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Analysis of Waste Generation from Extruder Machines

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ABSTRACT

This study investigated the material wastage occurred during extruder runs using an amorphous polymer. During the extruder process, polythene seeds are the main raw material used, and electrical and thermal energy were used to melt and transport the polymer to the extruder die. There are two types of extruder machines used by the company. This study was conducted to identify the root causes of material wastage in a flexible manufacturing plant and the difference in wastage generation from the two types of extruder machines. Secondary data were collected with the guidance of production managers and factory supervisors. The sample was randomly selected and it consisted of data in eight successive months. The sample consists of material wastage details in factor wise as well as machine wise. Finally, this study identified that there are differences between machine wastages, as well as there are some variation between wastages within one type of machines. This research identified the machines which are significantly contributing to material wastage.

KEYWORDS: Extruder machine, Flexible Manufacturing, Raw Material, Wastage

1 INTRODUCTION

This study was carried out in a company which manufactures corrugated packages and flexible packages. They have local and international customers. When two plants were visited, it was identified that there are some issues in flexible packages (polythene) manufacturing plant. The production manager mentioned that there was a mismatch between estimated material demand and actual material usage. So they had the necessity to find out what are the reasons for that issue and needed some solutions to eliminate them.

In this manufacturing process, polythene seeds are taken as a basic raw material.

Extruder machines are used for the manufacturing process, There are two types of extruder machines. Through this research, the production manager wanted to make management aware of the need of technological changes in improving productivity.

The Production Manager thinks that employees' experiences, their attitudes have an influence on material wastage. Without any evidence they are unable to take actions towards it, Management will be willing to use this research findings as their management tool.

The packaging and printing industry is facing a number of challenges that threaten the very existence of many well-established companies. Historically, the industry has been extremely cost conscious, priced its products based on a cost-plus philosophy, and has been slow to adopt new concepts and technologies such as Lean Manufacturing and ERP applications. The procurement of a new press is often seen as a tangible and logical purchase with a clear "return on investment." However, this is in stark contrast to alternative investments such as the commissioning of a consulting project to create a more integrated business workflow.

Additional challenges are forcing the pace on improved efficiencies, shorter runs, and reduced waste. New competitors from emerging markets have entered the industry and are gaining market share based on being a low-cost provider. And in boardrooms, owners and managers are working harder than ever to do more with less.

Managers have identified some points which contributed to the wastage according to their understanding. But they are not satisfied with the results. So they fight to find out reasons to minimize wastage.

2 LITERATURE REVIEW

According to Koskela (1992), waste can be defined as "any inefficiency that results in the use of equipment, materials, labour or capital in larger quantities than those considered as necessary in the manufacturing of product".

Waste can be classified as unavoidable waste (or natural waste), in which the investment necessary for its reduction is higher than the economy produced, and avoidable waste, in which the cost of waste is higher than the cost to prevent it (Formoso et al., 1999). The percentage of unavoidable waste depends on the level of the technological development of the company (Formoso et al., 1999; Womack and Jones, 1996). Formoso et al. (1999) stated that waste can also be categorized according to its source; namely the stage in which the root cause of waste occurs. Waste may result from the processes preceding production, such as materials manufacturing, design, materials supply, and planning, as well as the production stage (Formoso et al, 1999). Bossink and Brouwers (1996) classified the main waste causes in production into:

- Design
- Procurement
- Materials Handling
- Operation
- Residual

Materials are simply industrial goods that become a part of another physical product. They represent the major component of business cost and profitability. According to Ramakrishna (2005), on an average, half the sales income in an organization is spent on materials. This implies that to boost a firm's profit, there is the need to reduce materials cost which leads to a reduction in manufacturing cost. In the cost structure of most of the products manufactured, materials constitute 50% of the total cost, pointing to the need for the proper budgeting and control on cost of materials which is a core objective of Materials Management. The various types of materials to be managed in any organization include purchased materials, work-in process (WIP) materials and finished goods (Banjoko, 2000). Ogbadu (2009) identified basic price, purchasing costs, inventory carrying cost, transportation cost, materials handling cost, office cost, packing cost, marketing cost, obsolescence and wastages as the various costs involved in these materials. Thus, the management of these materials so as to reduce the costs associated is what we refer to as Materials Management. An integrated approach to Materials Management defines it as "the function responsible for the coordination of planning, sourcing, purchasing, moving, storing and controlling materials in an optimum manner so as to provide a predetermined service to the customer at a minimum cost" (Ramakrishna, 2005; Gopalakrishnan & Sundaresan, 2006). International Federation of Purchasing and Materials Management (IFPMM) defined it as a total concept having its definite organization to plan and control all types of materials, its supply, and its flow from raw stage to finished stage so as to deliver the product to the customer as per his requirements in time. These definitions provide the scope of Materials Management which includes decision on purchasing raw materials, staffing, inventories, stores and warehouse management, production levels, and distribution of finished goods at minimum cost at due time (Banjoko, 2000; Osotimehin, 2006; Ogbadu, 2009).

Every organization invests a considerable amount of capital on materials. In many cases, the cost of materials exceeds fifty percent of the total cost of goods produced. Such a large investment requires considerable planning and control so as to minimize wastage which invariably affects the performance and

profitability of organizations. Materials are the lifeblood and heart of any manufacturing system. No industry can operate without them. They must be made available at the right price, at the right quantity, in the right quality, in the right place and at the right time in order to co-ordinate and schedule the production activity in an integrative way for an industrial undertaking. A manufacturing firm will remain shaky if materials are under stocked, overstocked or in any way poorly managed (Lee et al., 1977, Banjoko, 2000). Materials Management encompasses all operations management functions from purchasing of raw materials through the production processes to the final delivery of the end products. It brings together under one management responsibility for determining the manufacturing requirement, scheduling the manufacturing processes and procuring, storing and dispensing materials (Wild, 1995, Ondiek, 2009). Thus, Materials Requirements Planning (MRP), purchasing, procurement of materials, inventory management, storage, materials supply, transportation and materials handling are the activities of Materials Management OFORI G (2000). Materials Management came to limelight at the advent of liberalization and globalization which posed intense competition on the business environment. Before that time, the concept was treated as a cost centre since Purchasing Department was spending money on materials while store was holding huge inventory of materials, blocking money and space (Ramakrishna, 2005). With the process of liberalization, there has been a drastic change in the market which has forced manufacturing companies to devise strategies to minimize production costs in order to remain competitive. Since then, Materials Management has been recognized as a source of opportunities to reduce production costs and can be treated as a profit centre.

3 METHODOLOGY

As the initial step, the research problem was identified. Then the importance and potential benefits of solving the problem was considered. Literature was then reviewed and parallel to that, processes with a potential to identify the factors affecting to material wastage in flexible packaging manufacturing process were observed.

Then the variables and factors were identified through literature and as well as by observations. Secondary data were then collected according to the variables identified. Hypotheses were derived based on the literature reviewed and the observations.

The research model is designed based on the derived hypotheses, to check whether,

- Extruder Machine Types (Old/New) affect material wastage
- Machines influence material wastage
- Material waste quantities differ from the waste causes/factors

Various statistical analysis techniques were carried out to identify the significant factors affecting raw material wastage. Hypotheses were developed and tested the normality of data, correlation between the variables. Finally, the conclusions and recommendations were made in order to minimize the raw material wastage problem by identifying what are the most significant factors that affect to the material wastage and investigate machine type and each machine belongs to two types how effected to the material wastage.

4 DATA ANALYSIS AND RESULTS

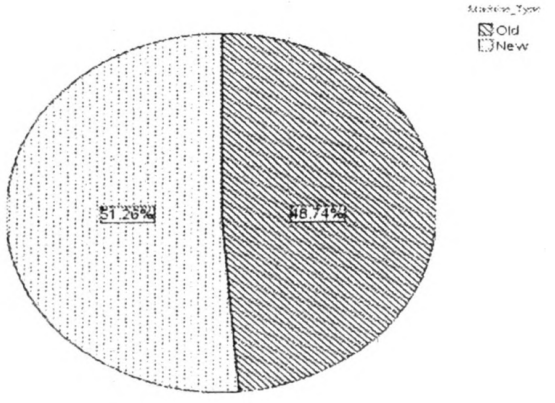

Figure1: Wastage according to Machine Type

Figure 1 Shows how machine types affect total material wastage. According to the graph contribution of the new machines is slimly greater than wastage of the old machines. But by using this graph, it is not fair to conclude that wastage is significantly large in new machines, due to the number of machines belongs to each category was not equal.

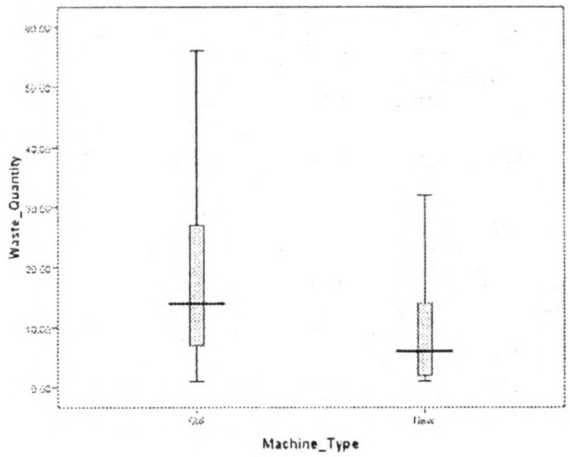

Figure 2: Distribution of Wastage according to Machine Type

Figure 2 indicates the dispersion of waste quantities according to machine types. It shows that mean value of wastage in old machines was greater than new machines. Even the ranges of data are higher in old machines than new machines.

4.1 Independent Sample T test

H_0: There is no significant difference between wastage of two machine types

H_1: There is a significant difference between wastage of two machine types.

Table 1: Independent Sample t-test

Group Statistics

	Machine_Type	N	Mean	Std. Deviation	Std. Error Mean
Waste_Quantity	Old	313	17.8211	13.5656	.76677
	New	651	8.9908	8.35003	.32726

Significant Two tail Value = 0.000

So, Null Hypothesis was rejected. That means there was significant difference between waste quantities of two types of machines.

4.2 Non Parametric Test

H_0: Effect of the wastage of all the machines are same

H_1: At least wastage of one machine is different

Table 2: Friedman Test Result

Test Statistics[a]	
N	8
Chi-Square	51.208
Df	7
Asymp. Sig.	.000

a. Friedman Test

Significant Value = 0.000

H_0 was rejected. There for there was no effect of all machines on the material wastage in same way. According to the results, machine-wise comparison is shown in Table 3 below.

Table 3: Friedman Test results

Ranks	
	Mean Rank
Machine1	7.88
Machine2	7.12
Machine5	5.38
Machine6	4.38
Machine7	1.88
Machine8	5.25
Machine9	2.00
Machine10	2.12

According to the machine type there was a difference in waste quantities. Even within the separate groups there were differences in machine-wise contribution towards waste generation. In that case we cannot conclude that one machine type highly affects on the material wastage.

5 DISCUSSION

Table 4: Comparison of Wastage in New Machines

Machine Type 2(New)	Mean Rank	Contribution to Material Waste
Machine2	7.12	Very High
Machine8	5.25	High
Machine6	4.38	High
Machine10	2.12	Moderate
Machine9	2.00	Moderate
Machine7	1.88	Low

Table 5: Comparison of Wastage in Old Machines

Machine Type 1(Old)	Mean Rank	Contribution to Material Waste
Machine 1	7.88	Very High
Machine 5	5.38	High

According to the results, machine type has an effect on wastage contribution. As well as deviation of waste quantity is larger in old machines when compared with the new machines.

Advanced statistical analysis lead to have a comparison between machine wise wastage, according to the results of the analysis the highest amount of wastage in old machines occurred due to machine 1. Machine 5 which belongs to old machine type was moderately low. When new machines are considered, contribution of wastage is higher in machine 2. Then machine 8 > Machine 6 > Machine 10 > Machine 9 > Machine 7.

There were six factors which were identified as factors affecting material wastage, they are size waste, startup waste, power cut waste, colour waste, sample waste, and other. Among them size change waste was the most significant factor affecting to the material wastage.

There should be an effective communication among all the departments. When it comes to this research, the marketing department has an important role as they act as the middle party between the customer and the company. They should identify customer requirements. Production department designs technical arrangements according to the marketing department order specifications.

Moreover the maintenance department should corporate with the production department. If there is an unexpected machine breakdown there should be a well prepared method to repair that machine immediately or replace it without any effect on the production process.

6 CONCLUSION

Material losses may take the form of waste, scraps, defectives and spoilage. Problems of spoilage, waste, defective units and scraps are bound to arise in almost all manufacturing concerns, so there is usually a difference between the quantity of the output and the input. Usually the quantity of the output is less than that of the input because of waste, scraps or spoilage. Efforts should be made to reduce the difference between the quantities of the output and the input so that cost of production may be reduced.

There is a difference between wastages of machine types. The research results indicate that machine wise wastages were also different from the other. Most of the wastage belongs to old machines was dominated by machine1. On the other hand, most of the wastage belongs to new machines was dominated by machine 2. Impact of wastage can be minimized by replacing or repairing these two machines after having an initial inspection.

It can be interpreted that the size change waste are the most significant root cause for wastage. If some actions can be taken to minimize the root cause, the company can expect a large amount of inflation in waste quantity.

It is recommended to take immediate actions to machine 3 and machine 4 which do not process daily. Such a machine overheads

lead unnecessary maintenance cost, as well as unnecessary layout (space) allocation.

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