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Analysis of Material Handling Management in Medium Scale Industry

Aarti Sahu[1], Manoj Kumar Gaur[1] and Pankaj Srivastav[2]

[1] Department of Mechanical Engineering, Madhav Institute of Technology & Science, Gwalior, India
[2] Department of Mechanical Engineering, RBS Engineering Tech. Campus, Agra, India
mits9917@gmail.com

ABSTRACT

The particularly ready for action condition, associated to the globalization phenomenon, stress from companies more rapidity, better recital and the eternal explore for cost cutback. The present revise focused on improvement in internal materials handling management, future the case of a medium scale company in the power generators industry. Materials handling is essentially linked with manufacture flow. Because of this, it has direct pressure on shipment time, capital usage, and service levels. The object was to appraise, in a methodical way, the collision of implemented changes in materials handling management on the internal customer perception of cost, security in service, service dependability, suppleness and overall satisfaction. A text evaluation preceded a case study in the company's manufacturing unit and the questionnaires were completed by 20 employees directly involved in the process. Analyze the answers, it was likely to propose that inner customers tacit that the new materials handling management system distended service agility and reliability and abridged costs, which caused an improvement in on the whole satisfaction.

Key words: Medium scale industry, Material flow, Material handling management, Service reliability, Agility

INTRODUCTION

Materials handling management is one of the frequent issue that disburse to get better a company's presentation. Materials handling defines as "Material Handling is the group, cargo space, manage and defense of material, cargo, and goods all through the procedure of manufacturing, sharing, use and removal. The stress is on the approach, mechanical equipment, systems and related controls used to reach these functions". Then it is perceived that handling is wider than simple materials movement, although both terms are sometimes used as substitutes. The significance of materials handling shoots from the basic relationship that it has with production flow. When it presents unevenness, there is formation of spare stock or break in supply. When the flow does not have sufficient rate, transportation time is long and the system is not accomplished of helping the customers when they requirement it. It is fine understood that material handling improvement may have optimistic properties over production. However, it is not only production, but the way the employees see the new situation. When the perception is satisfactory, the welfares are conceivable if not, behavioral issues can appear. Assessments are important when involvements into the work environment are implemented. The current effort is specifically associated to materials handling management. With the effective materials handling management, the business's active performance may improve targeting to content the customers or meet their expectations in terms of their needs, desires and demands.

The case study associated in this work was done in power generators industry situated in the Agra U.P. India. It was founded more than 25 years ago and is classified as a large-sized company since it has more than 3510 employees. This region contains a cluster of industries of metal mechanic, automotive and metallurgical sectors that in its majority belong to production chains which demand a high internal performance level from their partners. The key objective of this case study was to evaluate internal customers' satisfaction levels after the change. In order to do this, it was necessary to identify the factors that explain overall satisfaction; to do it, open ended questionnaires were applied. The respondents 20 people directly linked to daily materials flow were requested to identify the attributes and unfold them into sub-factors which represented the internal process in more details. The identified attributes were cost, safety in service, service reliability and agility. After this step, a second questionnaire with close-ended questions was applied to the same respondents in order to evaluate performance satisfaction at each factor and sub-factor and also overall satisfaction. The questions requested the respondent perception about the improvement perceived or not after the interventions.

The collected data were analyzed with multiple regressions. Data analysis indicated that the factors agility, service reliability and cost are able to explain overall satisfaction. In addition to that the satisfaction level of most of internal customers with the new materials handling management system is equal or even superior when compared to the previous one.

LITERATURE REVIEW

Material Flow

Materials handling makes production flow possible, as it gives dynamism to static elements such as materials, products, equipments, layout and human resources [1]. Despite its importance, materials handling is a topic that frequently is treated superficially by the companies. However, other authors have perceived its relevance. During the the development of the Toyota Production System, he developed the Production Function Mechanism that proposes to explain how the production phenomenon happens.

The West, production was treated as a process of a sequence of operations. In the Production Function Mechanism, the concepts are directly related to a production analysis focus. A process analysis consists of an observation of the production flows that turn raw materials into final products. From this concept, the author highlights that the main analysis is the one associated with the process, because it follows the production object. The analysis of the operations comes later because it focuses on production subjects (operators and machines). When making this distinction, it is possible to perceive the relevance of materials handling. Beyond the basic function of movement, it is also relevant to cite the functions of storage and information transfer, which occurs simultaneously and has both strategic and operational dimensions. Organizations are relying on information systems using tools like Electronic Data Interchange (EDI), or similar information technology resources, to gain in precision and reliability, in the interchange, and availability of information [2].

An important proportion of manufacturing expenses can be attributed to material handling and the most critical material handling decisions in this area are the arrangement and design of material flow patterns. An important aspect of any production system is the design of a material handling system (MHS) which integrates the production operations. The relevance also occurs in another context. Ballou [2] states that the storage and handling of goods are essential among the set of logistics activities, and their costs can absorb 12% to 40% of its costs. In addition, the MHIA estimates that 20% to 25% of manufacturing costs are associated to handling. Material handling accounts for 35–65% of the total cost of a product along the production chain, and efficient material handling can be responsible for reducing the manufacturing system operations cost by 20–35%.

The main logistic responsibility in manufacturing is to formulate a master program for the timely provision of materials, components and work-in-process. Logistics (including materials and goods flowing in and out of a production facility as well as its internal handling) has become very important to an organization to acquire competitive advantages, as the companies struggle to deliver the right product at the correct place and time [5]. The main challenge is to promote, with low cost, a flow whose velocity allows the execution of manufacturing process with the expected satisfaction level.

ELEMENTS AND CHARACTERISTICS OF A MATERIAL HANDLING SYSTEM

Materials handling study requires that several elements are considered. The first is a handling system project, which covers activities of sequencing, velocity, layout and routing. Therefore, the classification of which considers: (i) physical state (solid, liquid, gas); (ii) size (volume, length, width, height); (iii) weight; (iv) condition (hot, cold, dry, dirty, sticky, adhesive); (v) risk of damage (weak or strong); and (vi) safety hazards (explosive, flammable, toxic, corrosive, etc.). When dealing with equipment, a broad classification that covers five categories: (i) transporters (belts, chains, rollers, etc.); (ii) cranes, hoists and lifts; (iii) industrial vehicles (carts, tractors, pallet transporters, forklifts); (iv) positioning equipment, weighing and control (ramps, transfer equipment); and (v) stents and support structures (pallets, holders, reels).

A key factor in material handling system design process is the selection and configuration of equipment for material transportation. The equipment should be selected based on some preliminary considerations: take into account the utilization of the factory floor and its load capacity; examine the dimensions of doors and corridors; pay close attention to ceiling height, identify the environmental conditions and their nature, avoid the use of combustion engines traction equipment's in storage of food products, meet all safety standards to protect humans and to eliminate the possibility of incurring criminal and civil liabilities arising from accidents, and examine all kinds of available energy options and their capacity to supply required movements[3][7]. The right choice of equipment and location of work-in-process is fundamental for the optimization of a company's manufacturing capacity. A critical factor in positioning stocks in process is a balance between convenience and consolidation to create efficiencies when the stock flows along the value chain [6].

The importance of layout, which defines the placement of equipment and, consequently, restricts possible routes and sequencing, can be perceived by the prominence that the subject is treated in production management literature. The analysis of the relationship between layout studies and material handling, however, does not receive much attention in the same literature.

In order to improve the performance of distribution operations and, in this specific case, the internal material handling process, it is important to consider both human and technical factors. In this sense, this study assesses the internal customer perception of a material handling process improvement. With regard to the attributes to be considered in a material handling system, effective use of labor, providing system flexibility, increasing productivity, decreasing lead times and costs are some of the most important factors influencing selection of material handling equipment. These factors are directly related to some attributes found in the present study.

The determination of a material handling system involves both the selection of suitable material handling equipment and the assignment of material handling operations to each individual piece of equipment [4]. Hence, material handling system selection can be defined as the selection of material handling equipment to perform material handling operations within a working area considering all aspects of the products to be handled. In this context it is important to mention that, in this study, only the selection of the material handling equipment was considered.

PROBLEM AND INTERVENTION DESCRIPTION

The first sub-section describes the situation prior to the intervention, identifying the problems that were found. The second describes the factors that motivated the change. The third describes the changes and the situation after its completion. Besides variables and sub-variables, customers' overall satisfaction regarding the implemented changes was also evaluated.

Situation Prior to the Intervention

This study was conducted in the manufacturing sector of an automotive company. The manufacturing sector is responsible for almost all of the supply of assembly lines, including the components that go through a preassembly process before proceeding to final product assembly. In this sector are concentrated cutting and bending tools and dies required for components manufacturing to assembly lines. The whole process runs with the aid of forklifts. Often, the setup time is equal to or higher than the time needed for parts manufacturing. This situation, coupled with the cost of downtime, demonstrates the importance of the tooling exchange process.

Besides helping in the execution of setups and carrying out internal transport managed by an electronic scoreboard installed in the factory roof, forklifts also performed activities for transporting materials between pavilions. When executing this last activity, the forklifts often travelled on uneven roads, which caused great bouncing, burdening maintenance cost for equipment wear or premature breakage. When a forklift leaves its workplace to transport a container between pavilions, delays in machines' setups are generated, causing unnecessary costs and stress on the forklift operator. The operator could do little besides feel forced to increase the speed during the route, creating risks of accidents with personal injury and / or materials damage. This activity as well as the studied process relate to Goldratt's Theory of Constraints (TOC) to seek bottlenecks and reduce or eliminate them. Although there were enough forklifts to meet the demand from the manufacturing sector, many times it was not possible to meet immediately the manufacturing needs due to reasons like long distances to travel and frequent maintenance due to excessive use of the equipment. This directly affected internal customers' satisfaction. The presented problem was: how to increase internal customer satisfaction, while stabilizing or decreasing forklifts' maintenance cost?

Change Motivators

Due to development of new markets, manufacturing demands for a large variety of components and final product assemblies increased. This demand growth led to speed increases and changes in how materials and tools were being handled and transported in order to monitor manufacturing requirements. With these changes and demands for manufacturing to attain the company's goals, there was also pressure for growth and lack of tolerance with forklift operators, since the work did not always run quickly and with quality. Additionally, forklift maintenance costs were increasing, demanding sometimes excessive spending that jeopardized the budget. The dissatisfaction and demonization of forklift operators was notorious, and an increase was also noticed in the number of collisions between the equipments. Finally, boxes and containers were unsatisfactorily stored in the hallways together with the machines to attempt to reduce production interruptions.

The Situation after the Implementation

One suggested solution was to rent two forklifts as a way to solve the problem. But this only served to soften it, and brought a larger cost to the company. It was realized then that it was not the quantity of equipments that was going to solve the problem but the way material handling was being executed in relation to the necessity of the presented changes.

From this observation, processes and material flows were mapped and separated in two ways:
- Vertical movements which make greater efforts and little ground movement.
- Horizontal movements that rely on traction to travel longer distances, including transport out of the work units. Several cargo (pallets) units were constructed with special wheels, fitted with suspension coupled to support the material weight and traverse the gaps between the pavilions. Afterwards, several "cages" were made to be used for holding the parts that go through the processes of bath and painting. More robust containers for heavier and less delicate parts storage were also constructed.

The next step was to create spaces (pit stops) for pallets with their mobile parts on each workstation. In order to the truck driver to know when he could transport material, it was necessary to create an identification system. It was decided that every time that the operator finished the process in his station, he would put on the packaging a green sign indicating that the container would be ready to be transported to the next production step. The truck driver, when removing a filled container, should replace it with an empty one in the vacant post. Tests were conducted with a timetable for the train passage, but this alternative did not meet the need for flexibility in case of emergencies (pieces to technical assistance and replacement of damaged materials in the assembly process). It was then decided to set a path that would follow the manufacturing process sequence. To inform the train operator of some urgency, a mobile phone was given to him. Thus, the supervisor could communicate with the operator instantly when there were critical parts and / or components to be collected. After the changes were completed, it was necessary to evaluate their impacts. This study evaluated internal customers' satisfaction level with the new materials handling and transporting configuration.

METHODOLOGY

Objectives

To reach this objective, the following specific objectives were established:
- Describe the changes in material handling processes at the company.
- Evaluate internal material handling flow in manufacturing, verifying the improvements.
- Analyze internal customer satisfaction levels relative to the new system.

Data Collection

The sample was the people directly involved with the daily flow of materials, selected intentionally. The respondents held positions as leaders, supervisors, forklift drivers and warehouse operators, enabling a comprehensive view of the problem. Data collection for the satisfaction survey was divided into two stages. The first step was an open-ended question survey. Respondents were asked about their perceptions regarding the changes in materials handling emphasizing evidence of the improvements, problems still identified after change implementation and suggestions for the relevant attributes in question. Two criteria were used to define factors and sub-factors from the obtained answers: i) the factor must be cited by respondents of all positions (leaders, supervisors, forklift drivers and warehouse operators); ii) the number of times that the criterion has been cited by the 26 respondents. Table 1 shows the evaluated factors, their definitions and the associated sub-factors. Performance improvements (current state vs. status quo) were measured using the following scale: 1 = much worse, 2 = worse, 3 = same, 4 = better and 5 = much better. For instance, the employee was asked: "Comparing previous and current procedures for handling and internal transport, how do you assess the costs related to mechanical downtime?" To answer the question, the options of the scale mentioned above were offered. At this point it is important to highlight that the study was evaluating the respondents' perception, starting from the assumption that they had knowledge enough (even empirical) because they are directly involved in the process.

Table -1 Factors

	Factors	Factors Description	Sub-factors
1	Cost	Monetary value available to maintain the operation: expenditures with periodic maintenance linked to forklifts use	Mechanical shutdowns Electrical shutdowns Corrective painting
2	Safety in Service	Identifies forklifts operator's conduct on new handling and internal transport way	Safety in handling Tooling storage
3	Agility	Identifies manufacturing satisfaction level in terms of reliability	Setup agility Material handling quickness Tooling handling quickness
4	Service Reliability	Identifies the time spent with tool exchange coupled handling (discounting the times associated with the machine, such as loose and/or fix	Efficient routing Operator's autonomy Operator's performance and availability

DATA ANALYSIS AND RESULTS

Once the new situation was established, data collection started followed by analysis and presentation of the results. The data were tabulated in order to obtain an average percentage and standard deviation of overall satisfaction in relation to the factors and sub factors presented during sampling. Table 2 shows the results.

Table -2 Survey Data

Attribute	Average	S	Sat.>=4	Sat.=3	Sat.<=2
Cost	3.65	.69	69%	25%	3.5%
Safety in Service	3.67	.65	79.%	12.3%	3.5%
Reliability of the Service	3.32	.72	34.6%	55.7%	3.6%
Agility	3.41	.54	43%	52%	.12%
Overall Satisfaction	3.54	.58	50%	50%	.00%

Considering satisfaction levels equal to or higher than 4 in Table 2, it is identified that the overall satisfaction percentage shows that 50% of the respondents noticed improvements in the process after its implementation (answers ≥ 4 in the scale that was used). The data were analyzed with the aid of multiple linear regressions for each of the studied factors, as well as for general satisfaction. The results are shown as follows.

Cost Analysis

Regression analysis for the cost sought to understand how much it was influenced by each of its sub-factors. Regarding factor and sub-factors relationships, corrective painting was not statistically significant. The satisfaction in relation to the cost factor was considered as the dependent variable and the ratings of each of the other two remaining sub-factors were treated as independent variables. Expression 1 was obtained. The value of R2 = 0.63 indicates that expression 1 is able to explain 63% of the variability in cost assessments.

$$\text{Cost} = 0.36 \times \text{electrical shutdowns} + 0.31 \times \text{mechanical shutdowns} \quad (1)$$

The p-values found for the terms were less than 0.19. This should be considered as an exploratory result related to the significance of the sub-factors.

Safety in Service Analysis

Regression analysis for safety in service tried to understand how it was influenced by each of its sub-factors. For this factor, tooling storage was not statistically significant. Then, the satisfaction in relation to the safety in service factor was considered the dependent variable and the rating of safety in handling was treated as the independent variable and the expression 2 was obtained. The value of R2 = 0.73 can state that the second expression is able to explain 73% of the variability in safety in service evaluations.

$$\text{Safety in Service} = 0.66 \times \text{safety in handling} \quad (2)$$

The p-value found for the term was less than 0.0001, which allows us to assert that it is significant with a probability of at least 99.9%.

Service Reliability Analysis

Regression analysis for service reliability attempted to understand how it was influenced by each of its sub-factors. For this factor, efficient routing, operator's performance and availability did not show significance, so the only sub-factor that was considered as an independent variable was operator's autonomy according to expression 3, where we can see service reliability as the dependent variable. The value of R2 = 0.68 can state that expression 3 is able to explain 68% of the variability in service reliability's assessments.

$$\text{Service Reliability} = 0.69 \times \text{Operator's autonomy} \quad (3)$$

The p-value for the term was less than 0.0001, which allows us to assert that it is significant with a probability of at least 99.9%.

Agility Analysis

Regression analysis for agility aimed to understand how this was influenced by each of its sub-factors. In this factor all sub-factors presented statistical significance and were treated as independent variables in expression 4 where we observe agility as the dependent variable. The value of R2 = 0.89 can state that expression 4 is able to explain 89% of variability in assessments of agility.

$$\text{Agility} = 0.40 \times \text{tooling handling quickness} + 0.31 \times \text{setup agility} + 0.19 \times \text{material handling quicken} \quad (4)$$

The p-values found for the terms were less than 0.17, so the results should be considered exploratory.

Overall Satisfaction Analysis

The regression analysis for overall satisfaction aimed to understand how this was influenced by every factor. Analyzing the relation among the factors and overall satisfaction, safety in service was not statistically significant, so it was not considered as an independent variable in expression 5, where it is possible to observe that the three remaining factors are the independent variables and overall satisfaction is the dependent variable. The value of R2 = 0.89 shows that the expression 5 is able to explain 89% of the variability in overall satisfaction ratings.

$$\text{Overall Satisfaction} = 0.65 \times \text{agility} + 0.38 \times \text{service reliability} - 0.12 \times \text{cost} \quad (5)$$

The p-values found for the terms were less than 0.17, so the results should be considered exploratory. The weights of each attribute can be calculated from an expression obtained in Multiple Regression. To calculate the relative weight of each attribute, it is necessary to get an overall satisfaction value when it assumes its maximum (=5) and the others are at the minimum value (=1). After that, the values found with the attribute in maximum and minimum must be subtracted.

CONCLUSION

Due to continuous complaints of failures in service and also low speed in material transport, the company was inspired to improve internal processes that could increase the efficiency of services for manufacturing. The source of the implanted system was the idea of stock on wheels, practicing materials transport with the help of a tug internally named “train”. The tug pulls the wagons with more load than cranes (previous system), maximizing travels and loads through a specific route. With the new system implementation the need to evaluate its real effect in relation to the expected improvements appeared. From internal customers’ evaluation there was an increase in overall satisfaction. This increase can be explained by a greater agility (57%), greater reliability in service (33%) and lower cost (10%). The results recognized the significant sub-factors and their impacts on the described factors.

Besides internal customer satisfaction progress, which was evidenced by the present study, there was an effective improvement in the internal material handling. The improvement in material flow caused by the use of the proposed vehicle increased the accuracy of materials delivery time inside the company. Operations became safer. The system used was able to evaluate the perceptions of the implemented changes, as well as to identify factors and sub-factors that influenced satisfaction increase. These improvements in the company operations resulted in new subsidies to perform similar studies.

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