

Effect of Enterprise Resource Planning on Supply Chain Forecasting Capability through Collaboration: An Empirical Study of Frozen Foods Industry in Thailand

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Abstract— This study investigated how enterprise resource planning and collaboration influenced supply chain forecasting capability. The research sample consisted of 234 companies from various Thai frozen food industry enterprises. As the model consisted of collaboration as a mediator between enterprise resource planning and supply chain forecasting capability, the path analysis was used to test the statistical significance of the results. According to the result, the companies that used enterprise resource planning (ERP) to establish up a common information network across the supply and demand environment, and implement ERP to integrate information on the demand and supply chains by rotating staff in the departments in order to collaborate between customers and suppliers will have more reliable data to use when making demand predictions.

Keyword: Collaboration; ERP, Forecasting, Supply Chain

I. INTRODUCTION

Food production and agriculture are significant contributors to overall economic prosperity of Thailand. Frozen food market is considered to be of utmost significance on account of the growing quantity of merchandise that is shipped abroad on an annual basis. In fact, globalization leads to freer and more open trade, but also more intense. In order to modify their work patterns and keep up with the competition, businesses are embracing information technology. The market is becoming even more cutthroat and aggressively

competitive. Supply chain management, also known as SCM, has emerged as an essential tactic for gaining a competitive advantage in frozen food industry[1]. It is essential to have effective supply chain management in order to beat the intense level of current competition[2], reduce costs[3], and improve economic efficiency. Since the quality of Thai exports is acknowledged in advanced economies like Japan and the European Union, supply chain management has been an integral part of Thailand's economic development. Thai frozen food industry has been making an effort to improve its internal efficiency in order to reduce costs, improve quality, ensure on-time deliveries, and increase competitiveness. It is essential that the industry speed up its development across the entirety of the supply chain. The enterprise resource planning (ERP) system benefits the management of the frozen food industry in terms of decision-making since it is able to consolidate data from across functional areas[4], where it can be used to better forecast the future supply and demand.

The Thai government imposed a policy to support and encourage the food processing sector by introducing new technologies and providing knowledge in terms of product development and food processing with an emphasis on quality, hygiene, food safety, sanitation, and purity. It is believed that efficiency improvement can lower production costs while increasing value, which meet the rising demand for domestic and international exports. The Thai government has been pushing an economic model, known as "Thailand 4.0" in order to transform Thailand from a middle-income State to a

high-income one[5]. This transformation will be accomplished by placing an emphasis on research and development in science and technology, as well as creativity and innovation. The food industry needs to find effective tools and practices for value chain management to eliminate inefficient and ineffective practices that slow down processes and deter the industry from achieving better organizational performance.

The purpose of this study was to examine the relationship between an enterprise resource planning system and forecasting abilities as well as the efficacy of information management using a collaborative capacity-building approach. Interestingly, this study concentrated on how the data from enterprise resource planning systems affected collaboration and the effectiveness of decisions made by supply chain management.

II. LITERATURE REVIEW

A. Resource Based View

This study examined the relationship between the capabilities of enterprise resource planning and combined supply chain capability using the company's resource-based view as a ground-based theory. The resource-based view (RBV) is a well-known framework for examining the creation and maintenance of organizational advantages and market viability[6]. The RBV method of strategic management is based on the idea that market leaders develop implicit or intangible skills that set them apart from their competitors and give them a competitive advantage [7]. According to the RBV, superior company performance results from the company's ability to amass "VRIN" resources, which are (1) valuable (2) rare (3) imitable. (4) non-substitutable[8]. Several empirical studies that used the RBV to examine how enterprise resource planning and supply chains affected the performance of a company revealed that certain capabilities were strongly linked to important and positive business outcomes[9-11].

B. Enterprise Resource Planning and Supply Chain

The term "Enterprise Resource Planning" (ERP) refers to a type of business software that integrates data from all departments of an organization into a unified, all-encompassing database to facilitate enterprise-wide management functions, including accounting, sales, manufacturing, and purchasing. The enterprise resource planning system is centralized to support value chain management of business processes and communication with business partners, such as suppliers of raw materials and customers in the supply chain. Certain data is shared and passed across departments to facilitate value chain management of business activities. According to the findings of a study conducted by Jakraphun Srisawat and Natnarong Jaturat [12], companies operating in the food industry in Thailand that make use of enterprise resource planning systems can contribute to the smoother operation of supply chain management since the purpose

of the enterprise resource planning system is to put the information system to work and better support the company. It is possible that early adoption will cause some difficulties in the adoption and implementation processes. In order to succeed in the implementation, it is necessary to adopt the new system by considering the technological context of the business both internally and externally. This also includes personnel and organizational structure of the business management, as well as the environment so that the customers and suppliers can actively participate in the implementation process [13-15]. With the ERP system, the information and all processes in the organization are connected and become one system since it is easier to gather the information during purchase order process, delivery process, and payment process. Obviously, the company's day-to-day internal operations, the communication, and the supply chain become simpler due to the enterprise resource planning system, which is used to manage both internal and external resources in order to facilitate the flow of data among activities [16]. The attribute of internal and external connection enhances connection among the organization, customers, and all the stakeholders, which leads to the success of the business, cost reduction, and greater productivity[17]. This clarity would reduce misunderstandings and mistakes while increasing the efficiency of overall communication. The ERP system provides assistance in forecasting future situations, regardless of the sale rate, inventory level, or any other department prediction so that the management can be aware and make decisions regarding business planning as quickly and accurately as possible. The implementation of ERP in order to establish a competitive advantage has been proven to be a significant success on the fundamental platform for business processing, supply chain management, customer relationship management, knowledge management, decision supporting system, and strategic management [18]. Thus, the hypotheses are as follows:

H1: Enterprise resource planning has a positive effect on supply chain collaboration, and

H2: Enterprise resource planning has a positive effect on supply chain forecasting capability.

C. Information Integration, Collaboration, and Supply Chain Forecasting

Information integration may be accomplished by the utilization of information technology strategies for the coordination of activities among vendors, the facilitation of activities among suppliers and consumers, and the reduction of transaction costs[19, 20]. Privacy, information, motivation, dependability, cost, complexity, correctness, and efficient data consumption are some of the most significant challenges that businesses encounter while attempting to integrate their data[21]. The field of information management theory, of which information

integration theory is a subset, investigates how individuals gather and organize information in various forms. Thus, the data warehouse technology is necessary for storing information after categorization, which is a prerequisite for information integration. In fact, information and knowledge management rely on data warehouses to foster interoperability, information exchange, and integration through the evolution of software-based information systems. According to Fortier, et al. [22], information integration is the process of drawing out the knowledge and capacities of information and technology, whether such capabilities belong to an individual or to an organization. In order to use information and technology for one's purposes or in collaboration with others, it requires competence with a wide range of tools, data sources, processes, retrieval systems, and information valuation which includes the application of information to problem solving, communication, decision making, and the generation of new knowledge, products, and systems. Several organizations inevitably encounter difficulties while managing the data and information systems in a Data Warehouse. Thus, it is vital that information integration must be sped up so that the data can be analyzed and synthesized to reveal new approaches, technologies, and applications for database management. This improvement can lead to accuracy and accommodate the needs of various users in order to estimate and forecast consumer demand and supply.

1) Internal Supply Chain Integration

Internal supply chain integration refers to the dynamic relationship that exists between activities and procedures carried out by a single organization. The goal of supply chain integration within the organization is to knock down the walls that separate various parts of the organization and connect them together for better supports. In particular, the areas that need to be integrated include procurement, planning and control of warehouse management, transportation management, and customer relationship management. The majority of big companies put an emphasis on supply chain management by appointing a director of supply chain management to be responsible for operational, purchasing, and logistics management[23].

2) External Supply Chain Integration

Supply chain can be defined as a network that companies are connected to the integration of the implementation. The management of the supply chain, both upstream and downstream, should be the primary focus of any company in order to boost their own competitiveness and produce or provide superior goods or services to those offered by their rivals[24]. Integration of an external supply chain involves networking with other organizations to facilitate the shipment of products or services to final customers. In case one of the relevant organizations is inefficient in its business operation, such

inefficiency will lead the entire supply chain to be uncompetitive. In fact, there has been a change from rivalry among organizations to competition inside supply chains. Moreover, the capacity to effectively meet the demands of consumers contributes to the factors that impact the efficiency of the supply chain. The organizations in the supply chain are obligated to consider the driving variables: include management of inventory, management of transportation, management of facilities, and management of information[23].

Information has the greatest impact on supply chain performance since it impacts the dynamics of the entire supply chain[25, 26]. In case the amount of information shared with one another increases, the companies that make up the supply chain have to improve their output. However, incorrectly managed information can lead to the Bullwhip Effect[27], which is the variability in planning and inventory projections at different levels in the supply chain. As a result, there may be an excessively large quantity of inventory or an inadequate amount of inventory[28]. In addition, the business partners, including wholesalers or retailers, in the supply chain are required to share information with all of the other members in order to collaborate on inventory forecasting and planning. Thus, the hypothesis is as follows:

H3: Supply chain collaboration has a positive effect on supply chain forecasting capability.

D. Decision Making and Supply Chain Forecasting

Nowadays, information technology and business management methods are continually evolving to become more contemporary. This can be seen in the form of product innovation, as well as innovation in the corporate working process. If a company can employ technology in making sound decisions, its corporate competitiveness increases. One of the strategies is to promote items that to meet customer's needs. It is necessary to plan production effectively, use resources wisely, and look for methods to lower production costs. Efraim, et al. [29] defined a decision support system as the combination of people's computing abilities and knowledge to improve the quality and precision of their decisions. The best outcomes for a business usually depend on the management team making decent operational decisions in response to challenging situations. An occurrence of problems triggers the response model to find the optimal course of action, which may be a decision to safeguard, change, or adapt the company towards future issues. The management may also implement novel approaches, such as expanding the number and variety of business models to generate more revenue, introducing novel innovations to improve management, boosting the quality of services offered to customers, and enhancing information management collaboration with commercial partners in the supply chain. One aspect of business administration

that goes hand in hand with the management of different operations is making sound judgment calls. Productivity can be enhanced and the goals can be achieved if the company can manage its resources into the production process to create value and the entire processes function as intended. Obviously, decision making plays an important role in the operational process, and typically involves selecting the course of action that would produce the desired results. In general, the decision that must be made is linked to the management of decision-making functions that must be made in various contexts. Thus, as the leader of an organization, one must be in charge of making decisions, coordinating, and negotiating with business partners in order to maximize profits and lead the organization to sustainable growth.

The term "supply chain forecasting" refers to the practice of analyzing historical demand data for demand forecasts regarding product supply and demand. This process involves making predictions based on past and present information by making use of both concrete data and intuition, and achieving varying degrees of accuracy[30]. It is essential to have a good understanding of how to accurately forecast the needs of the supply chain since proper forecasts have the potential to lead to stronger relationships with the suppliers, higher levels of customer satisfaction, greater opportunities, growth, and corporate success. With enterprise resource planning (ERP), companies can make decisions by integrating sales, marketing, manufacturing operations, financial accounting, logistics, new product development, supply chain management, customer relationship management, and human resources. Additionally, inventory management tools improve forecasting and planning to match supply and demand[31]. Since intra- and inter-organizational collaboration and supply chain agility are strongly correlated, the synergy between ERP and e-business technologies should be used to improve intra- and inter-organizational collaboration and supply chain agility[32]. Thus, the hypothesis is as follows:

H4: ERP has a positive effect on supply chain forecasting capability through collaboration.

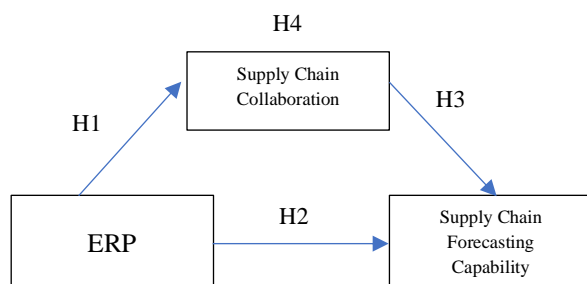


Figure I. Research Model

IV. RESEARCH METHODOLOGY

A. Research Design

This quantitative study used a survey and questionnaires to collect data. The sample group of this study was the 234 food processing companies in Thailand. The decision to focus on the food processing industry was influenced by two factors. Firstly, Thailand is one of the largest countries that produces and exports a large quantity of processed food exports, which makes a substantial contribution to the nation's economy. Secondly, it is well-known that the supply chain plays a crucial role in the food industry and the performance of the supply chain affects how the industry works, from getting raw materials to delivering finished products to customers.

To validate the content in the questionnaire and assess whether the research instrument can answer the research questions, consultation with experts in the field was conducted. Based on the Index of Item-Objective (IOC) methodology, the questionnaire was reviewed and assessed by six subject matter experts, including four university academicians, and two business professionals, and revised for precision in accordance with the evaluation results.

B. Variable and Measurement

The variables used in the research framework based on the study's literature review were (1) organizational resource planning, (2) collaboration, and (3) supply chain forecasting capabilities. Table I presents the detailed metrics and definitions of these variables. The data were gathered in the form of Likert scales with seven points, from one to seven, where 1 = strongly disagree, 2 = quite disagree, 3 = slightly disagree, 4 = neither agree nor disagree, 5 = slightly agree, 6 = quite agree, and 7 = strongly agree.

Table I: Variables

Variable Name	Details	Mean	SD
ERP1	Concentrate on establishing a common information network across the supply and demand environment.	5.50	1.08
ERP2	Concentrate on information resource management and information systems.	5.66	1.25
ERP3	Concentrate on policy for the most effective use of limited resources.	6.27	0.75
ERP4	Concentrate on implementing ERP as a cooperative readiness to work with others.	5.20	1.37
ERP5	Concentrate on implementing ERP to increase knowledge and ability, and to integrate information of demand and supply chains by rotating personnel responsibilities among departments.	4.91	1.48
Collaboration	Concentrate on IT management expertise strategies for internal sharing as well as customer and supplier collaborative operations.	5.33	1.16
Forecasting-capability	Concentrate on reliability of data for demand predictions.	5.44	1.19

C. Normality Testing

QQ plot and a histogram were utilized to examine the data whether each variable followed a normal distribution. The QQ Plot of the data set with a normal distribution presents a rising, roughly diagonal line as the plot moves from left to right along the x-axis, and the histogram looks like a bell curve. Its skewness and kurtosis index can be calculated by looking at its extremes. According to Kline [33], a variable with an absolute skew index value over 3.0 is extremely skewed, while a kurtosis index value over 8.0 is considered highly kurtosis.

D. Multicollinearity Testing

To rule out the possibility of a multicollinearity problem in the independent variables, which is one of the criteria of path analysis, it is necessary to conduct a multicollinearity test prior to hypothesis test. Pearson's correlation test shows that the coefficients of determination were less than or equal to 0.7 [34] (Table II).

Table II: Pearson's correlation testing

	1	2	3	4	5	6	7
1.ERP1	1						
2.ERP2	.64	1					
3.ERP3	.42	.48	1				
4.ERP4	.29	.34	.31	1			
5.ERP5	.28	.31	.17	.67	1		
6.Collaboration	.47	.27	.27	.45	.52	1	
7.SPC Forecasting Capability	.63	.54	.32	.61	.65	.65	1

V. RESEARCH RESULTS

A. Descriptive Statistics

As shown in Table I, the mean of ERP1 which concentrates on establishing a common information network across the supply and demand environment is 5.50, and the standard deviation is 1.08. The mean of ERP2 which concentrates on information resource management and information systems is 5.66, and the standard deviation is 1.25. The mean of ERP3 which concentrates on policy for the most effective use of limited resources is 6.27, and the standard deviation is 0.75. The mean of ERP4 which concentrates on implementing ERP as a cooperative readiness to work with others is 5.20, and the standard deviation is 1.37. The mean of ERP5 which concentrates on implementing ERP to increase knowledge and ability, and to integrate information of demand and supply chains by rotating personnel responsibilities among departments is 4.91, and the standard deviation is 1.48. For collaboration which concentrates on IT management expertise strategies for internal sharing as well as customer and supplier collaborative operations, the mean is 5.33, and the standard deviation was 1.16. Lastly, the mean of the supply chain forecasting which concentrates on reliability of data for demand predictions is 5.44, and the standard deviation is 1.19.

Table III. Comparison of the ERPs and the effect of supply chain collaboration on supply chain forecasting to evaluate mediator variables.

	Supply Chain Forecasting Capability		Supply Chain Collaboration		Supply Chain Forecasting Capability		Supply Chain Forecasting Capability	
	Standardized Coefficients	P-value	Standardized Coefficients	P-value	Standardized Coefficients	P-value	Standardized Coefficients	P-value
	Beta		Beta		Beta		Beta	
ERP1	0.427	0.000	0.416	0.000	0.230	0.001		
ERP2	-0.202	0.005	0.121	0.027	-0.259	0.000		
ERP3	0.094	0.118	-0.052	0.264	0.119	0.036		
ERP4	0.121	0.093	0.281	0.000	-0.012	0.864		
ERP5	0.362	0.000	0.271	0.000	0.233	0.001		
Collaboration					0.473	0.000	0.650	0.000
	Adjusted R ² = 0.405 F = 32.663 (p-value = .000)		Adjusted R ² = 0.643 F = 84.979 (p-value = .000)		Adjusted R ² = 0.482 F = 37.150 (p-value = .000)		Adjusted R ² = 0.420 F = 168.919 (p-value = .000)	
	Durbin-Watson = 2.113		Durbin-Watson = 2.091		Durbin-Watson = 2.298		Durbin-Watson = 2.236	

Table IV. Standard direct effect, standard indirect effect, and standard total effect of mediator variables.

	Standard Direct Effect			Standard Indirect Effect			Standard Total Effect		
	ERP1	ERP5	Collaboration	ERP1	ERP5	Collaboration	ERP1	ERP5	Collaboration
Collaboration	0.41	0.27					0.41	0.27	
Forecasting	0.23	0.23	0.47	0.19	0.12		0.42	0.35	0.47

To calculate the percentage of mediator, the effect of ERP1 on Forecasting through Collaboration is $0.19 / 0.42 * 100 = 46.23\%$, and the effect of ERP5 on Forecasting through Collaboration is $0.12 / 0.35 * 100 = 34.28\%$.

B. Hypothesis Testing Results

For hypothesis testing, path analysis was used to test the weight of variables in regression, and the results are shown in Table III and Table IV.

Hypothesis 1 (H1) was accepted since ERP1 and ERP5 were found to have an effect on collaboration. The findings indicate that enterprises concentrating on establishing a common information network across the supply and demand environments and implementing ERP to increase knowledge and ability and to integrate information on demand and supply chains by rotating personnel responsibilities among departments had a greater impact on IT management expertise strategies for internal sharing as well as customer and supplier collaborative operations.

Hypothesis 2 (H2) was accepted since ERP1 and ERP5 were found to have an effect on supply chain forecasting capability. The findings indicate that enterprises concentrating on establishing a common information network across the supply and demand environments and implementing ERP to increase knowledge and ability and to integrate information on demand and supply chains by rotating personnel responsibilities among departments had a positive impact on data reliability to predict demands.

The findings above are in line with the findings of Awa et al. [18], who indicated that ERP systems were implemented to facilitate supply chain management and decision support systems.

Hypothesis 3 (H3) was accepted since collaboration was found to have an effect on forecasting. The findings indicate that enterprises concentrating on IT management expertise strategies for internal sharing as well as customer and supplier collaboration had a positive effect on the reliability of data to predict demands. This supports the findings of Sharma et al. [28], who demonstrated that increased collaboration throughout the supply chain could reduce the impact of the bullwhip and permit more accurate inventory forecasting and planning.

Hypothesis 4 (H4) was accepted since an indirect effect of ERP1 and ERP5 on forecasting through collaboration was found. The findings indicate that enterprises concentrating on establishing a common

information network across the supply and demand environment and implementing ERP to increase knowledge and ability and to integrate information on demand and supply chains by rotating personnel responsibilities among departments had a positive impact on data reliability to predict demands through IT management expertise strategies for internal sharing as well as collaborative operations with customers and suppliers.

VI. CONCLUSION

With the aim to study the influences of enterprise resource planning (ERP) on supply chain forecasting capability, the supply chain collaboration was hypothesized as a product of a good strategy concept. The results of the hypothesis testing show that an emphasis on establishing a common information network across the supply and demand environments and implementing ERP to increase knowledge and ability, and to integrate information on both demand and supply chains by rotating personnel responsibilities between departments can improve the reliability of data used for demand predictions. Besides producing more accurate predictions in the supply chain, sharing accurate and up-to-date information with suppliers and customers in the supply chain can also lead to better collaboration.

Even though ERP is beneficial in centralizing information to support business processes and communications in the supply chain, it may leave users who work only in their own department without the background to fully comprehend the connections with other departments. The study suggests that rotating employees to different departments on a regular basis reflects that the organization is trying to build relationships across the departments by exposing new types of business processes that would help them collaborate with other supply chain members.

The findings of this study expand the evidence that supports the resource-based view (RBV), which posits that any business that adopts ERP systems and promotes data sharing across their supply chains exhibit distinctive characteristics. In addition, companies can gain a competitive edge in the market by anticipating shifts in supply chains thanks to a combination of the RBV concept of enterprise resource planning competency and the collaborative competency.

VII. REFERENCES

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