BENEFITS OF JOINING GLOBAL SUPPLY CHAIN IN UPGRADING FIRMS' TECHNOLOGICAL CAPABILITIES TOWARD INDUSTRY 4.0: THE CASE OF THAILAND

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Abstract

The technical knowledge is known to be spillover among supply chain members in the global value chain. It is interesting to investigate differences of firms' technological capabilities development among different types of supply chain structure, i.e., 1) local firms in local supply chain, 2) local firms in global supply chain, and 3) foreign firms in the local/global supply chain. There are three groups of firms' technological capabilities, which are investigated in this paper. They are technological capabilities in production planning (PP), inventory management (IM), and data analysis (DA). One-way ANOVA was used to analyze 141 responses, which was collected during May-April 2019 from management levels of manufacturing firms based in Thailand. Results from this empirical statistical analysis show that, first, foreign firms in the local/global supply chain have a significant difference and higher technological capabilities than local firms in local supply chain for all groups of firms' technological capabilities. Second, local firms in global supply chain have a significant difference and higher technological capabilities than local firms in local supply chain in the group of DA. The local firms in global supply chain have the mean of technological capabilities in production planning and inventory management higher than the local firms in local supply chain. The local firms may improve their technological capabilities by joining the global supply chain.

Keywords: Supply chain structure, Inventory management, Production planning, Data analysis, Technological capability, Industry 4.0

Introduction

Information and communication technology (ICT) is the core of the fourth industrial revolution or Industry 4.0. The concept of Industry 4.0 was initiated in Germany in 2011 (Kuo, Shyu & Ding, 2019). Industry 4.0 is defined as a new concept to improve technique and process by using cloud computing, execution of digitalization, big data, and Internet of Things (Castelo-Branco, Cruz-Jesus & Oliveira, 2019). ICT is considered as the main indicator of technological capabilities, as it can help firms to improve efficiency and productivity (Ahuett-Garza & Kurfess, 2018). On top of that ICT helps with organizational improvement, social change, and economic growth, (Yunis, Tarhini & Kassar, 2018) and

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innovation (Kamasak, 2015). The main objective of the industry 4.0 is to use ICT to improve productivity, increase the degree of automation, and enhance efficiency (Ahuett-Garza & Kurfess, 2018; Lu, 2017; Lukač, 2015). ICT helps firms to reduce costs of doing business and overcome geographical barriers (Chelariu & Osmonbekov, 2014). Well-managed ICT is the keys to success in the current business environment (Cragg & McNamara, 2018).

The source of fostering firms' technological capabilities toward Industry 4.0 can either be induced internally or influenced by external supply chain members (Nonaka et al., 2008). It requires a huge amount of financial and human resource, and time to achieve technological knowledge internally (Zhang & Yin, 2012). Local firms are also expected to have some basic level of technological capabilities to meet the various standard requirements in order to have a knowledge transfer process to occurs (Jeenanunta et al., 2017).

This leads to the investigation of whether joining the global supply chain provides any benefit toward developing firm technological capabilities in the group of production planning, inventory management, and data analysis. The reasons are because they are the main focus of manufacturing firms, and data analysis help to improve the efficiency of those activities. The structure of this paper is as follows: the literature review is presented in Section 2. Section 3 describes the research methodology. Section 4 summarizes the results and discussion. The conclusions and further studies are presented in Section 5.

Research Objectives

The objective of this research is to investigate factors that influence the development of technological capabilities of Thai based manufacturing firms among three types of supply chain structure, i.e., local firms in local supply chain, local firms in global supply chain, and foreign firms in local/global supply chain.

Literature Review

Upgrading Firms' Technological Capabilities

The newly emerged concept of Industry 4.0 has caught many attentions due to the fact that ICT is the core of this new concept, which can greatly improve the efficiency of manufacturing (Hamit-Haggar, 2011). Machine learning, digitalization, robotics, artificial intelligence, and robotics are the key elements of Industry 4.0. These ICT help firm to reduce the employment of human, and increase the efficiency of machinery (Syam & Sharma, 2018). ICT serves as a platform to spread the knowledge in order to enhance the firm's productivity and efficiency (Ahuett-Garza & Kurfess, 2018). The chance of achieving innovation knowledge is believed to increase, as the firm utilizes more technologies. ICTs also assist each firm in supply chain members to create new ideas for value creation (Barbu & Militaru, 2019) ICTs help to reduce labor cost, reduce production time, increase production capacity, improve production flexibility, improve product quality, increase productivity, and increase delivery speed (Percival & Cozzarin, 2008). E-procurement helps firm to operate more smoothly and cost-effective because in the manufacturing industries, importing raw material is a crucial element (Boyd et al, 2008).

Nath & Standing (2010) divided the driving force, which influences the usage of ICT in a firm into three levels of complexity. The first level is (1) a less complex use of ICT is driven by the urge to reduce costs, reduce lead times, reduce cycle times, increased operational capability, and improve information quality. It follows by (2) a medium complex use of ICT is driven by a desire for better relationships and information accessibility with supply chain partners, where this level requires the drivers in the first level. The last one is (3) the most complex use of ICT is driven by market sharing expansion, risk sharing and reduction, high-quality service, real-time information accessibility, and better decision making. This level requires the combination of both driving forces in level one and level two (Nath & Standing, 2010). Thus, different driven levels require firms to adopt different levels of technological capacities.

Supply Chain Structure

Göllü (2017) defined supply chain structure as an integrated system of sourcing, manufacturing, and distribution. The good cooperation between downstream and upstream supply chain members can help to increase profit, efficiency, and customer service; while reducing cost and capital investment (Tseng & Chen, 2014). Depend on the scope of operation, some firms only operate in the local environment, while others have international suppliers, customers or both. Tseng & Chen (2014) believed that the relationship between international multinational cooperation (MNCs) with local subsidiary can greatly enhance subsidiaries' technological capabilities.

Kafouros et al. (2008) emphasized an important of internationalization in enhancing firm innovation capabilities in partial and firm performance in general. This internationalization is helpful for knowledge creation within a firm and knowledge transfer within supply chain members. For knowledge transfer, firms need to improve absorptive capacity and build trust with supply chain members (Kim, Hur & Schoenherr, 2015). The greater the absorptive capacity, the higher the knowledge transfer among supply chain members (Minbaeva et al., 2003). The knowledge transfer from foreign firms does not equally spillovers on the local firms (Yi et al., 2015). The firms may not achieve adequate benefits if their internationalization with supply chain member below a threshold level (Kafouros et al., 2008). Customers sometimes can assert pressure to their suppliers to adopt some kind of technology, in return suppliers will follow because firms need customers' royalty (Basole & Nowak, 2018). Walmart, after entering the Brazil market, has helped to accelerate the adoption of ICT among manufacturing firm there (Dib & da Rocha, 2002). Basole & Nowak (2018) found that the external stakeholders in the firm supply chain often the ones who helped to initiate the assimilation of technology.

The supply chain and ownership structure are extensively studied in the literature. Yukongdi & Rowley (2017) classified firm based on the ownership structure as locally-owned and foreign MNCs. The respondent firms, main customer, and main supplier are considered as the three members of the supply chain structure. Each supply chain member belongs to only one type of ownership structure. The three types of supply chain structures that will be studied are local firms in local supply chain, local firms in global supply chain, and foreign firms in local/global supply chain.

After conducting a thorough literature review, there is no research paper studied on the benefit of joining global supply chain on improving technological capabilities. Therefore, the effect of supply chain structure in upgrading firms' technological capabilities in the group of production planning, inventory management, and data analysis should be investigated.

Technological Capability in Production Planning (PP)

Production planning referred to the process of making sure the production runs smoothly in order to meet the demand on time accordingly to company business strategy (Er et al., 2018). Production planning is important because firms need to improve their production efficiency and reduce production cost per unit. The manufacturing firms constantly look for solutions to improve production operation (Schreiber et al., 2018).

More advanced technique, e.g., Cyber-physical Production Systems caught a lot of attention due to an increase in popularity in Industry 4.0 (Schuh et al., 2019). This is because decentralized production control enables systems to plan for production schedule and production process (Meissner & Aurich, 2019). However, this system is difficult for firms to initiate by themselves.

In the case of Paten Brakes Replacement (PBR Ltd), which is a major Australian company, mainly supply original equipment to Ford Motor Company. In responding to its main customer's demand, PBR started to adopt Electronic Data Interchange technology (Ratnasingam, 2001).

In the case of IKEA, suppliers have been pressured to adopt the mixed-use of standardized software; such as Advanced Planning and Scheduling, excel, and ERP (Holmberg, Jonsson & Rudberg, 2013). As a result, the group members can continuously absorb knowledge and improve the working method and process. IKEA also enjoys the benefit of improving the overall supply chain visibility, increasing forecast accuracy, and having optimal safety stock level.

The Federation of Thai Industries (FTI) classified technological capability in production planning into four categories in incremental order based on complexity levels of ICT usage (IRDI, 2016). They are: (PP1) using papers to plan, discuss, and record information, (PP2) using spreadsheet and Material Resource Planning (MRP) software, (PP3) using Enterprise Resource Planning (ERP) software, and (PP4) having flexible and real-time systems to respond to customer demands. In this paper, the definition of the technological capability in production planning was adopted from the IRDI (2016).

H1: There is significant differences in technological capability in production planning among different types of supply chain structures.

Technological Capability in Inventory Management (IM)

Inventory management is a very import activity is any business. It is needed to be properly managed, otherwise, it will result in the delay of production, customers dissatisfaction and reduction of capital (Howard & Lancioni, 1978). De Vries (2013) defined inventory management system as a process of integrating, standardizing, and automating decision processes related to control of inventories and management. Automatic and systematic inventory may result from automatic production planning (Carvalho, Silva & Tavares, 2013). With an improvement of ICT, automation and real-time system were introduced for the inventory management. This system helps firms and their supply chain members to improve inventory efficiency (Carvalho, Silva & Tavares, 2013). Radio Frequency Identification (RFID) and MRP have been developed to reduce inventory costs and improve efficiency (Carvalho, Silva & Tavares, 2013). In 2005, Walmart required its major suppliers to put RFID tag on all shipments (Zare Mehrjerdi, 2011). This leads to the widespread use of RFID in the industry (Shin & Eksioglu, 2015). The RFID assists warehouse by monitoring inventory, enhancing information accuracy, and providing visibility of inventory (Fan et al., 2014). The decision making on inventory management also highly depends on the accuracy and robustness of forecasting (Barrow & Kourentzes, 2016). Walmart invested in Brazil and successfully changed some of the local supply practice to meet US standard (Dib & da Rocha, 2002). As a result, the usage of pallet increased up to 90% and supplier strictly followed the delivery deadline (100%) (Dib & da Rocha, 2002)

Firms tend to face difficulty in developing ICT systems for inventory management by themselves because this system requires lots of capital and high capability of human resources. The local firms mainly rely on external supply chain members, e.g., customers and suppliers, for knowledge and technology transfer to improve inventory management.

The FTI classified technological capability in inventory management into four categories in incremental order based on complexity levels of ICT use (IRDI, 2016). They are: (IM1) tracking products, using a warehouse BIN card, (IM2) monitoring inventory almost daily and managing products based on customer monthly demand, (IM3) using warehouse management software to track daily purchasing and inventory turnover by using Material Resource Planning, and (IM4) using Barcode or RFID as a real-time tracking system. In this paper, we use the definition from the IRDI (2016) for the technological capability in inventory management.

H2: There is significant differences in technological capability in inventory management among different types of supply chain structures.

Technological Capability in Data Analysis (DA)

In manufacturing firms, decision making is one the most important activity when it comes to the survival of firm (Sims & O'Regan, 2007). In order to make an optimal decision, a good data analysis skill is needed. There is a countless amount of data, which is valuable to the firm, being generated daily both inside and outside the company, those data can be very useful if it is properly organized and analyzed. Those data can be very useful in supporting major business decision, e.g. improving production planning and inventory management. Possessing the ability to examine the data to better understand the problem is crucial and it can help firm to increase performance, staff engagement, operation cost saving (Briggs, 2011).

The FTI classified technological capability in data analysis into four categories in incremental order based on complexity levels of ICT use (IRDI, 2016). They are: (DA1) using data analysis systems for decision making, (DA2) using simple programs such as Excel to analyze data, (DA3) having abilities to process and display business intelligence for decision making, and (DA4) having abilities to publish data in real-time. In this paper, the definition of the technological capability in data analysis was adopted from the IRDI (2016).

H3: There is significant differences in technological capability in data analysis among different types of supply chain structures.

Methodology

Questionnaire Design

In the initial stage, intensive, extensive and thorough literature review on firm ownership structures, supply chain structures, and firms' technological capabilities developments were conducted. Then the foundation of the questionnaire was built upon the one that was obtained from the Industrial Research and Design Institute (IRDI, 2016). These questionnaires were revised and edited by academic professors and experts in this field. The designed questionnaire consists of three parts: Part A: Profile of an establishment; Part B: Firms' technological capabilities, which is used as dependent variables; and Part C: Main customer's and main supplier's ownership structure which are used as independent variables.

Data Collections

Data was collected from the manufacturing firms based in Thailand, which respondents were expected to be in the top management level. The duration of data collection was between March to April 2019. The sample size was determined according to Sekaran & Bougie (2016) in multivariate research (including multiple regression analyses), the sample size should be several times (preferably 10 times or more) as large as the number of variables in the study. Therefore, in this study, the sample size should be around 140. From the Industrial Estate Authority of Thailand, a list of 1,000 firms was obtained (IEAT, 2019). The questionnaires were sent to these firms via post office and Google form. There are 111 respondent firms which is 11% (post office = 22, Google form = 89). Another list of 300 firms from the Thai Auto Parts Manufacturers Association was also used (TAPMA, 2019). Then the designed questionnaires were sent to them through Google form and 18 responses were attained. Through walk in data collection of 70 firms, there were 12 firms agreed to answer the questionnaires.

Table 1 Firms' Technological Capabilities

Dependent variable (Firms' technological capabilities)			N	Scale		Weight[a]	Scale * Weight			
				Min	Max		Min	Max	Mean	S.D.
Mean of technological capability in production planning (PP_m)	PP1	Using papers to plan, discuss, and record information.	141	1	4	0.1	0.100	0.400	0.253	0.071
	PP2	Using Spreadsheet and Material Resource Planning software.	141	1	4	0.2	0.200	0.800	0.482	0.157
	PP3	Using ERP software.	141	1	4	0.3	0.300	1.200	0.743	0.239
	PP4	Having flexible and real-time systems to respond to customer demand.	141	1	4	0.4	0.400	1.600	0.984	0.312
Mean of technological capability in inventory management (IM_m)	IM1	Tracking products, using a warehouse BIN card.	141	1	4	0.1	0.100	0.400	0.252	0.077
	IM2	Monitoring inventory almost daily and managing products based on customer monthly demand.	141	1	4	0.2	0.200	0.800	0.501	0.147
	IM3	Using warehouse management software to track daily purchasing and inventory turnover and using MRP software.	141	1	4	0.3	0.300	1.200	0.738	0.225
	IM4	Using Barcode or RFID as a real-time tracking system for inventory management.	141	1	4	0.4	0.400	1.600	0.987	0.312
Mean of technological capability in data analysis (DA_m)	DA1	Using data analysis systems for decision making.	141	1	4	0.1	0.100	0.400	0.257	0.075
	DA2	Using simple programs such as Excel to analyze data.	141	1	4	0.2	0.200	0.800	0.556	0.164
	DA3	Having abilities to process and display business intelligence for decision making.	141	1	4	0.3	0.300	1.200	0.751	0.229
Mean of technological capability in data analysis (DA_m)	DA4	Having abilities to publish data in real-time.	141	1	4	0.4	0.400	1.600	0.996	0.289

Note: a. Weight is used to calculate mean of technological capability

In total, there are 141 respondents, collected through a post office (22), Google form (107), and walk in (12). For some missing value, phone calls were made to fill the incomplete questionnaires. To compare mean different technological capabilities, ANOVA was used for this empirical statistical analysis.

Measurement Scale

There are three types of firms' technological capabilities; production planning, Inventory management, and data analysis. For each type of technological capabilities; there are 4 levels of capability, where each technological capability level is measured by the 4-point Likert scale (1 = No, 2 = Low, 3 = Medium, 4 = High).

The weighted average of the level of each technological capability is used for finding the mean of each type of firms' technological capabilities. The weight of 0.1, 0.2, 0.3, and 0.4 are given respectively to the different level of technological capabilities by numerical order. Details of each variable with frequency, mean, standard deviation, minimum value, and maximum value are presented in Table 1. The nominal scale is used for the independent variable, the respondent firm's ownership, the main customer's ownership, and the main supplier's ownership where 1 = locally-owned, 2 = foreign-owned, and 3 = joint venture.

Results and Discussions

Firms' Characteristic

For descriptive statistics, there are two groups of firms, which are SMEs and large firm (SME: 199 employees or less, large firm: 200 or more employees) as can be seen in Table 2. In the SME group, most of the firms are locally-owned (64.3%), where the majority of both customers and suppliers are also locally-owned, which accounts for 52.9% and 48.6% respectively. For the large firm group, mostly the firms are locally-owned, but most of the customers and suppliers are joint ventures which account for 52.1% and 57.7% respectively.

Table 3 shows the classification of supply chain structures of firms. For the firms that are entirely doing business only in the local supply chain accounts for 40% in the SME group Domestic firms that have at least one foreign supply chain member made of a similar percentage of 22.9% for SMEs and 28.2% for the large firm group. Foreign firms in the global supply chain constitute for up to 59.2% in the large firm group.

The mean of technological capability in production planning, inventory management, and data analysis in the group of foreign firms in local/global supply chain are the highest, as can be seen in Table 4.

Table 2 Ownership Structure of Respondent Firms, Customers, and Suppliers

The ownership structure of each supply chain member		Respondent firm size			
		SME (70)		Large firm (71)	
		N	%	N	%
Firms' capital structure	100% Locally-owned	45	64.3	30	42.3
	100% Foreign-owned	10	14.3	14	19.7
	Joint venture	15	21.4	27	38.0
Main customer's capital structure	100% Locally-owned	37	52.9	14	19.7
	100% Foreign-owned	9	12.9	20	28.2
	Joint venture	24	34.3	37	52.1
Mani supplier's capital structure	100% Locally-owned	34	48.6	16	22.5
	100% Foreign-owned	11	15.7	14	19.7
	Joint venture	25	35.7	41	57.7

Table 3 Supply Chain Structures Classification

Ownership structure of			Supply chain structure	Respondent in firm size			
				SME		Large firm	
Supplier[a]	Firm[a]	Customer[a]		N	%	N	%
Locally-owned	Locally-owned	Locally-owned	Local firms in local supply chain	28	40.0	9	12.7
Locally-owned /JV/ Foreign-owned [c]	Locally-owned	Locally-owned /JV/ Foreign-owned [c]	Local firms in global supply chain[b]	16	22.9	20	28.2
Locally-owned /JV/ Foreign-owned [c]	JV/ Foreign-owned [c]	Locally-owned /JV/ Foreign-owned [c]	Foreign firms in local/global supply chain	26	37.1	42	59.2
Total				**70**	**100.0**	**71**	**100.0**

Note: a. Each supply chain member possesses only one type of ownership structure (Locally-owned, Joint Venture, or Foreign-owned)

b. Local firms in local supply chain do not include from local firms in global supply chain

c. Locally-owned /Joint Venture/ Foreign-owned means that firms can be Locally-owned, Joint Venture, or Foreign-owned

It follows by local firms in global supply chain and local firms in local supply chain. It can be interpreted that the technological capability of foreign firms in local/global supply chain is always better than the other two supply chain structures. In this study, however, it is more interesting to investigate the differences in technological capabilities of local firms in global supply chain and local firms in local supply chain. The reason is to find out if joining global supply chain provide any benefit.

Technological Capability in Production Planning (PP)

ANOVA was conducted to investigate the benefit of joining a global supply chain in upgrading firms' technological capability in production planning. There is no significant difference in the mean of technological capability in production planning (PPm) for the three types of ownership structure.

Post-hoc comparisons by using the mean of technological capability in production planning indicated that the mean of foreign firms in local/global supply chain (M = 0.636, S.D. = 0.133) are significantly

different from local firms in local supply chain (M = 0.569, S.D. = 0.214). However, the local firms in global supply chain (M = 0.626, S.D. = 0.130) is not significantly different from the local firms in local supply chain.

Table 4 The Mean of Technological Capabilities for Each Supply Chain Structures

Supply chain structures for each technological capability		N	Mean	S.D.
Mean of technological capability in production planning (PP_m)	Local firms in local supply chain	37	0.569	0.214
	Local firms in global supply chain	36	0.626	0.130
	Foreign firms in local/global supply chain	68	0.636	0.133
	Total	141	0.616	0.159
Mean of technological capability in inventory management (IM_m)	Local firms in local supply chain	37	0.570	0.191
	Local firms in global supply chain	36	0.640	0.154
	Foreign firms in local/global supply chain	68	0.636	0.143
	Total	141	0.620	0.161
Mean of technological capability in data analysis (DA_m)	Local firms in local supply chain	37	0.557	0.176
	Local firms in global supply chain	36	0.659	0.111
	Foreign firms in local/global supply chain	68	0.675	0.116
	Total	141	0.640	0.142

From the result, there is no evidence to support that local firms that join global supply chain could help the firm to improve the technological capability in production planning. However, the means of capability in production planning of the local firm in global supply chain is higher than that of the local firms in local supply chain. Moreover, foreign firms in local/global supply chain have higher technological capability in production planning than that local firms in local supply chain.

This finding is consistence with our direct interview with the TMT Steel Public Company Limited, this company invested in ICT, e.g., MRP, ERP, and SAP to improve their production efficiency. Its suppliers are required to send direct notification on upcoming of raw materials and truck delivery through its ICT systems. As a result, suppliers are indirectly pressured have some basic ICT capability in order to meet with a minimum requirement of the TMT Steel Public Company Limited such that they can supply products to this company. Therefore, being in the supply chain of TMT Steel Public Company Limited helps suppliers to improve technological capabilities in production planning.

Table 5 Differences of Supply Chain Structures of Firms' Technological Capability (ANOVA test).

Firms' technological capability		Sum of squares	df	Mean square	F	Sig.
Mean of technological capability in production planning (PP_m)	Between groups	0.112	2	0.056	2.247	0.11
	Within groups	3.429	138	0.025		
	Total	3.541	140			
Mean of technological capability in inventory management (IM_m)	Between groups	0.126	2	0.063	2.480	0.087
	Within groups	3.507	138	0.025		
	Total	3.634	140			

Table 5 Differences of Supply Chain Structures of Firms' Technological Capability (ANOVA test) (Cont.)

Firms' technological capability		Sum of squares	df	Mean square	F	Sig.
Mean of technological capability in data analysis (DA_m)	Between groups	0.354	2	0.177	9.946	0.000***
	Within groups	2.459	138	0.018		
	Total	2.814	140			

Note: *p<=0.05; **p<=0.01; ***p<=0.001

Technological Capability in Inventory Management (IM)

ANOVA was conducted to investigate the benefit of joining a global supply chain in upgrading firms' technological capability in inventory management (IMm).

Table 6 Pair-wise Analysis of the Mean Differences for Each Type of Supply Chain Structure

Mean different (post-hoc)	I	J	I-J	SE	Sig.	95% CI	
						LB	UB
Mean of technological capability in production planning (PP_m)	Local firms in global supply chain	Local firms in local supply chain	0.057	0.037	0.126	-0.016	0.130
	Foreign firms in local/global supply chain	Local firms in local supply chain	0.067*	0.032	0.040	0.003	0.130
Mean of technological capability in production planning (PP_m)	Foreign firms in local/global supply chain	Local firms in global supply chain	0.010	0.032	0.759	-0.054	0.074
Mean of technological capability in inventory management (IM_m)	Local firms in global supply chain	Local firms in local supply chain	0.070	0.037	0.063	-0.004	0.144
	Foreign firms in local/global supply chain	Local firms in local supply chain	0.067*	0.033	0.042	0.002	0.131
	Foreign firms in local/global supply chain	Local firms in global supply chain	-0.003	0.033	0.923	-0.062	0.068
Mean of technological capability in data analysis (DA_m)	Local firms in global supply chain	Local firms in local supply chain	0.102*	0.031	0.001	0.040	0.164

Table 6 Pair-wise Analysis of the Mean Differences for Each Type of Supply Chain Structure (Cont.)

Mean different (post-hoc)	I	J	I-J	SE	Sig.	95% CI	
						LB	UB
Mean of technological capability in data analysis (DA_m)	Foreign firms in local/global supply chain	Local firms in local supply chain	0.119*	0.027	0.000	0.065	0.173
	Foreign firms in local/global supply chain	Local firms in global supply chain	0.016	0.028	0.554	-0.038	0.071

Note: *p<=0.05; **p<=0.01; ***p<=0.001

Post-hoc comparisons by using the mean of technological capability in inventory management indicated that the mean of foreign firms in local/global supply chain (M = 0.636, S.D. = 0.143) are significantly different from local firms in local supply chain (M = 0.570, S.D. = 0.191).

From the result, there is no evidence to support that local firms that join global supply chain could improve firms' technological capability in inventory management. However, the means of technological capability in inventory management of the local firm in global supply chain are higher than that of the local firms in local supply chain. Moreover, foreign firms in local/global supply chain have better technological capability in inventory management than that of local firms in local supply chain.

This finding is consistent with the study of Dib & da Rocha (2002) which highlighted the case of Walmart, which is one of the world largest retailers, invested in Brazil and successfully influenced some of the local suppliers' practice to meet US standard. With the integration of ICT and the usage of pallet increased up to 90% and supplier strictly followed the delivery deadline (100%).

Technological Capability in Data Analysis (DA)

ANOVA was conducted to investigate the benefit of joining a global supply chain in upgrade firms' technological capability in data analysis. Results show that there is a significant effect of technological capability of data analysis (DAm) at P< 0.05, for the three types of supply chain structure [F(2, 138 = 9.946, p = 0.00].

Post-hoc comparisons by using the mean of technological capability in data analysis indicated that the mean of foreign firms in local/global supply chain (M = 0.675, S.D. = 0.116) are significantly different from local firms in local supply chain (M = 0.556, S.D. = 0.176). The local firms in global supply chain (M = 0.658, S.D. = 0.111) also are significantly different from the local firms in local supply chain.

The result shows that local firms that join global supply chain have better technological capability in data analysis than local firms in local supply chain. Moreover, foreign firms in local/global supply chain have better technological capability in data analysis than local firm in local supply chain.

This finding is consistent with the study of Endo (2014), which showed that 7-Eleven Japan, has a system that requires its suppliers to adopt ICT such that they can become suppliers of the 7-Eleven. The ICT enables suppliers to store data and publish data in real-time for analysis. Therefore, they can manage their inventory in a more effective way.

Conclusions and Further Studies

This paper investigates the benefit of joining a global supply chain in upgrading firms' technological capabilities toward industry 4.0 in the group of production planning, inventory management, and data analysis. Data for this empirical statistical analysis was collected from the Thai manufacturing firms during March-April 2019. An ANOVA and Post-hoc analysis were used to compare the mean of technological capabilities of 141 respondent firms.

Results show that there are significant differences among groups in the mean of technological capabilities in production planning, the mean of technological capability in inventory management, and the mean of technological capabilities in data analysis. Foreign firms in local/global supply chain have significant better technological capabilities than the local firms in local supply chain. However, local firms in global supply chain have significant better technological capability only in data analysis than that of local firms in local supply chain. There is no evidence to support the difference in technological capabilities in the group of production planning and inventory management but the mean of technological capabilities of local firms in global supply chain is higher than the local firms in local supply chain. Therefore, the local firms may improve their technological capabilities by joining the global supply chain in some specific areas of technological capabilities.

Through a direct interview with Thai Summit, a local Thai auto spare part manufacturer, revealed that the company has significantly improved technological capabilities by cooperating with Toyota in the area of production planning and inventory management. It is clearly shown that having interactions with foreign firms or participating in global supply chain proved to be beneficial. This is consistent with the finding of Charoenrat & Harvie (2017) which highlighted the importance of working with global supply firm as a driver of transferring of technology, attaining international standard, knowledge spillover effect., etc.

The limitation of this study is the lack of evidence to support the difference in technological capabilities between foreign firms in the local/global supply chain and local firms in global supply chain, particularly in the group of production planning and inventory management. The geographical scope of this study was only limited to the Bangkok metropolitan area and the surrounding provinces. Therefore, this is interesting to know whether similar results will be obtained in the more developed industry. The other factors that can help local firms to upgrade their technological capabilities in production planning, inventory management and data analysis should also be investigated.

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