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The Impact of RFID Utilization on Firms Performance through Decision Making of Automotive Manufacturers Industry

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Abstract

The adoption of Radio Frequency Identification (RFID) becomes a popular technology used in many organizations in order to exchange information within their supply chains for better support decision making process. The purpose of this paper is to examine the impact of radio frequency identification (RFID) technology utilization on firm performance. Data from a sample of 151 automotive manufacturers were collected and the model was statistically assessed using a structural equation methodology.

The results indicate that utilization of RFID technology for operational and supply chain decision-making process have a positive directly impact on firms' benefit particularly, in terms of the ability to purchase and receive products, the convenience of sales and delivery, and have ability to examine when customers encounter problems.

Keywords: RFID, firm performance, automotive manufacturers

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1. Introduction

Thailand is the one of world's largest car production base in 2018, producing about 2.1 million vehicles, according to the International Automobile Manufacturers Organization (OICA). As of 2017, the Thailand automotive industry was the 12th largest in the world and the largest in Southeast Asia followed by Indonesia is the second. Due to the fact that, the automotive parts manufacturers classified as upstream industry providing raw materials/ assembly parts into automotive supply chain is also likely growing [1]. However, the success of doing business in this decade, the utilizations of advances in communication technology become significant role in creating storage systems and information systems, as well as linkage purchase order systems for domestic and international supply chain management.

The problems typically encountered in the automotive parts manufacturing industry are lacks of real-time or up-to-date data to be captured and available for business executives making decisions in planning and operational management purposes. Advances communication technology like Radio Frequency Identification (RFID) technology has been introduced in many businesses in order to improve their manufacturing capabilities and efficiency as well as to control the inventory movement and connection the supply chain to the partners.

According to the research of Cao, et.al, it indicated that RFID technology has been used in production line in the automotive parts industry [2]. In addition, the use of RFID technology improved the efficiency and effectiveness operation including reducing the production process costs confirmed by Zelbst, et.al [3] whereas, Leung, Cheung and Chu [4] supported the use of RFID technology to generate three benefits, namely 1) income 2)operating profit and 3) capital efficiency. However, using RFID technology to increase productivity will lead to operational costs increasingly such as hardware, software, installation, system integration and process modification costs and training costs [5].

As mentioned above, in the automotive parts industry, RFID has been widely used not only as a sensor for detecting products, but also as information storage. When RFID technology used to manage storage and shipping, which process should be used to make the right decisions that affect success, therefore, bring to the research goals as following;

1) To investigate the RFID utilization factors affecting in Thailand's automotive parts manufacturing industry,

2) To study the relationship between the use of RFID and firms' benefit emphasized on information system for decision-making process.

2. Review of the Literature

2.1 RFID Technology

Radio Frequency Identification (RFID) technology was developed in 1948 during the Second World War to be used on planes to identify which aircraft belonged to prevent false targets [6]. Today, RFID technology is often used as a

replacement or enhance ability with barcode technology to automatically identify or track everything [7]. Moreover, RFID technology has been used in industrial systems, such as stock management systems, raw material management, process tracking, and finished products so that it can be traced back to all previous processes [8]. It is also used for other business activities likes; navigation, transportation, retail, pharmacies, animal husbandry, food management, ticket sales, apparel industry, books, and prevent counterfeit products [9]. It is also used for warehouse management, enabling it to efficiently, easily and quickly control the movement of goods, to understand detailed information that make work more efficient, reduce work steps, count and receive records and improve work efficiency accuracy of product placement and also including support sales information and quickly manage supply chain [1].

There are three important components of using RFID technology [10-11]; firstly, RFID tag or Transponder, are small labels with a chip that serves to collect data of objects such as product codes and antennas for transmitting and receiving radio frequency signals and have ability to interact by using radio waves as a medium to interact with the RFID Reader [12]. Secondly, reader is a device used to read ID Code from the RFID tag [6]. The function of the RFID reader is for reading and writing Tags and at the same time it acts as a connection to the computer in order to collect data and output the data from the reader. And thirdly, host computer is a computer system for data processing and storage.

2.2 RFID Technology in Warehouse

Many studies have shown that the management of such work in the past lacks of speed and overcrowd, so the application of RFID technology enables tracking and monitoring to be completed quickly. The findings from Rechaipichitkul and Archint's study on the "Intelligent Warehouse Management System with RFID Technology" [13], illustrated that using RFID technology in the warehouse generates more effectively support on managing warehouse system to reduce data and information errors and warehousing cost so as to enhance customer confidence in the organization. If the RFID system is connected to a real-time system, it will reduce overall costs and provide more efficient serviceability to other systems [14].

2.3 RFID Framework

The information collected from the RFID technology by the reader device can be used as an inspector and stored in a database for decision making. However, the data collected by RFID tags can be very large; therefore, data warehousing and data mining as data analysis techniques have been introduced to analyze data to improve data-driven efficiency [15]. After the data from RFID has been stored completely, its use in the warehouse and then forwarded to the other departments, where linked in the supply chain and also supported for Vendor Managed Inventory (VMI) that that seller will receive the sales information every day in order to

analyze and calculate the required number of products so that the product must be sent to the warehouse according to the customer's needs [16].

3. Research Methodology

3.1 Population and Sample

Theoretically, to be an adequate sample size for data analysis, the sample size required 10 times the number of variable studied. For this study, there were nine variables then the sample size should be not less than 90 samples. Consequently, the sample size of this study was 151 companies, selected from a total of 1,975 automotive parts manufacturing companies listed by the Ministry of Commerce,

3.2 Variables

The questionnaire was created from literature reviews in the areas of RFID utilization and manufacturing performance. Then the research model was constructed with three main groups of latent variables. RFID Usage as the first group of variables emphasized on how companies use the benefits of RFID for, namely, raw material management (RFID1), warehouse management (RFID2) and finished goods management (RFID3). The second group of variables was decision making process involved how the companies employed information for, namely, operation working (DM1), sharing information to any department (DM2), and decision making (DM3). Lastly, firms' benefit became the third group of variables involving how company's capabilities increased by using RFID technology. There were three variables in the third group for example, ability to purchase and receive products (FB1), the convenience of sales and delivery (FB2) and ability to re- examine when customers encounter problems (FB3).

3.3 Variables Validity

The research model was statistically assessed using a structural equation methodology. Then, the convergent validity must be analyzed by considering the Average Variance Extracted (AVE) of each latent variable which must be greater than 0.5 while, the discriminant validity must be considered by the AVE of each latent variable must be greater than the correlation between any latent variable.

4. Research Results

Data of each variable was statistically analyzed by the mean value and the standard deviation as shown in Table 1.

Table 1 mean and standard deviation

RFID Usage		$\overline{X}$	S.D.
RFID1 .		4.31	1.60
RFID2		4.31	1.55
RFID3		4.34	1.57
	Total	4.32	1.57
Decision Making		$\overline{X}$	S.D.
DM1		4.56	1.47
DM2		4.83	1.53
DM3		4.76	1.52
	Total	4.72	1.52
Firms' Benefit		$\overline{X}$	S.D.
FB1		4.47	1.57
FB2		4.46	1.57
FB3		4.45	1.49
	Total	4.46	1.55

Reliability testing of each group of variables was measured by the Cronbach's alpha. The values of Cronbach's alpha exceeding 0.70 were considered to be indicative of a reliable-scale instrument. All values of Cronbach's alpha in each of the three sections were greater than the minimum acceptable level, ranging from 0.85 to 0.94 as shown in Table 2.

Table 2 Reliability testing

Variable	Cronbach's Alpha
RFID Usage	0.93
Decision Making	0.85
Firm Benefit	0.94

To avoid Multi-collinearity problem among variables, the VIF value must be less than 10 or Torrance value must be greater than 0.1. The test results met the above criteria; it showed that all variables have no Multi-collinearity problem.

Consequently, data were tested on convergent validity and discriminant validity by using confirmatory factor analysis (CFA) technique, considering the average variance extracted (AVE) which not less than 0.5 and greater than their relationships among other latent variables. The results of validity testing are shown as Table 3 and Figure 1 while the correlation analysis was presented as Table 4.

Table 3 Factor Loading, Critical Ratio, R^2, Composite Reliability, Average Variance Extracted

Variables	Factor Loading	R^2	Composite Reliability	AVE
RFID			.933	.823
RFID1	.87	.77		
RFID2	.93	.86		
RFID3	.92	.84		
Decision Making			.868	.691
DM1	.66	.44		
DM2	.92	.84		
DM3	.89	.80		
Firms' Benefit			.951	.866
FB1	.94	.88		
FB2	.96	.91		
FB3	.89	.79		

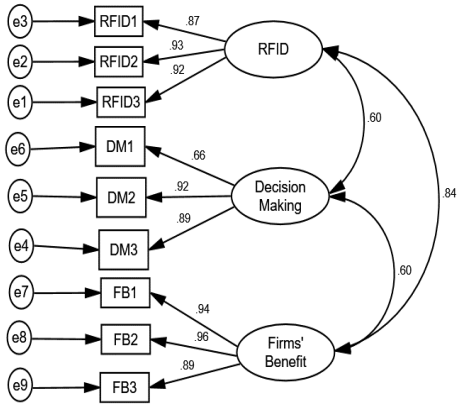

Figure 1 Confirm Factor Analysis

Table 4 Correlation Matrix for Variables

Variable Name	RFID	DM	FB
RFID	.90		
Decision Making (DM)	.60	.83	
Firms' Benefit (FB)	.84	.60	.93

Square root AVE in Diagonal

From the SEM analysis shows that measuring of RFID technology utilization and firm performance is reliable and valid. The result supports the research hypothesis that the RFID technology utilization has a positive effect on firm performance with significant at .001, shown in Figure 2 and Table 5-6.

Research Model

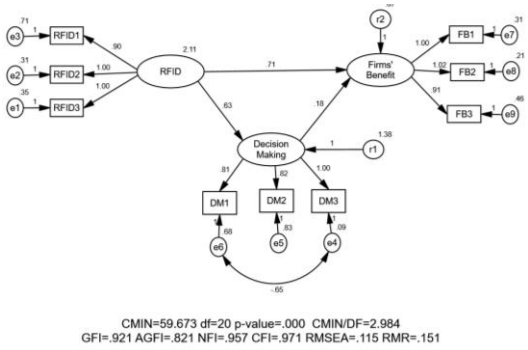

Figure 2 Statistical Model

Table 5 Assessing the model fit indicators

Chi-square/Degree of freedom (CMIN/df)	2.984
Goodness-of-Fit Index (GFI)	.921
Adjusted Goodness-of-Fit Index (AGFI)	.821
The Root Means Square Error of Approximation (RMSEA)	.115
Normed Fit index (NFI)	.957
Comparative Fit Index (CFI)	.971

Table 6 Hypothesis Testing

			Estimate	S.E.	C.R.	p-value
DM	<---	RFID	.63	.070	8.923	***
FB	<---	RFID	.71	.074	9.594	***
FB	<---	DM	.18	.062	2.893	**

*** p-value < .001 ** p-value < .01

Furthermore, as Table 7, it presents that the use of RFID technology has a direct influence on both the benefits of the business (β=.71, p-value <.001) and decision making (β=.63, p-value <.001), whereas, decision making have effect to benefits of the business (β=.18 with p-value <.01). On the other hands, the use of RFID technology indirectly affects the business interests through decisions making (β = .11), which accounts for 15% of direct influence.

Table 7 Direct and indirect effect of regression weight

	Direct Effect		Indirect Effect		Total Effect	
Variables	RFID	DM	RFID	DM	RFID	DM
DM	0.63	0.18	0.11		0.74	0.18
FB	0.71				0.71	

5. Discussion and Conclusion

As the objective, this research is to study the extent to which organizations are using RFID technology to directly improve operational results. Findings indicate that RFID technology utilization has a positive impact on decision making and firm performance as hypothesized.

This can be more explained that as hypothesis 1; implementing RFID as a sensor to detect or search for products in managing products or raw materials have a positive influence on firm performance. While, hypothesis 2; the use of RFID technology has a positive influence on decision making process in which executives able to use

available information from RFID system to strengthen decision making in various operational situations properly. Lastly, hypothesis 3; the use of decision-making data has a positive influence on firm performance. It can be clearly identified that if the RFID technology is used both as sensors to search for products and store data to decision making system, it will enhance the firm capabilities in monitoring the product flows from downstream process; purchasing and receiving to upstream process; selling and delivering. Moreover, if there is any problem occur during delivering products to customers, firm will able to quick track and resolve the problem as possible it can.

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