Kasetsart Journal of Social Sciences 40 (2019) 380–388

Kasetsart Journal of Social Sciences

journal homepage: http://kjss.kasetsart.org

Enhancing the innovation of small and medium enterprises in food manufacturing through Triple Helix Agents

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Article Info

Article history:
Received 2 July 2017
Revised 19 September 2017
Accepted 12 December 2017
Available online 28 December 2017

Keywords:
food manufacturing,
innovation,
small and medium enterprise,
Thailand,
Triple Helix

Abstract

This research aimed to enhance the innovation of Thai small and medium enterprises (SMEs) in food manufacturing through Triple Helix Agents, namely, the university, industry, and government sectors. For the study 87 responses were received from a questionnaire collecting data regarding SME collaboration with Triple Helix Agents and innovation performance based on convenience sampling. The majority of the sample were fruit and vegetable processing manufacturers followed by meat and fish/aquatic animal processing manufacturers. SME collaboration with the industry sector was at the highest level when compared with the university and government sectors, respectively. Confirmatory factor analysis was applied to construct the measurement using PLS-SEM, and then multiple regression was applied to quantify the relationship between the identified factors. The statistical analysis provided insights into the influence of Triple Helix Agents on product and process innovation. The findings indicated that SME collaboration with the industry sector had a positive effect on enhancing the innovation of Thai food manufacturing SMEs at the .05 significance level and the government sector also had a positive influence at the .05 significance level. The study contributes to explaining the level of interactions among Triple Helix Agents in the SME context. The results revealed the potential benefits for SMEs in emerging economies when collaborating with Triple Helix Agents in terms of enhancing their innovation performance.

Introduction

Small and medium enterprises (SMEs) are entities that are essential for the economic growth of a country. In Thailand, these are defined as having the number of employees less than 200 or having an asset value of less than USD 6.04 million (USD 1 = THB 33.068) (Ministry of Industry, 2002) and produced 41.1 percent of total GDP, with growth in 2015 of 5.3 percent over the previous year. Furthermore, in 2015, SMEs involved 2.76 million enterprises or around 99.7 percent of the total (The Office of SMEs Promotion, 2016). Based on an action plan to support Thai SMEs, the key achievements of business are the integration of knowledge, creativity, innovation, and cultural uniqueness to grow a business sustainably (The Office of SMEs Promotion, 2011). The Organization for Economic Cooperation and Development (OECD) has noted that innovation occurs when there is an exchange of knowledge and technology among the university, industry, and government sectors (OECD, 1997). Innovation refers to the implementation of creative ideas, involving different approaches, within an organization (Brink & Madsen, 2016). Innovation, which is significant for business, currently is brought into national innovation

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Peer review under responsibility of Kasetsart University.

https://doi.org/10.1016/j.kjss.2017.12.007
2452-3151/

systems under the framework of innovation and advanced technology development (Intarakumnerd, Chairatana, & Tangchitpiboon, 2002; Yokakul & Zawdie, 2011). Each sector takes on a role that fosters innovation, the so-called Triple Helix effect (Etzkowitz & Leydesdorff, 2000; Ranga, Miedema, & Jorna, 2008). The Triple Helix model is a network-based approach that targets social relationships and collaboration among sectors so as to facilitate knowledge exchange and interactive learning (Yokakul & Zawdie, 2011). This collaboration produces the circulation of knowledge leading to innovation (Herliana, 2015). The university sector is a source of academic knowledge and research and development (R&D) as well as knowledge transfer to the industry and government sectors. The industry sector drives the research through the university (Razak, Rowling, White, & Mason-Jones, 2016) as well as undertaking product and process development, while government bodies work as supporters to plan the innovation policy for the industry sector and also provide the universities with funding for laboratories and R&D (National Innovation Agency, 2008; National Science Technology and Innovation Policy Office, 2015). The Triple Helix when focused on innovation infrastructure can benefit society and economics (Yokakul & Zawdie, 2011).

In Thailand in 2015, food manufacturing generated the largest GDP value (USD 17.54 billion) or 17.24 percent of total manufacturing and there were 117,205 Thai SMEs in that sector in that year (The Office of SMEs Promotion, 2016). In 2016, the Thai government encouraged the food industry in cities to develop food innovation for driving the economy and creating value-adding for agricultural products via new food processes (National Science Technology and Innovation Policy Office, 2016). In addition, the Ministry of Industry in Thailand has focused on the development of food manufacturing as a major foundation of ASEAN through R&D (Ministry of Industry, 2012). The development of the food industry is very important to Thailand—a country based on agricultural productivity—for enhancing competitiveness in the global market. Many SMEs in the food industry favor improving their product offering through investment that will then deliver value-added returns (Kiumarsi, Jayaraman, Isa, & Varastegani, 2014).

Nevertheless, SMEs face major challenges, because they lack knowledge and/or financial support (Talib, Ali, & Idris, 2013). Very few have effective R&D activities and thus, face barriers to innovation (Diez, 2002). The interaction of SMEs with universities, industry, and government could enable them to access resources to enhance their innovation (Guerrero & Urbano, 2017; Yuwawutto et al., 2010).

In previous research, Ranga et al. (2008) studied the main means for enhancing the innovative capacity of small firms in the Northern Netherlands through Triple Helix interaction in the form of a round table and interviews with representatives of the main stakeholders (small firms, knowledge institutions, government agencies). Zeng, Xie, and Tam (2010) investigated the relationship between different cooperation networks and the innovation performance of SMEs in China. Yuwawutto et al. (2010) examined the university-industry-government relationship for improving the efficiency and competitiveness in a case study of dried banana products in a Thai community enterprise. Yokakul and Zawdie (2011) highlighted the significance of social capital as a factor for enhancing the effectiveness of the Triple Helix network in influencing technological capability development in Thai dessert firms. Handoko, Smith, and Burvill (2014) studied the role of government, universities, and enterprises according to knowledge and technology transfer in terms of influencing the process innovation and competitiveness of SMEs in Indonesia. Herliana (2015) proposed a regional innovation cluster approach for SMEs in Indonesia, involving collaboration by academia, industry, and government, for strengthening regional innovation systems and enhancing the competitiveness of SMEs, after carrying out in-depth interviews and reviewing secondary data. Wonglimpiyarat (2016) reviewed the role of the innovation incubator, university business incubator, and government in Thailand based on the Triple Helix model in supporting the entrepreneurial development and innovation commercialization. Brink and Madsen (2016) studied how SMEs can enable innovation and gain benefits from the Triple Helix approach in terms of reducing the cost of energy in the offshore wind energy sector in Denmark. Li, Arora, Youtie, and Shapira (2016) investigated the Triple Helix relationship in the context of the growth of U.S. green goods SME manufacturing enterprises. Guerrero and Urbano (2017) focused on the influence of enterprises' links with Triple Helix Agents on innovation performance produced by entrepreneurial initiatives in Mexico as a study in an emerging economy.

However, there have only been a few studies that investigated the effect of interaction with Triple Helix Agents on innovation performance from an SME perspective. There is also a lack of information regarding the level of SME interactions with Triple Helix Agents. Moreover, consideration of innovation performance in terms of product and process (Rowley, Baregheh, & Sambrook, 2011; Rujirawanich, Addison, & Smallman, 2011) has not been pursued. Furthermore, the prospects of, enhancing the innovation of food manufacturing, which is the most important sector to the economic development in Thailand, through application of the Triple Helix model in this emerging country context has also received scant attention. Hence, there is a need for research investigating the level of interactions among Triple Helix Agents from an SME perspective. SMEs in the Thai food manufacturing context, for the reasons explained above, provide the focus this study. This paper also delivers understanding regarding the influence of SMEs' interaction with Triple Helix Agents on product and process innovation in that industry.

Literature Review

The Triple Helix concept has been discussed in the development of dynamic knowledge based on innovation systems (Li et al., 2016). Recent studies have explored the relationship between SMEs and collaboration amongst Triple Helix Agents to boost innovation performance. Nakwa, Zawdie, and Intarakumnerd (2012) noted that the

Triple Helix approach produced benefits in relation to access to resources, for example, knowledge and skills, which could then be applied to develop SME innovation. Brink and Madsen (2016) revealed that SMEs can enable innovation from integration in a Triple Helix context.

Innovation has been defined as an idea, practice, or object that is perceived as new by an individual or other unit of adoption (Rogers & Shoemaker, 1983). It has also been defined as pertaining to the implementation of a new or significantly improved product or process/method in business practices (UNESCO, 2008), which can help to improve enterprises' competitive advantage (Rujirawanich et al., 2011). According to Rujirawanich et al. (2011), innovation can and should be divided into product and process innovation. Product innovation refers the development of a new product or improvement of an existing one. Process innovation pertains to creating, implementing, or improving methods of production (Handoko et al., 2014; Oke, Burke, & Myers, 2007). Accordingly, the current study involved investigating SME collaboration with Triple Helix agents (universities, industry, and government) to ascertain whether such collaboration influences the product and/or process innovation performance of firms.

SME Collaboration with Universities

Universities and other research organizations provide technology transfer, formal R&D collaboration, personal training in relation to skilled workforce, and innovative knowledge to firms (Zeng et al., 2010). Etzkowitz and Leydesdorff (2000), after carrying out a meta-review, concluded that universities would benefit from linking their research with that of Triple Helix Agents, thereby promoting the primacy of the university as a source of innovation. Belderbos, Carree, Diederen, Lokshin, and Veugelers (2004) found that collaboration with academic institutions in the Netherlands was the most effective way to achieve innovation. In developing countries, collaboration with higher education and public research institutions has been elicited as being an important source of new knowledge for SMEs (Liefner, Hennemann, & Xin, 2006). Liefner et al. (2006) suggested that universities in China could have a direct impact on innovation of SMEs in other developing countries. Razak and Saad (2007) elicited that Malaysian universities were responsible for knowledge and skills leading to new industries, product and services. Fritsch and Franke (2004) concluded that having a relationship with a research organization in Germany enabled firms to achieve innovation for patenting. Similarly, Nieto and Santamaría (2007) contended that a firm's collaboration in Spain with research organizations can improve its innovation. Dzisah and Etzkowitz (2008) pointed out how many universities have become involved in knowledge transferring with Brazilian incubators and development with the aim of instigating innovation. Ranga et al. (2008) discovered that universities are important not only in relation to R&D, for they also are crucial for new ideas generation, both of which can lead to innovation development for small firms in Netherlands. Yuwawutto et al. (2010) reported that the university sector supports Thai SMEs in enhancing their innovation performance. Zeng et al. (2010) showed that collaboration with universities leads to improvements in the innovation performance of SMEs. Klomklieng, Ratanapanee, Tanchareon, and Meesap (2012) explained the role of Thai universities as intermediaries for property rights commercialization, consultancy, equipment sharing, and human resource exchange. Audretsch (2014) revealed that an enterprise was more likely to choose university partners when it needed a source of new technological knowledge for innovation. Wonglimpiyarat (2016) pointed out that a program provided by a university business incubator is one of the major policy mechanisms for supporting innovation. Based on the relationships discussed above, we therefore hypothesize that:

H1: SME collaboration with universities produces a positive effect on product innovation.
H2: SME collaboration with universities produces a positive effect on process innovation.

SME Collaboration with Industry

Enterprises require collaboration within their industrial sector in order to tap into sources of know-how, new technologies, and/or new markets (Fischer & Varga, 2002). In the case of emerging economies, Crespi and Zúñiga (2012) found that knowledge sharing through firms' collaboration in six Latin American countries had positive effects on enterprises' innovation performance. Sammarra and Biggiero (2008) argued that firms' collaboration within their industry in Italy could lead to increased innovation. Moreover, Chung and Kim (2003) contended that cooperation between suppliers and manufacturers in the Korean industry enabled firms to enhance product quality. Nieto and Santamaría (2007) pointed out how suppliers in industry could be valuable sources of information for developing the products of Spanish manufacturing. Klomklieng et al. (2012) found that inter-firm relationships could increase innovation through identification of common requirements and prototype testing through product/process development, equipment sharing, information and knowledge exchange, and consultancy provision. Nakwa et al. (2012) discovered that a stronger inter-firm relationship in Thai industry led to information exchange and product development. Landström, Åström, and Harirchi (2015) claimed that firms collaborating with other innovative enterprises had a positive impact on their innovation performance. This discussion leads to the following two hypotheses:

H3: SME collaboration with industry produces a positive effect on product innovation.
H4: SME collaboration with industry produces a positive effect on process innovation.

SME Collaboration with Government Agents

There may be a role for government to support greater collaboration between enterprise and universities (Freel, 2000). Hewitt-Dundas (2006) explained that the Ireland

government had carried out policy initiatives to promote innovation of small firms as a source of innovation. Smallbone, North, Roper, and Vickers (2003) discovered that there were a number of policies launched by the government, encouraging SMEs in Ireland to assure product and process innovations. Biggs and Shah (2006) found that there was a linkage between informal government agents and innovation performance for African SMEs. Government supported university's role in creating an industrial environment (Dzisah & Etzkowitz, 2008).

Ranga et al. (2008) revealed thus government played a key role in supporting the trilateral network and hybrid organizations in the Netherlands, thus contributing to innovation. Moreover, it has been argued that government agents could effectively support universities in China to enhance knowledge, thereby making them valuable contributors to process innovation for SMEs (Zeng et al., 2010). Yuwawutto et al. (2010) elicited that the government sector has assisted Thai firms in technology knowledge through R&D, expertise and equipment. Yokakul and Zawdie (2011) contended that government support was positively linked to the technological capability of Thai SMEs and their process development. Nakwa et al. (2012) revealed that government agents could play a role as regulators and promoters of a knowledge network for Thai SMEs-based industries. Furthermore, the government has promoted the regulation, programme, resource, and actions for collaborative projects involving universities and firms in Belgium. This perspective allows enterprises to promote

Table 1
Indicators of SME collaboration with Triple Helix agents and innovation performance

Construct	Item	Author(s)
Triple Helix		
- Collaboration with universities (U)	- SMEs receive knowledge transfer from universities (U_1) - SMEs receive advice/help from universities about innovation development (U_2) - SMEs use the services of universities as incubators for entrepreneurs (U_3) - SMEs receive support and help from teachers, specialists, or students from universities (U_4) - SMEs receive support from universities in the form of use laboratories, tools, or equipment (U_5)	Dzisah and Etzkowitz (2008), Etzkowitz and Leydesdorff (2000), Klomklieng et al. (2012) and Ranga et al. (2008)
- Collaboration with industry (I)	- SMEs in the industry participate in creating innovation with the academic sector (I_1) - SMEs in the industry make joint investment for R&D or other research projects (I_2) - SMEs in the industry apply knowledge from research and development to real practice (I_3) - SMEs in the industry are able to access resources from universities/government (e.g. funding, technology, venue, utilities) (I_4) - SMEs exchange their knowledge through inter-firm collaboration (I_5)	Dzisah and Etzkowitz (2008), Etzkowitz and Leydesdorff (2000), Klomklieng et al. (2012), Nakwa et al. (2012) and Yuwawutto et al. (2010)
- Collaboration with government (G)	- SMEs have opportunities to contact/access government agents regarding their policies (G_1) - SMEs can access knowledge through the support of government agents (G_2) - SMEs receive utilities infrastructure from government agents when wanting to establish new plant in Thailand (G_3) - SMEs receive financial support from government agents (G_4) - SMEs know about the services or information available from government agents (G_5)	Dzisah and Etzkowitz (2008), Freel (2000), Nakwa et al. (2012), Ranga et al. (2008) and Yuwawutto et al. (2010)
Innovation		
- Product innovation (PD)	- Introduction of new products of the organization to the market is as a result of innovation (PD_1) - Improving existing product through innovative activity (PD_2) - New/Improved product is able to provide benefits commercially for the organization (PD_3) - New/Improved product is able to increase competitiveness for the organization (PD_4) - New/Improved product can provide value-added to customers (PD_5)	Oke et al. (2007), Rujirawanich et al. (2011) and UNESCO (2008)
- Process innovation (PC)	- Introduction of new process or methodology to the organization during its development (PC_1) - Improvement or changing the process/methodology during the running of the business (PC_2) - New/Improved process leads to an increase in the competitiveness of an organization (PC_3) - New/Improved process results in lower costs for the organization (PC_4) - New/Improved process results in the creation of value-added from higher productivity (PC_5)	Handoko et al. (2014), Oke et al. (2007), Rujirawanich et al. (2011) and UNESCO (2008)

R&D activities and enhance collaboration with other agents (Cassiman & Veugelers, 2002). Guerrero and Urbano (2017) found that Mexican SMEs were able to access knowledge, technology, capital, and support from the government through the Triple Helix approach. Hence, we propose that:

H5: SME collaboration with government produces a positive effect on product innovation.
H6: SME collaboration with government produces a positive effect on process innovation.

Methods

Questionnaire, Measurement, and Data Collection

For this research, a questionnaire was devised to collect data and thus meet the objectives of this research. The study focuses on the food manufacturing sector, because it generates the largest GDP in the manufacturing sector in Thailand (The Office of SMEs Promotion, 2016). Moreover, Thailand needs to develop food innovation for its economic development as well as to enhance competitiveness in the global market (Ministry of Industry, 2012; National Science Technology and Innovation Policy Office, 2016). The questionnaire contained three parts, with the first probing each respondent's SME's characteristics. SME collaboration with universities, industry, and/or the government sector was investigated through the second part. The third part probed the level of product and process innovation of SMEs in the food industry. For each of these two parts, the respondents were asked to express the degree to which they agreed with two sets of statements on a seven-point Likert scale, where 1 indicated the least agreement and 7 the most agreement. The average scores were divided into seven equal-sized categories: 1) very low level [1.000–1.857] 2); low level [1.858–2.714] 3); quite low level [2.715–3.571]; 4) moderate [3.572–4.428]; 5) quite good level [4.429–5.285]; 6) good level [5.286–6.142]; and 7. very good level (6.143–7.000). The average scores of the two latter parts were used to test the above hypotheses.

Before sending out the questionnaire, we consulted an advisor to check the content validity of the questions and their comprehensibility. The authors collected 10 completed questionnaires from Thai food SMEs during a pilot testing, and calculated the Cronbach's alpha (0.958–0.990), which was higher than 0.7, thus indicating adequate reliability of the measurement scales (Nunnally, Bernstein, & Berge, 1967). The survey involved collecting data from 87 Thai SME food manufacturers based on the definition of SMEs in Thailand, or around 0.07 percent of the total in the sector. According to VanVoorhis and Morgan's (2007) rule of thumb from their formula for multiple regression with three independent variables, the sample size n needed to be greater than 74, which it clearly was. The data were collected from three food agriculture-related and manufacturing-related events during March 2017 and hence, the process involved convenience sampling. Specifically, these events were: 1) Thai Franchise & SME Expo 2017 (300 enterprises); 2) The product community of OTOP (104 enterprises); and 3) Food Safety and Agricultural Products (400 enterprises).

Constructs and Statistics Analysis

We based our model structure on a PLS-SEM from SmartPLS, which is recommended for small sample sizes without any distribution requirements as this is a non-

Table 2
Assessment of the measurement model

Construct	Indicator	Factor loading	CR	Cronbach's alpha	AVE
Collaboration with universities	U_1	0.930	0.954	0.940	0.807
	U_2	0.950			
	U_3	0.896			
	U_4	0.950			
	U_5	0.905			
Collaboration with industry (I)	I_1	0.925	0.959	0.946	0.824
	I_2	0.934			
	I_3	0.918			
	I_4	0.878			
	I_5	0.881			
Collaboration with government (G)	G_1	0.916			
	G_2	0.929			
	G_3	0.912	0.966	0.956	0.850
	G_4	0.854			
	G_5	0.879			
Product innovation (PD)	PD_1	0.917	0.973	0.965	0.879
	PD_2	0.955			
	PD_3	0.944			
	PD_4	0.952			
	PD_5	0.919			
Process innovation (PC)	PC_1	0.919	0.968	0.959	0.858
	PC_2	0.922			
	PC_3	0.914			
	PC_4	0.927			
	PC_5	0.928			

parametric technique (Hair, Joseph, Tomas, Ringle, & Sarstedt, 2014). We constructed indicators regarding related studies with five latent variables as SME collaboration with universities, industry, or government bodies along with product and process innovation in Thai SMEs in food manufacturing, as summarized in Table 1. We used confirmatory factor analysis (CFA) to establish the convergent validity and discriminant validity of our construct. The results, as shown in Table 2, revealed that the factor loading of the indicators for these five latent variables was higher than 0.6 (Latan & Ghozali, 2012). The composite reliability (CR), Cronbach' Alpha, and the average variance extracted (AVE) for the five latent variables were greater than the minimum cutoff values of 0.7, 0.6, 0.5, respectively, thus indicating acceptable construct reliability and convergent validity (Hair, Ringle, & Sarstedt, 2011; Latan & Ghozali, 2012). Table 3 shows the square roots of the AVEs for the constructs and the correlations among the constructs, indicating that the model possesses acceptable discriminant validity (Latan & Ghozali, 2012). For a goodness-of-fit test, Henseler et al. (2014) introduced the SRMR as a such a measure for PLS-SEM that can be used to avoid model misspecification, the value of which should be less than 0.8 (Hu & Bentler, 1998), which was the case for the current study (SRMR = 0.051). Thus, the structural model in this research was presented in Figure 1. Subsequently, multiple regression analysis was used to test the hypotheses regarding the influence of SME collaboration with Triple Helix Agents on product and process innovation at the .05 significance level.

Table 3
Discriminant validity

Construct	U	I	G	PD	PC
U	**0.898**				
I	0.604	**0.908**			
G	0.615	0.861	**0.922**		
PD	0.600	0.852	0.910	**0.937**	
PC	0.657	0.727	0.662	0.607	**0.926**

The square root of AVE is shown diagonally in bold

Results

SMEs Characteristics

Most of the 87 SMEs in Thai food manufacturing had 1–50 employees and 92 percent had fixed assets of less than THB 50 million. The types of food manufacturing in this survey mainly involved fruit and vegetable processing, meat processing, and fish and aquatic animal processing (34.5%, 26.4%, and 14.9%, respectively).

SME Collaboration with Triple Helix Agents

The descriptive statistics in Table 4 show the average scores with regard to SME collaboration with university, industry, and government bodies. The network of entrepreneurs in food manufacturing collaborates together, with a score ranging from 4.562 to 4.844, by encouraging Thai entrepreneurs to participate in and create innovation and to join investment in research projects with universities. SMEs collaborating with universities had scores ranging from

Table 4
SME collaboration with universities, industry, and government bodies

Construct	Ites	Mean	S.D.	Min	Max
Collaboration with universities (U)	U_1	4.563	1.561	1	7
	U_2	4.531	1.493	1	7
	U_3	4.479	1.436	1	7
	U_4	4.542	1.457	1	7
	U_5	4.437	1.621	1	7
	Total	4.510	1.408	1	7
Collaboration with industry (I)	I_1	4.844	1.644	1	7
	I_2	4.792	1.666	1	7
	I_3	4.729	1.573	1	7
	I_4	4.562	1.428	1	7
	I_5	4.583	1.287	2	7
	Total	4.702	1.390	1	7
Collaboration with government (G)	G_1	4.167	1.639	1	7
	G_2	4.042	1.542	1	7
	G_3	3.979	1.556	1	7
	G_4	3.771	1.573	1	7
	G_5	3.792	1.528	1	7
	Total	3.950	1.411	1	7

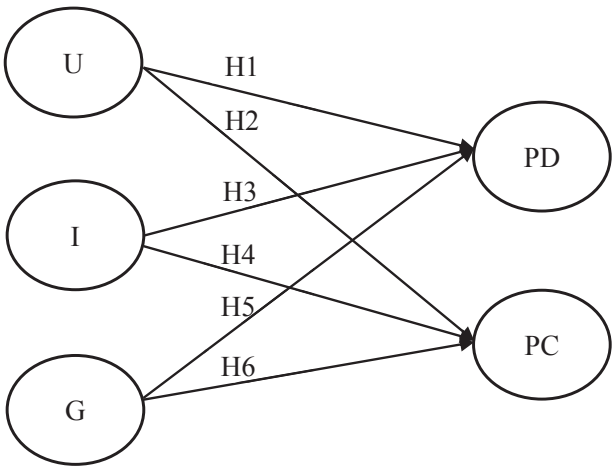

Figure 1 Structural model

Table 5
Innovation performance of Thai SMEs in food manufacturing

Innovation performance	Item	Mean	S.D.	Min	Max
Product innovation (PD)	PD_1	4.750	1.556	1	7
	PD_2	5.063	1.614	1	7
	PD_3	5.000	1.576	1	7
	PD_4	4.833	1.567	1	7
	PD_5	4.927	1.488	1	7
	Total	4.915	1.467	1	7
Process innovation (PC)	PC_1	4.802	1.498	1	7
	PC_2	4.594	1.411	2	7
	PC_3	4.698	1.509	1	7
	PC_4	4.479	1.501	1	7
	PC_5	4.792	1.595	1	7
	Total	4.673	1.384	1	7

4.437 to 4.563, with the important roles of providing knowledge transfer from research as well as supporting human development for the food manufacturing industry. Government agents working with SMEs had scores ranging from 3.771 to 4.167 and developed policies to support collaboration with regard to the Triple Helix concept, including encouraging intermediaries (such as incubators) to help the food manufacturing industry. The results indicated that SME collaboration with industry had the highest score (4.7) followed by universities (4.51) and government (3.95), respectively. The findings suggest that interaction between industry and universities with Thai food manufacturing SMEs was at quite a good level, whereas government agencies interactions with Thai food manufacturing SMEs had the lowest overall score of just 3.95.

Innovation of Thai Food Manufacturing SMEs

The study investigated the performance of SMEs in food manufacturing with regard to product innovation and process innovation. The descriptive statistics in Table 5 provide the average scores for innovation performance. The results regarding product innovation (4.91) of SMEs were at the quite good level, ranging from 4.750 to 5.063. Improving existing products and providing benefits from new or enhanced products received a good score for product innovation in the food manufacturing industry. However, launching new products of SMEs onto the market had the lowest score regarding product innovation. The findings also showed that SMEs in food manufacturing performed at quite a good level too regarding process innovation (4.67), with scores ranging from 4.479 to 4.802. SMEs are able to introduce new processes or methodologies into their firms as well as propose new/improved processes for creating value-adding productivity. Nevertheless, new/improved processes to lower the costs of the firm had the lowest score in relation to the performance of process innovation. In sum, the results clearly indicated that SMEs in food manufacturing were better at product innovation than process innovation.

Relation Between SME Collaboration with Triple Helix Agents and Innovation

Multiple regression analysis was employed to examine the relationship between SME collaboration with Triple Helix Agents and innovation performance at the .05 significance level (Tables 6 and 7). Normality was assessed according to the value of the skewness and kurtosis of the independent variables and dependent variable, which ranged from −0.319 to −0.758, and −0.092 to −0.981, respectively. They are acceptable in terms of normality, because the absolute values of skewness and kurtosis were less than 2 for each measure (George & Mallery, 2003). The plot of the standardized residual by the regression standardized predicted value was quite constant, thus implying that there was homoscedasticity. The values resulting from multicollinearity testing of the variance inflation factor

Table 6
Regression model of product innovation

	Unstandardized coefficients		Standardized coefficients	t	Sig.	Collinearity statistics	
	B	SE	*β*			Tolerance	VIF
Constant	0.524	0.308		1.702	.092		
University	−0.113	0.094	−0.107	−1.200	.234	0.396	2.523
Industry	0.877	0.089	0.821	9.818	.000*	0.453	2.210
Government	0.184	0.078	0.178	2.341	.022*	0.545	1.835

Statistically significant at $^*p < .05$ level, F-value = 77.668, $n = 87$, $R^2 = .737$; adjusted $R^2 = .728$; Durbin–Watson = 2.172

Table 7
Regression model of process innovation

	Unstandardized coefficients		Standardized coefficients	t	Sig.	Collinearity statistics	
	B	SE	*β*			Tolerance	VIF
Constant	0.382	0.288		1.330	.187		
University	0.006	0.088	0.006	0.070	.944	0.396	2.523
Industry	0.779	0.083	0.763	9.338	.000*	0.453	2.210
Government	0.148	0.073	0.151	2.021	.047*	0.545	1.835

Statistically significant at $^*p < .05$ level, F-value = 82.522, $n = 87$, $R^2 = .749$; adjusted $R^2 = .740$; Durbin–Watson = 2.177

(VIF) were in the range 1.835−2.523 (less than 10), while the tolerances of the three variables were in the range 0.396−0.545 (greater than 0.1), thus indicating there was no multicollinearity. The Durbin−Watson significance test was acceptable (2.172 and 2.177), indicating that there was no auto-correlation for the regression model.

The evidence supporting the first, third, and fifth hypotheses with regard to product innovation is provided in Table 6. The results showed that SME collaboration with industry and government produced a positive effect on product innovation (significant at the .05 level). The standardized coefficients in the regression model indicated that SME interaction with industry impacted significantly on the product innovation of Thai SMEs in food manufacturing, followed in importance by interaction with government. The model regarding Triple Helix Agents was able to explain 72.8 percent of the variance (adjusted $R^2 = .728$) of the performance of product innovation.

The findings also supported the second, fourth, sixth hypotheses with regard to process innovation and are presented in Table 7. The results showed that SME collaboration with industry and government produces a positive effect on process innovation (significant at the .05 level). The standardized coefficients in the regression model indicated that SME collaboration with industry impacts positively on the process innovation of Thai SMEs in food manufacturing, followed in importance by interaction with government. Furthermore, 74 percent of the variance (adjusted $R^2 = .740$) of process innovation was explained by the Triple Helix-based model.

Whilst collaboration between universities and SMEs in food manufacturing stands at quite a good level, according to the descriptive statistics, the results of the hypothesis testing indicated that SME collaboration with universities had no significant impact on the innovation of Thai SMEs in food manufacturing. This could be explained according to Yuwawutto et al. (2010), by the primary aim of universities being to focus on academic-based research, which is usually required for publication, rather than meeting the needs of industry. As a result, whilst SMEs want universities to act as innovative centers through knowledge transfer, thereby enhancing human development sector, this is not occurring to a great extent because their main focus is on basic research. Hence, it is important that universities are encouraged to understand SME needs in terms of how they could enhance their innovation performance.

Conclusions

For this paper, the levels of collaboration were probed of Thai SMEs involved in food manufacturing with university, industry, and government agents with regard to innovation. The results showed that SME collaboration with Triple Helix Agents was not that high, especially with regard to the government sector. Moreover, innovation performance in relation to both product and process needs to be developed. In addition, encouraging SME collaboration with industry and government bodies could significantly develop innovation of both the products and processes of food manufacturing SMEs. The results are in line with the findings of Biggs and Shah (2006), Godin and Gingras (2000), Landström et al. (2015), Sammarra and Biggiero (2008), Smallbone et al. (2003), Yokakul and Zawdie (2011) and Zeng et al. (2010), revealing that there are positive effects of SME collaboration with industries and government agents in terms of improving innovation performance. However, this research did not find a significant relationship between SME collaboration with universities and innovation performance, for the reasons explained above in relation to the different research foci of these two sectors.

The contribution of our research paper is to explain the level of interactions among Triple Helix Agents based on the SME perspective in a manufacturing sector. The study provides understanding of the influence of collaboration among these agents on product and process innovation in the food industry. The managerial implications from this paper's findings are that SMEs in food manufacturing could benefit from collaboration with Triple Helix Agents as such activity can have a strong positive influence on their innovation performance. For instance, SMEs can work with enterprises in the industry as networks to create joint investment for R&D projects as well as participate with government agents to secure access to resource. SMEs can apply knowledge transfer from R&D into practice to improve their innovation performance. The government can also develop policy support and encourage SME collaboration with Triple Helix Agents, including intermediaries, through programs, resource allocation, and other actions. Universities should take on the role of innovative centers in collaboration with SMEs in order to understand their requirements. For future research, we recommend scholars or practitioners should investigate how universities can collaborate with SMEs to enhance innovation performance in manufacturing. We also suggest that university business incubators as intermediaries should be investigated as mediators in the Triple Helix model for theoretical development. In addition, we recommend the use of control variables in the regression model, especially the characteristics of SMEs themselves (size, location, and year established), as these could well impact the final results.

Conflicts of Interest

There is no conflict of interest.

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