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ScienceDirect

Procedia Manufacturing 51 (2020) 1696–1702

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

30th International Conference on Flexible Automation and Intelligent Manufacturing (FAIM2020)
15-18 June 2020, Athens, Greece.

Short-term logistics management at a multinational corporation

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Abstract

Nowadays, many companies still operate without any process standardization in relation to short-term logistics management, which leads to a lack of control of both times and costs of logistical operations. This paper starts from a study that has been performed at a multinational corporation which manufactures fiber-reinforced plastic boxes and cabinets with doors, where the final product-storage area and the picking section frequently become overloaded. In addition, warehouse operators do not follow standardized procedures and usually carry out too many movements to complete their tasks. Finally, there is not a suitable daily logistics planning system to make sure that capacity and demand are in balance. This paper proposes a solution to this problem by means of a Methods-Time Measurement (MTM) study as well as a daily workload planner to control short-term logistical operations. Thanks to the implementation of this system, the company has been able to plan the day-to-day workload in an accurate way and to precisely determine the necessary resources for the picking and shipping orders. Moreover, the company has gained flexibility in order to better match demand and capacity and has experimented significant cost savings and a better delivery service to its customers.

Keywords: Short-term logistics management, simulator, MTM, operational excellence

1. Introduction

Over the last decades, companies are facing a competitive challenge in the context of the global economy. Operations management is the activity of managing the resources which are devoted to the production or delivery of products or services [1]. Operations contributions to competitive advantages are embodied in the so-called competitive priorities, namely price, quality, delivery, flexibility and service and they represent ways to in which companies choose to compete in the market [2]. Therefore, in order to survive, organisations must strive to run operations at the lowest possible cost with the highest speed and flexibility and apply continuous improvement [3]. Moreover, it is of paramount importance to reduce waste and increase the value for the customer in order to become world-class organisations and achieve superior performance, according to the Lean Manufacturing principles [4].

This paper is organised as follows. Section 2 briefly reviews the relevant literature about Lean Manufacturing, Method Study and Methods Time Measurement. Section 3 depicts the proposed methodology, explaining its steps. Section 4 focuses on short-term logistics management. Finally, Section 5 gathers the conclusions.

2. Literature review

The ideas behind Lean Manufacturing were originally developed in the Toyota's Operations department in the 50s and spread through its supply chain in the 70s and 80s under the name of the Toyota Production System (TPS). At the time, it was a revolutionary production system that managed to make a profit even in periods of slow growth [5]. This

10.1016/j.promfg.2020.10.236

production system later gave rise to Lean Manufacturing, as a systematic approach to reduce waste and increase productivity [6]. The term "lean" is used because this system aims to use less inventory, smaller batches and reduce lead-times, machine breakdowns and defects. The idea behind is to eliminate all sources of waste or *muda* which from the customer's perspective derives in non-value activities. Eliminating waste is usually the greatest potential source of improvement in productivity and customer service [2]. Some authors have proposed some leanness measures to quantify how lean the system is and how much waste exists [7].

The Operations function is responsible for organizing its staff members and structure the content of their work in order to achieve its objectives, which is often called work design. Work design comprises two main approaches, namely Method Study and Methods Time Measurement [8]. Method Study is the analytical study of how work is performed, in order to improve the effectiveness of methods currently in use and reduce waste. Methods Time Measurement (MTM) is a work measurement method that is concerned with calculating the time that should be taken for performing jobs [1]. It is based on the Scientific Management theory, where Frederick Taylor studied the most efficient ways of doing things to increase worker productivity. Later, two followers of Taylor, Frank and Lillian Gilbreth developed the principles of time-motion studies, where they showed that every job can be broken down into a series of elementary motions that can be analysed to make them more efficient [9]. Moreover, the amount of time each task should take can be calculated considering basic human motions and the conditions under which the motion is made.

Effective production and logistics management can significantly improve the competitiveness of enterprises through an enhanced productivity. But in many companies, planning is based on average values, which induces serious errors and explains important inefficiencies that can be estimated between 45% and 60% [10]. Operational excellence specifically focuses on improving work productivity and therefore enhance service speed, quality, and reduce cost. Operational excellence and continuous improvement should be strategic pillars of any company today. Else, manufacturing costs will be higher than necessary, customer orders will not be filled in-full and on-time and manufacturing capacity will be over-dimensioned. Some of the reasons accounting for that are the following [11]

- There is no accurate calculation of the resources load, generally caused by a lack of standardization of the tasks, thus leading to either overproduction or underutilization of resources.
- Productivity is not controlled on a regular basis; therefore, the actual execution time of the tasks is unknown.
- Bottlenecks are not detected on time, thus causing queues and delays.

In relation to logistics processes, MTM can be used as a standardization method that can improve the stability and productivity in logistics [12]. According to the Council of Supply Chain Management Professionals (CSCMP), logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements [13]. Internal logistics employs both human resources and materials handling equipment and includes activities such as loading and unloading, materials handling, warehousing, picking and transportation.

3. Description of the problem and methodology

A real-world case study has been selected, namely a multinational manufacturing company specialized in the production of electrical panels including fiber-reinforced plastic boxes and cabinets with doors. Its process starts with the purchase of raw materials, mainly large polyester sheets and secondary components for assembly, such as screws and hinges. After that, several production operations are performed, including machining the sheets to final product packaging, through a series of finishing and assembly stages. Final products are then temporarily stored while awaiting the arrival of an order, which sets the beginning of the logistical operations, where this study has been applied. The company has classified its logistical operations into three main types: *Picking*, *Final product shipment* and *Truck unloading*. Several problems have been detected in these operations:

- The level of waste evidenced is high, which means that the margin for improvement in the logistics area is high. The main types of waste that have been found in this area are the following:
  - Waste due to lack of standardization, which means that operators take longer than optimal times to carry out their operations.
  - Waste due to unnecessary movements of the workers due to non-optimized layout.
  - Waste due to lack of scheduling. This means that picking orders are randomly sequenced, no matter if they are urgent or can wait.
- Operators and middle managers themselves accept that the process is currently deficient and have an open mentality in search of change, which is not always the case in projects of this type.

In addition, it must be noted that the company has three different types of customers:

- *National.* In this case, the customer is located in Spain. Every day, towards the end of the shift, a truck from a subcontracted transport company is loaded with all the orders that have been prepared on that day for customers of this type. These orders are generally small, comprising no more than one or two pallets for a single customer.
- *ExWorks*. This is a variant of the previous type, in which the customer is located near the plant and is responsible for collecting and transporting the orders. In general, these

orders are composed of just a few units of products, in no case complete pallets.

- *International*. This type of customer is characterized by the fact that it groups together all those clients that are located outside the national territory, i.e., companies located anywhere in the world. Generally, orders for this type of customer involve a large number of pallets and require additional documentation depending on the country of destination.

Currently, the company has assigned three workers to the logistics area. They work on an 8-hour shift and are also trained to perform tasks in the production area if necessary.

In order to carry out the project, a methodology comprising five stages has been applied (see Fig. 1).

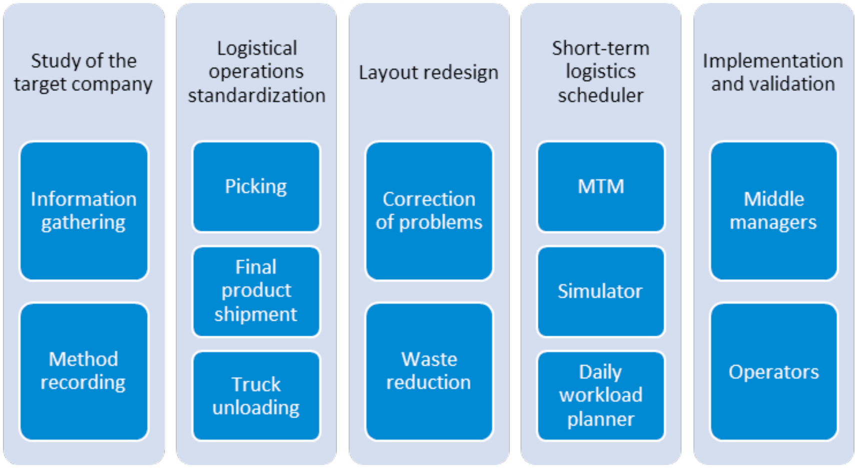

Fig. 1. Methodology diagram.

Each stage is briefly described below:

- *Study of the target company*. To this end, an on-site study of the current method has been carried out, where both operators and middle management have participated, so that everybody could understand the complexity of the operations. Afterwards, the method has been recorded in order to gain insight into it and gather material for a later analysis in search of improvements.
- *Logistical operations standardization*. Based on the videos made, the different processes performed in the logistics area by the operators have been standardized using the Method Study, so that they are perfectly defined. These processes correspond to the three basic operations: Picking, Final product shipment and Truck unloading.
- *Layout redesign*. Considering the different areas and products that are handled, the standardized process that must be followed and the space available in the factory, a series of feasible solutions avoiding the current problems has been obtained to meet the objectives set and reduce waste.
- *Short-term logistics scheduler*. This is the core of the system which aims to control all the logistical operations performed at the company. In order to obtain this scheduler, firstly an MTM model and then a simulator for logistical operations have been created, in charge of computing the standard time for the different operations. Finally, a daily workload planner has been put in place.
- *Implementation and validation*. The short-term logistics scheduler has been tested, and the middle management has been trained in its use, so as to ensure that it works properly, and its objectives are met.

4. Short-term logistics management

The first stages of the methodology can be considered as previous steps in order to manage logistical operations in the short-term. Concerning the first stage, the *Study of the target company*, a thorough understanding of the three operations and the role played by the operations in the corresponding processes has been achieved. Regarding the second stage, *Logistical operations standardization*, it has enabled to set an optimized method to perform the operations and a standard time for them [14, 15]. Moreover, it has improved the previous situation in the following way:

- The cycle time has been reduced with respect to non-standardized methodology.
- A greater control, in terms of productivity and efficiency, has been reached because operations always take the same time.
- It avoids human error, in view of the fact that operations are executed according to the standard method.
- It brings out possible problems that may occur during execution.
- It has enabled greater versatility of the operators.
- It facilitates the training phase of new operators.

In relation to the third stage, *Layout redesign*, a new optimized layout has been designed using a distance/path matrix, its main achievements being as follows:

- The point at which the logistical order started for picking and the point at which it finished was separated, resulting in the placing of two different computers. The first computer was used to inform the operator about the operations to be performed and the second one to record the completion of the order. It was also possible to define a fixed position around the initial operation point where the forklifts were parked, so that it was not necessary to look for them all over the entire facility as it happened before.
- A better layout allowed to extend the areas to store pallets of already finished picking orders, avoiding past situations where those pallets would have been left at any free point of the facility, since those areas were always full.
- In the past, those orders composed of just a few products which did not fill a pallet or box were wrapped in protective plastic and arranged in a chaotic storage area. An improvement was put in place consisting in differentiating zones based on the product code, up to a total of 10 zones. Therefore, if for example the product code was 1008, as it ended in 8, it was stored in a certain position, so the logistics operator went directly to the corresponding rack where the eights were, thus reducing search time.

We will explain the fourth stage in the next section in more depth. Concerning the fifth and last step, *Implementation and validation*, the following activities have been performed:

- The standard times of the operations have been validated during a working week to check deviations or possible changes.
- A training activity has also been launched. Firstly, the new short-term logistics scheduler has been explained to the logistics manager. As regards operators, they have been taught the new standards and the middle managers have also been informed of the new standards, thus ensuring that these standards are met.

Fig. 2. Structure of the short-term logistics scheduler.

4.1. Short-term logistics scheduler

The short-term logistics scheduler encompasses an MTM study, a simulator of logistical operations and a daily workload planner to control the logistical operations (see Fig. 2).

The MTM study has been applied to the three types of logistical operations and has allowed to configure each type and compute its standard times by taking into account all possible circumstances such as materials and tools used, order quantities, or distances to be covered. To this effect, three different types of parameters have been considered:

- *Technical parameters*: They refer to those parameters whose value is not fixed for all the operations, e.g. the number of pallets that fit on a full truck. They are used to parameterize different scenarios.
- *Statistical parameters*: These are generally standardized and the same for any MTM, e.g. operator speeds under different conditions, however, there are some other parameters that are unique to each operation.
- *Supplements*: These are percentage increases that should be applied to normal time. They are applied for different reasons: rest, unexpected events, abnormal posture, use of force, intense concentration or other conditions at work (e.g. noise, heat, humidity).

However, the MTM itself presents a problem because it is static, i.e. the parameters used to calculate the different process considerations must be changed manually within the MTM of each process, causing the system to be very tedious to modify. In order to avoid this problem, a simulator of logistical operations in Excel has been designed and implemented, so that the company can modify the different parameters of the MTM study in a simple and visual way. The simulator behaves as an intermediate step that allows to represent the different possible scenarios and calculate an accurate total execution standard time for the existing orders. In order to illustrate this, a simulator input table is shown in Fig. 3, where you can see that the operator can select and modify different parameters, such as the number of units to be picked for a specific order, the type of customer or the kind of logistical operation. Conceptually, this simulator brings together in a table all the parameters: technical, statistical and supplements, and allows the company to select for which type of logistical operation you would like to calculate its standard time. The output of the simulator for two specific logistical operations called I and II is shown in Fig. 4, where their total standard time is displayed.

Moreover, a daily workload planner in Excel has been created in order to control the logistical operations that are performed in the company. The objective of this planner objective is twofold:

- For the company.
  - To compute the daily workload required to carry out all the required logistical operations.
  - To accurately calculate the number of operators that are necessary at any time in the logistics area.
  - To have a measurement system that allows to quantify deviations arisen on a daily basis in order to apply future improvements to the system, thus closing the loop of the planning system.
- For the workers.
  - To have first-hand knowledge of the logistical operations that they must carry out every working day, with specification of their planned start and end times.

Every day, the daily workload planner allows to calculate the necessary capacity requirements for the next day and includes the following tasks:

1. Select those orders that have the earliest shipping date for which all the products ordered by the customer are available.
2. Enter the internal code of the order in the simulator.
3. Add up the units of the order.
4. Enter the type of customer since depending on it, the length of the tasks may vary.
5. Select the type of operation: only picking, only shipping or both on the same day.
6. Any observation that the operator must know for its execution.
7. Starting from the MTM, times are calculated.
8. These steps are also valid for receiving operations, once we know which trucks will arrive loaded with materials on the next day.

The output of this planner is shown in Fig. 5. Note that the necessary workers in this case is 0.7208, thus rounding up the number, just one full-time worker. This table is printed on a DIN-A3 sheet, one copy for the operators and one for the middle managers. Operators follow the plan every day, noting in the box termed *Operator* their name to know who has prepared what. Therefore, the middle managers can control the operations and the fulfillment of the standard times making frequent rounds in plant, being able to reschedule the operations in case of urgent orders. Through the daily workload planner, the company is able to calculate the necessary capacity requirements for the picking and shipping orders. Now it operates with only one worker instead of three and it can dynamically allocate more workers to the logistics area when unplanned operations arise.

LOAD OF LOGISTICAL OPERATIONS				
		FOR WHICH OPERATION WOULD YOU LIKE TO CALCULATE ITS STANDARD TIME?	PICKING AND SHIPPING	
		PARAMETERS	QUANTITY	UNITS
PICKING AND SHIPPING		Type of customer	NATIONAL	
	PICKING	Number of units of product type A	4,00	units
		Number of units of product type B	22,00	units
		Number of units of product type C	16,00	units
		Number of units of product type D	0,00	units
	FINAL PRODUCT SHIPPING	CONSTANT PARAMETERS		
RECEIVING AND REPLENISHMENT		Mode of transport	TRUCK	
	TRUCK UNLOAD AND RAW MATERIAL REPLENISHMENT	Number of pallets of raw material	40,00	pallet
FIXED PARAMETERS		Speed on foot with no load	0,80	m/sec
		Speed on foot with load	1,26	m/sec
		Speed with unladen cart	0,6	m/sec
		Speed with loaded cart	1,08	m/sec
		Number of units of type A products that fit in a pallet	30	units/pallet
		Number of units of type B products that fit in a pallet	40	units/pallet
		Number of units of type C products that fit in a pallet	1000	units/pallet
		Number of units of type D products that fit in a pallet	20	units/pallet
		Number of items in the operation	40	units
		Number of pallets in the order	2	pallets
		Number of units of type C products that fit in a box	20	units/box
		Average distance from one point to another in the warehouse	22	m

Fig. 3. Input of the simulator of logistical operations.

STANDARD TIME OF THE LOGISTICAL OPERATION I			
	PICKING AND SHIPPING		RECEIVING AND REPLENISHMENT
	PICKING	FINAL PRODUCT SHIPPING	TRUCK UNLOAD AND RAW MATERIAL REPLENISHMENT
PARTIAL ACTIVITY TIME (SEC/UNIT)	35,33	2,96	0,00
TOTAL ACTIVITY TIME (SEC/UNIT)	**38,29**		**0,00**
TOTAL ACTIVITY TIME (SEC/UNIT)	**38,29**		
TOTAL ACTIVITY TIME (MIN)	**0,64**		

STANDARD TIME OF THE LOGISTICAL OPERATION II			
	PICKING AND SHIPPING		RECEIVING AND REPLENISHMENT
	PICKING	FINAL PRODUCT SHIPPING	TRUCK UNLOAD AND RAW MATERIAL REPLENISHMENT
PARTIAL ACTIVITY TIME (SEC/UNIT)			214,27
TOTAL ACTIVITY TIME (SEC/UNIT)	**0,00**		**214,27**
TOTAL ACTIVITY TIME (SEC/UNIT)	**214,27**		
TOTAL ACTIVITY TIME (MIN)	**3,57**		

Fig. 4. Output of the simulator for two logistical operations.

DAILY WORKLOAD PLANNER

DATE:

ORDER PREPARATION + EXPEDITION

ORDER NUMBER	ORDER CODE	OPERATOR	TOTAL UNITS	KIND OF CLIENT	KIND OF OPERATION	OBSERVATION	TOTAL TIME (MIN)	TOTAL TIME (HOURS / DAY)
1	V01901		12	THEIR SENT	PREP. + EXPED.	-	25,20	3,9886
2	V01903		72	NATIONAL	PREP. + EXPED.	-	52,80	
3	V01908		93	INTERNATIONAL	PREPARATION	-	60,45	
4	V01910		25	NATIONAL	PREPARATION	-	22,92	
5	V01919		34	NATIONAL	PREP. + EXPED.	-	37,40	
6	V01923		53	INTERNATIONAL	PREPARATION	-	31,80	
7	V01924		21	THEIR SENT	PREPARATION	-	8,75	
8								
9								
10								

RECEPTION + REPLACEMENT

ORDER NUMBER	ORDER CODE	OPERATOR	TOTAL PALLETS	KIND OF OPERATION	OBSERVATION	TOTAL TIME (MIN)	TOTAL TIME (HOURS / DAY)
1	E02932		10	RECEP. + REPLAC.	-	40,00	1,7778
2	E02941		20	RECEP. + REPLAC.	-	66,67	
3							
4							
5							
6							
7							
8							
9							
10							

DAILY SUMMARY

TOTAL TIME (HOURS)	OPERATORS NEDEED
5,7664	0,7208

Fig. 5. Output of the daily workload planner.

5. Conclusions and future work

This paper describes a short-term logistics management system at a multinational company. The firm detected a bottleneck at its logistics section, where the picking and finished products areas were often full. In addition, standardized procedures were not defined in this section, therefore operators usually made too unnecessary motions to perform their tasks. Finally, they lacked a short-term logistics planning system to calculate the necessary capacity requirements.

In order to address these problems, a methodology and its main components have been described.

The most important achievements attained by this system are the following:

- A partial redesign of the existing layout in the logistics area of the company has been carried out, thus meeting the objectives set, given that the new distribution will not only facilitate the work of the operators, but will also reduce the time spent on carrying out the different logistical operations.
- Thanks to the implementation of an MTM study, a simulator of logistical operations and a daily workload planner, the company is always be able to plan and control the work that operators must do within the logistics area of the company.
- In addition, the company used to allocate three operators to this area. After implementing the daily workload planner, the company has been able to accurately determine the necessary resources for the picking and shipping orders. Now it operates with only one worker, and it can always know when to assign more workers to cover unplanned operations that must necessarily be carried out.
- Finally, all the logistical operations performed by the operators have been standardized, resulting in a system in which the execution time and errors are reduced. Moreover, training all operators for the different tasks has enabled a versatile staff, thus increasing flexibility.

To sum-up, this system has allowed the company to take control of the work carried out in the logistics area, and has implemented a series of systems and methodologies that will make its logistics system much more competitive, being able to reduce delivery times and offer a better service to its customers.

Some future lines that the company is studying are the following:

- Establish a single system that integrates manufacturing and logistical operations to better meet customer needs.
- Carrying out a study of the current cost policy to lead to a better allocation of the available resources and, therefore, to achieve greater profitability in its transactions.

Acknowledgements

We would like to thank ZADECON for giving us access to their data.

References

[1] Slack, N, Chambers S and Johnston R, Operations Management, Fifth Edition, Prentice Hall; 2007.

[2] Samson D, Singh P. Operations Management. An Integrated Approach, Cambridge University Press, 2008.

[3] Drohomeretski E, Gouvea da Costa SE, Pinheiro de Lima E, da Rosa Garbuio PA. Lean, Six Sigma and Lean Six Sigma, IJPR 2014; 52(3):804-824.

[4] Cuatrecasas L, Lean Management: la gestión competitiva por excelencia. Profit Editorial; 2000.

[5] Monden Y, El Just in Time hoy en Toyota, Ed. Deusto, S.A. Ediciones, 1996.

[6] Womack JP, Jones, DT, Roos, D, Sammons Carpenter D, The Machine that Changed the World. McGraw Hill; 1990.

[7] Wan H, Chen F. A leanness Measure of Manufacturing Systems for Quantifying Impacts of Lean Initiatives. IJPR 2008; 46(23): 6567-6584.

[8] Domínguez Machuca MA, García González S, Ruiz Jiménez A, Álvarez Gil MJ, Domínguez Machuca JA. Dirección de Operaciones, Aspectos estratégicos en la producción y los servicios, Mcgraw Hill, 1995.

[9] Nickels WG, McHugh J, McHugh, S., Understanding Business 12th Edition, McGraw-Hill; 2018.

[10] Roberto M, Araújo A, Varela ML, Machado J, Mendonça JP. Methods Time Measurement on the Optimization of a Productive Process: A Case Study, Proceedings of the CoDIT'17 Conference, 2017.

[11] Cruelles Ruiz, JA, Soluciones para la mejora de la productividad industrial, Zadecon; 2014.

[12] Dzubáková M, Kopták M. Work Standardization on Logistics Processes. Quality Innovation Processes 2017; 21(2):109-123.

[13] Council of Supply Chain Management Professionals (accessed 08/02/2020). https://cscmp.org/CSCMP/Academia/SCM_Definitions_and_Glossary_of_Terms/CSCMP/Educate/SCM_Definitions_and_Glossary_of_Terms.aspx?hkey=60879588-f65f-4ab5-8c4b-6878815ef921

[14] Cruelles Ruiz, JA, Mejora de métodos y tiempos de fabricación, Marcombo; 2012.

[15] Stephens, MP, Meyers, FE, Manufacturing Facilities Design & Material Handling, Fourth Edition., Pearson ,2010.