RFID utilization on operational performance through supply chain management

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บทคัดย่อ — อุตสาหกรรมต่างๆได้ใช้เทคโนโลยี RFID สำหรับการจัดการภายในองค์กร เพื่อเพิ่มประสิทธิภาพในการดำเนินงาน การลดความซ้ำซ้อนและข้อผิดพลาดในการตรวจนับสินค้าการปรับปรุง ประสิทธิภาพในด้านความรวดเร็วในการอัพเดตข้อมูล อุตสาหการการผลิตชิ้นส่วนยานยนต์เป็นอุตสาหกรรมหนึ่งที่ได้มีการนำเทคโนโลยี RFID มาใช้งานภายในอุตสาหกรรมการผลิตชิ้นส่วนยานยนต์ เพื่อตั้งค่าทางด้านของความปลอยภัย และนำข้อมูลที่ได้จาก RFID ไปใช้ในการวิเคราะห์ การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อศึกษาการใช้ RFID ในด้านของ supply chain management ที่มีอิทธิพลต่อความสำเร็จของผลการดำเนินงานในการปฏิบัติงาน ในอุตสาหกรรมการผลิตชิ้นส่วนยานยนต์ของประเทศไทย ซึ่งมีจำนวนของผู้ที่ตอบแบบสอบถามทั้งหมด 99 บริษัทในกลุ่มอุตสาหกรรมการผลิตชิ้นส่วนยานยนต์ของประเทศไทย หลังจากที่ได้ทำการรวบรวมข้อมูลและทำการวิเคราะห์ด้วย structure equation model ผลของการวิจัยในครั้งนี้ แสดงให้เห็นถึงความสำคัญของการใช้เทคโนโลยี RFID สามารถเพิ่มประสิทธิภาพใน suppy chain management และแสดงให้เห็นว่า RFID มีผลกระทบในทางออมไปยังผลการดำเนินงานในการปฏิบัติงานผ่าน supply chain management

คำสำคัญ – การใช้ประโยชน์ RFID, Operational performanc, Supply chain management

Abstract— Various industries have utilized RFID technology for internal management within organizations for an effective operation, reduction of the complexity and errors in products counting, improving speed and information update efficiency. The automotive parts industry is one of the industries which use RFID technology. As mentioned, in the automotive parts industry, RFID technology is used for the safety of equipment setting and as well, use information obtained from RFID for further analysis. This research aimed to study the use of RFID in supply chain management and its influence on the success of the operational performance in the automotive parts industry of Thailand. Ninety-nine (99) were sample companies from Thailand automotive parts industry to answer the questionnaire. The data were gathered and a structure equation model was placed here for the testing model. The result of this research showed that to paying attention to RFID technology usage can help increase operational performance by supply chain management. It was noticed that RFID has an significant indirect effect operational performance through supply chain management.

Keywords - RFID utilization; Operational performance; Supply chain management

Introduction

Presently, the automotive parts industry in Thailand have up to 1, 975 industrial plants throughout the country. Bringing RFID technology to use within the automotive parts industry of Thailand has the aim to create the operational performance in the industry. Since the RFID technology can check the inventory information, sources of product, times saving in products count, cost saving for employees hiring, and cost saving for products stock.

From a previous research study, it was found that, the RFID technology has the ability to track sources such as recall 1.4 million of cars globally by Toyota after the testing officer found some abnormality of the airbag. If there is the RFID tag at the airbag, the office could know the source and production date[1].

Accordingly the RFID technology to helps in the automotive parts industry operation to add more compatibility for competition and efficiency on the aspect of transparency in supply chains, production control, logistics, products distribution, products submission, and equipment installation safety.

Research objective

1) To study the supporting factors for the use of RFID in the operational Performance in Thailand's automotive parts industry.

2) To study the relationship of using RFID with the aspect of supply chain management and its influences on the success of Operational Performance in Thailand's automotive parts industry.

3) To study the success of using RFID and its impact on the current Operational Performance of Thailand's automotive parts industry.

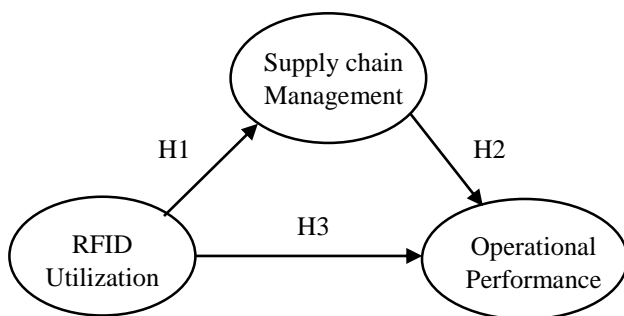## Research framework and hypothesis

Research framework

Figure 1 Research Framework

Research hypothesis

H1: Using RFID can have a positive impact on the Supply chain Management.
H2: Supply chain management has a positive impact on Operational Performance.
H3: Using RFID has a positive impact on operational performance.
H4: Using RFID has a positive impact on operational performance through supply chain management

Theoretical background

RFID technology

Radio Frequency Identification or RFID is an RFID technology invented in 1948. It was firstly used in the second world war era to define where the planes that flew over the sky territory came from, and to prevent false attack [2]. RFID is a technology developed to replace the barcode technology in identification or automatic follow up [3]. Besides, RFID technology can re-check the inventory such as checking for the raw material, work-in-process, and finished goods [4]. This allows for more work efficiency, reducing the process of counting and record the receiving as well as increase the accuracy in products arrangement including sale information and fast supply chain management [5].

At present, RFID technology is applied to use in increasing the efficiency and effectiveness in operations or any services provided. Therefore, the application of RFID technology on the aspect of warehouse management can be seen in the research by[6] on the subject of "Genius warehouse management system via RFID technology: the case study of Pimaifoot co,. ltd.". It was found from the study results that bringing RFID to use can support the effective warehouse management and reduce the errors in information technology.

The key motivation of bringing RFID technology to use in the production process is the automatic operation and speed in operation and the ability to trace back. Thus, it is installing within the automotive parts such as airbags etc. [7] has brought RFID technology to use in airbag installation to control the pressure in the airbag. Includs the re-check of the date the parts were produced and who was the producer in case the equipment or other parts have problems, the re-check can be done fast.

Adoption and diffusion of RFID technology

RFID technology has the technology with the ability to transparency and to increase efficiency within supply chain. In the past , there was the apparent adoption and diffusion of RFID technology especially in the automobile industry [8]. There are four aspects in the key elements of diffusion rationale: 1 innovation 2 communication channels 3 time 4 social system [9]. [10] studing the potential of RFID for the automobile industry and found the factors of RFID diffusion from the interview with the experts such as costs, perceived benefits, cooperation, performance, compatibility, top management support, and centralized plants and control. Besides, [11] explored the potential of RFID in the automotive parts industry in the aspect of information system. The goal was to study the influencing factors on the diffusion of RFID technology such as costs, complexity, top management support, compatibility, coercive influence, privacy, and strategy. [12] has explained the future development of the use of RFID in the production industry from many firms in which the influential factors on the future RFID diffusion ware performance, standards and costs. The innovation diffusion theory is important for the adoption and diffusion of RFID technology in the automotive industry

Supply chain management

Supply chain management has a major role in the firms that aim at the competitive business advantage [13]. The operation system of Supply Chain covers all the relevant department either direct or indirect way to respond to the needs of customers in the Supply Chain. There include the producer, supplier, transportation, warehouse, marketing, distribution, financial, and customer service.

Supply chain management are beneficial for the business to prepare the products in response to the customers in each time period both in season and non-season. It affects the preserving of production process to keep operating at the constant rate and to help in preserving the level of employment, preventing out of stock and the most crucial impact on the business to generating profit.[14]. It can be concluded that the supply chain procedure can result in a better response to the customers of the organization and can reduce the costs of supply chain management which increase the competitive potential.

Operational performance

Operational performance is the performance result that suite to the operational process in the organization or activities that the organization must do to meet its objective. Operational performance also refers to the operational quality, flexibility, transportation and efficiency in other aspects of management[15]. Many researchers give diverse meaning of operational performance, for instance, [16] stated that operational performance relates to the cost per unit, conformance of product, efficiency of time in transportation, speed of transportation and Inventory turnover. Operational performance can be measured in several aspects such as quality performance, delivery performance, cost performance and flexibility performance[15]. [17] found that throughput, inventory expense, operating expense, and lead time is the key variance in operational performance evaluation. From the views of researchers, the measurement of the success in the operational performance relates to inventory expense, operating expense and lead time.

Research methodology

Research sample assumption

To analyze Structure Equation Model, it requires having sufficient and suitable data for the model indicator. The minimum data can be computed from the formula p(p+1)/2; where p is an indicator of the model.

Research tool

The questionnaire was used as a tool for data gathering from research samples. The questionnaire was constructed from the review of the literature and designed to meet the research objectives. The questionnaire comprised of three parts: gives importance of RFID technology in business, gives importance of RFID technology in transportation, and utilization of technology RFID. The questions used Likert's 7 scale to obtain the attitudes from respondents.

Table 1. Variables Dimensions

Variable Label	Descriptions	Mean	Std. Deviation	Cronbach's Alpha
RFID2_1	RFID adoption into the management of raw materials quantity	4.505	1.358	0.962
RFID2_2	RFID adoption into the inventory	4.424	1.278	0.962
RFID2_3	RFID adoption in the management of the amount of ready-product	4.494	1.248	0.963
SCM2_1	transparent in level of products stock	4.737	1.359	0.962
SCM2_2	information into Real-time	4.575	1.317	0.961
SCM2_3	problems of out of stock event	4.596	1.211	0.960
SCM2_5	counting of inventory	4.565	1.386	0.961
OP1_1	increase the effectiveness in the operation	4.565	1.254	0.963
OP1_2	reduce the cost of inventory	4.565	1.271	0.962
OP1_4	generate more preciseness and punctuality in the operation	4.737	1.258	0.962

Validity and Reliability

Validity Testing can help reduce the cost of inventory

The discriminate and convergent validity were tested by the factor analysis, AVE, and correlation between latent variables. There were many questions representing each factor or variable. The research tested the reliability of internal consistency by Cronbach's alpha after the questionnaire was designed. The score ranged from 0 to 1 and the score acceptance for this research was more than 0.7 [18]. This research was designed to test the reliability for two times. First before the sampling, 30 questionnaires were piloted to test and adjust for the term if the score was less than 0.7. Second, reliability testing was tested again after completing all data collection.

The structural equation model was analyzed as follows

1. Constructing the model related to the variables in research framework

2. Defining the observation and latent research model

3. Assessing the model fit

   3.1 Chi-Square/ Degree of Freedom should less than 2.00

   3.2 Goodness of fit index should be close to 1

   3.3 Root Mean Square Error of Approximation should be less than 0.05

4. Considering the standardized regression weights for model acceptance, it had a significant and square multiple correlations to confidence for the prediction of the model. After model was accepted, the result of regression weight was considered for hypothesis testing.

Research result

The researchers measured Convergent Validity by Confirm Factor Analysis. If the research model was converged, the value of factor loading

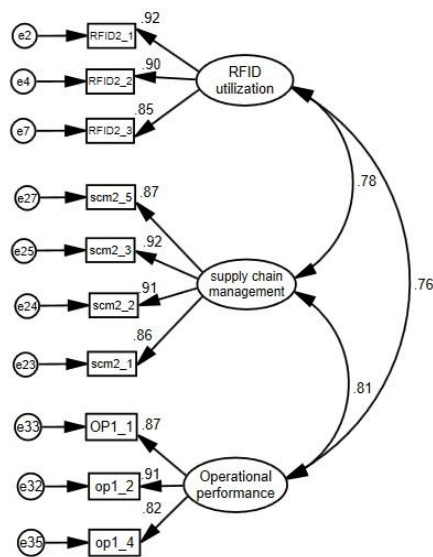should be greater than 0.6 [19] Figure 2 presents the construct model for Convergent Validity testing.

Figure 2. Factor Loading

Table 2. Factor Loading of all latent variables

Variable	Factor Loading	AVE	Composite Reliability
RFID Utilization		0.890	0.920
RFID2_1	0.92		
RFID2_2	0.90		
RFID2_3	0.85		
Supply chain management		0.890	0.939
SCM2_1	0.86		
SCM2_2	0.91		
SCM2_3	0.92		
SCM2_5	0.87		
Operational Performance		0.867	0.901
OP1_1	0.87		
OP1_2	0.91		
OP1_4	0.82		

The squared correlation values ranged from

0.86 to 0.89; the discriminant validity could be checked from the comparison between average variance extracted (AVE) value and the squared correlation [20]. Finally, the researcher proved the discriminant validity of the instrument by examining the AVE which should be more than the squared correlation as recommended by[21]. The testing of results showed that the value as obtained supported the discriminant validity as shown in table 3. The value of AVE for each construct was greater than the level of correlation involved in the construct

Table 3 Discriminant Validity

	RFID Utilization	Supply chain management	Operational Performance
RFID utilization	0.89		
Supply chain management	0.78	0.89	
Operational Performance	0.76	0.81	0.86

The construct model

This model was constructed to measure that RFID utilization has a positive effect on operational performance and then to measure that RFID utilization has a positive effect on operational performance through supply chain management. The finding show that RFID utilization affects operational performance through supply chain management.

Figure 3 presents the results of the construct model tested and the measurement model by confirmatory factor analysis, In this research , the goodness of fit is show as follows : Chi-square = 57.868, Degrees of freedom = 29 , CMIN/DF = 1.995, P-value = .001, GFI = 0.901, AGFI = 0.813, RMSEA = 0.101
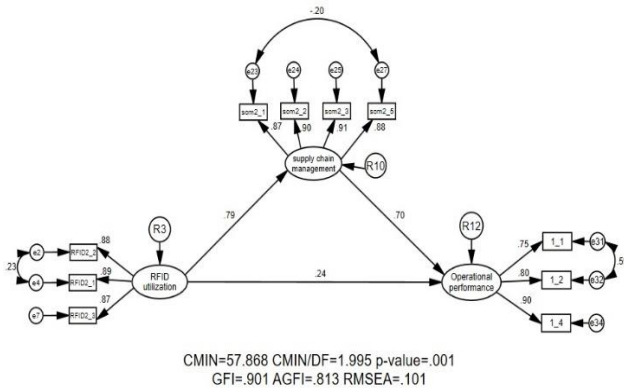
Figure 3 Construct Model

Hypothesis Testing

H1: Using RFID can have the positive impact on the Supply chain Management. This hypothesis was supported with standard regression weight of 0.79 (P < .001).

H2: Supply chain management has the positive impact on Operational Performance. This hypothesis was supported with standard regression weight of 0.70 (P < .001).

H3: Using RFID has the positive impact on operational performance. This hypothesis was supported with standard regression weight of 0.24 (P < .05).

H4: Using RFID has the positive impact on operational performance through supply chain management. This hypothesis was supported with standardized indirect effects weight of 0.55 with higher weight than standardized direct effects to operational performance.

Conclusion

This research aimed to study and test the influence of RFID utilization toward operational performance through supply chain management. Supply chain management variable had, mediating effect on operational performance. The investigation was conducted with 99 organizations in an automotive parts industry of Thailand. From the hypotheses testing in Figure 3, it was found that the organization that

brings RFID to use in the operation and inventory management which generally aims to apply it in checking and controlling on the amount of inventory, the application here can help the organization to know about the quantity of raw materials immediately when the product is sold. It helps the organization in recognizing the quantity of stocks. It results in the organization having the information to considering in making decision toward the operation. It can result in supply chain management and operational performance and partly help the organization in saving costs of inventory management. The organization can recognize the level of product inventory to create convenience in operation. When the organization recognizes the level of inventory, it partly helps the organization to have the information for operation analysis.

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