

Can Lean Manufacturing and 4.0 Industry Enhance the Financial Performance of Pharmaceutical Industries of Thailand? Mediating Role of Waste Reduction Behavior

CHAYONGKAN PAMORNMAST¹, THANAPORN SRIYAKUL², KITTISAK JERMSITTIPARSERT^{3,4*}

¹Faculty of Business Administration, Mahanakorn University of Technology, Bangkok, Thailand

E-mail: chayongkanp@hotmail.com

²Faculty of Business Administration, Mahanakorn University of Technology, Bangkok, Thailand

E-mail: ajbamut@gmail.com

³Department for Management of Science and Technology Development, Ton Duc Thang University, Ho Chi Minh City, Vietnam

⁴Faculty of Social Sciences and Humanities, Ton Duc Thang University, Ho Chi Minh City, Vietnam

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ABSTRACT

The study had the aim to analyze the impact that lean manufacturing casts on financial performance and the impact that is caused by industry 4.0 practices on financial performance and the study also took waste reduction behavior as a mediator. As, the past studies mostly focused on old methods of analysis of the data on the same problem and also did not address industry 4.0 practices. So, based on critical review of past studies, the study proposed four hypotheses. For testing those, the study took a sample of 302 individuals from the Pharmaceutical Industry of Thailand. The data about the problem was collected from the sample with help of questionnaires and then it was analyzed through SPSS, AMOS and other latest analytical techniques. The results of the study showed that the impact of lean manufacturing on financial performance is significant and positive and the impact that is caused by industry 4.0

practices on financial performance is significant and positive and waste reduction behavior as a mediator acts significantly as well. The study is helpful for industries present globally to reduce wastage and maximize returns, it also enhanced theoretical evidence about significance of lean manufacturing. Yet, the research is short of sample and is very specific to only one sector.

Keywords: Lean Manufacturing, Industry 4.0 Practices, Financial Performance, Pharmaceutical Industry, Thailand, Waste Reduction Behavior

Correspondance:

Kittisak Jermstittiparsert

Email: kittisak.jermstittiparsert@tdtu.edu.vn

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INTRODUCTION

Varela, Araújo, Ávila, Castro, and Putnik (2019) describe in their study that lean industry and 4.0 industry are significance aspect tin developing sustainable production, so these are the basic ways for society to maintain financial condition. Lean and 4.0 manufacturing practices are the main strength for three sustainability pillars which include social, environment and economic concern. From many years, the manufacturing industries practice principles of lean to minimize the complexity of the manufacturing and enhance productivity. The lean manufacturing practices have standardized methods which become base for excellence operational work. It develop a culture in which workers in their field are empowered and improve their techniques continuously in industries. Further, operational complexities are increasing with time due to which many industries found that only lean industry cannot sufficient to fulfil the desire task. Currently, 4.0 industry which having up to date digital base technologies is emerged, which deliver significance services with its unique and latest technology (Shrafat & Ismail, 2019; Xu, Shang, Yu, & Liu, 2019). Hence this 4.0 industry which also term as fourth industrial revolution is important practice which promote improved industrial performance with lower waste material. Pharmaceuticals products in its all stages of life cycle such as production, use and finally dispose stage which include waste material, can enter in environment in different forms. Residue of Pharmaceutical industries of

Thailand have been find out in drinking, ground or surface water along with in sewage effluents, soil, manure and in various metrics of environment. This is scientifically prove that even small concentrations waste material of pharmaceuticals have dangerous effects in the environment (Garcia de Oliveira, Fang, & Lin, 2019). Pharmaceutical industries of Thailand have very key position in international pharmaceutical market. Pharmaceutical industries of Thailand have value of 5 billion dollar in 2016 which double in 2020. It had a large share in economy of the Thailand. Along with economic and health benefits pharmaceutical industries of Thailand posing a threat on environment sustainability with its waste material discharge (Song, Fisher, Wang, & Cui, 2018). Such waste material can be reduce with practice of lean manufacturing and 4.0 industry. This 4.0 industry contain advance approaches for handling productivity enhancement and minimize complexity, manufacturing industries get speed, coordination, efficiency and manage industries operations (Koinig, Diehl, & Mueller, 2017). Manufacturing industries start to practice Lean Industry and 4.0 practices which reduce as much as forty percent of the product conversion rate within 5 to 10 years which is best than those industries which have no lean and 4.0 industries. Such financial improvement due to less conversion cost can be attainable with technologies which improve and enhance industries structures and processes of manufacturing (Friedli, 2017).

Below figure showing the market size of pharma industry of Thailand

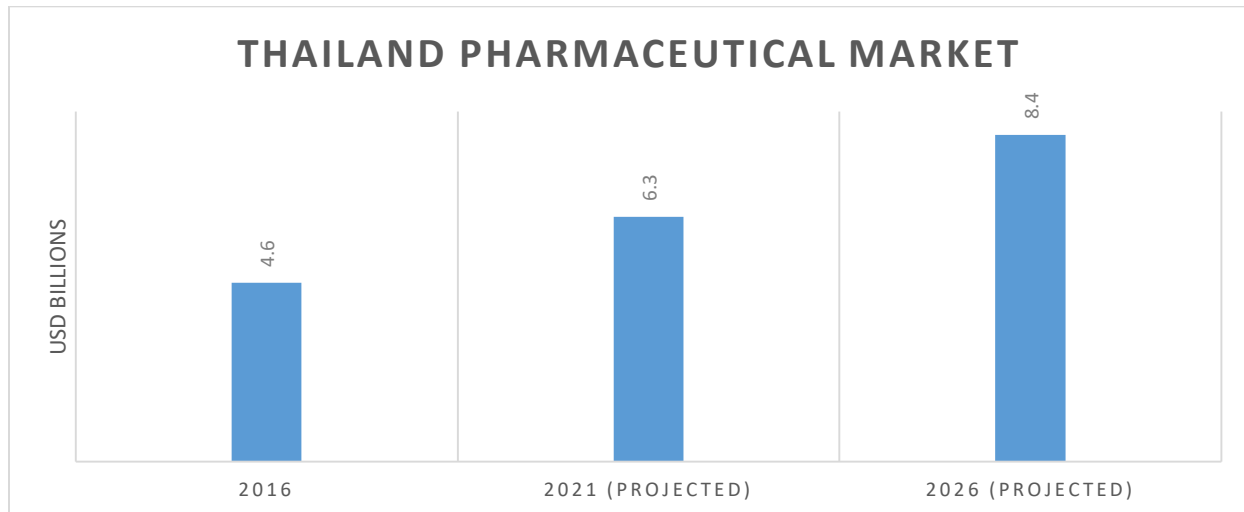


Figure 1: Thailand Pharma Market Size

Lean industries and 4.0 industries is spread all over the world and many manufacturing industries implemented such practices. Because these practices enhance the financial performance of the industries with effective operational measures of low waste material at lower cost (Nimeh, Abdallah, & Sweis, 2018). But in developing countries such industries are not implemented in pharmaceutical industries (Ayoub, Abdallah, & Suifan, 2017; Nimeh et al., 2018). Many pharmaceutical industries in Asia and Africa focus on implementation of Current Good Manufacturing Practices (cGMP) rather than lean and 4.0 industries. Such practices ensure the financial structure of the industries and ignore the operational performance of the industries with high waste products (Awad, Al-Zu'bi, & Abdallah, 2016). Due to the lack of study in lean industry and 4.0 industry in respect of their performance and management of waste material in the pharmaceutical industry it is necessary to initiate such study which highlight the importance of these industries in pharmaceutical sector (Garza-Reyes, Betsis, Kumar, & Radwan Al-Shboul, 2018). Thailand pharmaceutical industries have important role in its GDP but it pose harmful effects on environment and use a large portion of its income to settle the residue products of pharmaceutical products. By using lean and 4.0 industries the waste material of manufacturing industries attain low proportion due to which less income is serve in management of waste material. This study highlight the effective strategies of Lean and 4.0 industries which support the pharmaceutical industries in enhancing their financial performance with less waste management cost (Alkhalidi & Abdallah, 2018). the objective of current study are given below:

1. To analyze the impact of lean manufacturing on financial performance of pharmaceutical industries of Thailand.
2. To check the role of 4.0 industry practices in financial performance of pharmaceutical industry of Thailand.

3. To check the mediating role of waste reduction behavior in the relationship between lean manufacturing practices and financial performance of pharmaceutical industry of Thailand.
4. To analyze the role of mediating waste reduction behavior in the relationship between 4.0 industry and financial performance of pharmaceutical industry of Thailand.

In industrial sector, Lean manufacturing consider as well recognized and accepted practice. It enhance the improvements of production and increase value adding practices with avoiding waste lean practices are used in Thailand airlines industries in which it highlight the involvement of the employees, manage the customer relation which ultimately effect the its improvement which enhance under such practices. (Pongugsorn, Buavaraporn, & Punnakitikasem, 2016). According to Nagy, Oláh, Erdei, Máté, and Popp (2018) the 4.0 industry consider as advance technology of industrial manufacturing in terms of production and industrial process. Fraunhofer Institute use 4.0 industry practices in 2013 to enhance the productivity and industry's potential for growth. In the same way, Malaysian textile Industry use 4.0 features to minimize its low performance. (Ślusarczyk, Haseeb, & Hussain, 2019). The structure of this paper include introduction in first part. Literature review cover in second part. After this methodology of the paper is mention. And finally result and discussion are explain in forth part of the paper. At the end conclusion and references are added.

LITERATURE REVIEW AND THEORIES

Contingency theory for lean manufacturing

In recent years, Contingency theory attain a popular place in operational management and it is highly effective in that fields which have no proper theory related to operational management. Contingency theory, basically, describe the context and operational structure in which industries and

organization will be synchronized and lead towards better performance of the industries. With contingency theory, the practices of Lean manufacturing is consider as response variable which are interrelated to theory (Gütter, 2014). Such Response variables consider as actions which are used by industries in response to contingency and contextual factors. These response variable are not only aligned with above factors but also link with each other (Mohammad & Oduoza, 2018; Sahoo, 2019). Internal appropriation of structure link with single lean activities while the external factors show the alignment of the lean industry with environmental aspects such as minimization of waste material. Further, another concept of this theory is configurational aspect which is defines a multidimensional installation of industries with various characteristics that occur at a time with distinct concept and this concept occur when relationship with contingency not possible. Lean industry and 4.0 industry perform configuration concept not do a single activity relate to production. Hence they contribute in effective performance along with limited the difficulty of extra waste material.

Porter's Value Chain Theory for 4.0 practices

Another theory which is called Porter's Value Chain Theory related with 4.0 practices in manufacturing industries. Porter theory explain how 4.0 industry link with better performance of the industry. This theory suggest that without examine the industry internally no benefit will be achieved. It highlight the approaches in which industries find out the sources of production. Value chain is different with in different companies. Its implantation depend on industry strategy. Similarly, Chain value produce an amount of income which is worth for customers. According to this theory, whole industry is monitor with value creation activities due which whole industry work with value added aim. This gave information about the products process, its manufacturing and term as value adding activity which ultimately enhance the industry financial condition. This theory use 4.0 industry tool to understand the industry performance with low waste material amount (Nagy et al., 2018).

Lean industry enhance the financial performance of pharmaceutical industry

Production of Lean industry is composed of various practices of lean and implementation of these practices highlight the industry success in the sector of manufacturing (Bellm, 2015). Lean industry of manufacturing or lean industry of production is a well-organized method which originate in manufacturing industries of Japan where in manufacturing system it minimize the waste without sacrificing its productivity (Alkunsol, Sharabati, AlSalhi, & El-Tamimi, 2019). In developing world, the pharmaceutical industry face various challenges such as high cost of production while polices of the authorities are less effective and having strong rivals in the market. Such manufacturing practices

enhance the financial performance with increase profit, high share of products, low operational cost and effective performance (Díaz-Reza et al., 2016). All these factors generate the desire to implement such practices which increase and boost the industry output along with high profit which ultimately enhance the financial performance (Pampanelli, Found, & Bernardes, 2015). According to contingency theory the lean manufacturing improve the financial performance with well know the structure of the industries and its relation with external variables due which it ultimately reduce the high cost procedure and highlight the value added practices. In this context, lean industry is seen as an important strategic practice which improve the effectiveness of pharmaceutical industries and create efficiency in operational structures. Such practices also enhance the industry value in the whole world (Shokri, 2017).

H1: Lean manufacturing industry has positive impact on financial performance of pharmaceutical industries.

4.0 industry enhance the financial performance of pharmaceutical industry

The 4.0 industry also called fourth industrial revolution is highly significance in terms of advance technology which enhance the production performance. 4.0 industry have a key role in the requirement of high production with less cost waste management and improve financial condition (Moon, Lee, Park, Kiritsis, & Von Cieminski, 2018). with enhancing the production in industry manufacturing, the 4.0 industry with its advance technology also increase the industry performance in term of its capital along with reduce the waste material (Nagy et al., 2018). 4.0 industry generate high level creation of value, flexibility, and initiate new business model and high profit with advance techniques. Porter's Value Chain Theory gave information about the products process, its manufacturing and term as value adding activity which ultimately enhance the industry financial condition. This theory use 4.0 industry tool to understand the industry performance with low waste material amount. The 4.0 industry with advance techniques move the industry towards more economic favorable conditions. It paved the practices in which savings occur and capital increase with low amount of man power and operator which are replace with 4.0 techniques. It also save energy with efficient working and minimize the production duration with high productive materials and reducing waste materials. Such practices use high amount of income but due to 4.0 practices income which spent on workers and energy save.

H2: 4.0 practices industry has positive impact in financial performance of pharmaceutical industry

Mediating role of waste reduction behavior in lean manufacturing

Lean industry is widely accepted and well recognized in industrial sector. It highlight the human integration in the process of manufacturing with continuously improvement

and emphasize on profitable activities with reducing the waste material. (Mrugalska & Wyrwicka, 2017). Krafcik in 1988 first time use the term lean production industry in his study of Toyota Production System (TPS). His main aim was to eliminate the waste products which produce after the manufacturing process (Alkhalidi & Abdallah, 2018). The key objective of lean industry is to identify the production of flow with optimum condition, increase value for the customer and eliminate the waste products. Identification of value refer to the concept which industries used in their manufacturing methods to deliver the value to the customers. And that activities which does not gave value are excluded from the products and term as waste materials of pharmaceutical industries which have no significance value but it utilize the resources such as capital to manage the waste effectively. Lean industries work to manage the waste which produce after the manufacturing and such waste include transport, overproduction, over processing, high inventory, useless creativity of employees and defects of production (Gambatese, Pestana, & Lee, 2016). The optimum flow creation consider the idea in which production process remain continues without any defect (Alkhalidi & Abdallah, 2018). Lean industry ensure that production process should not be stopped, along with production efficiency in which the waste material should be in low quantity that save the capital and enhance the financial condition (Annas, Erhan, & Sulaeman, 2019). According to contingency theory, lean practice understand its external variables which include low waste production effect and highlight those practices and production process which are form less residue and save the finance which use in waste management (Cai et al., 2019). The main aim of Lean industry is to reduce the variation which are unnecessary and made ways for valuable production in which minimum waste along with elimination of waste materials. Such elimination and low production of waste save the income of the industry which it utilize for waste

management (Albzeirat et al., 2018; Maleka, Nyirenda, & Fakoya, 2017; Maware & Adetunji, 2019). Generally, waste elimination contain material movement, unnecessary steps, over production and excess inventory (Pinto, Matias, Pimentel, Azevedo, & Govindan, 2018).

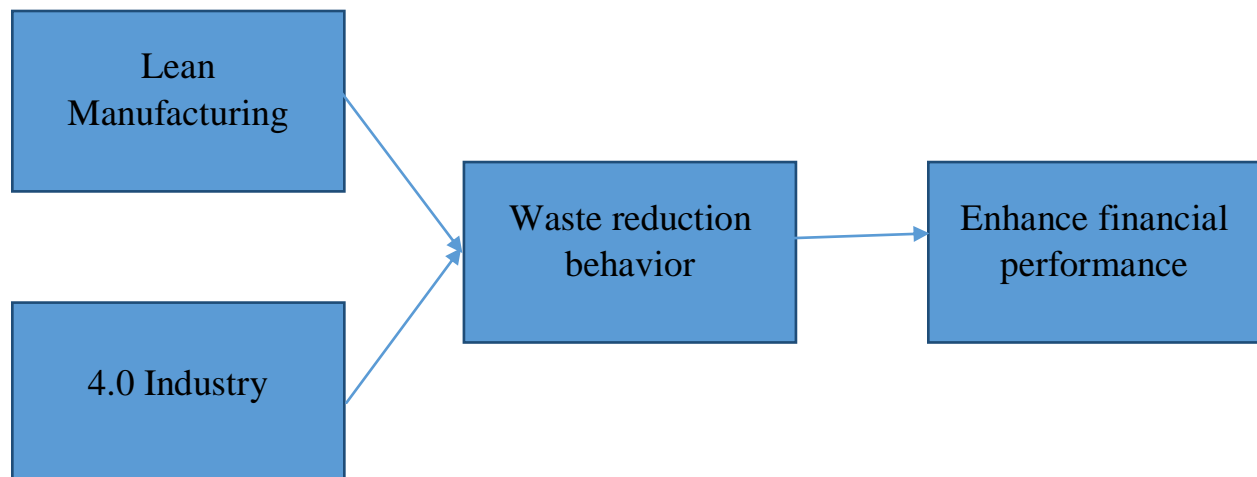
H3: Mediating role of waste reduction behavior in the relationship between lean manufacturing practices and financial performance

Mediating role of waste reduction behavior in 4.0 industry

Shamim, Cang, Yu, and Li (2016) describe in their study that with increasing learning and innovation the 4.0 industry play a vital role in management purposes. Such practices initiate the effective management of waste material which ultimately reduce the cost of management. This study show an approach towards management with sustainability with the help of new techniques in 4.0 practices. It contain advance digital techniques which reduce the workers involvement with less consumption of energy and waste production. 4.0 industry with its advance technology have positive impacts which are depend on various types of analysis which are carried out under different industries. (Varela et al., 2019). In 21 century, 4.0 industry consider as main changes which are require in daily life and in the manufacturing process of various industries (de Sousa Jabbour, Jabbour, Foropon, & Godinho Filho, 2018). According to Porter's Value Chain Theory, 4.0 industry use a chain practices which reduce the residue of the pharmaceutical industries by its value added techniques. Such practices reduce the waste production cost which ultimately save the capital which reserve for the waste management (de Sousa Jabbour et al., 2018).

H4: Mediating role waste reduction behavior in the relationship between 4.0 industry and financial performance pharmaceutical industry.

RESEARCH MODEL



Researcher conducts this proposed study for observing the effect of lean manufacturing and industry 4.0 practices on financial performance, in mediating role of waste reduction behavior. Population of study for this proposed study is pharmaceutical industry of Thailand as Thailand has achieved second largest economy or rank in southeast Asia because of revenue generated from pharmaceutical industry. Thai government desired to enhance the GDP of their country by increasing the financial performance of Pharmaceutical companies, in this research study researcher proposed few variables such as lean manufacturing and industry 4.0 practices. Further, researcher chooses three pharmaceutical companies of Thailand such as Pfizer, GSK and Roche because these companies have high financial performance and these have been incorporated concerned variables in their business operations that's why they can best narrates the impact of concerned variables on financial performance. Researcher selects purposive sampling technique for choosing employees of these three companies because he or she required only these individuals who can entail about functionality of concerned variables. Researcher proceeds data collection process by distributing 440 questionnaires among respondents but out of which only 398 responded. After discarding incomplete and invalid responses, researcher attains only 302 valid responses.

Data Collection Procedure

In the proposed research study, researcher requires primary data and objective data about the concerned variables of study that's why researcher considers survey questionnaire has been selected as best suitable option for data collection procedure. Researcher has to categorized questionnaire into closed ended questions rather than open ended because researcher requires objective responses and data, not subjective responses and descriptive detail. In order to check that survey items are understandable by respondents or not, researcher performed pilot study in which researcher collects responses about wording of items and structure of questions. On the bases of feedback, researcher rectifies mistakes and minimize errors in survey questionnaire. Further, researcher has to checked language of questionnaire must be understandable by respondents and has to verified the content validity of measures through other industrial professionals. After finalizing questionnaire, researcher administered it through self-administering and online-administering techniques in order to collect more appropriate responses, in more efficient and convenient way.

MEASURES

Many other authors have already been taken into account concerned variables in their research work but in totally different context and measures used for measuring role of concerned variables have already been tested with respect to validity and reliability. Due to these reasons, researcher

takes into consideration previous literature and adapts various survey items from these specific research studies. For measuring lean manufacturing constructs, 3 measurement items have been taken from research study of (Varela et al., 2019) and researcher measures industry 4.0 with 3 survey items, which have been taken from (Varela et al., 2019). Coming towards mediating variable such as waste reduction behavior, it has been measured through 4 survey items, which have been adapted from (Yuan & Shen, 2011). Further, depending role of financial performance has been measured through 3 measurement items, adapted from research work of (Lin, Tan, & Geng, 2013). 5-point Likert scale has been taken into consideration for measuring responses of respondents about all these measurement items, in this scale responses ranges from 1 (strongly disagree) to 5 (strongly agree).

Data Analysis Techniques

In the proposed research study, researcher proceeds data analysis process by accompanying two main software such as AMOS and SPSS, which helps researcher to statistically analyzed the authenticity, validity and reliability of outcomes. As far as SPSS is concerned, it has been taken into consideration for performing various tests such as regression test, descriptive statistics test and correlation test for statistical analysis of collected data and conducts reliability test for checking items reliability. Reliability test is based on two criteria such as Cronbach's alpha test and Composite reliability test, both of them must have values greater than 0.70 cutoff value because above that value items reliability and internal consistency can be confirm. Further, AMOS has been accompanied for running the diagnosis of two analysis such as confirmatory factor analysis, which assessed convergent validity, model fitness and discriminant validity and structure equation modeling, which helps to perform hypothesis testing in order to report acceptance or rejection status of hypotheses.

RESULTS AND ANALYSIS

The frequency distribution of respondents is tested to examine their relevant share according to gender, age and education. The primary data is composed on 302 residents of Thailand. In whole dataset, the share of male and female respondents are almost equal. The share of female and male respondents are 47.3 percent and 52.2 percent, respectively. The frequency distribution of data shows that the individual having master and post-graduate degree have 34.1 and 43.4 percent share, respectively. The higher education of respondents are good for getting response as they can easily recognize the scope of questionnaire. Furthermore, in order to check the proportion of respondents according to their ages the frequency distribution based on age group is tested. The findings show that respondents older than 50 year have 15.2 percent share in whole dataset. The share of respondents fall under the category of 40s is 32.1 percent. Hence, most of the respondents belongs to middle age category.

Table 1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
FinanPerf	302	1.00	5.00	3.5430	1.12334	-.718	.140
WasRedB	302	1.00	5.00	3.3890	1.12949	-.466	.140
Industry4.0	302	1.00	5.00	3.5795	1.14706	-.775	.140
LeanManuf	302	1.00	5.00	3.5883	1.08962	-.817	.140
Valid N (listwise)	302						

Table 1 presents the descriptive statistics of variables' data that includes average, maximum, minimum, skewness, and standard deviation of variables' data. Maximum and Minimum values of all the variables is 1 and 5, respectively. The values denote that variables' responses are noted on five point Likert scale. The mean values of all the variables

are hovering around 3.4 to 3.6 that mean significant number of respondents are agree or neutral with the statement. The values of skewness test confirm the normal distribution in data as values lie under the threshold range such as -1 to 1.

Table 2: Factor Loading and Convergent Validity

	WR	IN	FP	LM	CR	AVE
WR3	.868				0.895	0.684
WR4	.859					
WR2	.843					
WR1	.758					
IN3		.872			0.920	0.793
IN2		.860				
IN1		.849				
FP2			.876		0.920	0.794
FP3			.844			
FP1			.831			
LM2				.861	0.889	0.728
LM3				.815		
LM1				.776		

Table 3 indicates that according to component factor analysis (CFA) the measures' construct are valid. The table 3 also presents the rotated component matrix of measures. The stats of CFA test also authorizes that all variables have

valid construct as the load factors are higher than threshold value that is 0.7. The issue of cross loading has also not observe in the variables' construct and convergent and discriminant test also authorizes the validity of measures.

Table 3: Discriminant Validity

	FP	IN	LM	WR
FP	0.891			
IN	0.600	0.891		
LM	0.620	0.536	0.853	
WR	0.404	0.459	0.508	0.827

Table 4 illustrates the statistics of Kaiser-Meyer-Olkin and Bartlett's Test. The KMO test is employed to check how relevant data is for Factor Analysis. The test also assesses sampling adequacy for whole model and for each variable. Furthermore, the KMO test also depicts the variance

proportion among variables that might be common variance. The results of KMO also confirms adequacy in sample data because the value is 0.89 which lies under the threshold range of 0.6 - 1.0.

Table 4: Model Fitness and KMO

CFA Indicators	CMIN/DF	GFI	IFI	CFI	RMSEA	KMO
Threshold Value	≤ 3	≥ 0.80	≥ 0.90	≥ 0.90	≤ 0.08	0.6 – 1.0
Observed Value	1.225	0.965	0.996	0.996	0.027	0.886

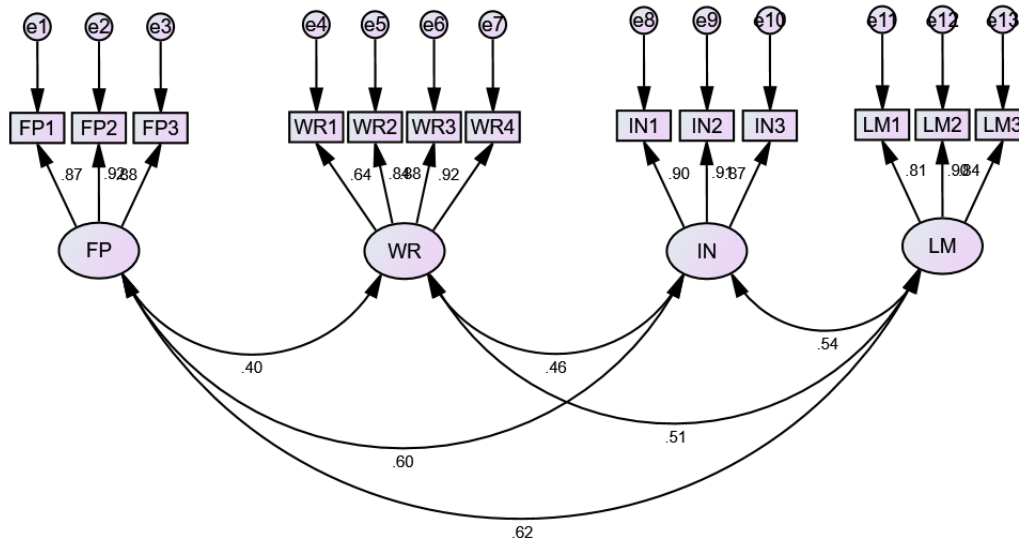


Figure 2: CFA

Table 5 presents the results of the empirical model estimated by using SEM estimators. The SEM is estimated on the AMOS, which is most efficient for estimating the Model. The model investigates the relationships between independent and dependent variables. The results indicate that that Lean Manufacturing has significant impact on the Financial Performance of Pharmaceutical Industry of Thailand. The coefficient illustrates that 1 unit increase in Lean Manufacturing will increase the financial performance of pharmaceuticals by 24.6 percent. Moreover, the coefficient of Industry 4.0 Practices specifies that 1 unit increase in Industry 4.0 Practices will increase the financial performance of pharmaceuticals by 24.9 percent. In addition, the indirect impacts of all the variables through

the channel of waste reduction behavior are significant on financial performance of pharmaceutical in Thailand, as p-value is less than 0.05. The mediating coefficient of waste reduction behavior indicates that one unit increase “waste reduction behavior” will increase financial performance about 13.2 percent through lean manufacturing. Likewise, the mediating coefficient of waste reduction behavior and Industry 4.0 Practices indicates that one unit increase waste reduction behavior will increase financial performance about 8.8 percent through Industry 4.0 Practices. Therefore, it can be inferred that direct and indirect impact (through waste reduction behavior) is positive and significant on financial performance of pharmaceutical in Thailand.

Table 5: Structural Equation Modeling

Hypothesis	B-Value	SE	P-Value	Decision
LM→FP	.246	.057	.000	Accepted
IN→FP	.249	.051	.000	Accepted
LM→WR→FP	.132	.036	.010	Accepted
IN→WR→FP	.088	.027	.010	Accepted

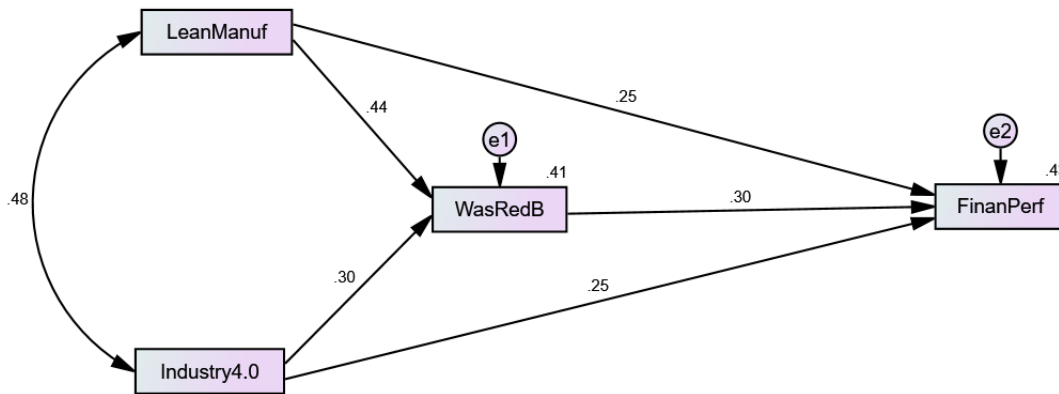


Figure 3: SEM

DISCUSSION AND CONCLUSION

Discussion

The aim of the study was to dig out the impact that lean manufacturing casts on financial performance and the impact that is caused by industry 4.0 practices on financial performance and the study also took waste reduction behavior as a mediator. The first hypothesis that the study proposed was that, “The impact of lean manufacturing on financial performance is significant.” This hypothesis was accepted, based on the results of the study and the study of (Chalongsuk & Sribundit, 2013) as well, which claims that lean manufacturing saves cost. It is because, lean manufacturing is the manufacturing that is done only on orders so the waste is minimized to almost its lowest point which is cost efficient for the company (Kuek, Phillips, & Kohler, 2011), so increases financial benefits and financial performance as well (Pongcharoensuk & Prakongpan, 2012). The second hypothesis proposed by the study was that, “The impact of industry 4.0 practices on the financial performance is significant.” The hypothesis has been accepted based on the results of the study and the research work of (Pothitong & Charoensiriwath, 2011). The third hypothesis proposed by the study was that “the mediating role of waste reduction behavior between lean manufacturing and financial performance is significant.” This hypothesis is accepted based on the results and the study of (Suvachitanont & Ratanapan, 2011), lean manufacturing occurs as per the order of customer, no extra piece manufactured or wasted which increases the scenario of waste reduction, ultimately increasing financial performance positively by being cost effective for the organization. The fourth hypothesis proposed by the study was that, “the mediating role of waste reduction between industry 4.0 practices and financial performance is significant, by the results of the study, this hypothesis has been accepted and the study of (Tejavaniya, 2011) also back up the same idea of waste reduction through industry 4.0 practices, which also enhance the financial performance.

CONCLUSION

The study was conducted to dig out the impact that lean manufacturing casts on financial performance and the impact that is caused by industry 4.0 practices on financial performance and the study also took waste reduction behavior as a mediator. The study took a sample of 302 individuals from the Pharmaceutical Industry of Thailand. The data about the problem was collected from the sample with help of questionnaires and then it was analyzed through SPSS, AMOS and other latest analytical techniques. The results of the study showed that the impact of lean manufacturing on financial performance is significant and positive and the impact that is caused by industry 4.0 practices on financial performance is significant and positive and waste reduction behavior as a mediator acts significantly as well.

Implications of the study

The study has increased theoretical evidence and knowledge about the fact that industry 4.0 practices and the implementation of lean manufacturing increase the financial performance. The pharmaceutical industry of Thailand as well as industries of any other sector around the globe that are looking forward to enhance their financial performance can implement lean manufacturing and industry 4.0 practices in their systems to avoid waste and to maximize financial returns. Through this study, industries around the globe can look forward to be implementing the total waste reduction policies in their setups.

Limitations and future research recommendations

The study has taken into account, a very limited scope. The study is only focusing on the pharmaceutical industry of Thailand, whereas, industries like the automotive industry and heavy engineering industry are the ones, looking forward to waste management and reduction methods so that their waste can be minimized and financial performance can be maximized. Moreover, the study has

also taken a very small sample which could be increased by the researchers in the near future.

REFERENCES

1. Albzeirat, M. K., Hussain, M. I., Ahmad, R., Salahuddin, A., Al-Saraireh, F. M., & Bin-Abdun, N. (2018). Literature Review: Lean Manufacturing Assessment During the Time Period (2008-2017). *International Journal of Engineering Management*, 2(2), 29.
2. Alkhalidi, A., & Abdallah, A. B. (2018). Lean bundles and performance outcomes in the pharmaceutical industry: benchmarking a Jordanian company and operational excellence international project. *Modern Applied Science*, 12(8), 90-102.
3. Alkunsol, W. H., Sharabati, A.-A. A., AlSalhi, N. A., & El-Tamimi, H. S. (2019). Lean Six Sigma effect on Jordanian pharmaceutical industry's performance. *International Journal of Lean Six Sigma*, 10(1), 23-43.
4. Annas, M., Erhan, T. P., & Sulaeman, S. (2019). THE RELATIVE EFFECTS OF UPSTREAM AND DOWNSTREAM LINKAGE ON MODERN RETAILERS DISTRIBUTION PERFORMANCE IN JABODETABEK. *JBFEM*, 2(1), 77-88.
5. Awad, H., Al-Zu'bi, Z. b. M., & Abdallah, A. B. (2016). A quantitative analysis of the causes of drug shortages in Jordan: a supply chain perspective. *International Business Research*, 9(6), 53-63.
6. Ayoub, H. F., Abdallah, A. B., & Suifan, T. S. (2017). The effect of supply chain integration on technical innovation in Jordan: the mediating role of knowledge management. *Benchmarking: An International Journal*, 24(3), 594-616.
7. Bellm, D. (2015). Operational Excellence in the Pharmaceutical Industry—An Architecture for Emerging Markets. *Unpublished PhD thesis, St. Gallen: University of St. Gallen*.
8. Cai, W., Lai, K.-h., Liu, C., Wei, F., Ma, M., Jia, S., . . . Lv, L. (2019). Promoting sustainability of manufacturing industry through the lean energy-saving and emission-reduction strategy. *Science of The Total Environment*, 665, 23-32.
9. Chalongsuk, R., & Sribundit, N. (2013). Usage of chitosan in Thai pharmaceutical and cosmetic industries. *Science, Engineering and Health Studies (FORMER NAME" SILPAKORN UNIVERSITY SCIENCE AND TECHNOLOGY JOURNAL")*, 7(1), 49-54.
10. de Sousa Jabbour, A. B. L., Jabbour, C. J. C., Foropon, C., & Godinho Filho, M. (2018). When titans meet—Can industry 4.0 revolutionise the environmentally-sustainable manufacturing wave? The role of critical success factors. *Technological Forecasting and Social Change*, 132, 18-25.
11. Díaz-Reza, J., García-Alcaraz, J., Martínez-Loya, V., Blanco-Fernández, J., Jiménez-Macías, E., & Avelar-Sosa, L. (2016). The effect of SMED on benefits gained in maquiladora industry. *Sustainability*, 8(12), 1237.
12. Friedli, T. (2017). *Nikolaus Lembke*. University of St. Gallen.
13. Gambatese, J. A., Pestana, C., & Lee, H. W. (2016). Alignment between lean principles and practices and worker safety behavior. *Journal of construction engineering and management*, 143(1), 04016083.
14. Garcia de Oliveira, B., Fang, M. M., & Lin, J. (2019). All Hands on Deck: Addressing the Global Marine Plastics Pollution Crisis in Asia. *Forthcoming, Chinese Journal of Environmental Law*, 3(1).
15. Garza-Reyes, J. A., Betsis, I. E., Kumar, V., & Radwan Al-Shboul, M. d. A. (2018). Lean readiness—the case of the European pharmaceutical manufacturing industry. *International Journal of Productivity and Performance Management*, 67(1), 20-44.
16. Gütter, S. P. (2014). *Lean Practices in Pharmaceutical Manufacturing: An Empirical Investigation*.
17. Koinig, I., Diehl, S., & Mueller, B. (2017). Health Communication and Integrated Corporate Social Responsibility *Handbook of Integrated CSR Communication* (pp. 471-494): Springer.
18. Kuek, V., Phillips, K., & Kohler, J. C. (2011). Access to medicines and domestic compulsory licensing: Learning from Canada and Thailand. *Global public health*, 6(2), 111-124.
19. Lin, R.-J., Tan, K.-H., & Geng, Y. (2013). Market demand, green product innovation, and firm performance: evidence from Vietnam motorcycle industry. *Journal of Cleaner Production*, 40, 101-107.
20. Maleka, T., Nyirenda, G., & Fakoya, M. (2017). The Relationship between Waste Management Expenditure and Waste Reduction Targets on Selected JSE Companies. *Sustainability*, 9(9), 1528.
21. Maware, C., & Adetunji, O. (2019). Lean manufacturing implementation in Zimbabwean industries: Impact on operational performance. *International Journal of Engineering Business Management*, 11, 1847979019859790.
22. Mohammad, I. S., & Oduoza, C. F. (2018). Influence of Lean Practice on Performance of Manufacturing SMEs in Kurdistan Region of Iraq (KRI).
23. Moon, I., Lee, G. M., Park, J., Kiritsis, D., & Von Cieminski, G. (2018). *Advances in Production Management Systems: Smart Manufacturing for Industry 4.0: IFIP WG 5.7 International Conference, APMS 2018, Seoul, Korea, August 26-30, 2018, Proceedings* (Vol. 536): Springer.
24. Mrugalska, B., & Wyrwicka, M. K. (2017). Towards lean production in industry 4.0. *Procedia Engineering*, 182, 466-473.
25. Nagy, J., Oláh, J., Erdei, E., Máté, D., & Popp, J. (2018). The role and impact of Industry 4.0 and the internet of things on the business strategy of the value chain—the case of Hungary. *Sustainability*, 10(10), 3491.
26. Nimeh, H. A., Abdallah, A. B., & Sweis, R. (2018). Lean supply chain management practices and performance: empirical evidence from manufacturing companies. *International Journal of Supply Chain Management*, 7(1), 1-15.

27. Pampanelli, A. B., Found, P., & Bernardes, A. M. (2015). Sustainable manufacturing: the lean and green business model *Sustainable Operations Management* (pp. 131-161): Springer.
28. Pinto, J. L. Q., Matias, J. C. O., Pimentel, C., Azevedo, S. G., & Govindan, K. (2018). Introduction to Lean and Just-in-Time Manufacturing *Just in Time Factory* (pp. 1-4): Springer.
29. Pongcharoensuk, P., & Prakongpan, S. (2012). Centennial pharmacy education in Thailand. *Journal of Asian Association of Schools of Pharmacy*, 1, 08-15.
30. Pongugsorn, W., Buavaraporn, N., & Punnakitikasem, P. (2016). Investigating of Current Practices of Lean Implementation for Improving Service Quality in Airlines Industry.
31. Pothitong, P., & Charoensiriwath, C. (2011). *Improve supply chain efficiency through a web-based system: A case study on a pharmaceutical company in Thailand*. Paper presented at the 2011 IEEE International Conference on Quality and Reliability.
32. Sahoo, S. (2019). Lean manufacturing practices and performance: the role of social and technical factors. *International Journal of Quality & Reliability Management*.
33. Shamim, S., Cang, S., Yu, H., & Li, Y. (2016). *Management approaches for Industry 4.0: A human resource management perspective*. Paper presented at the 2016 IEEE Congress on Evolutionary Computation (CEC).
34. Shokri, A. (2017). Quantitative analysis of Six Sigma, Lean and Lean Six Sigma research publications in last two decades. *International Journal of Quality & Reliability Management*, 34(5), 598-625.
35. Shrafat, F. D., & Ismail, M. (2019). Structural equation modeling of lean manufacturing practices in a developing country context. *Journal of Manufacturing Technology Management*, 30(1), 122-145.
36. Ślusarczyk, B., Haseeb, M., & Hussain, H. I. (2019). Fourth industrial revolution: a way forward to attain better performance in the textile industry. *Engineering Management in Production and Services*, 11(2), 52-69.
37. Song, M.-L., Fisher, R., Wang, J.-L., & Cui, L.-B. (2018). Environmental performance evaluation with big data: Theories and methods. *Annals of Operations Research*, 270(1-2), 459-472.
38. Suvachitanont, S., & Ratanapan, P. (2011). *Evaluation of microcrystalline cellulose from corn cob for development to the pharmaceutical industry*. Paper presented at the TICHe Int. Conf.
39. Tejavaniya, M. (2011). A New Kind of Drug War: Thailand's Taking on the Pharmaceutical Industry to Improve Access to HIV/AIDS Drugs through the Use of Compulsory Licensing. *Ariz. J. Int'l & Comp. L.*, 28, 659.
40. Varela, L., Araújo, A., Ávila, P., Castro, H., & Putnik, G. (2019). Evaluation of the Relation between Lean Manufacturing, Industry 4.0, and Sustainability. *Sustainability*, 11(5), 1439.
41. Xu, J., Shang, Y., Yu, W., & Liu, F. (2019). Intellectual Capital, Technological Innovation and Firm Performance: Evidence from China's Manufacturing Sector. *Sustainability*, 11(19), 5328.
42. Yuan, H., & Shen, L. (2011). Trend of the research on construction and demolition waste management. *Waste management*, 31(4), 670-679.