guanxi have significant and positive relationships with TI. However, customer relationship, information quality, and information sharing were found to have no significant relationship with TI.

Postponement in the SC has been found to improve the TI of firms. Our result concurs with that of Wadhwa *et al*. (2006), van Hoek *et al*. (1999), and Lee (2004), in that when postponement is implemented, the firm's SC will be more agile and flexible in responding to customers' changing needs. This, in turn, guides firms to manufacture distinguishable and innovative products according to consumers' demands, while keeping holding cost low as firm keeps undifferentiated inventories (Beamon, 1998). Our study has thus supported that when products are designed for modular assembly, or when production process modules can be re-arranged to enable customization to be carried out later at different distribution centres, manufacturers are able to develop new products at a faster rate as compared to their competitors. Additionally, the Malaysian manufacturers opine that final product assembly activities are delayed until orders from customers have actually been placed or until the last possible position in the supply chain, thus enabling manufacturers to update the technology used in their processes. This confirms an earlier statement made by Fisher (1997) in that postponement strategy is a wise move for innovative products.

Strategic supplier partnership was also found to positively influence TI. Such result is parallel with the past findings of Petersen *et al*. (2005) and Cao and Zhang (2011), where both have concluded that supplier integration is vital in the process of new product and process development. The managerial personnel in our sample data have seriously looked into the active involvement of key suppliers in their planning activities, continuous improvement programs and in the management of new products so as to significantly inspire the development of new products and the use of the latest processes. Quality was taken into serious consideration when choosing suppliers, and hence a close long-term partnership with key suppliers enables firms to resolve problems faster jointly with suppliers, capitalizing on market opportunities, and be more flexible in their product offerings.

Most essentially, our study reveals that internal operations is the most important SCM practice in affecting TI of the Malaysian manufacturing firms. Such a result is on par with the findings from Perry and Sohal (2000) and Elmuti (2002) which concluded that it is paramount for organizations to integrate the internal operations effectively with the external functions to improve a firm's operational efficiency and competitiveness. The internal integration improvements play a significant role in the innovativeness of a firm, as confirmed by O'Marah (2002), Swink (1999) and Rozemeijer *et al*. (2003). When: (1) the current production level of a firm is up-to-date; (2) the current internal logistics flow for the main product is satisfactory; and (3) continuous improvements in the production system are in place, it is believed that such operations can help spur the TI of a firm. The senior managers of the manufacturing firms are aware that when the supply chain improves its effectiveness and that the production system is flexible to handle any variations, this enable their firms to respond to market changes faster, thus improving the rate of TI. This explains why internal operations was found to have the strongest significant influence on TI performance.

Guanxi, likewise, was also found to positively and significantly affect TI. This is consistent with past findings, in that close relationships with business partners provides an insurance against business uncertainties (Abramson and Ai, 1999; Lee et al., 2001; Fan, 2002); positively affecting firm's financial performance (Lobo *et al*., 2013), market performance (Murray and Fu, 2016); contributes to business growth (Park and Luo, 2001); and is a main source of sustainable competitive advantage (Fock and Woo, 1998; Tsang, 1998). Malaysia is a multicultural society, famously known as a 'melting pot' of races, consisting of Malays, Chinese, Indians, and scores of tribal communities. Given that Malaysians are more of a collectivist (Fontaine and Richardson, 2005; Isa, 2017) and that interpersonal relationships in business dealings was found to be essential in Malaysia (Ngau, 2006), the Malaysian manufacturers in our sample data have also recognized the importance of maintaining a

harmonious relationship with their key suppliers. As such, when close ties or strong guanxi is established, the inter-organizational trust between alliance partners is present. This serves to be a key ingredient in the sustainability of a business network, and thus an important catalyst for new product and process development.

On the other hand, customer relationship was found to be insignificantly related to TI. This research finding is inconsistent with that of Goffin and New (2001), and Hult and Swan (2003), where customers' requirements are taken into detail consideration when developing new products and services that are distinctive and unique. Though not significant, Malaysian manufacturers are still encouraged to frequently interact with customers, continuously evaluating on their satisfaction level, and consistently determining their future expectations, so that new solutions can be developed for customers, transforming customers' specifications into desirable outputs, and offering a distinctive range of product and service features that can differentiate itself constantly from other competitors.

Inconsistent with past studies (e.g. Zhou and Benton (2007) and Harland *et al*. (2004)), information sharing between SC members in this study did not play a significant role in facilitating TI of the Malaysian manufacturers. Despite such findings, firms are strongly advised to look into how they can collaborate and analyze information jointly with their SC members, allowing firms to respond quickly to the changing customer needs through the use of company's latest processes. It is essential that the Malaysian manufacturers keep their trading partners well informed about any events, issues or changes that may affect the partners in the chain, sharing of proprietary information and business knowledge that is of core value, and exchanging of any information which helps in business planning. By so doing, it would inevitably increase the flow of information, enhance the efficacy of supply chains, and thus ease the response to the changing customers' needs more speedily. However, one of the main

issues for organizations is to overcome the challenge of convincing all SC members to change their mindsets and enable the sharing of important SC information (Chong *et al*., 2009).

Information quality has also been found to have no significant effect on TI. Findings from previous studies by Monczka *et al*. (1998), Holmberg (2000) and Lee and Strong (2004) contradict with our results, in which the quality of information (i.e. accurate, timely, complete, reliable, and adequate) was found to be a necessary element for business entities in their managerial planning and their daily decision-making, which will eventually lead to business advantages. As confirmed by Berry *et al*. (1994), this phenomenon could be attributed to the fact that disclosing quality information would mean the loss of one's power. Nevertheless, it has been demonstrated countless times through past studies that the quality of business information (i.e. one with minimal distortion and delay) exchanged between trading partners through the chain enhances firms' ability to respond to environmental changes. The Malaysian manufacturers should continuously ensure that the information exchanged between trading partners be of a certain quality (i.e. timely, accurate, complete, adequate, and reliable), in which such quality information will assist firms to make informed decisions on the updated-ness of their processes, techniques and technology, thus being technologically competitive.

In terms of mediation, guanxi was found to partially and significantly mediate three SCM practices (i.e. strategic supplier partnership, postponement, and internal operations) with TI and a full mediation between information quality and TI. This was confirmed by the PLS-SEM test. Such a finding strongly concurs with that of the past literature (Feng & Wang, 2013; Wong et al., 1999; Lee & Humphreys, 2007; Park & Luo, 2001; Cheng et al., 2012) in that a proper execution of SCM practices is vital to attain a higher firm performance via the utilization of good guanxi between the firm and its partners in the supply chain. Such informal networks with SC partners are essential for long-term business operations, serving as a fertile ground for new product and process development to transpire. Guanxi has been found to be highly valued

in the Malaysian context (Ngau, 2006; Isa, 2017). As and when a harmonious relationship is cultivated with key suppliers in any planning or goal-setting activities, it will assist the Malaysian manufacturers to be more responsive to emerging business challenges. Where guanxi is present between SC partners, their integrity toward one another can effectively lessen market uncertainty. Good guanxi with key suppliers influence the degree to which transactions can be fairly negotiated and commitments upheld. This in turns ascertains that coordination and transactions between partners can continue successfully, and that partners can rectify conflicts smoothly and with adequate communication. Such communication and coordination will help enhance the level of joint planning and joint problem solving, thus facilitating new product development and improving their speed to market.

On the same note, when strong guanxi is maintained between manufacturers and customers, and that the final product assembly activity is delayed until customers' orders have been actually received, the Malaysian firms will be in a greater capacity to innovate customized products according to customers' preferences and requirements. This will give suppliers a clearer understanding of the customers' requirements, allowing them to better organize their raw materials sourcing, plant utilization, man power arrangements, and delivery scheduling, therefore greatly enhancing their TI performance. By coordinating a firm's resources effectively and efficiently, firms can consistently create greater value for their customers, resulting in the ability of the firm to meet its customer demands.

Such close informal relationships between SC partners can also ease the sharing of core business information between buyer and supplier, thus strengthening communication and trust, which in turn will positively influence firm's TI performance. Such vital and timely information will facilitate firms in their business planning, establishing plans to update firm processes to ensure they are technologically competitive with major competitors. In other words, manufacturers can depend on such information exchanges through close guanxi with

suppliers, partners, and customers to develop innovation. It is suggested in this study that guanxi can help firms increase their TI performance with the gaining of greater access to information exchanges between trading partners. Guanxi is a highly efficient and effective way to gain access to various information sources which are of high-quality, timely and at lower costs between trading partners, therefore assisting firms to develop an open innovation environment.

Close guanxi is not only important externally, but internally as well. As healthy communication flows between different levels of the organisation, managers of these manufacturing firms will be more aware of the effectiveness of their SCs and will make wise decisions on the appropriate and acceptable level of innovation for their products and processes. Guanxi ensures smooth running of day-to-day business operations, securing information concerning government policies, and securing administrative approvals. Firms with a higher degree of guanxi are more likely to be informed of the existing strategies used by their business counterparts in their channel networking. This might assist firms with a high extent of business guanxi to promptly adjust their internal operations in response to the market needs. The finding in this study suggests that a high level of inter-functional coordination via a high degree of business guanxi is likely to achieve a stronger TI performance. In summary, this study has statistically supported that apart from investing in SCM practices to enhance one's TI, it is also vital to preserve a good guanxi with trading partners to reap long-term benefits.

7.0 CONCLUSIONS AND IMPLICATIONS

The study of the relationships between SCM, guanxi, and TI is an emerging field. In this research, we have investigated which SCM practices will help organizations improve their TI

performance, and whether guanxi plays the role of a mediator. This research has several implications. First, the practical, and then theoretical implications are discussed below.

Practically, internal operations was found to be the most important SCM practice to improve a manufacturer's process and product innovations. Firms should focus on improving their internal SC integration first, if they wish to achieve improvements in TI performance. In addition, our results have revealed that strategic supplier partnerships plays a significant role in facilitating the production of more competitive products with innovative processes. Therefore, manufacturers should continue to work closely with a few key "right" suppliers to expand the total gains for both parties through the production of new innovative products at a faster rate. Furthermore, postponement or the delaying of final product assembly until an order is received will also enable the chain to be more flexible in responding to customer orders and needs. Not only does it reduce holding cost of inventories, it also increases the rate of producing customized and innovative products that satisfy the needs of the end users. The outcome of this research serves to be a guide for Malaysian manufacturers to improve their TI performance by recognizing the key SCM practices to focus on. In addition to that, the intervening role of guanxi from an emerging nation perspective is the major highlight for this study. Having a close bond or guanxi with key suppliers was found to be a key determinant to unlocking a higher TI. Not only does guanxi directly influence TI, guanxi has also been found to partially intervene between three SCM practices (i.e. strategic supplier partnership, postponement, internal operations) and TI and a full mediation was found between information quality and TI. Our findings, if replicated successfully, have significant implications for developing supply chain partnerships, particularly in Asia. Managers are suggested to build on traditional Asian values of groups and relationships, and a close-knit relationship (i.e. guanxi) was found to be of great value for networking between suppliers and manufacturers in our study. Goals and aspirations among SC partners should be harmonized and aligned to ensure goals are

compatible. Additionally, open-minded discussion on opposing views should be encouraged. It is thus imperative for manufacturers to give weight to establishing a close relationship with SC members (i.e. both internally and externally), as guanxi has an intangible ability to generate trust, helping firms to react quickly to critical changes and emerging business challenges, which is an essential catalyst for new product development and process innovation.

Theoretically, this study extended the previous research on SCM by examining each SCM practice individually on TI. With that, organizations are therefore able to prioritize the SCM practices that maximise their TI performance. Guanxi was further added as a mediator between these SCM practices and TI, which serves as another consideration for firms to improve their relationships with SC partners if they intend to adopt these six SCM practices to increase their rate of TI. This empirical research has supported that guanxi plays an important intervening role between SCM practices (in particularly strategic supplier partnership, information quality, postponement, and internal operations) with TI. This research has paved the way for more empirical work to be conducted, to test the applicability of this framework, whether in part or in whole, in another country's context. It would be interesting to find out how this model fares with firms located in another country. In summary, our study has illuminated the intervening role of guanxi between the adoption of SCM practices and TI performance. Understanding the role of guanxi will facilitate firms to cultivate closer relations with their SC partners in order to strengthen their TI performance, ensuring sustainability and survival.

7.1 Drawbacks and future plans

This research has several drawbacks and offers opportunities for further improvement. First, the sample data gathered for this research narrowly focuses on Malaysian organizations. Similar research can be conducted in other countries and cross-country comparisons can be undertaken with other parts of the world given the similarities among emerging economies,

such as the Philippines or South Africa. Second, the sample size for this study is relatively small. While justification has been made that 197 is an adequate sample size and that the results are valid, future studies may replicate our research model by gathering more samples from the manufacturing sector to make a more conclusive statistical inference about the characteristics of the population. Third, our research aims specifically at testing the relationships between SCM practices, guanxi and TI performances of Malaysian manufacturing firms. Having tested this relationship, future research can expand on this study by conducting a similar study based on different industries (e.g. textiles, construction, electronics etc), and examine if the results are consistent between different industries. Third, our research aims specifically at testing the relationships between each SCM practices on TI among the Malaysian manufacturers, with guanxi acting as a mediator. Some scholars have commented that such guanxi networks have its dark side as well. The close personal ties among firms in the guanxi networks have a tendency to weaken and impair a firm's efficiency (Uzzi, 1996, 1997; Lou, 2002), given the high costs of developing and utilising guanxi networks (Park and Luo, 2001). Hence, it will be an interesting find for future researchers when testing the effect of guanxi on different industries, and examine if the results are consistent between different sectors. Lastly, future research can consider gathering data from different respondents within the same organization. This will help improve the validity of the research framework.

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Appendix - Measurement Scales

Supply Chain Management Practices

Strategic Supplier Partnership (SSP)[a, b]

- "We consider quality as our number one criterion in selecting supplier" (SSP1)**
- "We regularly solve problem jointly with our suppliers" (SSP 2)
- "We have helped our suppliers to improve their product quality" (SSP3)
- "We have continuous improvement programs that include our key suppliers" (SSP4)
- "We include our key suppliers in our planning and goal-setting activities" (SSP5)
- "We actively involve our key suppliers in new product management" (SSP6)

Customer Relationship (CR) [a, b]

- "We frequently interact with customers to set reliability, responsiveness, and other standards for us (CR1)"
- "We frequently measure and evaluate customer satisfaction" (CR2)
- "We frequently determine future customer expectations" (CR3)
- "We facilitate customers' ability to seek assistance from us" (CR4)
- "We periodically evaluate the importance of our relationship with our customers" (CR5)

Information Sharing (IS) [a, b]

- "We inform trading partners in advance of changing needs" (IS1)
- "Our trading partners share proprietary information with us" (IS2).
- "Our trading partners keep us fully informed about issues that affect our business" (IS3).
- "Our trading partners share business knowledge of core business processes with us" (IS4)
- "We and our trading partners exchange information that helps establishment of business planning" (IS5)
- "We and our trading partners keep each other informed about events or changes that may affect the other partners" (IS6)

Information Quality (IQ) [b]

- "Information exchange between our trading partners and us is timely" (IQ1)
- "Information exchange between our trading partners and us is accurate" (IQ2)
- "Information exchange between our trading partners and us is complete" (IQ3)
- "Information exchange between our trading partners and us is adequate" (IQ4)
- "Information exchange between our trading partners and us is reliable" (IQ5)

Postponement (PPN) [b]

- "Our products are designed for modular assembly" (PPN1)
- "Our production process modules can be re-arranged so that customization can be carried out later at distribution centers" (PPN2)
- "We delay final product assembly activities until customer orders have actually been received" (PPN3)
- "We delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain" (PPN4)
- "Our goods are stored at appropriate distribution points close to the customers in the supply chain" (PPN5)

Internal Operations (IOP) [b, c]

- "The current production level is up-to-date" (IOP1)**
- "The current internal logistics flow for the main product is satisfactory" (IOP2)
- "The production system is flexible to handle order pattern/variations" (IOP3)
- "The innovation level of the main product is acceptable" (IOP4)
- "There are continuous improvements made in the production system" (IOP5)
- "The senior management is aware of the effectiveness of the supply chain processes" (IOP6)
- "There are excessive automated processes to produce the core product" (IOP7)
- "The extent of modular production is reasonable" (IOP8)

Note: ** Items have been deleted due to the low loading

Source: [a]Li *et al*. (2005, p. 634); [b]Chong *et al*. (2011, pp. 420-421); [c]Petrovic-Lazarevic *et al*. (2007)

Guanxi (GX) [d]

- "You and your supplier are flexible in managing terms in negotiation situations" (GX1)**
- "You and your key supplier maintain a harmonious relationship" (GX2)
- "You and your supplier do favors for each other" (GX3)
- "You are your suppliers have many social interactions" (GX4)

Note: ** Items have been deleted due to the low loading

Source: [d]Cheng et al. (2012); Luo *et al*. (2014, pp.108)

Technological Innovation

Product Innovation (PD) [e]

- "The level of newness (novelty) of new products" is high compared to our competitors (PD1)**
- "The use of latest technological innovations in new product development" is high compared to our major competitors (PD2)
- "The speed of new product development" is high compared to our major competitors (PD3)
- "The number of new products introduced to the market" is high compared to our major competitors (PD4)
- "The number of new products that is first-to-market (early market entrants)" is high compared to our major competitors (PD5)

Process Innovation (PS) [e]

- "The technological competitiveness" of our processes is high compared to our major competitors (PS1)
- "The updated-ness or novelty of technology used in our processes" is high compared to our major competitors (PS2)
- "The speed of adoption of the latest technological innovations in our processes" is high compared to our major competitors (PS3)
- "The rate of change in processes, techniques and technology" is high compared to our major competitors (PS4)

Note: ** Items have been deleted due to the low loading

Source: [e]Prajogo and Sohal (2003); Singh and Smith (2004)

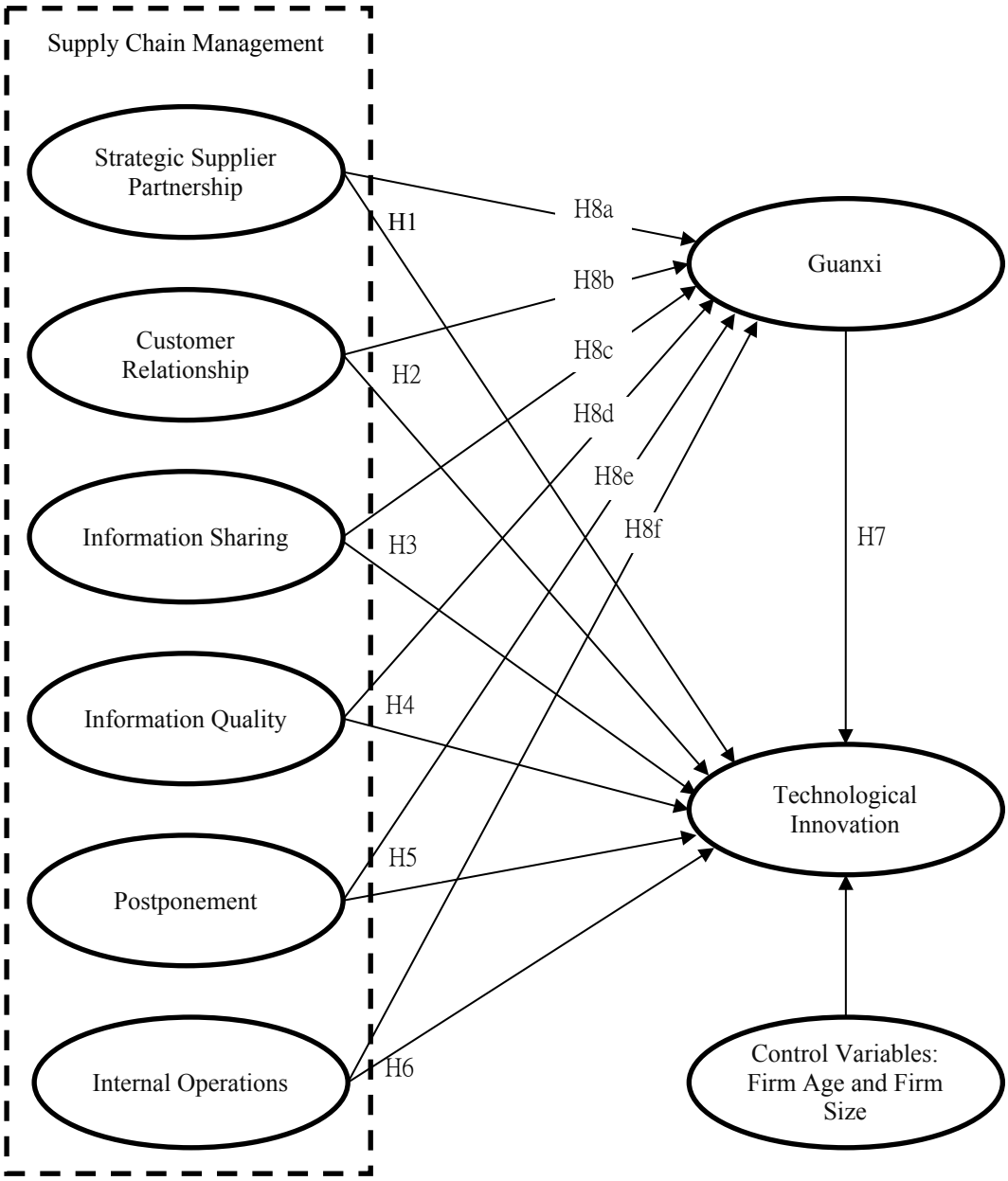


Figure 1: Conceptual model of SCM practices and its relationship with TI, with guanxi as the mediator

Table 1: Company Characteristics (N=197)

Profile	Number	Percentage
Age of firm		
≤ 10 years old	60	30.5
> 10 years old	137	69.5
Category of firm's product		
Electrical & electronics products	38	19.3
Food products	22	11.2
Chemical & chemical products	18	9.1
Rubber & plastic products	60	30.5
Textiles & textile products	24	12.2
Machinery & hardware	28	14.2
Other	7	3.6
Number of employees		
Less than 200	88	44.7
Above 200	109	55.3
Status of organization		
ISO 9000 Certified	140	71.1
Planning to obtain ISO certification	26	13.2
Non-ISO certified	31	15.7

Table 2: Factor Loadings, Validity, AVE, Composite Reliability, Cronbach's Alpha

First-order constructs	Items	Loadings	AVE	Composite Reliability	Cronbach's Alpha
Strategic Suppliers Partnership (SSP)	SSP2	0.8018	0.6666	0.9090	0.8748
Scale type: Reflective	SSP3	0.8020			
	SSP4	0.8617			
	SSP5	0.7998			
	SSP6	0.8152			
Customer Relationship (CR)	CR1	0.7868	0.6556	0.9048	0.8695
Scale type: Reflective	CR2	0.8506			
	CR3	0.8350			
	CR4	0.8118			
	CR5	0.7534			
Information Sharing (IS)	IS1	0.7273	0.6164	0.9058	0.8748
Scale type: Reflective	IS2	0.7587			
	IS3	0.8331			
	IS4	0.8304			
	IS5	0.8001			
	IS6	0.7549			
Information Quality (IQ)	IQ1	0.8268	0.6803	0.9140	0.8821
Scale type: Reflective	IQ2	0.8568			
	IQ3	0.8568			
	IQ4	0.8153			
	IQ5	0.7650			
Postponement (PPN)	PPN1	0.7562	0.6410	0.8992	0.8596
Scale type: Reflective	PPN2	0.8002			
	PPN3	0.8042			
	PPN4	0.8445			
	PPN5	0.7956			
Internal Operations (IOP)	IOP2	0.7861	0.6169	0.9184	0.8962
Scale type: Reflective	IOP3	0.8257			
	IOP4	0.7398			
	IOP5	0.8387			
	IOP6	0.7540			
	IOP7	0.7660			
	IOP8	0.7827			
Guanxi (GX)	GX2	0.8365	0.7470	0.8985	0.8302
Scale type: Reflective	GX3	0.8984			
	GX4	0.8568			
Product Innovation (PD)	PD2	0.8553	0.7279	0.9144	0.8747
Scale type: Reflective	PD3	0.8689			
	PD4	0.8882			
	PD5	0.7977			
Process Innovation (PS)	PS1	0.7950	0.7112	0.9077	0.8641
Scale type: Reflective	PS2	0.8414			
	PS3	0.8682			
	PS4	0.8666			

Note: Items SSP1, IOP1, GX1, and PD1 were deleted due to the factor loadings < 0.60 (Nunnally, 1978)

Table 3: PLS-SEM loadings AVE, Composite Reliability, Cronbach's Alpha on second-order TI

TI Dimensions	PLS outer loadings	AVE	Composite Reliability	Cronbach's Alpha
PD	0.9222	0.6080	0.9254	0.9077
PS	0.9175			

Note: all loadings are significant at $p < 0.01$; PD = Product Innovation; PS = Process Innovation

Table 4: Assessment of discriminant validity

	CR	GX	IOP	IQ	IS	PD	PPN	PS	SSP
CR	**0.8097**								
GX	0.4473	**0.8643**							
IOP	0.6234	0.6316	**0.7854**						
IQ	0.4722	0.5417	0.5886	**0.8248**					
IS	0.5818	0.5374	0.5841	0.6870	**0.7851**				
PD	0.4585	0.6428	0.5998	0.5496	0.5690	**0.8532**			
PPN	0.3911	0.5540	0.5530	0.5065	0.4641	0.5056	**0.8006**		
PS	0.5464	0.5382	0.6595	0.5488	0.5431	0.6923	0.5384	**0.8433**	
SSP	0.6133	0.5402	0.5292	0.5295	0.6069	0.5642	0.4888	0.5463	**0.8164**

Notes: N = 197; Diagonal elements (bold) are the square root of the average variance extracted (AVE) for each construct.); CR = customer relationship; GX = guanxi; IOP = internal operations; IQ = information quality; IS = information sharing; PD = product innovation; PPN = postponement; PS = process innovation; SSP = strategic supplier partnership

Table 5: Hypotheses results with PLS (Basic Model)

Constructs	Hypotheses	Sign	Estimate	Remarks
SSP → TI	**H1**	+	**0.1467***	**Supported**
CR → TI	H2	+	0.0591	Not supported
IS → TI	H3	+	0.0938	Not supported
IQ → TI	H4	+	0.0941	Not supported
PPN → TI	**H5**	+	**0.1238(*)**	**Supported**
IOP → TI	**H6**	+	**0.2636****	**Supported**
GX → TI	**H7**	+	**0.1986***	**Supported**
Control variables:				
Age of firm		+	0.0778	
No. of employees		-	0.0244	

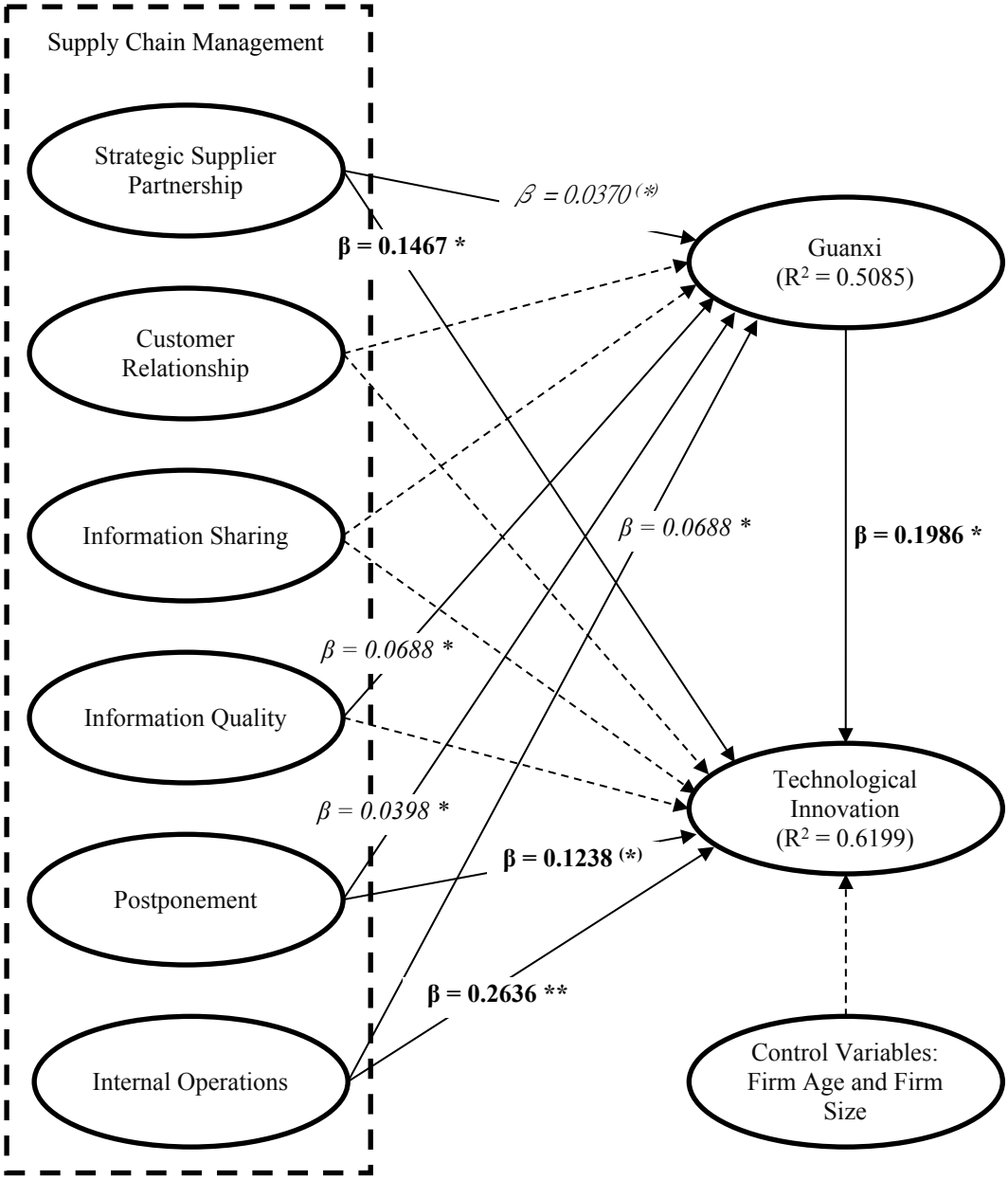
Notes: N = 197; $^{**}p < 0.01$; $^{*}p < 0.05$; $^{(*)}p < 0.10$; $R^2 = 0.6199$; $Q^2 = 0.3460$

SSP = strategic supplier partnership; CR = customer relationship; IS = information sharing; IQ = information quality; PPN = postponement; IOP = internal operations; GX = guanxi; TI = technological innovation

Table 6: Testing for mediation effects with PLS

Path	Direct effect	t-value	Indirect effect	t-value	Effect
SSP->TI via GX	0.1467*	2.2746	0.0370(*)	1.6630	Partial
CR->TI via GX	0.0591	0.6987	-0.0131	0.6734	Non-mediation
IS->TI via GX	0.0938	1.2211	0.0193	0.9699	Non-mediation
IQ->TI via GX	0.0941	1.0754	0.0688*	2.0069	Full
PPN->TI via GX	0.1238(*)	1.8869	0.0398*	2.0093	Partial
IOP->TI via GX	0.2636*	3.0831	0.0688*	2.0069	Partial

Notes: N = 197; ** $p < 0.01$; * $p < 0.05$; (*) $p < 0.10$; based on 5000 bootstraps; SSP = strategic supplier partnership; CR = customer relationship; IS = information sharing; IQ = information quality; PPN = postponement; IOP = internal operations; GX = guanxi; TI = technological innovation.



Notes:
1. ** p < 0.01; * p < 0.05; (*) p < 0.10.
2. Direct effects from supply chain management to technological innovation are denoted in bold, while indirect effects via guanxi are denoted in italic.

Figure 2: Direct and indirect effects of supply chain management to technological innovation