FACTORY LOGISTICS AND RULES OF OPERATIONS

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ABSTRACT

Integration all of the activities in a manufacturing plant is one of the keys to success of the plant as it allows the company to reduce cost, increase productivity and run the plant more efficiently. To better focus on integrating in-plant logistics functions, and to remove variablity in a production process, standards for tasks and rules of operations need to be established. In this study, through a real-life example we demontrate how in-plant logistics may be improved by setting a set of standards and rules of operations in a washing mashine manufacturing facility.

Key Words: In-plant logistics, supermarket, milkrun, just-in- time production.

INTRODUCTION

To strive for achieving the highest degree of operational efficency and delivering optimum outcomes, a large number of companies operating in various industries are improving their in-plant logistics and integrating various activities in their plant. Integration all of the activities in a manufacturing plant is one of the keys to success of the plant as it allows the company to reduce cost, increase productivity and run the plant more efficiently.

To better focus on integrating in-plant logistics functions, and to remove variablity in a production process, standards for tasks and rules of operations need to be established. Implementing an integrated in-plant-logistics and standardizing tasks can help align logistics operations with business strategies. Hence, in-plant logistics and the standards for tasks should be designed to deliver maximum efficency and optimize activities performed by employees. Until the tasks are standardized and in-plant logistics is optimized, the company may not achieve sustainable competitive advantage.

The degree of in-plant logistics and standardization should be aimed at steamlining the tasks that are directly related to producing a products and improving employees' safety and performance. Improvements in in-plant logistics and standardization should also facilitate communication among the team members working on the same project, identify and clearify the responsibilities, eliminate waste, increase productivity, and reduce cost.

Standardization of tasks may involve efffective space utilization, efficient storage and internal transportation methods. In this study, through a real-life example we demontrate how in-plant logistics may be improved by setting a set of standards and rules of operations in a washing mashine manufacturing facility.

LITERATURE REVIEW

Logistics and logistics management is both a fundamental business activity and the underlying phenomenon that drives most other business processes (Kample et al., 2011). While in-plant logistics plays a vital role in achieving the ideal balance of process efficiency and labor productivity, unoptimized in-plant logistics may present a considerable challange for companies in all sectors of consumer goods and result in poor operation management, human error, and some other problems. As pointed out by Jiang (2005), in-plant logistics plays a key role in maximizing the value of an organization as a whole.

All the management and movement of materials within industrial units correspond to internal logistics (Saboia et al. 2006), and the ultimate objective of in-plant logistics is to eliminate waste and increase the speed and flow of material and information. Optimized in-plant logistics is an essential component of lean manufacturing, which is a management philosophy derived mostly from the Toyota Production System. Lean manufacturing considers the expenditure of resources for any goal other than the creation of value for the end customer to be wasteful, and thus a target for elimination of waste (Womack et al., 1990; Holweg, 2007).

To improve in-plant logistics and to reduce inventory cost and associated carrying cost, the just-in-time (JIT) production system is employed by various industries. JIT is a philosophy that has been described as an approach with the objective of producing the right part in the right place at the right time (Elanchezian et al., 2007).

As part of in-plant logistics, to reduce cost of transportation, traveling path and fuel consumptions, various manufacturing facilities have been implementing a milkrun logistics system (Brar and Saini, 2011). In milkrun logistics, vehicles circulate between the warehouse and the production facilities of the plant according to a pre-defined schedule, often with multiple routes serving different departments (Kovacs, 2011). The milkrun logistics is frequently applied in internal plant logistics to transport raw materials, finished goods, and waste between manufacturing stations and the warehouses of the plant (Brar and Saini, 2011).

One of the most important components of milkrun logistics is a supermarket, which is a decentralized in-house logistics area in the direct vicinity of the final assembly line, which serves as intermediary store for parts. Small tow trains are loaded with material in a supermarket and deliver parts Just-in-Time to the stations lying on their fixed route (Emde and Boysen, 2012).

AN APPLICATION

This project was undertaken at a Bosch-Siemens washing machine factory located in Turkey. In this study, we report on a real-life example of improving in-plant logistics.

Company Profile

The Bosch-Siemens Home Appliances Group (BSH) is the leader in the European appliance industry and the world's third largest appliance manufacturer. With 12 brands, and a total of 41 factories around the world, the BSH group runs the largest production center in Turkey. Consisting of nearly 4000 dealers across the country with a strong distribution network, the company also provides after-sales support services to its customers. Spread over a land area of 450.000 m2 and industrial facilities, and having spent 66 million euros improving and modernizing its manufacturing facility in 2005, the company makes 3.5 million units of washing machines.

The Current Situation

Through a project undertaken in 2011 at a Bosch-Siemens Home Appliances washing machine factory located in Turkey, the washing machine control panel assembly (CPA) section previously located in the upper floor was relocated next to the main assembly line. With this project the control panel assembly cell was integrated separately into assembly lines A and B and became a branch of the main assembly line. It is important to run it smoothly as the slightest disruption in this cell affecta all lines.

A new supermarket was established in the plant due to the need for feeding the material to the new control panel assembly line. This new supermarket (SM4) (Figure 1) houses only the control panel materials. These materials are: electronic cable group, program button, operating module, display unit, and function buttons. A pallet can hold a total 16 boxes with each one containing a total of 96 units of electronic cables. The storage areas in SM4 shown in figure 1 are the places where the extra materials are stored. Shelves called the rolling racks are 4-level racks and are used to store the materials in boxes. Racks labeled SM racks also have 4 levels and are used to store marerials in pallets.

Because the materials used in SM4 come in different types and sizes, a kanban system is not used as it requires a storage area for each type of the material next to the assembly line. Thus, in SM4 a push system is used.

The control panel assembly line is relocated next to the main assembly line because they wanted to reduce the amount of stock. In SM4 the workers receive a paper in the morning showing the production schedule. This schedule shows which product for which line should be produced and how much material for each product is required. Materials are loaded onto milkrun and moved to the control panel assembly section.

Two employees work in SM4. One of the supermarket workers stays in supermarket (SME-4), and the other uses the milkrun (MRE-4). 3 trolleys are attached to the milkrun. The first trolley carries program buttons, operating modules, display units, and function buttons. The other two trolleys are used to transport electronic cables.

Because SM4 has recently been established, there are several problems in the functioning. In particular the main problem is associated with handling materials in a non-standard way. Hence, it was decided that in-depth examination of this issue must be done.

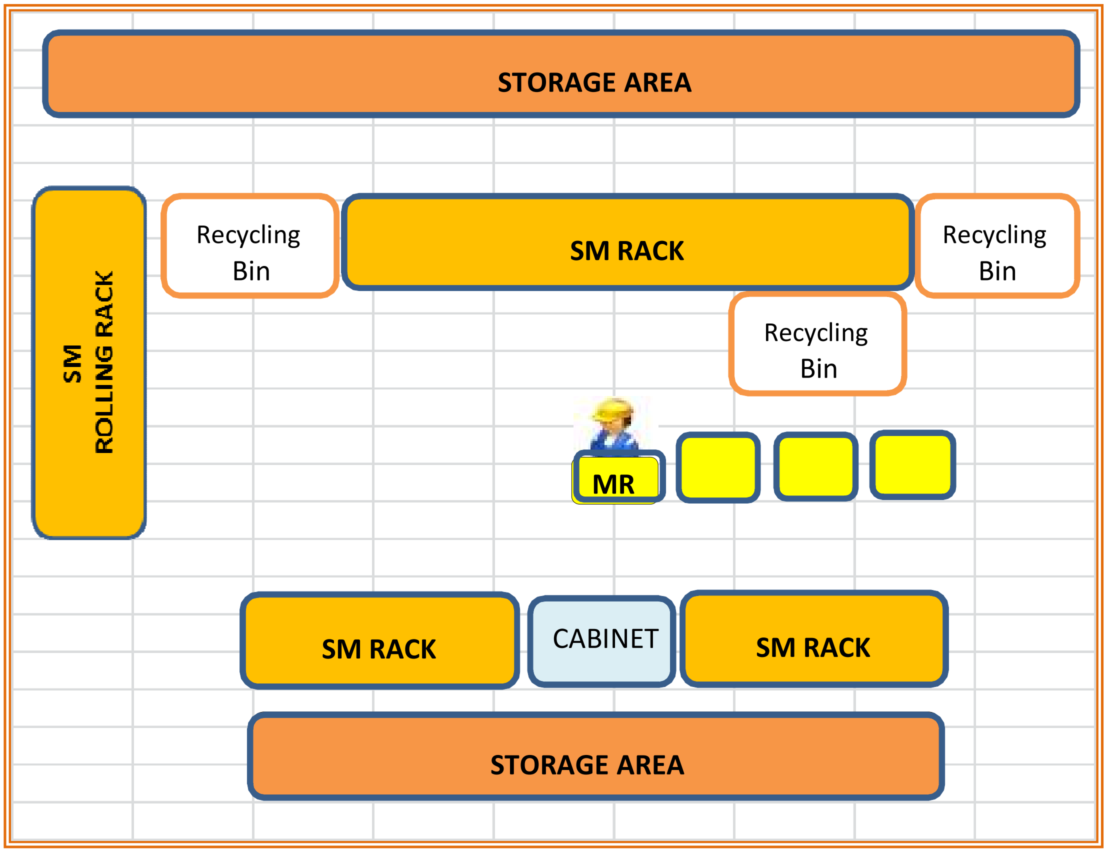

Figure 1: SM4 layout

DATA ANALYSIS

First, all workers in SM4 were examined in terms of their jobs for one hour (Figure 2). Later, MRE-4 was surveyed for 2 hours and the time it takes to distribute materials to the milkrun line was measured.

Figure 2 shows the arrival and exit times for milkrun in supermarket. In the section labeled "Note" observations were written. For insrance, between 09:15 and 09:30, a 7-minute break is given. Between 09:46 and 09:52, the worker moved only the common trolley and the B line electronic cable group trolley. At other times, workers carried other 3 trolleys. Milkrun distribution time indicates how much time is spent distributing materails by milkrun. The "supermarket" column shows which jobs were done and who performed them.

As seen in figure 2, there is no standard for performing tasks and running milkrun in the supermarket. If we examine figure 2, we see that sometimes only MRE-4 handles the boxes but sometimes the work is done by someone else. Also, boxes stayed on the milkrun line for a long time, which creates unnecessary vehicular traffic.

Tasks done in an hour								
Milkrun				Supermarket				
Time			Milkrun cycle time	Time				
Departure	Arrival	Note		Departure	Arrival	Task	Done by	Time taken
9:15	9:30	7 minute break	8	9:30	9:32	took out empty boxes	Together	2
9:32	9:38		6	9:32	9:41	prepared material	SME	9
				9:41	9:45	loaded material	Together	4
9:46	9:52	only trolley B	6	9:45	9:53	organized SM4	SME	8
				9:52	9:53	empty trolley	MRE	1
				9:53	10:03	loaded material	Together	10
10:03	10:10		7	10:03	10:10	prepared material	SME	7
				10:10	10:13	emtied and loaded milkrun	Together	3
10:13	10:22		9	10:13	10:22	prepared material	SME	9
				10:22	10:25	emptied milkrun	Together	3
				10:25	10:32	loaded material	Together	7

Figure 2: Task analysis for an hour

SM4 material layout was not fully determined, creating chaos. Therefore, SME-4 is forced to use forklift more frequently. This is because when materials are delivered to the factory, they were stored in the supermarket if there is a storage area. If not, then the materials are stored in a warehouse. If there is no storage area in the supermarket but the materials are needed in that shift, then the materials are brought by forklift on a palette and left directly in front of the supermarket. SME-4 gets the materials of the rack 2, 3 or 4 when needed using a portable forklift. After getting the materials workers place them anywhere in the supermarket. It takes 60 second for SME-4 to put a pallet picked up by forklift on the trolley. If the materials are on the rack, then a worker goes to the back of the supermarket, picks them up by forklift and places them into SM4, which requires another 130 seconds. It is done 15 times per day, and half of the materials are located on the upper level racks. If we want to compute the time wasted doing all these in a shift:

The loss of time in a shift created using a forklift to put the materials on the trolley: 15 x 60 = 900 seconds = 15 minutes

The amount of time wasted because the materials are picked up using a forklift from upper level racks : 15 / 2 x 130 = 975 seconds = 16.25 minutes ~ 16 minutes

In a shift, a total of 31 minutes is wasted.

A palette has 16 different boxes each of which contains 96 electronic cable. This is more than needed for a cycle. SME-4 loads a trolley a pallet of materials and takes the unused materials back. When needed a worker brings them back and forth again. MRE-4 has to carry more boxes than needed and there is no room on the trolley to carry the empty boxes sitting next to assembly line, creating unnecessary work as well as unnecessay inventory by KPM line.

Next to the KPM cell, there is also a storage area where the display units and the operating modules are stored. Here, the operating modules and display units are connected with a cable and are made ready for assembly. A close examination showed that because it is difficult for

MRE-4 to check the racks and bring the materials to the KPM line, SME-4 walks up to the KPM cell from SM4 to control the stock shelves. After seeing what materials are missing, he goes back to SM4, waits for milkrun to stop by, and loads the materials onto the milkrun. He goes back to the KPM cell again and puts the materials on the racks. On average, SME-4 spends 40 second walking up to the KPM cell from SM4, 40 seconds checking the material therein, 40 second returning, 40 seconds going, 40 seconds putting the materials onto racks, and 40 seconds going back. This is done an average of 6 times in a shift. This process creates a waste of time per shift, 6x6x40 = 1440 = 24 minutes.

SM4's shelves have 4 floors and there is no mechanism to prevent the materials from falling. If a forklift worker acts in a careless way the materials can fall unto SME-4.

Because the rules pertaining to SM4 and milkrun are not clearly and fully prescribed, supermarket workers act completely arbitrary. In addition, because SM4 is newly established it has the following shortcomings:

- Boxes must be opened at the supermarket but they are opened next to the asssembly line thus causing MRE-4 to waste his time.
- Arbitrary determination of what could be distributed to which production line,
- Because there is no clear division of labor, it is not clear who performs which task.
- Unnecessary waiting in the KPM line creates unnecessary traffic.
- A waste of time created because SME-4 had to load materials onto racks in KPM line. He is supposed to work only in SM4.
- Piling up the empty boxes instead of taking them back.
- There is no mechanism on SM4 shelves to prevent pallets from falling,
- A waste of time resulting from the use of forklift by SME-4 more frequently than needed.
- A waste of time because milkrun cannot easily maneuver in SM4.

To solve these problems and the loss of time, various improvements discussed in the following section have been made, new rules have been implemented, and a certain order has been created.

SOLUTIONS

Based on the above observations, we generated a set of solutions.

First, a work schedule for the supermarket has been created and implemented. Arbitrary determination of milkrun schedule has been prevented. A new schudule is created by considering 24 minutes gained in the first design attempt. For each milkrun travel 10 minutes was given and that is the average of the periods listed in figure 3. Milkrun needs to complete each cyle in 24 minutes, the remaining 14 minutes (24 - 10 = 14) is given to MRE-4 to load materials in SM4.

A roller system is implemented in SM4 to solve the disorder. Two separate roller systems were established for both assembly lines in SM4. With this system, electronic cable groups requiring the most space at the supermarket and carried by 2 trolleys are arranged in the order of production rank. In addition, the forklift arrival schedule is organized, and the materials coming from the warehouse are placed only on the supermarket shelves. The materials to be used in production are taken by forklift from the racks and placed on the rollers. Thus, the use of forklift by SME-4 is reduced to the lowest level. With this improvement, a new order was implemented in SM4 , and the 31 minutes loss is prevented.

The sequences and the lines milkrun trolleys belong to were determined. The first trolley carries program button, operating module, instrument cluster, inlays, and keypads for the 2 lines. The second trolley carries electronic cable group for line A, and the third trolley carries electronic cable group for line B.

It was decided that milkrun will carry three trolleys at a time and supply the material to the two lines. Because it not possible for milkrun to maneuver backward in SM4, a new place for milkrun to exit the supermarket was established. Hence, the loss of time caused by the milkrun trying to manevuer backward is prevented.

Time saved by this application:

The loss of time associated with attaching and detaching trolleys: 25 seconds
The number of trips done by milkrun per shift = 17
Total time saved = 425 seconds = 7 minutes.

A waste of time associated with SME going to load materials onto the racks next to the KPM cell is prevented by using a kanban system. Because MRE-4 checks the racks one by one each time and this creates a waste of time, it was decided to use kanban cards for the materials therein. The number of kanban cards to be used was calculated by the formula below.

The number of Kanban cards = {[the units used * hourly usage * cycle time (h)] + Safety stock} / the amount of materials in boxes.

The unit used: The number of pieces of materials used at a time.
Hourly usage: The number of pieces of materials used per hour.
Cycle time: Time interval of the material distribution
Safety stock: The number of units in safety stock.
The amount of material inside the box: The number of units in a box.

When producing a washing machine, only certain materials with specific codes are used. For instance, when making a washing mashine requiring 100 pieces such as a display units with a code of 2423, inlay with a code of 2275, and an operating module with a code of 4111, then only these materials will need to be replenished in stock. Therefore, the remaining materials will not be replenished after each milkrun cyle. Each time checking stock level creates unnecessary work for MRE-4. Thus, the optimum time for checking the stock was determined. The number of the boxes that can be stored on the racks are compared with the number of kanban cards, and if cycles overlap then we go back 2 cycles and select it as the control point. If we go back just one cyle then there is a risk of being out of stock by the time milkrun supplies the line with the materials. This change also allows us to gain 24 minutes per shift. In addition, the number of boxes on the shelf is reduced from 149 to 76 allowing us to reduce the stock level in the assemply line by 49%.

The inner side of supermarket shelves were closed using cages due to the risk of pallets falling off the racks.

In addition, the following rules have been identified for SM4 and milkrun:

- Materials on trolley must be layered. Material will not be moved in cardboard or plastic box. This rule is implemented to prevent MRE-4 from opening boxes right next to the line, allowing them to get rid of unnecessary traffic and the loss of time.
- During each milkrun cycle, trolley should not have more than 10 boxes of cable. This rule is implemented to avoid unnecessary work.

Similarly, some rules have been implemented in order to maintain order:

- Trolley is divided into A and B lines. Each of the line material must be in its place.
- Milkrun cycle times must be strictly observed.
- Recycling bins and waste must be kept in defined areas.
- After loading the full boxes onto the racks, empty boxes and sponges should be taken to the supermarket.
- A cable group car should not be next to the production line. This rule is implemented to prevent workers from stocking the empty boxes on the line.

After all these arrangements are made, rules have been implemented to clarify the responsibilities of the employees.

MRE-4 tasks:

- Distribution of materials by milkrun to the KPM line,
- Removing the empty boxes and put them in their designated areas,
- Loading the materials packaged by SME-4 unto the milkrun,.

SME-4 tasks:

- Keeping the internal order at supermarket.
- Preparing the materials to be distributed.

After these arrangements, it was observed that MRE-4 would have some free time. Surveys show that it takes an average of five minutes for MRE-4 to remove the empty boxes from and to load the materials onto the milkrun. Since 14 minutes is reserved for the job, the worker stands idle for the remaining 9 minutes. Because the worker loads the materials 17 times per shift, this leaves us with 17 * 9 = 153 minutes of free time.

After all these arrangements and improvement made for SM4, the following benefits were realized:

- By creating a timeline, arbitrary determination of milkrun cycle time was prevented.
- 7 minutes was achieved by re-routing milkrun's way out of the supermarket.
- By implementing a roller system in SM4, the use of forklift by SME-4 was reduced to the lowest level. This improvement has brougt an order to the SM4 and prevented the loss of 31 minutes due to the unnecessary use of forklift.
- 24 minutes per shift was gained by implementing a kanban system. In addition, the number of boxes on the shelf was reduced to 76 from 149 allowing us to reduce the stock by 49%.
- Implemented safety measures by putting shelves on the upper floors in the supermarket.
- Resolved uncertainity by clarifying who will do what task. As a result of streamlining, it was uncovered that SME-4 has 153 minutes free time per shift.
- By putting rules in motion, an order has been brougt to the supermarket.

CONCLUSIONS AND DISCUSSIONS

In this study, improving in-plant logistics through supermarkets and milkrun activities, within the framework of just-in-time production and lean manufacturing philosophies, was investigated through time spent, and distance traveled by the employees.

Through the real-life example discussed here, a newly founded supermarket in the factory was investigated. Because it was newly established, there was no order in the supermarket and the workers were doing unnecessary work which in turn created a waste of time. The necessary adjustments and improvements were made and standardization of jobs was provided in the supermarket.

In this study, we have provided solutions based on operational needs of a washing machine factory. The major contribution of this study is that it demonstrates how redesigning in-plant logistics can improve human and organizational performance as a whole.

References:

References available upon request from Tuncay Bayrak, tbayrak@wne.edu