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Warehouse Carrying Cost Reduction by Using Lean Tools and Supplier Analysis

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Abstract

The purpose of this research is to investigate the existing problems in warehouse carrying cost structure of wooden packaging company, to apply lean tools and to lower warehouse carrying cost, and to propose the cost structure strategy based on the lean tools and supplier analysis. The researchers study the factors of warehouse carrying cost that include ordering cost, holding cost, and cost of administrative of wooden packaging company, utilize lean tools (5S/Visual Control, VSM/Value added, JUST IN TIME/ Pull system), and collect data on raw material, flow warehouse operation, and suppliers' analysis. The researchers interviewed the three top managers of the company about the work flow, main cost, and the problems of the company. After that the researcher attempted to figure out the company problems by apply the proper lean tools and analyzed the existent suppliers to lower warehouse carrying cost and it is leading company to gain more profit.

Keywords: Warehouse Carrying Cost, Supplier Analysis, Lean Tools

1. Introduction

The company is wooden packaging company who is service provider under the ISO 9001:2008 quality management system standard to package machinery or products for keeping and maintaining machine such as refrigerator, washing machine, and any other cargo., and for delivering and for moving the products from one place to another place. The company provides pallets, both solid and airy (wooden case and wooden crate) depending on the drawing from customers. The customers can order or specify their own size of the pallets. The company does packing under International Plant Protection Convention (IPPC) system both normal and vacuum pack. The company will produce the product according to customer orders by using raw materials from domestic wood and pine wood from New Zealand, Chili, and Australia.

1.1 Background and statement of problems

Warehouse carrying cost is the cost that arises from holding of inventory at an inappropriate level. If the company orders too much, the company has to pay for maintenance, inventory, opportunity cost, and other related costs, and it will affect the company overall costs of capital. If the order is not enough, the company will lose the opportunity in selling their finished goods and it will affect to the company profit.

To avoid running out of stock the company requires a good planning and a future forecast for ordering products because the company has to ensure that their safety stock level must be acceptable or high enough to cover their vendor transit time on new shipments and high enough to cover the customer demands (Priest, 2016). This transit time is also known as a delivery time or how long that the product will be sent. Transportation time is the most important portion of inventory replenishment time and is critical when determining safety stock levels. The company must recognize that the more wood they have, the more cost they have for maintenance and too much inventory or high carrying cost will reduce the company gross profit therefore, the company should order and stock inventory at appropriate and adequate levels.

Warehouse carrying costs include ordering cost, holding cost, and administration cost. These costs can be checked by management and how much inventory is kept on hand. Ordering cost is the cost for the company to order the wood, machine, or any other raw materials to produce the pallets and also including the purchasing transaction, taxes, and labor cost. Holding cost is also known as cost of inventory and is related to cost of space to keep or stock the inventory, the cost of maintenance, the risk of loss, and other related costs of inventory. Administration cost includes the cost of the accounting department, cost of goods sold, accounting staff paper work, and any office equipment (Bragg, 2018).

Warehouse management is important to the company business because good warehouse management allows the company to manage the work flow effectively and efficiency, real-time information can be accessed at any time which makes the company work faster and easier, also includes other information such as tracking number that helps the company run their business more effectively (Robertson, 2014). Warehouse carrying cost and the price of raw materials from each supplier are the major factors of warehouse carrying-cost that affect the operation cost and it leads to impact on the gross profit of the company so we want to reduce the warehouse carrying cost and maintain the company profits by using lean tools and supplier analysis. The objectives of the study were: 1) investigate the existing problems with warehouse carrying cost, and 2) apply lean tools and supplier analysis to lower warehouse carrying cost.

To study the factors on warehouse carrying cost that includes ordering cost, holding cost, and cost of administrative of wooden packaging company, utilize lean tools (5S,Visual Control, Value stream mapping, Value added, JUST IN TIME), and collected data on raw material, flow of warehouse operation, and inventory control.

2. Literature Review

In this chapter, the researchers describe the elements that are concerned with this research topic, the researchers studied from related periodic academic researches, articles, and case studies which are the similar topic.

2.1 Carrying Cost

The warehouse carrying cost is the cost that is related to the company storage. The carrying costs will be higher if the inventory level is high and it will be lower if the inventory level is low.

According to Murray (2017), carrying cost of warehouse has four main components including:

1. Capital cost: the cost that the company expends at the beginning to run the production such as land, building, construction, and equipment.
2. Storage space cost : the cost while keeping inventory such as rental warehouse cost
3. Inventory service cost : the cost that might occur from insurance and taxes
4. Inventory risk cost: the risks that might occur from keeping inventory such as the risk of loss and damage

2.2 Wastes in Service

Wastes in service are the activities or operations that are extravagant and intangible. According to Andrés-López, González-Requena, and Sanz-Lobera (2015), wastes in service were classified by the analysis of the customer experience.

Table 1 The table collects the previously defined wastes (muda), comparing them to their analogue wastes in manufacturing environment.

Service	Manufacturing analogy	Example	Root cause
1. Overproduction	Overproduction	Processing items before being required	Poor planning
2. Delay	Waiting	Pending requests	Poor coordination
		Delayed information provisions	
3. Un-needed transport or movement	Motion	Looking for data and information	Poor office housekeeping
	Transport	Excessive e-mail attachments	Outdated work habits
4. Over-quality, duplication	Over-processing	Repeated details on forms	Excessive bureaucracy
5. Lack of standardization	Inventory	Fluctuating lead times	Demand fluctuations
6. Failure Demand	Defects		
Lack of customer's focus		Poor attention to the customer	Lack of motivation
Obsolescence or Inadequacy		Error, incomplete work in service transaction	
Loss of opportunity			Unclear workflow
Miscommunication			
7. Under-utilized resources		Limited responsibility	Manager's resistance to change
8. Manager's resistance to change	Manager's resistance to change	Rejected suggestions	Belief of "Saying no" attitude is safer

Source: E. Andrés-López et al. / Procedia Engineering132 (2015) 23-30

Overproduction is a miss matching between customer's demand and company's supply. Unneeded transport or movement is the unnecessary transportation of delivery of some documents. The company can send the information through e-mail instead of delivering them.

2.3 Lean logistics

Lean tools also known as Lean Manufacturing System is designed to eliminating loss or non-value added within the process of value stream. There are over production waste, transportation waste, waiting waste, inventory waste, defect waste, motion waste, and over-processing waste. The concept of Lean tools is to make the whole process from the process of production until the process of delivering to be without loss or non-value added by implementing the pace of the customer needs and continually improvement to create the value of the stream (Ramirez, 2014).

There are many of lean tools to apply for the company subject to the suitability and the adaptation of the company, but this project will focus only 5S, Visual control, VSM, Value added, JIT, and supplier analysis.

2.4 5S Lean Tools

5S is a technique use for organizing work space and workplace so the company can perform the work efficiently, effectively, and smoothly.

Source: AskLean (2018)/ http://asklean.com/5s-success-tips-apply-it-to-your-office-home-and-factory-too.

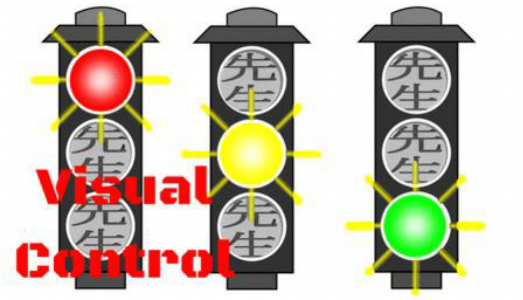
Figure 2 5S methodology

Lean manufacturing techniques (5-S) has been found to be powerful tools and can be applied in any industry. 5-S is a significant technique in the reduction of the wastage of time, material, and manpower (Hindoliya & Sarathe, 2017).

The objective of this concept is to create a clean and orderly workplace environment. The researchers want to apply this concept to help the company reduce mistakes from employees and reduce time in navigating the facility and locating tools.

2.5 Visual Control

Visual control – also known as Visual Factory Management is the way that people communicate to others by the symbols, labelling, sign, color, and whatever else through the visual and auditory senses.



Source: Lean Strategies International LLC / https://www.leanstrategiesinternational.com/lean-and-six-sigma-glossary/visual-control

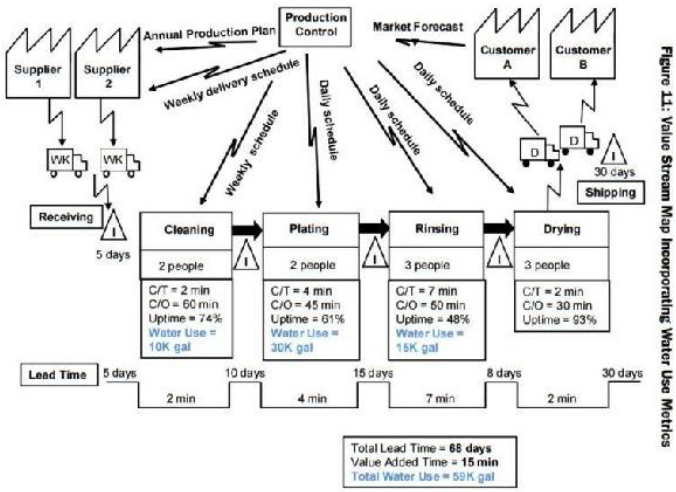
Figure 3 Visual Control

Visual Control, Visual display relates to visual displays that contain information, data, and audio signals to control and guide actions of the employees in a particular area for example Toyota uses Andon tool in production system. Andon is a visual aid that helps an organization warn and alert when the problems occur and highlights where action are required (Group, 2011).

Visual control can effectively communicate the company work performance and prevent problems, and it can help the company to make decisions for long term investment. The researchers want to apply this tool to help the company increase efficiency and clarity by putting critical information at the point of use.

2.6 Value Stream Mapping

VSM - Value Stream Mappings also known as a lean management method is used for analyzing every step of how the product is made until it is sent to the customers.



Source: Brion Hurley (2018) / http://leansixsigmaenvironment.org/index.php/vsm-with-water-usage.

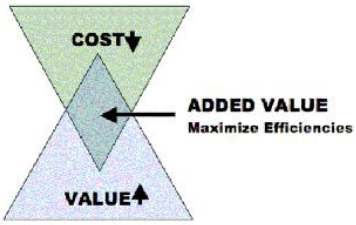
Figure 4 Value Stream Mapping

Value Stream Mapping or VSM, Value stream mapping is an effective tool to analyze a company's current production state and point out problem areas so that it will be helpful for the company to be able to fix the problems exactly (Worcester Polytechnic Institute (WPI), 2007).

The use of Value Stream Mapping can distinguish between the value-added activities and the nonvalue added activities and provide greater visibility and quicker resolution of problems. The researchers want to apply this tool to the company for better communication and coordination.

2.7 Value added

Value added is function of the product or service that customer is willing to pay for. The purpose of the company is to satisfy the existing customers, grow by adding new customers, and improve profitability.



Source: Nikos Kontorigas (2014) / https://theqnote.com/calculate-the-value-added-of-income-for-your-business

Figure 5 Value added

Value added, value-added service helps manufacturers reduce costs and lead times, while increasing work performance and providing a complete connectivity solution (Connector Supplier, 2016).

Value added is the concept of adding value for the company, not only money, but time, process, and value effort also. Value adding can help the manufacturing improve the output performance and it can reduce the amount of cycle time. The researchers want to apply this concept to help the company add value and improve the performance.

2.8 Just in time

JIT – Just in time is a management system in which materials or products are produced or acquired only as demand requires.

Source: Market Business News (2018) / http://marketbusinessnews.com/financial-glossary/just-time-definition-meaning

Figure 6 Just in Time

Toyota has applied Just-In-Time to maximize efficiency output by using this program to help calculate quality and production to meet demands exactly (Monden, 1993).

Just in Time is the concept of producing the necessary items in necessary quantities at the necessity time. This tool can improve production performance and help the company to reach greater performance. The researchers want to apply this tool in order to help the company reduce inventory and it leads to reduce warehouse carrying cost.

2.9 Supplier Performance Measurement

According to Handfield, R. B. et al. (2012), the performance criteria which the company must consider are between objective (quantitative) and subjective (qualitative) methods of measurement. The quantitative variables that are most used for measure include:

1. Delivery performance: how fast supplier can be sent the product from the company purchase order and how well the supplier is satisfied with the company by sending the product on time with quality and quantity that meet the company requirements.
2. Quality performance: the supplier measurement includes quality performance, track trend, and improvement rate by comparing among exiting suppliers.
3. Cost reduction: comparing a supplier's cost between suppliers within the same industry by target price or last price paid.

2.10 Weighted-Point System

According to Handfield, R. B. et al. (2012) weighted-point system is a supplier measurement technique to measure supplier performance by weight and quantify the score in each criterion. The advantage of weighted-point system is flexibility, quantitative and qualitative factors can be combined into one system. The user can change the weight depend on the requirement factors of the company. Table 2.2 is an example of weighted-point system.

3. Research Methodology

The excessive inventory is the most important issue influencing warehouse carrying cost. Without proper tools and management system, long term profits can be affected and lower warehouse carrying cost will lead the company to gain more profits. The researchers were interested in lean tools and would like to study how lean tools can save or reduce the company warehouse carrying cost by utilizing 5S, Visual control, Value stream mapping, Value added, Just in time, and Supplier analysis to the company.

3.1 Data Collection

The researchers have collected data in three ways which are:
1. Unstructured interview
2. Electronic related documents
3. Related prior researches

3.2 Population and sample

There are 140 employees in the wooden packaging company but the researchers interviewed three managers which are managing director, board director, and general manager of wooden packaging company. The reasons why we have to interview three managers because of some information is sensitive.

3.3 Research design

The purpose of this research is to reduce warehouse carrying cost and the optimal of product's flow and warehouse operation. Then the researchers select the proper Lean tools that suitable with the company's problems. The researchers use both of qualitative and quantitative information about the company and find the better solutions for them in saving warehouse carrying cost.

3.4 Designing the results

After the researchers were finished with the data collection, the researchers analyzed the data by weight point system to find the most suitable supplier for the company given the criteria that the company focuses on. For example, the company focuses on price, lead time, credit term, and quality. The researchers designed the proper tools that match with the company problems from the lean tools that the researchers have studied and then desired the results.

3.5 Data Analysis

Supplier measurement decision by weighted-point system

Weighted-point system is the supplier measurement technique to measure supplier performance by weight and quantified the score in each criterion. The advantages of Weighted-point system are flexibility because quantitative and qualitative factors can be combined into one system. The user can change the weight depend on the requirement factors of the company (Handfield, R. B. et al., 2012).

The researchers use weight score system to find the result by setting the score criteria are as follows:

1. Lead time to deliver the wood is equal to 0.25
2. The price of the wood is equal to 0.4
3. The volume of the wood is equal to 0.1
4. Credit term is 0.25

Score criteria comes from what does the company focus on and what does the company want from each supplier. The company focused on price, lead time, credit term, and volume.

For lead time criteria, supplier who required long lead time will get the minimum score.

For price criteria, supplier who offered the highest price will get the minimum score.

For volume criteria, supplier who can provides and delivers for a high volume will get the maximum score.

For credit term criteria, supplier who offers the longest credit term will get the maximum score.

Table 1 The table for measure supplier performance in weighted-point system

Suppliers	Lead Time (0.25)	Price (0.4)	Volume (0.1)	Credit Term (0.25)	Total score
Supplier A form Australia					
Supplier B form New Zealand					
Supplier C form Chili					

4. Results Analysis

4.1 To investigate the existing problems on warehouse carrying cost structure

From the interview results, it was found that the ordering system of the company is not stable because it depends on the wood price. The company will order higher quantities when the price is cheap so it leads to having excess inventory and the company has to pay for maintenance which affects to warehouse carrying cost and it also affects to the gross profit of the company. Due to the company ordering more when the price of the wood is cheap so that it leads to the company lacking space for stock of the finished goods which is why the company needs to deliver their finished goods immediately after the company finished their production line.

The company brings this wood to be made into pallets depending on the order from the customers. The customers will be the one who formulate and set the size of the pallet and schedule the time. The customers will send the diagram of each order to the company so that the company cannot stock premade pallets. After that, the company will cut the wood by following the drawing from customers to make sure that the pallet will meet the requirements.

4.2 Main cost in warehousing

Owing to the fact that wooden packaging company, the main cost in warehousing is the maintenance of wood for moistness and protection from termites. As a result, keeping the wood for long time according to the company results in having too much inventory of stock of wood.

Table 2 The table shows average costs in warehouse in 2017

Month	Cost in warehouse in 2017						Total Costs
	Labor Cost	Transportation cost	Insurance	Electricity cost	Maintenance	Others	
January	124300	17400	8600	11500	10800	3500	176100
February	135100	18300	8600	12400	10800	2800	188000
March	132700	20000	8600	16000	10800	2950	191050
April	136200	19300	8600	16300	10800	3100	194300
May	154500	19400	8600	21300	10800	3350	217950
June	145600	20200	8600	20600	10800	2850	208650
July	145700	24000	8600	19600	10800	3150	211850
August	159400	30300	8600	22700	10800	2950	234750
September	166200	38000	8600	26300	10800	4200	254100
October	152900	27200	8600	16600	10800	2850	218950
November	164300	28300	8600	20200	10800	3050	235250
December	154600	23000	8600	13900	10800	3300	214200

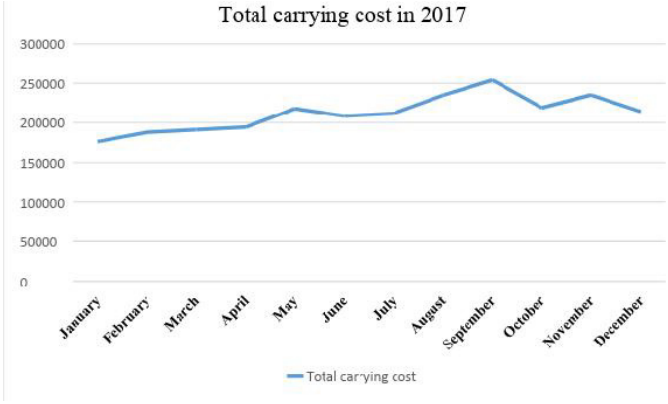


Figure 7 The graph shows total carrying cost each month in 2017

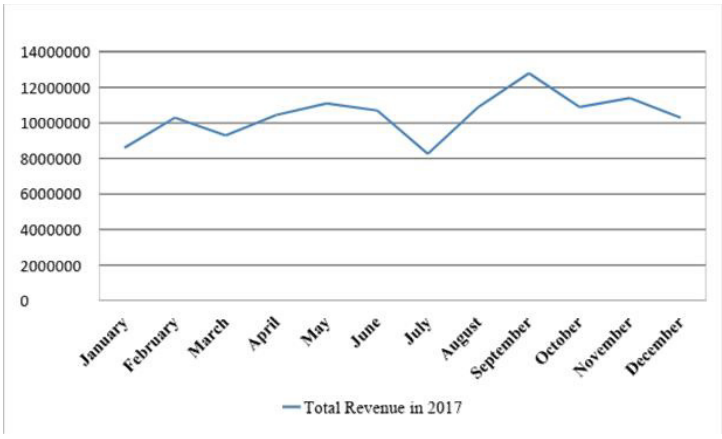


Figure 8 The graph show total revenue in 2017

From Figure 7 and Figure 8 that carrying cost is direct variation with the revenue of the company. Because the company had more tasks to gain the revenue so the workforce will do over-time, use more electricity, and high transportation cost.

4.2 To apply lean tools and supplier analysis to lower warehouse carrying cost

After the researchers have studied from related prior researches and from lesson learned, the researchers founded that 5S, Visual control, Value stream mapping, Value added, and Just in time is the basic tools that the company should use in order to improve quality, eliminating wastes, eliminating mistake, reduce lead time, and reduce warehouse carrying cost. The researchers found that each of the tools can help the company save cost and improve work performance differently as follows:

4.2.1 5S

From the researchers have studied, 5S is the set of method to improving company performance and lowering cost by

1) Sort: distinguish unnecessary items from necessary items for current pallet production line and eliminate what is not required in order to reduce waste and save the time to find the items or the tools that the company wants to use.
2) Set in order or straightening: organize and arrange needed items in the proper place so that the items can be picked easily and be ready for use.
3) Shine: Keep everything clean and neat, instead of buying something new because it is missing and pay for the repairing of the tools or the items, the company can save these costs by always clean and take care of them such as fix what they are broken, keep them safely, and use them following the instructions.
4) Standardize: Educating all of the employees to have good habits in order to make the company more effectively and efficiency by developed a work structure and set up the standard so that can make them have a good habit.
5) Sustaining: Maintain standard and make the employees have a commitment to practice 5S daily.

4.2.2 Visual control

From the information the researchers have studied, visual control as a communication aid helps company to improve, support, and sustain the productivity and for the flow smoothly of the company information by using symbols, colors, flowchart, and audio signals instead of text to communicate or identify for easy and quick understanding.

Visual control provides the company options to make operation standards visible such as using the flow chart, color, and sign which will allow the employees to be able to follow the instruction easily and this can also allow the company to see the abnormal conditions so the company can fix the problem immediately and exactly.

4.2.3 Value stream mapping

From what the researchers have studied, value stream mapping is the tool that distinguishes the value activities from the non-value activities for production and delivery of the pallets to the customers. Value stream mapping can help company improve the flow of inventory and the company information, eliminate the waste processes, and provide value to the company and customer.

4.2.4 Value added

From what the researchers have studied, value added is the concept to create the extra value for the company and the customers, so we have suggested the company to sell the sawdust after they have finished the production line so that the company can gain more money from selling their sawdust.

4.2.5 Just in time

From what the researchers have studied, we have suggested that instead of the company ordering a large volume of the wood when the price is cheap, the company should order in necessary quantities at the necessary time to reduce inventory cost.

4.2.6 Supplier Analysis

Supplier analysis is the tool used to evaluate the existing suppliers to find the most suitable supplier that matches with the company requirements.

Table 3 The lead time, price, volume from supplier A, supplier B, and supplier C from import ordering in 2017

Suppliers	Lead Time	Price	Volume	Credit Term (payment time)
Supplier A form Australia	84 days 112 days	$198 $190	345 310	30
Supplier B form New Zealand	124 days 129 days	$185 $183	210 210	45
Supplier C form Chili	66 days 75 days	$205 $200	310 310	60

The researchers use weight score method to find the result by set the score criteria are as follow;

1. Lead time to deliver the wood is equal to 0.25
2. The price of the wood is equal to 0.4
3. The volume of the wood is equal to 0.1
4. Credit term is 0.25

Therefore, the total score of each supplier is as follows:

Table 4 The table shows the score of each supplier for each criteria.

Suppliers	Lead Time (0.25)	Price (0.4)	Volume (0.1)	Credit Term (0.25)	Total score
Supplier A form Australia	2	2	3	1	0.5+0.8+0.3+0.25= 1.85
Supplier B form New Zealand	1	3	1	3	0.25+1.2+0.3+0.25= 2.3
Supplier C form Chili	3	1	2	2	0.75+0.4+0.2+0.25= 1.85

The table above shows the score of each supplier, supplier A got 1.85 points, supplier B got 2.3 point, and supplier C got 1.85 point. The supplier B got the highest point which means that the supplier is the most suitable and worth for the company because supplier B tends to be the best one. However, the supplier B should improve the long lead time for delivering the wood and the volume of the wood to deliver for the company.

5. Conclusion and Recommendation

5.1 Conclusion

There are many factors that affect the company warehouse carrying cost. The researchers found that the company has an inconsistent ordering system. The company orders much when the price of the wood is cheap so that leads to the company having too much inventory and insufficient space to store the finished goods so the company has to deliver the pallet immediately after the production line. The company has spent too much money on maintenance cost according to the company because they have too much inventory on hand. The objectives of this research were to investigate the company existing problems about warehouse carrying costs by utilizing lean tools (5S, Visual control, VSM, Value added, JUST IN TIME) and supplier analysis to lower warehouse carrying cost. However, this research was made to suggest the company to utilize lean tools and supplier analysis to the lower warehouse carrying cost. From the researchers have studied found that these tools can help the company improve work performance, improve quality, eliminate waste, eliminate mistake, save cost, reduce lead time, reduce warehouse carrying cost, and the company can find the most suitable supplier for them.

5.2 Recommendation

The company should have the good ordering system because the company buys more when the wood price is cheap so it leads to have excess wood in the inventory and the company has to pay for maintenance and pay for destroying as a result from stocking wood for too long. The researchers have suggested that the company can save by finding the balance and buying not so much per each time and the company should require the information or the production planning of their customers in order to plan to order the wood next time or how much should the company order the wood from outside the country because the company must consider the long lead time. From the results of the study the researchers have analyzed and found the proper lean tools for the situation of this company. The company should apply 5S, Visual control, Value stream mapping, Value added, and Just in time in order to save on the warehouse carrying cost. These tools require at least 6 months in order to perform them effectively so the company should send at least one staff from each department to training in the lean concepts and follow up on the outcome every month.

References

Andrés-López, E., González-Requena, I., & Sanz-Lobera, A. (2015). "Lean Service: Reassessment of Lean Manufacturing for Service Activities". In J. M. Canela, & B. I. Corral (Ed.), Procedia Engineering : MESIC Manufacturing Engineering Society International Conference 2015. 132, pp. 23-30. Elsvier.

AskLean. (2018). AskLean. Retrieved June 12, 2018, from http://asklean.com/5s-success-tips-apply-it-to-your-office-home-and-factory-too.

Bevilacqua, M., Ciarapica, F. E., Sanctis, I. D., & Paciarotti, C. (2015). "A Changeover Time Reduction through an integration of lean practices: A case study from pharmaceutical sector". Assembly Automation, 35(1), 23-34.

Bragg, S. (2018). Inventory cost. Retrieved from https://www.accountingtools.com/articles/what-is-included-in-inventory-cost.html.

Connector Supplier. (2016). The Importance of Value-Added Services and Manufacturing. Retrieved February 2, 2018, from http://www.connectorsupplier.com/importance-value-added-services-manufacturing.

Corke, P. I. (1993). Visual Control of Robots Manipulators - A Review. Retrieved April 23, 2018, from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.45.1487&rep=rep1&type=pdf

Deepradit, E. (2010). Supplier Selection of Japanese Food Ingredient: A Case Study of Hanabi Restaurant. Master Thematic Paper, Dhurakij Pundit University, Bangkok.

El Dabee, F. F., & Hokoma, R. A. (2012). Just-In-Time for Reducing Inventory Costs. Retrieved April 23, 2018, from http://www.waset.org/publications/6499

Group, M. S. (2011). Visual Control and Management : Manufacturing Management. Retrieved Mar. 15, 18, from https://www.slideshare.net/Sarvajeet/visual-control-and-management-manufacturing-management

HaldanMES. (2018). Haldan Consulting. Retrieved May 17, 2018, from https://www.haldanmes.com/detail/i/haldanmes

Handfield, R. B., Monczka, R. M., Giunipero, L. C., & Patterson, J. L. (2012). Sourcing and Supply Chain Management 5th Edition. Canada: Nelson Edition.

Hindoliya, S., & Sarathe, A. K. (2017). "Implementation 5-S for efficient manufacturing in a plastic industry". International Journal of Mechanical And Production Engineering, 5(10), 102-106.

Huadchai, P., & Suksithong, P. (2012). SE Catalog : Thai Social Enterprise. Bangkok: Acme Printing.

Hurley, B. (2018). VSM With Water Usage. Retrieved March 13, 2018, from http://leansixsigmaenvironment.org/index.php/vsm-with-water-usage

J. Rodrigue. (2017). The Geography of Transport Systems 4th Edition. New York: Routledge.

Jiao, J., Ma, Q., & Tseng, M. M. (2003). Towards high value-added products and services: mass customization and beyond. Retrieved March 15, 2018, from https://www.sciencedirect.com/science/article/pii/S0166497202000238

Keyte, B., & Locher, D. (2015). The Complete Lean Enterprise: Value Stream Mapping for Administrative and Office Processes. New York: Productivity Press.

Kontorigas, N. (2014). Calculate the value-added of income for your business. Retrieved February 02, 2018, from https://theqnote.com/calculate-the-value-added-of-income-for-your-business.

LLC, Lean Strategies International. (2018). Lean Strategies International LLC. Retrieved June 12, 2018, from https://www.leanstrategiesinternational.com/lean-and-six-sigma-glossary/visual-control

Makmoon, S. (2014). An Application of Lean manufacturing of power amplifier manufacturing process. Chonburi: Burapha University.

Market Business News. (2018). What is just in time? Definition and meaning. Retrieved February 2, 2018, from http://marketbusinessnews.com/financial-glossary/just-time-definition-meaning.

Monden, Y. (1993). An integrated approach to Just-In Time. Retrieved from https://www.ifm.eng.cam.ac.uk/research/dstools/jit-just-in-time-manufacturing/

Mujtaba, S., Feldt, R., & Petersen, K. (2010). "Waste and Lead Time Reduction in a Software Product Customization Process with Value Stream Maps". Proceeding of the Australian Software Engineering Conference, (pp. 139-148).

Murray, M. (2017). Inventory Carrying Costs - Components and Considerations. Retrieved from https://www.thebalance.com/inventory-carrying-costs-2221373

Orville, S. (2015). "Development Of Plant Layout Using Systematic Layout Planning (SLP) To Maximize Production – A Case Study". International Journal of Mechanical and Production Engineering, 2(8), 63-66.

Panyavai, T., & Phumchusri, N. (2016). Design of Electronic Kanban System for the Preparation Process of Rubber. Faculty of Engineering. Chulalongkorn University.

Parry, G. C., & Turner, C. E. (2007). "Application of lean visual process management tools". Production Planning & Control : The Management of Operations, 77-86.

Patel, V. C., & Thakkar, H. (2014). "A Case Study: 5s Implementation in Ceramics Manufacturing Company". Bonfring International journal of Industrial and Management Science, 4(3), 132-139. Retrieved May 5, 2018, from http://www.journal.bonfring.org/papers/iems/volume4/BIJ-10346.pdf

Petcharak, P., & Jangruxsakul, S. (2010). A Study of Toyota Production Systems (TPS) in Thai Autoparts Industry. Bangkok: Dhurakij Pundit University.

Priest, C. (2016). Safety Stock Calculation. Retrieved from https://www.tradegecko.com/blog/calculating-safety-stock-levels.

Ramirez, D. L. (2014). A Lean Logistics Self-Assessment Tool For SMEs in the manufacturing sector. Industrial Technology. Purdue University.

Rauniyar, M. (2007). Value Stram Mapping at XYZ Company. Wisconsin: University of Wisconsin-Stout.

Robertson, D. (2014, June). BAASS Insight Technology. Retrieved from https://www.baass.com/blog/three-reasons-why-your-company-needs-a-warehouse-management-system

Seth, D., & Gupta, V. (2007). "Application of value stream mapping for lean operations and cycle time reduction: an Indian case study". Production Planning & Control: The Management of Operations, 44-59.

Smith, J. B., & Colgate, M. (2007). "Customer value creation: A practical framework.". Journal of Marketing Theory and Practice, 7-23.

Sorooshian, S., Salimi, M., Bavani, S., & Aminattaheri, H. (2012). "Case Report: Experience of 5S Implementation". Journal of Applied Sciences Research, 8(7), 3855-3859.

Tezel. (2010). Visual management in construction: Study report on Brazilian cases. Retrieved May 12, 2018, from http://usir.salford.ac.uk/12865/2/Visual_Management_in_Construction.pdf

Titu, M. A., Oprean, C., & Grecu, D. (2010). Applying the Kaizen Method and the 5S Technique in the Actvity of Post-Sale Service in the Knowledge-Based Organization. Retrieved May 05, 2018, from http://www.iaeng.org/publication/IMECS2010/IMECS2010_pp1863-1867.pdf

Yourawd, P. (2009). Application of the AHP Method of Logistics Service Providers Selection : A Case Study of a Commercial Bank. Graduate School, Integrated Supply Chain Management. Dhurakit Pundit University.