

Lean Manufacturing Implementation on Strategic Cost Management of Medical Devices Industrial

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ABSTRACT

This research aims to investigate (1) the factors affecting lean manufacturing implementation (2) impacts of lean manufacturing implementation on strategic cost management and (3) influences of strategic cost management on competitive advantage in medical devices industry. The data were collected with questionnaire. There were 429 samples selected who are executives of different companies. The data were analyzed with Multiple Regression Analysis. The findings revealed that manufacturing planning and control, new product development, process and equipment, workforce management, and supplier relationship factors have significant influences on lean manufacturing implementation. Besides, lean manufacturing implementation showed the positive influence on strategic cost management and further impact on competitive advantage of the companies.

Keywords

Lean Manufacturing, Strategic Cost Management, Value Added Customer, Cost Reduction, Competitive Advantage

Introduction

Companies are currently facing business competition. Manufacturing industries need to adapt to various environments, especially the rapid development of manufacturing that leads to competitive advantage. The rising demands for higher performance, more productivity, a wider range of productivity, the expansion of international trade and the increase in the use of technology raise the complexity of the business. In order for the industries to survive, the production process must be improved to reduce costs and increase competitiveness. The method that would help develop the production process is organizing wastes of production to obtain quality products and deliver products on time at low cost. Many organizations select lean manufacturing as a tool used to increase competitiveness and recognize it as a good production system that improves high efficiency production standards by focusing on eliminating wastes of production activities which is the concept of the lean manufacturing implementation.

The manufacturing industry is crucial for generating primary income to the country. There is a growing interest in establishing a manufacturing base from both major and minor international enterprises which are manufacturers of automobiles, electronics, textiles and food. Currently, Thailand has 138,807 firms registered with the Department of Industrial Works. (Department of Industrial Works, 2020) Most firms operate in the form of industrial estates, which are dispersed throughout the country. Each industrial estate has different manufacturing goals depending on the purpose and availability of the estate. Undoubtedly, the development of the manufacturing industry is critical to the development of Thailand's economy. Thus, the model scheme for the development of manufacturing industry in line with volatile and rapid global economic conditions is necessary in order to achieve sustainable structural development. The reduction and

solutions of the problems in manufacturing system are an important part of organization's performance and must be continuously improved to increase the capacity of Thailand's manufacturing industry to compete with domestic and international competitors. The increased competitiveness in the manufacturing industry market has made many companies realize the importance of developing their own production systems to increase their capacity, raise their efficiency and reduce their production wastes. Consequently, lean manufacturing system has gained widespread attention, in order to improve the capacity of industrial operations, especially in industries related to health and medicine as shown that the growth rate of the global medical devices market is more than 6.4% per annum. Therefore, the medical devices manufacturing industry becomes an industry that helps strengthen the economy. Accordingly, Thailand has established medicine and public health in its 20-Year National Strategy as one of Thailand's future goals in 2036 to promote Thai's physical healthcare and Thailand as an international health center, as known as Medical Hub. In addition, a roadmap was established to implement Thailand 4.0 regarding to health, wellness and bio-med and develop medical infrastructure to promote Thailand into ASEAN's Medical Hub by 2025. (Final Report, NSTDA, 2020) Although Thailand's medical devices market is growing in demand, the medical devices industry in Thailand still has not sufficiently developed. It is due to entrepreneur's lack of knowledge, manufacturing technology, international technology transfer, low level of user acceptance of domestic products, high manufacturing cost and missing data links between agencies regarding information, standards oversight and quality assurance to reinforce customers' confidence.

Lean manufacturing system is globally recognized and has clear guidelines that can be used in development to ensure organization's survival (Chetthamrongchai, & Jermittiparsert, 2019; Pamornmast, Sriyakul, &

Jermsittiparsert, 2019; Saengchai, & Jermsittiparsert, 2019). Most organizations apply lean manufacturing system in the production process with the intention to reduce wastes, instability, and cost in order to increase competitiveness in the business. However, many organizations have struggled and failed to implement lean manufacturing system. The main reason for the failure is that the organizations do not have deep comprehension of the necessary principles and factors in the lean manufacturing implementation. There are many elements involved in the lean manufacturing implementation, such as the changing of organizational culture, leadership characteristics, commitment of executives, communication, training, awareness of lean manufacturing system, the relation between lean manufacturing system and business strategy, the relation between lean manufacturing system and rewards to personnel, monitoring, auditing and other elements. With the priorities mentioned, the researchers then studied the effect of application of lean manufacturing system on adding values for customers and the cost reduction in medical devices manufacturing industry. Therefore, the purpose of this research is to investigate (1) the factors affecting lean manufacturing implementation (2) impacts of lean manufacturing implementation on strategic cost management and (3) influences of strategic cost management on competitive advantage in medical devices industry.

Literature Review

Resource Based View of the Firm (RBV)

Resource Based View of the Firm (RBV) theory stated the important role in the conduct of business activities in the competitive market that the organizations that use their existing resources effectively and efficiently will create an advantage over competitors in the market. Based on the results of the study on business resources and sustainable competitive advantage, Jay Barney offered a perspective on the source of competitive advantage, demonstrating the key characteristics of the strategic resources needed by each organization to conduct business activities. In other words, (1) the resources must increase value within an organization (2) the resources must be rare (3) the resources must be inimitable or imitable at high cost and (4) the capabilities must be non-substitutable (Barney, 1991; Barney and Wright, 1998).

RBV theory has changed perspectives to the use of competitive strategies by modifying the view from the original view that considers the results to the view that considers the origin of competitive advantage, namely resources. (Forsman, 2004) Resources are an internal factor in an organization which can define the differences in performance of each organization. In the literature on accounting information system that are part of information system, it is said that information system is the creator of management knowledge, collaboration, and innovation. These elements are considered to be on-premise resources. If an organization has an effective information system, it can provide a competitive advantage in the long term. (Tarafdar & Gordon, 2007)

Resource Based View of the Firm (RBV) theory has described lean manufacturing implementation approach which is the concept for this research because lean manufacturing and management when successfully implemented can help organizations improve processes, reduce and even eliminate waste. The lean manufacturing implementation is regarded as an idea of resources and capacity for an industry, a significant tool in the business competition that increases customer service effectiveness, build customer relationships inside and outside an organization and reduce production costs, and the basis of business growth, resulting in rapid growth due to various factors. Therefore, these resources and capability have created a strategy for cost management and lead to competitive advantage as shown in the research concept framework in Figure 1. Moreover, conceptual model in this research shows how lean implementation is not limited to one type or size of company, but rather all types, sizes and industries that strive to increase their competitive advantages, operations and profits in the regional and global markets.

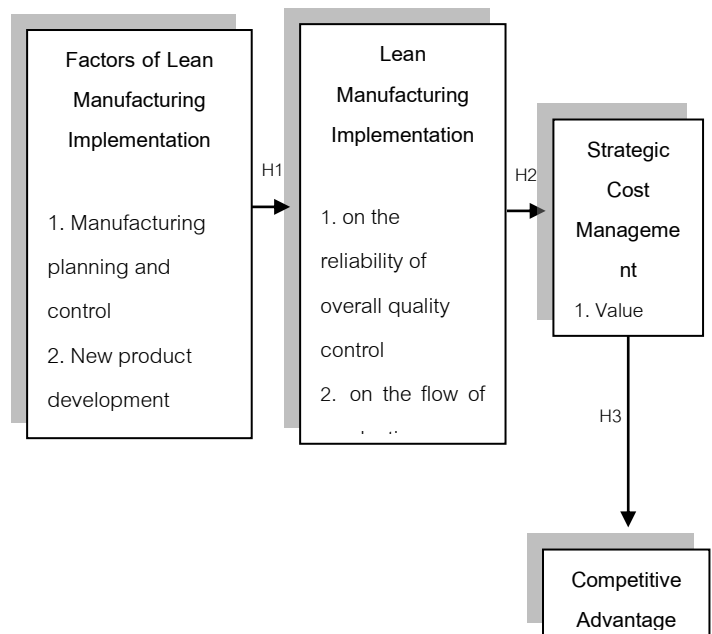


Figure 1 Research Concept Framework

Lean Manufacturing Systems

The key to manufacturing in terms of industry is to reduce costs, increase productivity and improve quality. These requirements are consistent with the Toyota Production System concept, also known as Lean Manufacturing. It was initiated by Taiichi Ohno, who had the idea that wastes were something that had to be organized. (Kyoungill, Bang, 2018; Toyota Motor Corporation, n.d.) This concept focuses on reducing production wastes (Muda) by considering an excessive or over prescribed standards production (MURI) and unevenness in operations (MURA) (Kaizenman, 2006). The evolution of lean manufacturing system begins with the craft production to volume-oriented production system process until it develops into a lean manufacturing system with high production flexibility in order to support the current condition that the cycle time is shortened while

trying to reduce costs. Currently, the just-in-time manufacturing is called lean manufacturing. Lean manufacturing focuses on working more to reduce inventory, employ fewer employees, and exploit less space. According to the lean concept proposed by Womack and Jones in 1996, the principles of lean manufacturing needs analysis to extract value, reduce wastes or 7 Muda in Japanese, and induce flow of the value to customers. The analysis for value is to define the needs of customers and determine the manufacturing process to meet their needs. Taiichi Ohno (1912-1990), Toyota executive, had identified seven types of wastes or MUDA that mentioned under the topic of the just-in-time manufacturing, therefore, what will effectively fix MUDA is the "lean thinking". The concept was initially described as a concept that contributes to establishing a way to identify values, prioritizing the best value creation operations, and oversighting activities to prevent interruption. Lean manufacturing can be called "lean" because it is a way to manage working process better with less force, less equipment, less time, and less space while also getting closer to producing only what customers need. Lean manufacturing concept also improves operations to be more responsive to demand by reflecting the effect of the efforts to transform Muda to value spontaneously. This is the opposite of process reengineering because the lean concept creates new processes rather than dismantling the processes. Therefore, lean approach serves to respond to changing circumstances. (Kafuku, 2019)

Lean manufacturing activities are divided into three types: 1) Value Added Activity 2) Non-Value Added Activity (Sundar, Balajib, & Satheesh Kumar, 2014) and 3) Business Non-Value Added Activity (Lean Methods Group, n.d.) By classifying lean manufacturing activities, it can identify that value-added activities have an impact to organization's profitability and give an organization a competitive advantage. The essential element is the consistent flow of work that does not ignite the bottleneck affecting efficiency in the production process by eliminating cost-generating waste, raising value and increasing customer satisfaction. AlManei et.al. (2018) said lean manufacturing systems provide a wide range of job opportunities as well as improved performance. In general, lean manufacturing systems help increase production capacity through eliminating wastes, discarding non-value added activities and establishing flow of values activities to customers (Wiktorssom et.al., 2018) The success of lean manufacturing implementation is not only the application of manufacturing tools. On the other hands, the effective lean manufacturing implementation has to derive from these factors, namely manufacturing planning and control, new product development, process and equipment, concurrent engineering, workforce management, customer and supplier relationship (Kafuku, 2019). The emphasis on these factors will make the manufacturing industry sustainable as a result of reducing production costs and decreasing non-value added activities. (Nordin et al., 2010) Furthermore, Abernathy et al., (2000) suggested that the success of lean manufacturing implementation comes from an effective management of employees, accurate resources, and suitable tools. Liker (2004) also stated that long-term production planning with the use of lean manufacturing systems is vital to achieve production success. Narayanan, Raj, Ananth,

Aravindh, and Karthik (2016) research has improved the work rate of employees in the engine accessory production line with lean manufacturing concept, enabling it to reduce the number of employees. In addition, Suhardi, Anisa, and Laksono (2019) have studied the furniture industry in Indonesia with an intention to increase competitiveness and customer satisfaction by implementing lean manufacturing principles, enabling it to reduce actual lead time to 4.79%. The results of the literary review can be concluded that lean manufacturing concept can analyze wastes and resolve production problems. This is due to the factors that lead to efficient production practices with lean manufacturing systems that will reduce production costs, add values for customer and increase productivity to gain competitive advantage in the market. Therefore, lean manufacturing concept has been adopted to help with strategic cost management to create a competitive advantage of the medical devices manufacturing industry to increase production efficiency by implementing the lean manufacturing to overtake changes in the current business environment.

Methodology

Data Collection

The samples used to collect data are the executives from 429 companies in medical devices manufacturing industry (www.medicaldevices.oie.go.th, 2020). The reason for selecting companies in this industry is because it has been reported that the Office of the Board of Investment (BOI) has invested in the Thai medical devices industry totaling 1,933 million Baht during the period between January and June 2020. The questionnaires were sent to the company's executives in all industrial estates based on the amount available in the database. The scope of the data collection period is June to September 2020. As a result, the data from 414 respondents were received to analyze for non-response bias by comparing variables in demographic group before and after completing questionnaires. These variables used in the test are period of business operation, current registered capital, total number of employees and business model. The results of this non-response bias test showed that the central value of the two demographic groups was not biased.

Tool Quality Inspection

Inspection of the tool quality was conducted with reliability test tool by determining the Cronbach's coefficient alpha (Cronbrach, 1946) and the result value should be greater than 0.7.(Nually, 1978) For this study, the coefficient alpha of Cronbach at between 0.84-0.92 indicates that the question or questionnaire of this research is reliable. For the index of objective congruence (IOC) of this research, the factor loading value is between 0.75-0.87, which is greater than 0.4 (Hair, 2006). It implies that those questions can be used for measuring those variables.

Data Analysis

The preliminary analysis of the samples and the variables performed in the study are average, standard deviation, correlation coefficient, Cronbach's coefficient alpha, Factor loading and VIF. Statistics used to test assumptions include multiple regression analysis to test research hypothesis.

The test of the impact of factors on the lean manufacturing implementation (hypothesis 1) is shown in equation 1 as follows:

Equation 1:

$$LIPM = \beta_{01} + \beta_1MPC + \beta_2PD + \beta_3PRO + \beta_4WM + \beta_5SR + \beta_6FS + \beta_7FA + \varepsilon$$

The test of the impact of the lean manufacturing implementation on strategic cost management (hypothesis 2) is shown in equation 2 as follows:

Equation 2:

$$SCM = \beta_{02} + \beta_8REV + \beta_9FLOW + \beta_{10}ACCU + \beta_{11}TIME + \beta_{12}DEVP + \beta_{13}FS + \beta_{14}FA + \varepsilon$$

The test of the impact of strategic cost management on competitive advantage (hypothesis 3) is shown in equation 3 as follows:

Equation 3:

$$COMPET = \beta_{03} + \beta_{15}VAC + \beta_{16}RC + \beta_{17}PRO + \beta_{18}FS + \beta_{19}FA + \varepsilon$$

When	
MPC	is Manufacturing planning and control factors
PD	is New product development factors
PRO	is Process and equipment factors
WM	is Workforce management factors
SR	is Supplier relationship factors
LIPM	is Lean manufacturing implementation
REV	is Lean manufacturing implementation on the reliability of overall quality control
FLOW	is Lean manufacturing implementation on the continuing flow of production operation
ACCU	is Lean manufacturing implementation on the accuracy of resource allocation.
TIME	is Lean manufacturing implementation on the timely production
SCM	is Strategic Cost Management
VAC	is Strategic cost management in terms of value added to customers
RC	is Strategic cost management in terms of reducing costs
PRO	is Strategic cost management in terms of productivity increases
COMPET	is Competitive Advantage
(The control variables include FS, is the firm size, FA is the firm age)	

Research results

In Table 1, the correlation coefficient is less than 0.80 and the VIF value of each variable is less than 10 which is between 1.13 – 3.37. The correlation coefficient less than 0.80 indicates that there is no Multicollinearity problem or an independent variable problem associated with each other (Hair, 2010).

Table 2 shows the result of multiple regression analysis of five factors affecting lean manufacturing implementation which are (1) Manufacturing planning and control (2) new product development (3) Process and equipment (4) Workforce management and (5) supplier relationship. The result shows that these five factors statistically significantly have positive impact on lean manufacturing implementation. (Accepted Hypothesis 1) (Model 1: $\beta_1 = 0.084$ $p < 0.05$, $\beta_2 = 0.064$ $p < 0.05$, $\beta_3 = 0.158$ $p < 0.01$, $\beta_4 = 0.245$ $p < 0.05$, $\beta_5 = 0.156$ $p < 0.01$) In other words, organizations are actively ready to compete in a highly competitive era and dare to implement different manufacturing methods to simplify their operations and enhance business planning capabilities to support the current business environment. Planning and control operations, increasing market share by launching new products, and building good relationships with suppliers instigate efficient application of lean manufacturing system, which is in consistent with the research of Kafuku (2019), Bhamu & Sangwan (2016), Adamu & Abdulhamid (2015), Aguado et al. (2013) on each factor, and affect the application of lean manufacturing system in various areas, such as reducing the time in the production process, developing JIT delivery, improving equipment error.

The result of the multiple regression analysis between the impact of lean manufacturing implementation and strategic cost management in Table 2 shows that the application of five factors in lean manufacturing system has positive impacts on strategic cost management in terms of adding values to customers, reducing production costs and increasing productivity (Accepted Hypothesis 2). Thus, it is consistent with the researches of Thomas et al., (2008), Gnanaraj et al., (2010), Roth and Franchetti (2010) and Aticha Watcharanurak (2009) that study about the success of applying lean manufacturing system in reducing costs, increasing productivity and satisfying customers. This is because Lean helps reducing the waste that occurs in the production process. Lean manufacturing characteristics are just-in-time production process, apply one-by-one product flow, adopt pull-up and balance production systems in the production process. Furthermore, continuous improvement of lean manufacturing system also reduces problems, such as excessive waste, loss of time waiting for unbalanced production processes, or loss of time to modify operational equipment to change production models in the production process. Those have a significant impact on the company's competitive advantage. According to multiple regression analysis of the impact of strategic cost management on competitive advantage in Table 3, it shows that strategic cost management in all three areas, namely customer value-add, production cost reduction, and productivity increases, statistically significantly has a positive impact on the competitive advantage (Accepted Hypothesis 3) (Model 3: $\beta_{15} = 0.442$ $p < 0.01$, $\beta_{16} = 0.478$ $p < 0.01$, $\beta_{17} = 0.498$ $p < 0.01$). In other words, the value or benefits arising from improving the production process by applying lean manufacturing system and implementing strategic cost management can maximize customer satisfaction. Additionally, when a company can reduce costs, it can generate more profits than its competitors. Therefore, the success of the business reflects the differences beyond the competitors. Those differences are customer recognition in the quality of goods

and service, quick response to customer demand and increased productivity, which is consistent with the theory of perspective on a resource-based basis. The theory states that the important characteristics of business that will give rise to competitive advantage are from the reputation of the

business, business relations, differentiation and cost leadership building, superior performance and quality of goods and services, which will enable the business to be sustainable and able to survive.

Table 1: Mean, Standard Deviation, and Correlation Analysis

Variable s	PD	PRO	WM	SR	REV	FLOW	ACCU	TIM E	VAC	RC	PRO	COMPE T	FS	FA
Mean	3.57	3.49	3.42	3.52	3.57	3.51	3.68	3.50	3.52	3.64	3.42	3.44	2.25	1.79
S.D	0.48	0.49	0.57	0.67	0.58	0.50	0.55	0.57	0.64	0.60	0.65	0.55	0.51	0.52
PD														
PRO	0.41*													
WM	0.29*	.65*												
SR	0.36*	.61*	.68*											
REV	0.46*	.55*	.57*	.46*										
FLOW	0.39*	.57*	.50*	.48*	.54*									
ACCU	0.46*	.44*	.48*	.42*	.52*	.56**								
TIME	0.48*	.55*	.43*	.43*	.32*	.33**	.62**							
VAC	0.49*	.54*	.36*	.47*	.61*	.55**	.56**	.51**						
RC	0.42*	.65*	.69*	.55*	.69*	.59**	.63**	.60**	.56*					
PRO	.65**	.48**	.49*	.69*	.54*	.60**	.45**	.43**	.68*	.68*				
COMPE T	.49**	.43*	.51*	.41*	.56*	.51**	.54**	.54**	.46*	.49*	.48*			
FS	.11	.13	.10	.02	.10	.06	.09	.11	.13	.08	.89	.34		
FA	-.06	-.04	-.06	-.08	-.03	-.05	-.13	-.20	.07	-.07	.06	-.05	.06	

** Correlation is significant at the .01 level (2-tailed)

* Correlation is significant at the .05 level (2-tailed)

Table 2 Multiple Regression Analysis

Independent Variables	Dependent Variables		
	Lean Manufacturing Implementation (1)	Strategic Management (2)	Cost Competitive Advantage (3)
Manufacturing planning and control factors	.084** (.044)		
New product development factors	.064** (.083)		
Process and equipment factors	.158*** (.056)		
Workforce management factors	.245** (.044)		
Supplier relationship factors	.156*** (.058)		
Lean manufacturing implementation on the reliability of overall quality control		.332*** (.036)	
Lean manufacturing implementation on the continuing flow of production operation		.082*** (.042)	

Lean manufacturing implementation on the accuracy of resource allocation		.454*** (.045)	
Lean manufacturing implementation on the timely production		.062** (.037)	
Strategic cost management in terms of value added to customers			.442*** (.041)
Strategic cost management in terms of reducing costs			.478*** (.041)
Strategic cost management in terms of productivity increases			.498*** (.043)
Firm Size	-.012 (.035)	-.043 (.039)	-.058 (.037)
Firm Age	.054 (.036)	.060 (.042)	.080 (.035)
Adjusted R ²	.579	.560	.578

* $p < .10$, ** $p < .05$, *** $p < .01$

Managerial Contributions

. Conclusion

Theoretical Contributions

According to the research framework reflecting the impact of factors on the lean manufacturing implementation and resulting in strategic cost management to create a competitive advantage, It can be implied that manufacturing planning and control, new product development, process and equipment, workforce management, and supplier relationship factors propose the effective implementation of lean manufacturing systems, as if the organization has internal resources, a factor that can enable sustainable competitiveness. However, the resources must increase value, be rare, be inimitable or imitable at high cost and be non-substitutable within an organization. If the organization has these strengths, this will lead to a positive effect on the organization's effectiveness as well. This is followed in the Resource Based View of The Firm (RBV) theory that is the concept of resource management within the organization. The resource management is considered an internal factor of the organization which can be modified or developed. Executives should give priority and deepen the understanding of lean manufacturing system as the system can provide useful information to the organization in aiming to counter changes, to respond the needs of the environment outside the organization, and, especially, to focus on reaching the needs of the target customers, reducing production costs, and increasing productivity. This concept is likely to be creating a consistency between weaknesses and strengths within the organization and the opportunities and obstacles arising from the change of the environment outside the organization. It contributes to the future results of good performance and the long-term competitive advantage of the organization through valuable and scarce resources. This advantage can be sustained which firms are able to protect against resource imitation, migration, or replacement (Wade and Hulland, 2004). Strategic cost management in various fields is considered to be another part in enhancing the ability to generate useful information in decision making in business operations both inside and outside the organization.

In practice, the organization can use the research results as a model for the factors that can lead to the effective implementation of the lean manufacturing system. In other words, it is not just an investment in technology to meet the current environment but it needs to elaborate on the factors that will drive lean manufacturing systems to generate useful information throughout the organization, customers and suppliers. Moreover, executives have to be open to this lean manufacturing system in organizing cost management, customer focus, and human resource development which is a vital force for sustainable success.

Suggestion for Future Research

1. Researches should carry out about interfering variables that may influence the creation of competitive advantages, such as technological fluctuation, economic value, and study in the current situation caused by COVID-19.
2. The samples used in this research are executives of a medical device manufacturing industry. The further research may collect data from executives of other organizations such as service groups and industrial groups in industrial estates to provide the research results to cover all companies in Thailand.

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