POLITECNICO DI MILANO

MASTERS OF SCIENCE IN MANAGEMENT, ECONOMICS AND INDUSTRIAL ENGINEERING

Lean Management – Eliminate/ Reduce all types of Wastages in Production Cycle

COMPANY : NATIONAL FOOD LIMITED

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Abstract

The core objective of this project is to reduce/eliminate all types of wastages which are occurring during complete production cycle at National Foods Limited, Karachi. The Business Unit which we are focusing are located SITE Area Karachi-Pakistan with two main Plants 1- Salt plant 2- Paste plant. There were requirements for the calculation of raw salt waste during handling and process at Salt Plant and calculation of efficiency, defect rates and wastages of cooking area and individual machines at Paste Plant.

To achieve this objective, our very step was to observe and analyze currently operating steps and procedures. We are gathering all the relevant data and examine it to know the root cause of the problem, which include various tools like Control Charts, Plant Layout, Cause & Effect Diagram, Finite Mode, and Effect Analysis (FMEA), Sampling etc. The primary step is to calculate the percentage of total salt lost, detecting the uneven filling of Food Machinery Technology (FMT), to develop a facility with minimum material loss and optimum productivity.

By evaluating and monitoring the data and operating procedures we need to propose a solution for salt and its suitable handling mechanism and compute the defect rates of Paste Plant and recommend solutions for their improvement, thus eliminating various non- value-added activities which results in an improved productivity. The first phase which we will work is the salt plant where 20 to 25% raw salt are wasted in process and handling. We must segment first the total number of wastage in each area by using statistical tools and then propose solution of each area.

The second phase is related to Paste plant in which several sauces cooked in a vessel and packed by using different pipes (connected with pumps) and buffer tanks to the packing machines. Different SKU's have different wastage along each month and thanks to data base management software SAP, we can have all the data. We will first evaluate all the data by using different statistical technique and will focus on those SKU's which wastage is highest. The wastage started from the supplier end e.g. 100 or 200 gm tolerance can affect the whole batch, then it can be related to washing of pipes, vessels, buffer tanks and finally packing machines. It can also include the tolerances of each unit. We first must analyze all the data and then we will be able to propose solution of it.

Sometimes it also happens that over dose of any ingredient results the wastage of the complete batch. So, we must keep in mind to segments these batches and proposed solution to get rid of this problem.

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CHAPTER 1

1.1 INTRODUCTION

1.1.1 ABOUT COMPANY:

National Foods Limited is one of the leading FMCG of Pakistan with 20.85 Billion revenue last year. It started its journey in 1970 as a Spice company and continued the growth in different categories of products that popularized the concept of having clean, healthy food. The company objective were to make hygienic food, decrease the overall time spent in the kitchens, improve health of the consumers and contribute towards more positive and rewarding lifestyle. Now with more than 250 different products to its name with over 5 major categories, the company is a big force in the food industry. The company has several factories around the country includes Port qasim Karachi, SITE Karachi, Nooriabad, Murikde and Gujrawala. Also company has several warehouses in which some are operated by NFL itself and some are operated by 3rd parties. The strong supply chain and strategic leadership of the company allows it to grow not only in local region but also globally.

1.1.2 ABOUT PROJECT:

The National Foods Limited is currently having some troubles in the proper utilization of the raw material hence return on investment is not up to projected level. The purpose of this project is to highlight and upgrade the unnecessary steps and activities that are the root cause of major losses. Issues like handling losses, process losses and raw material losses will be analyzed, and an optimized solution will be provided and implemented. The hierarchy of National Foods Limited is shown below:

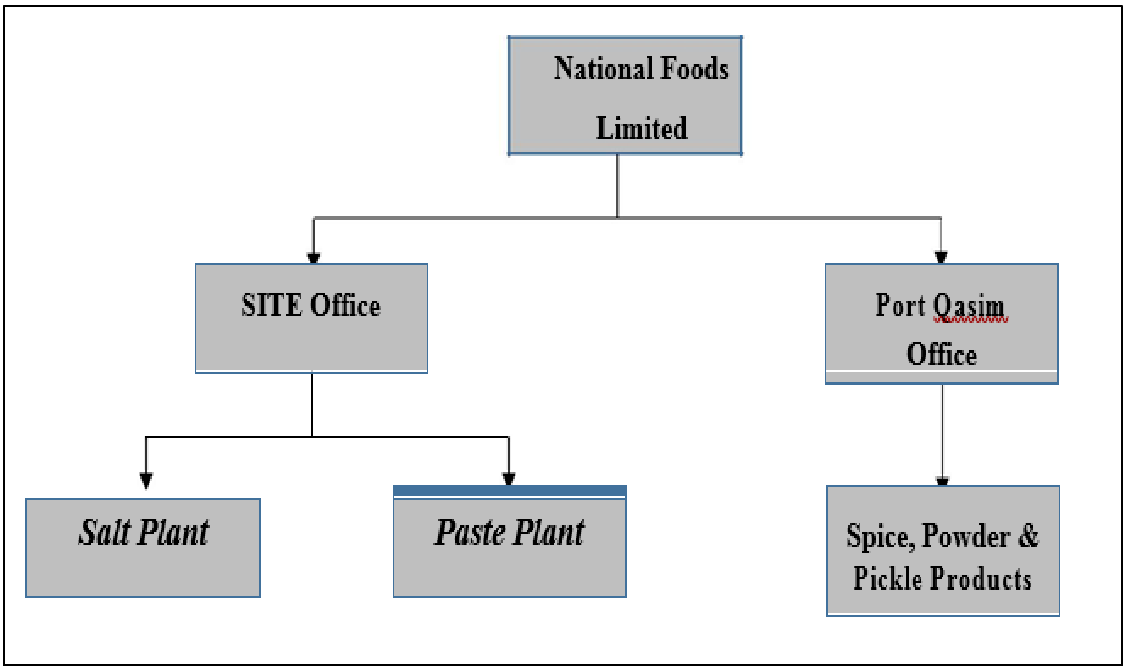

Figure 1

We assigned to work at SITE unit which consists of Salt & Paste Plants as shown above. The major issues there were of low quality sacks, poor handling and some of the machines were not in good condition and hence some of the salt got wasted there.

The other part of our project based on Paste plant where problems lies in the Filling machine where after fillings between each bottle results in a significant loss, there might be chance line losses serving up to the main line. Also, there were issues in capping machine as some of the bottles goes to the Pasteurization machine uncapped and finally there were problems in the Pasteurization machine where bottles fall inside the machine which contributes to the overall losses in the plant.

1.1.3 AIMS AND OBJECTIVES:

The goal of this project is to reduce all types of wastages during production cycle that are affecting seriously in generating a desired Gross Profit Margin. To achieve the goal of this project, the objectives are as follows:

- To reduce the amount of salt wastage during its transfer from truck to inventory.
- To minimize the amount of salt wastage during its transfer from inventory to feeding belt.
- To decrease the amount of salt wastage from rolling back of the feeding belt (1-inch opening).
- To design an improved quality bags that should be reliable.
- To provide a system for the handling of improved bags.
- To calculate the defect rates of Filling, Capping and Pasteurization Machines.
- To estimate the loss per day (in terms of money)
- To lessen the wastage of Pasteurization Machine.
- To lower the problems of Capping Machine.

1.1.4 PROJECT SCOPE:

Project scope or the boundary of the project are as follows**:**

1.Inventory space is not large enough to install some machines that provides ease in operation in material handling (conveyor etc.)

2. Cost or budget should be used optimal (cost should be as minimum as possible). This also provides some restrictions in installing highly automated machines that are very expensive.

3. During crushing about 20% of total waste occur so process up gradation can be one of the option

4.Plant is currently operating at optimal speed[1] (belt speed i.e. 74 bottles/min)

5. Products ingredients are predefined, so changing viscosity or other factors is restricted.

[1] Average speed of plant and recommended by supplier

CHAPTER 2

2.1 LITERATURE REVIEW

2.1.1 What is LEAN?

The term lean is used for several meaning, but the main idea is to reduce wastages and maximize customer value, eliminating waste along entire value stream. This concept was primarily introduced in Toyota Production System (TPS[2]) it has been called World Class Manufacturing (WCM), Continuous Flow Manufacturing and Stockless Production to name few.

2.1.2 What is Waste?

Waste is defined as non-value added activity from the customer's perspective. According to research conducted by the LERC[3] ,waste is about 60% of production activities in any typical manufacturing operation i.e. they don't add value at all for the customer.

2.2.2.1 7 MUDA(Wastages)

There are seven types of wastages which effects overall productivity in a manufacturing firm. These wastes are often referred as TIMWOOD which is acronym of (Transport, Inventory, Motion, Waiting, Overproduction, Over-processing and Defects).

i. **Transportation:**

Transporting goods throughout the production process is an essential but non-value-added activity, excessive movement and handling can cause damage and quality issues in goods.

ii. **Inventory:**

Inventory keeping is used to make possible smooth production and material flow throughout the production cycle and to cater sudden changes and fluctuations in production plan, but actually excess inventory is non-value-added activity. Excess inventory rises up the lead times, slow down the process of identification of problems, consumes productive space of the floor and restrain the communication

iii. **Unnecessary/Excess Motion:**

This waste is related to ergonomics and method study in which there is a lot of unnecessary movement of a person and material throughout the production which increases overall cycle time.

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[2] The Toyota Production System (TPS) is an integrated socio-technical system, developed by Toyota.

[3] Lean Enterprise Research Centre

iv. **Waiting:**

Goods moved on time or before time but then wait to further process, this waste is Waiting. Much of a product's lead time is tied up in waiting for the next operation; this is usually because material flow is not good, production runs are too long, and distances between work centers are too high.

v. **Over Processing:**

Sometimes products are made with more complex processing method or with high precising tools and method although they were not required to do so,this would increase cost and time which is non value added due to over processing.

vi. **Over Production:**

Over Production is producing goods in excess quantity as com pare to requirement or need. This creates high lead times, results in excess storage costs, and makes it difficult to identify defects. The Toyota Production System is also referred to as "Just in Time" (JIT) because every item is made just as it is needed.

vii. **Defects:**

Defect arises when the product does not meet the required specification, quality defects resulting in rework or scrap are a tremendous cost to organizations.

2.1.3 Lean Manufacturing Tools and Techniques:

Lean Manufacturing tools and techniques is used to reduce the above wastages as much as possible and increase overall productivity and efficiency throughout the production cycle. Some of the common tools and methods are as follows:

2.1.3.1 5S:

This is a simple and powerful Japanese tool that is used for organizing a workplace in a very systematic, clean and safer way. This would increase productivity, Work standardization efforts and helps to reduce accidents and errors.

The five in a 5S workplace organizational and housekeeping methodology refers to five steps. The steps in detailed are as follows

i. **Sort**: Sort out & separate that which is needed & not needed in the area.

ii. **Straighten**: Arrange items that are needed so that they are ready & easy to use. Clearly identify locations for all items so that anyone can find them & return them once the task is completed.

iii. **Shine**: On regular basis, clean the workplace & equipment for identify defects and maintaining the standards

iv. **Standardize**: The first three of the 5S are most important and come back there again always on a regular basis and make sure the condition of the Gemba using standard procedures.

v. **Sustain**: Keep to the rules to maintain the standard & continue to improve every day.

2.1.3.2 Kaizen:

Kaizen is a Japanese word which means Continuous Improvement. It is a methodology that follow the proceeding quality cycles called Deming Cycle or PDCA cycle. They are as follows:

i. **Plan** – In this phase an opportunity for change is identified and the planning is carried out to bring about this change within the system.

ii. **Do** –the plan is then executed for the change to be implemented within the system.

iii. **Check** – In this stage, data is collected and viewed to check the success of the change, which was implemented. The results are analyzed with a view to determine whether the change brought about was successful

iv. **Act** – Once the change is determined to be successful, the plan is implemented on a much wider scale and continuous assessment takes place. Again, the check stage is followed large-scale implementation.

2.1.3.3 Value Stream Mapping:

VSM is a lean manufacturing technique used to improve and analyze the information and material flow from supplier to customer. This maps help you to focus where the delays are in the process, or and excessive inventory. Current state map is the first step in working towards the ideal state for the organization followed by future stream map

2.1.4 What is Quality?

Quality can also defined as excellence in the product or service that accomplish or increase the expectations of the customer.

Different approaches of quality:

- User Based
- Production Based
- Value Based (Manufacturing & Service Dimension)

What is TQM?

Total Quality Management is a management approach that strives to provide customers with products and services that satisfy their needs. It required quality in all steps of the company's operations, where the processes should being done right at the first time and defects and waste should be remove from operations.

TQM is the consolidation of each processes & functions processes of the organization to get continuous improvement of the quality services and goods. The main goal behind this all working is customer satisfaction.

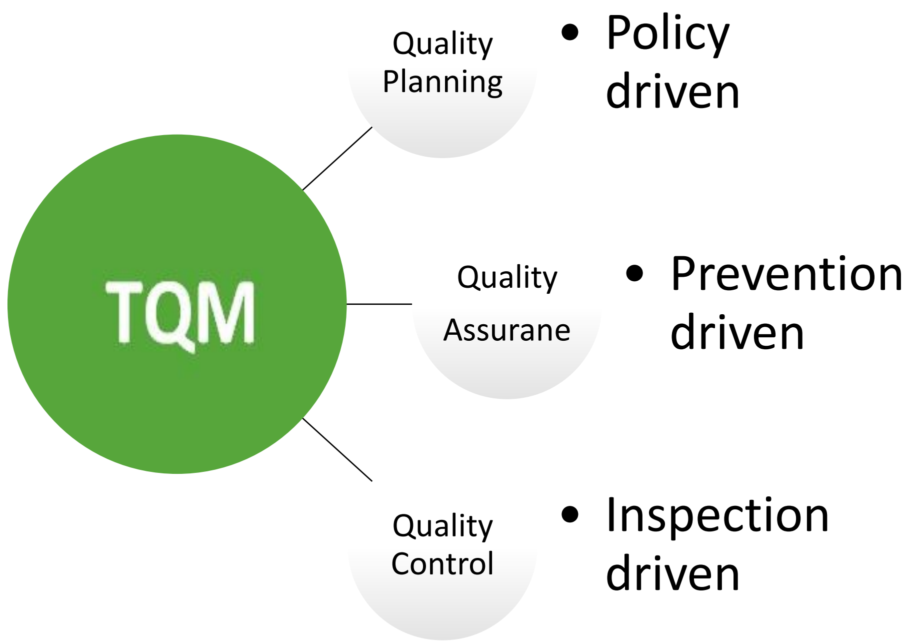


Figure 1

2.1.4.1 Quality Control:

Overview:

Quality control (QC) is a process by which entities review the quality of all factors involved in production.

It is a function which aims to ensure that a product manufactured in an organization or any service comply to a defined set of quality criteria or meets the customer requirement

Quality control emphasizes testing of procedures to uncover defects and reporting to management.

Quality control implemented in an efficient manner enables managers to **optimize operations. Process optimization/ continuous improvement** in turn lead to:

- Reduction of waste
- Operational standardization
- Cost control

2.1.4.2 Quality Control Tools:

Quality Control is implemented by using Quality Control tools. Some of which are basic while many are new. The use of each tool depends mainly upon requirements of project to obtain necessary results.

List of tools are as follows.

The seven basic tools are:

- Cause-and-effect diagram (also referred as the "fishbone" or Ishikawa diagram)
- Check sheet
- Control chart
- Histogram
- Pareto chart[4]
- Scatter diagram
- Stratification (alternately, flow chart or run chart)

The seven new tools are:

- Relations diagram
- Tree diagram
- Arrow diagram
- Affinity diagram
- Matrix diagram
- Matrix data analysis diagram
- Process decision program chart. (PDPC)

Note: The above list is not exhaustive. There are other quality control tools, some of which will be discussed in the later stages of the report.

[4] Commonly used in companies to focus special items by applying 80/20 rule

CHAPTER 3

3.1 INTRODUCTION TO SALT PLANT

3.1.1 ABOUT SALT PLANT

Salt plant is the 3rd major contributor in term of revenues after spices and ketchups and 2nd in terms of number of products sold per year after spices. The major issues in this plant are low quality sacks, poor handling and some of the machines are not in good condition and hence some of the salt got wasted there.

Two types of salts are produced in this plant, namely:

Two types of salts are produced in this plant, namely:

1. Iodized Salt
2. Chinese salt

Salt is packed in 800g by automatic packing machine and another 3kg bags are also produced on special orders which are handled and packed manually. Each carton is packed with 24 pouches of 800g packs with a total production of 115,000 pouches/day.

3.1.2 PROCESSES

3.1.2.1 Salt Sources

Raw salt comes from two sources. These are Khepro and Dhabeji[5]. Khepro is the lake salt where as Dhabeji is the sea salt. Khepro fulfils about 90-95% of total salt demand while Dhabeji serves as 5-10% supplier of raw salt. Sea salt contains a larger amount of water content and thus contains a greater amount of impurities than lake salt, thus its processing is more challenging when compared to lake salt. As an average, raw material has around 4-5% moisture left when it arrives in plant.

3.1.2.2 Bags unloading at gate

Approximately 2 trucks[6] are unloaded at the gate of SITE plant per day. Salt comes in 50Kg woven polyethylene bags. Each truck contains around 1350-1400 bags so each truck contains 67,500-70,000kg raw salt. This means total usage of raw salt is approximately 135-140 Tons.

3.1.2.3 Storage to Conveyor

The raw salt is then stored in a temporary inventory. The inventory has a total storage capacity of 300 tons. This means that the inventory can store around 6000 bags in full capacity. The

[5] Dhabeji and khepro are different areas of Sindh-Pakistan where supplier supply salt to NFL

[6] Two long and open trucks which contain around 2 hours to unload in company

bags are then picked, dragged, sheared and then the salt is poured in the conveyor manually by the workers.

3.1.2.4 Conveyor to crusher

The salt is then transferred from a 3m long conveyor to a primary crusher during which workers remove objectionable and unwanted particles manually by visual inspection. The crusher crushes the larger particles of raw salt into small size that are suitable for further processing.

3.1.2.5 Salt Washing & crushing

The raw salt is then washed in larger washing chamber where dust particles that were embedded in salt crystals are now removed and all undesirable particles are also removed. After that the salt is passed through primary crusher which decrease the particle size at some extent and then it is moved to secondary crusher known as china crusher which further reduces the particle size. Salt is washed with the help of a brine solution which is prepared and stored in another section, located outside the production facility. The brine is a saturated solution which means it already contains a huge amount of salt dissolved in it, so raw salt can be washed with this solution without a fear of Salt dissolve. After washing, it is passed with a centrifugal cone which separates the salt and water.

3.1.2.6 Drying chamber

The salt from china crusher is then transferred to a giant drying chamber. A predetermined amount of Iodine is also added in salt. Iodine is important for good health and, fortunately, our bodies require it in relatively small quantities. Iodine is part of a hormone, thyroxin, which is important for maintaining a human metabolic rate. It also decreases Goiter. The drying chamber is a vibratory furnace which removes all the moisture content in it.

3.1.2.7 Meshing Chamber

Salt from the furnace is transferred to a screen machine which breaks the salt into required particles sizes. Mesh is available in three sizes i.e.

a. 16 (16 holes per square inch)
b. 50 (50 holes per square inch)
c. Above 50 (More than 50 holes per square inch)

First, the salt is meshed with 16 no. mesh into smaller size. Particle sizes obtained after 50 no. mesh is the required size of salt. Size obtained after above 50 mesh holes is powder, which is sent to Port Qasim[7] plant for spice production.

[7] Another factory located in Karachi, and specialized in Spices and pickle

3.1.2.8 Packaging

The process salt is finally packed. There are two bucket elevators, with picks the salt from meshing chamber and transfers it into the packaging section. Currently three packing machines[8] are available for this purpose. The packed salt in 800g pouches is finally compiled in boxes with 24 pouches per box. The final product is then ready to reach the customer.

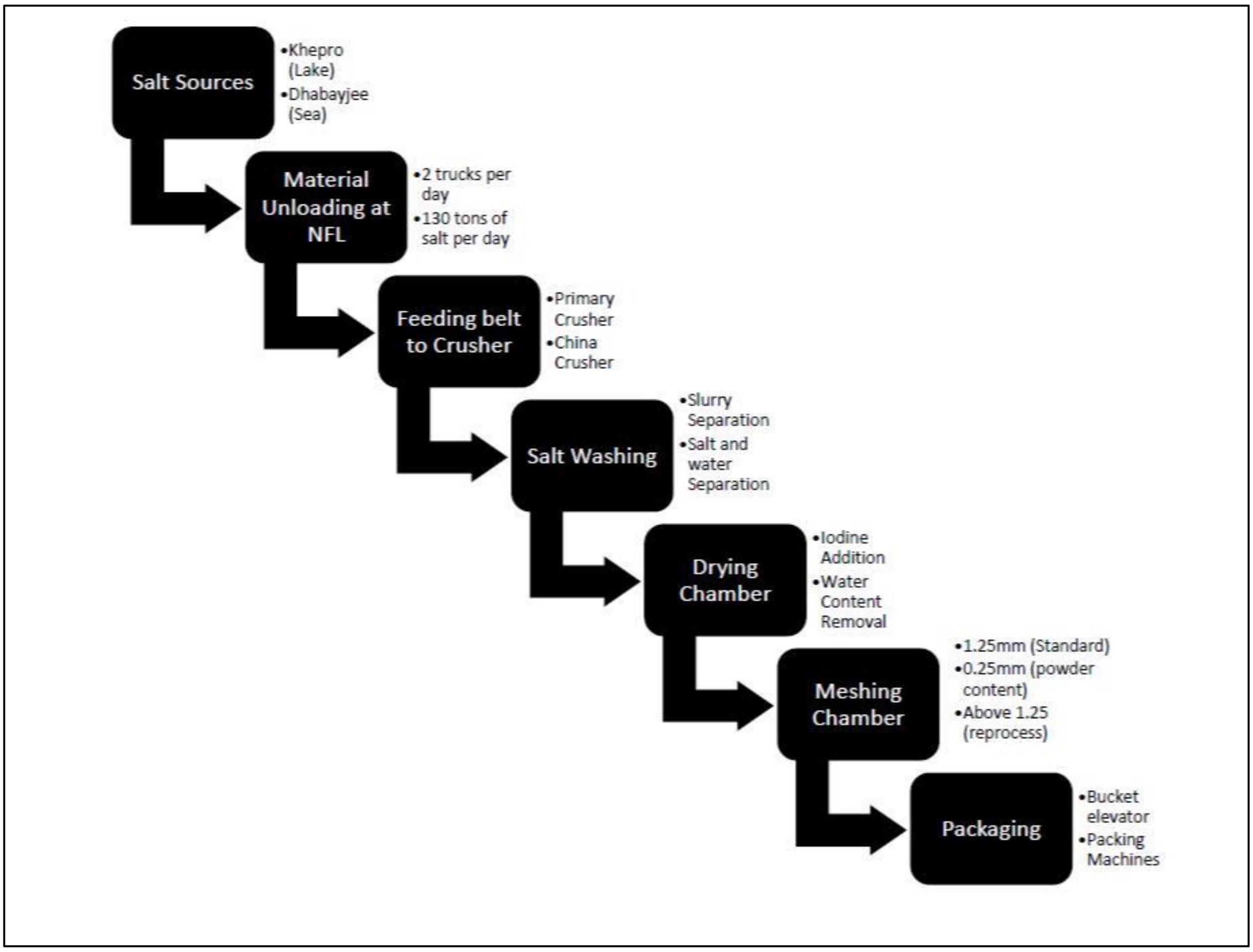


Figure 2: Series of operations in salt plant

[8] One is dedicated to MSG (Monosodium glutomate), which is only packed by NFL and material is imported from China

3.2 SALT LOSS

The Raw salt that arrives at NFL gate, is unfortunately unable to convert into the final product efficiently. There are number of losses that are associated with the failure for a successful and efficient raw to product conversion. The total amount of salt loss can be divided in two major categories.

1. Raw Material Loss
2. Process Loss

3.2.1 Raw Material Loss[9]

These are the losses which are associated with the loss of raw material i.e. loss before the salt being processed. These kinds of losses can be minimized up to a great level by adopting some key engineering solutions. The cause of these losses are;

i. **Loss During material unloading from truck to inventory**

A huge amount of salt is lost when the material is unloaded from truck to inventory. The unloading process is totally manual. Workers picks the 40kg bags, load it on their back, travels a distance of 16 to 36ft and then dumps it into inventory. The bags are of poor quality and due to which an enormous amount of salt is leaked from them, thus contributing to one of the major factors of salt loss.

ii. **Loss during material feed to conveyor**

Salt after storage is then poured to conveyor for further processing. Here again the worker picks a bag, shears it with a L shaped handle, drags with it from inventory to conveyor where another worker shears the mouth of bag with a knife and then discharges the bag onto the conveyor. All this process reduces the weight of bag due to large amount of salt drop. This area is the 2nd contributor of major salt loss.

iii. **Loss at conveyor roll back**

A considerable amount of material is also lost when the raw salt starts its journey with conveyor belt. Here the problem arises when the salt due to its sticky nature and moisture, sticks with the belt surface. There a 2-inch-wide gap between the base and the belt in the transfer section. When the belt rolls back, the salt attached with it passes through the opening and falls onto the floor. Due to quality reasons, Raw material that drops on the floor cannot be used for further processing.

[9] Total Product loss is around 2.7 – 3 %

3.2.2 Calculations

The Excel sheet below shows the actual amount raw salt lost, the number of bags that could be made and the loss in terms of money. The raw material from the supplier costs around Rs.3.11/kg. Hence, we can easily calculate the amount company is paying and not getting anything in return. All losses described in this sheet are voluntary losses which can be reduced directly to increase the overall plant efficiency.

Table 3.1: Raw Material Loss in Salt Plant

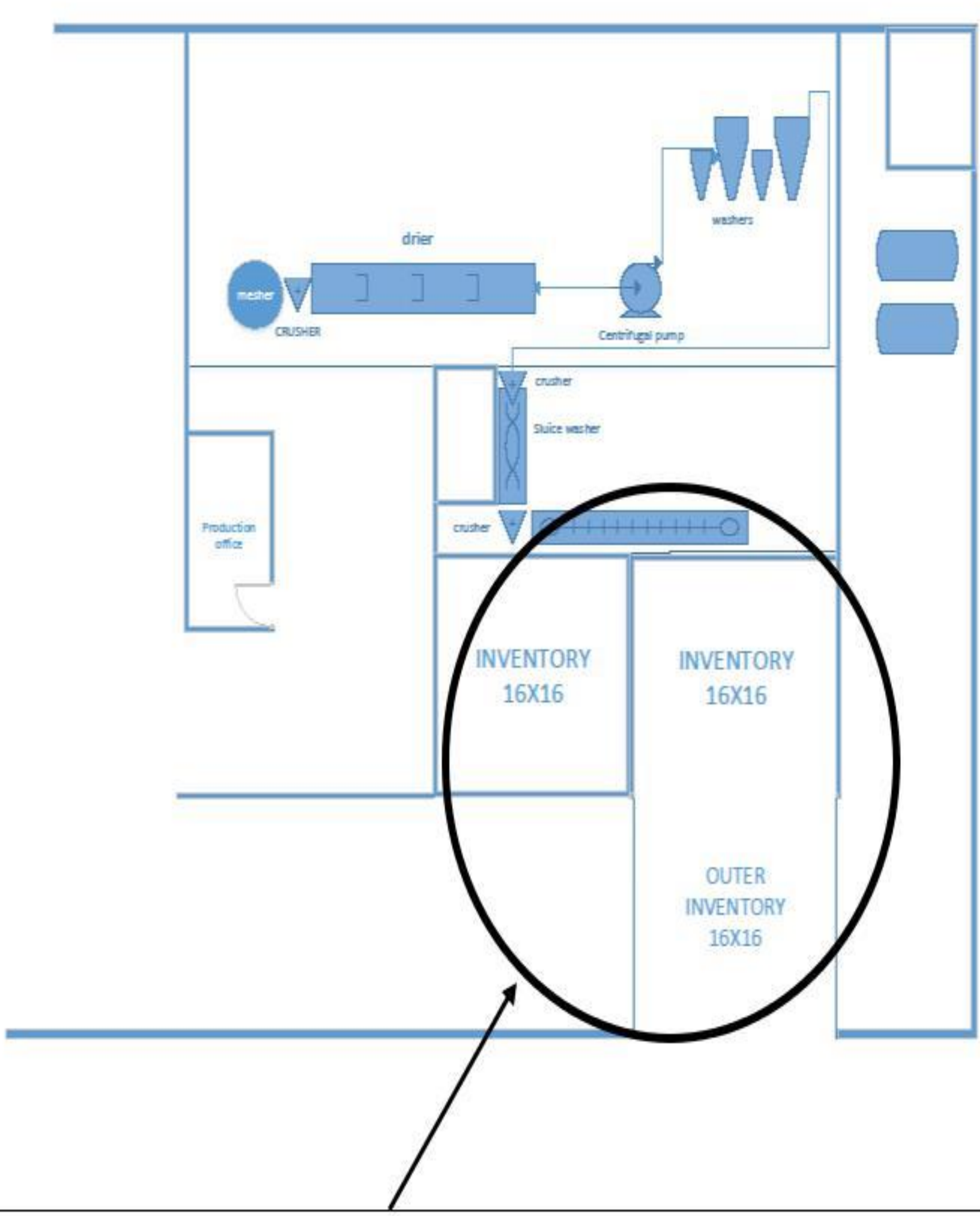
DATE	WORKIN G DAYS	NUMBER OF BAGS	BAGS DISCARDED PER DAY	WEIGHT OF MATERIAL DISCARDED PER DAY (KG)	NUMBER OF PRODUCTS CAN BE MADE	RAW MATERIAL LOSS (Rs/Day)
12-Apr-17	None	200	None	None	None	None
20-Apr-17	1	50	50	2000	2487.6	6218.9
22-Apr-17	2	150	75	3000	3731.3	9328.4
23-Apr-17	1	180	180	7200	8955.2	22388.1
27-Apr-17	4	250	63	2500	3109.5	7773.6
3-May-17	6	250	42	1667	2073	5182.4
16-May-17	13	250	19	769	956.8	2391.9
17-May-17	1	180	180	7200	8955.2	22388.1
18-May-17	1	150	150	6000	7462.7	18656.7
29-May-17	11	500	45	1818	2261.4	5653.6
2-Jun-17	4	500	125	5000	6218.9	15547.3
16-Jun-17	14	500	36	1429	1776.8	4442.1
27-Jun-17	11	464	42	1687	2098.6	5246.5
8-Jul-17	11	500	45	1818	2261.4	5653.6
16-Jul-17	8	500	63	2500	3109.5	7773.6
31-Jul-17	15	434	29	1157	1439.5	3598.7
1-Aug-17	1	500	500	20000	24875.6	62189.1
17-Aug-17	16	500	31	1250	1554.7	3886.8
23-Aug-17	6	309	52	2060	2562.2	6405.5
25-Sep-17	33	500	15	606	753.8	1884.5
30-Sep-17	5	394	79	3152	3920.4	9801
12-Oct-17	12	339	28	1130	1405.5	3513.7
1-Nov-17	20	395	20	790	982.6	2456.5
12-Nov-17	11	377	34	1371	1705.1	4262.8
21-Nov-17	9	339	38	1507	1874	4684.9
13-Dec-17	22	299	14	544	676.2	1690.4
17-Dec-17	4	985	246	9850	12251.2	30628.1
19-Dec-17	2	300	150	6000	7462.7	18656.7

AVERAGE BAGS DISCARDED PER DAY	87
AMOUNT OF SALT WASTE PER DAY (KG)	3481.66
RAW MATERIAL LOSS PER DAY	10826 PKR or 83.27 €
AVG NO. OF UNITS LOSS PER DAY	5386.09

The Salt which fails to convert into final product, is collected, filled in bags, and then is returned to the supplier at negligible cost basis.

The first column shows the date at which the wasted raw material is lifted from the store to start its journey back to supplier. The second column shows the working days between these days. Third column shows the number of bags lifted. When number of bags is divided by the working days between applicable date intervals, we get the fourth column, showing the Number of bags discarded per day. Fifth column shows the amount of salt loss in kg per day as each bag contains around 40kg wasted salt in them. Each final product weights 0.804kg, hence 6th column shows the amount of salt that could be made if the all the wasted raw material were converted into final product. Finally, the last column indicated the loss in terms of money.

3.2.3 Layout of Salt Plant



This is the area of concern. 3 inventories (2 with roofs, one without roof) stores the Raw material. These three stores can store up to 300 tons or 6500 bags of salt at full capacity.

Figure 3.1:Salt Plant Layout

3.2.4 Process Loss

These are the losses which are related with the processing of salt. Some of the factors that contributes the process loss are fixed and cannot be improved up till a certain limit. Around 21% salt is lost during its processing. Process losses arise due to following main reasons:

i. Loss in washing section.

At the start of processing, the salt is washed thoroughly to remove the dust, dirt, and other solid particles. Washing is carried out by a brine solution. Brine solution is a saturated solution of salt which cannot dissolve more salt further. But during washing, a considerable amount of salt is dissolved and lost in brine solution.

ii. Unwanted number of units produced.

Number of scrap also contributes in salt loss but this loss serves as a minor factor in contribution of overall salt loss.

3.2.4.1 Calculations:

Salt that arrive at NFL gate is in sacks. Each sack weighs about 40 kg. The workers, who pours the salt on conveyor belt, collects and piles up empty sacks so that the number of sacks or amount of salt consumed per day is computed.

DATE	RAW SALT (SACK)	RAW SALT (KG)	RAW SALT WITHOUT MOISTURE	TOTAL CARTONS PRODUCED	SALT PRODUCE (KG/DAY)	POWDER SALT (Sack/day)	POWDER SALT (Kg/Day)	TOTAL PROD. (Kg/Day)	TOTAL WASTE (Kg/Day)	EFFICIENCY (%/Day)
15-Apr-17	2350	94000	88830	3376	65143.3	110	5500	70643.3	18186.7	79.5%
19-May-17	2758	110320	104252.4	3400	65606.4	120	6000	71606.4	32646	68.7%
9-Jun-17	3410	136400	128898	4900	94550.4	194	9700	104250.4	24647.6	80.9%
29-Jun-17	2963	118520	112001.4	4270	82393.92	165	8250	90643.92	21357.48	80.9%
4-Jul-17	2908	116320	109922.4	4247	81950.1	160	8000	89950.1	19972.3	81.8%
25-Jul-17	1490	59600	56322	2150	41486.4	60	3000	44486.4	11835.6	79.0%
9-Aug-17	2239	89560	84634.2	3400	65606.4	140	7000	72606.4	12027.8	85.8%
19-Aug-17	1872	74880	70761.6	2700	52099.2	110	5500	57599.2	13162.4	81.4%
14-Sep-17	2291	91640	86599.8	3300	63676.8	130	6500	70176.8	16423	81.0%
21-Sep-17	1839	73560	69514.2	2650	51134.4	100	5000	56134.4	13379.8	80.8%
5-Oct-17	1942	77680	73407.6	2800	54028.8	118	5900	59928.8	13478.8	81.6%
23-Oct-17	3234	129360	122245.2	4660	89919.36	173	8650	98569.36	23675.84	80.6%
1-Nov-17	3489	139560	131884.2	4400	84902.4	198	9900	94802.4	37081.8	71.9%
11-Nov-17	2730	109200	103194	3700	71395.2	170	8500	79895.2	23298.8	77.4%
30-Nov-17	3055	122200	115479	4400	84902.4	170	8500	93402.4	22076.6	80.9%
5-Dec-17	3468	138720	131090.4	5000	96480	185	9250	105730	25360.4	80.7%
18-Dec-17	3155	126200	119259	4600	88761.6	158	7900	96661.6	22597.4	81.1%
29-Dec-17	3492	139680	131997.6	5025	96962.4	181	9050	106012.4	25985.2	80.3%
AVERAGE	2704.7	108188.9	102238.5	3832.1	73944.4	146.8	7338.9	81283.3	20955.2	0.80

Table 3.2: Salt Production Data

Each carton contains 24 packets of salt and each packet is about 804g in weight. Powder salt is packed in 50Kg sacks and dispatched to National Foods Port Qasim plant. Total production hence is the sum of table salt plus powder produced per day. Difference between total raw material usage and total production gives us the overall process loss per day, which is estimated to be around 21%. Hence to Plant efficiency reduces to 79% when only process loss is considered alone.

3.2.5 Final Calculation[10]

RAW MATERIAL LOSS

- Raw Material Loss = 3482 Kg/day
- Raw Material loss (Direct loss) = Loss per day in Kg * Cost of Salt per Kg

= 3482 * 3.11

Raw Material loss (Direct loss) = 10,830 PKR/day or 83.30 €/day

- Per unit profit = Rs 5/ pack or 0.04 €
- Opportunity Loss (Indirect loss) = No. of Unit that can be produced * Revenue per unit

= 5386 * 5

Opportunity Loss (Indirect loss) = Rs. 26,930/day or 207.15 €/day

Total Monetary Loss = Direct loss + Indirect loss

= 10,830 + 26,830

Total Monetary Loss = **Rs 37,760/day or 290.46 €/day**

PROCESS LOSS

- Total Production = 81,283 Kg/day
- Total Consumption = 108,189 Kg/day
- Amount of Moisture content = 4- 5 % Approx.
- Weight of Salt without moisture = Raw salt * 0.955

= 108,189 * 0.955

[10] Taking 1 €= 130 PKR (Average)

= 103,321 Kg

Process Loss = 103,321 – 81,283

= 22,038 Kg/day

Total Material Loss = Raw material Loss + Process Loss

= 3482 + 22038

Total Material Loss = 25,466 kg/day

This is the big number for the company and currently a major problem, before suggesting anything to the we calculated above the total amount of loss while keep in mind all the factors associated to the plant. We also shared these calculations with the company at this point to alarm them the current situation and look to our recommendation which we will going to suggest overcoming or reduce this problem.

CHAPTER 4

4.1 INTRODUCTION TO PASTE PLANT

4.1.1 ABOUT PASTE PLANT

National foods Limited has two main areas of production, one is the PASTE PLANT where the cooking, filling and packing of different sauces, Jams and ketchup are done, where as other is the SALT PLANT where mainly the lake salt are converted to daily use food salt with the help of different processes as we defined above.

Almost 60 workers are working in the paste plant in one shift by which 55 is directly associated to plant work while others are indirectly related to plant e.g. fork lifter operator etc. The plant is mainly working in two shift day and night depends upon the demand or plan. The planning department provides weekly schedule to production which further segregate to daily plan and plan quantity (batches). Production creates the material reservation of the material which will be used in the plan product recipe and operates according to the plan. There are different machines and section located in the Paste plant which as follows;

No. of machines[11]

- KOSME Plant/FMT (Food Manufacturing Technology)
- PAKONA Machine
- MESPECK Machine
- SAMA Machine
- SQEEZY Machine
- 1 kg Manual
- 3.25 kg/Manual Machine

Moreover, we have a cooking area inside the paste plant in which the different ingredients are mixed in the standardize quantity and cooked in order to make a final product.

Also, we have 2.5 fire tube Boiler in the boiler room which generates specified energy/steam required in the above plants and cooking area.

[11] Name of machines are assigned on the basis of brand of machine and process

4.1.2 BASIC FLOWCHART OF PRODUCT WITH ITS RESOURCES

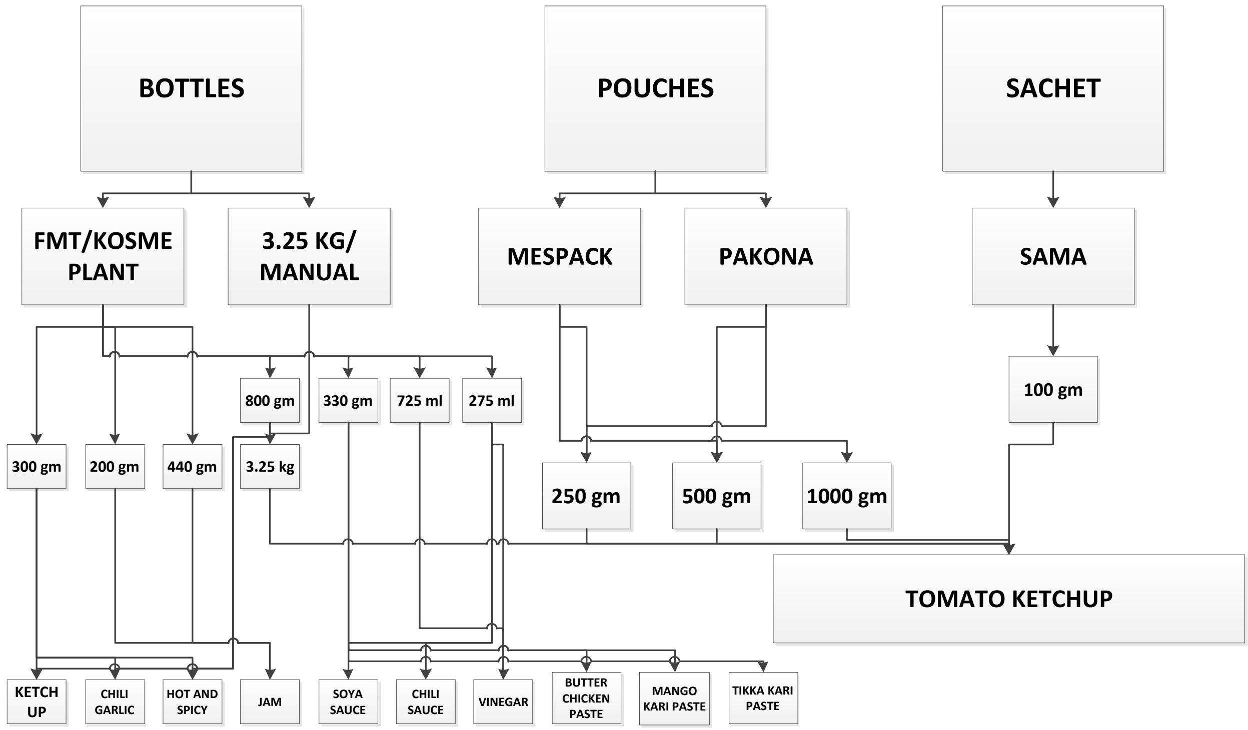


Figure 4.1: Flowchart of Product and its Resources

4.1.3. Types of Products:

4.1.3.1 Classification according to product type

There are 5 major categories of products that are being produced in paste plant which can further be classified into a total of 17 products. The detailed classification of the product is as follows:

1. Ketchup

- Tomato
- Hot and spicy
- Chili garlic

2. Jams

- Apple Mango
- Strawberry
- Orange Marmalade Mix fruit

3. Chinese Category

- Soya sauce
- Chinese chili sauce
- Vinegar

4. Apple Jelly

5. Export

- Mango chili sauce
- Green chili sauce
- Tangi tamrot
- Bhail pori sauce
- Red chili sauce

4.1.3.2. Classification according to container size:

1. BOTTLES

FMT/KOSME Plant

- 300 gm (ketchup, chili garlic, hot and spicy)
- 200 gm (jam)
- 440 gm (jam)
- 800 gm (ketchup, chili garlic, hot and spicy)
- 330 gm (soya sauce)
- 725 gm (vinegar)
- 275 gm (soya sauce, chili garlic, vinegar)

3.25 KG/ Manual

- 3.25 KG (tomato ketchup, chili garlic, hot and spicy)

2. POUCHES

Mespack

- 250 gm (tomato ketchup)
- 1000 gm (tomato ketchup)

Pakona

- 250 gm (tomato ketchup)
- 500 gm (tomato ketchup)

3. SACHET

Sama

- 100 gm (tomato ketchup)

4.2 WORKING OF PASTE PLANT AND LAYOUT:

4.2.1 Cooking Section:

In this section, all the ingredients including pectin, sugar in case of making jam and marmalade and pastes and spices for ketchup, chutney and vinegar. All the required raw material that comes from the National Foods inventory are mixed according to product requirement and cooked in that area up till certain time and temperature.

4.2.2 Bottle Washing:

In the second stage, the emptied bottles are washes thoroughly in bottle washer plant that first make bottle upside down and then wash with water. Bottles are usually comes from outside vendors of different shapes and size depends upon the required demand.

4.2.3 Filler:

In this stage, the bottles are fed with paste in form of liquid that comes from cooking section. The pistons that are used to fill the bottles are set and adjusted to desired quantity required for the filling of bottles up to required amount. The machine used to fill the paste in bottles is FOOD MACHINE TECHNOLOGY **F.M.T**. The machine contains 12 pneumatic piston cylinder that fills the bottles in sequential manner.

4.2.4 Capping:

In capping section, the filled bottles that comes from F.M.T are capped. Different bottles have different cap size and shapes according to shape of bottle (jams bottles and ketchup bottles). There is a belt that is used to tighten the cap of bottles which is then sent for pasteurization.

4.2.5 Washing Cooling and Pasteurization:

Filled and capped bottles are then send to low temperature zone for about 20 to 22 minutes to have good effect in paste quality. The bottles clusters at the beginning of the starting process of pasteurization because bottles come from single belt that comes after the filling and capping section are then send to the wide belt which is located inside the pasteurizing plant are move slowly (20 to 22 minutes)

4.2.6 Drier:

The pasteurized bottles that comes after pasteurizing process are then send to drier in which wetted bottles that comes from washing zone are dried in the machine called drier and all the drier dries all the moisture from the bottles.

4.2.7 Labeling:

The washed, dried bottles are then send to labeling machine where the labels are stick to the bottles according to the type of bottle. Different bottles have different types of labels depends upon the type of product.

4.2.8 Palletization:

After completing all the stages, the bottles are then send to the machine that pack the bottles in the form of groups and then set in pallets, the pallets are then lift by fork lifter that send pallets into inventory and then on truck at the time of delivery.

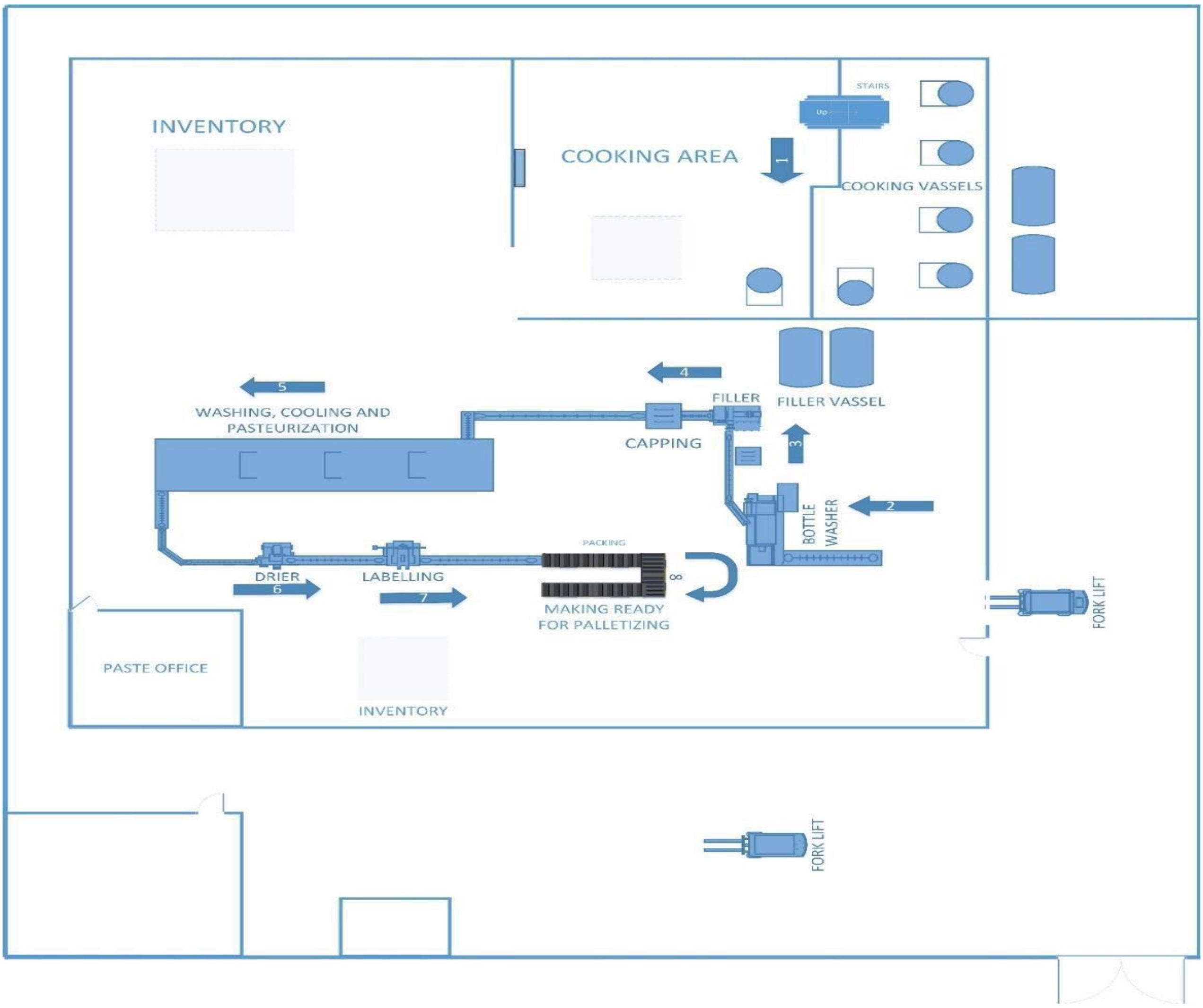


Figure 4.2: Detailed view of Paste Plant

4.3 CAUSE AND EFFECT DIAGRAM OF PASTE PLANT

The cause and effect diagram show the all the factors and aspects associated with a process. It is a brainstorming session which can help us to immediately sort ideas into useful categories.

Cause and effect diagram of Paste plant shows that the key contributing factors that effects the production are related with Machines and Methods followed. Environment and Man power have a very little effect on total production. Moreover, Material and Measurements are assumed to have no effect at all on the overall production of Jams in paste plant.

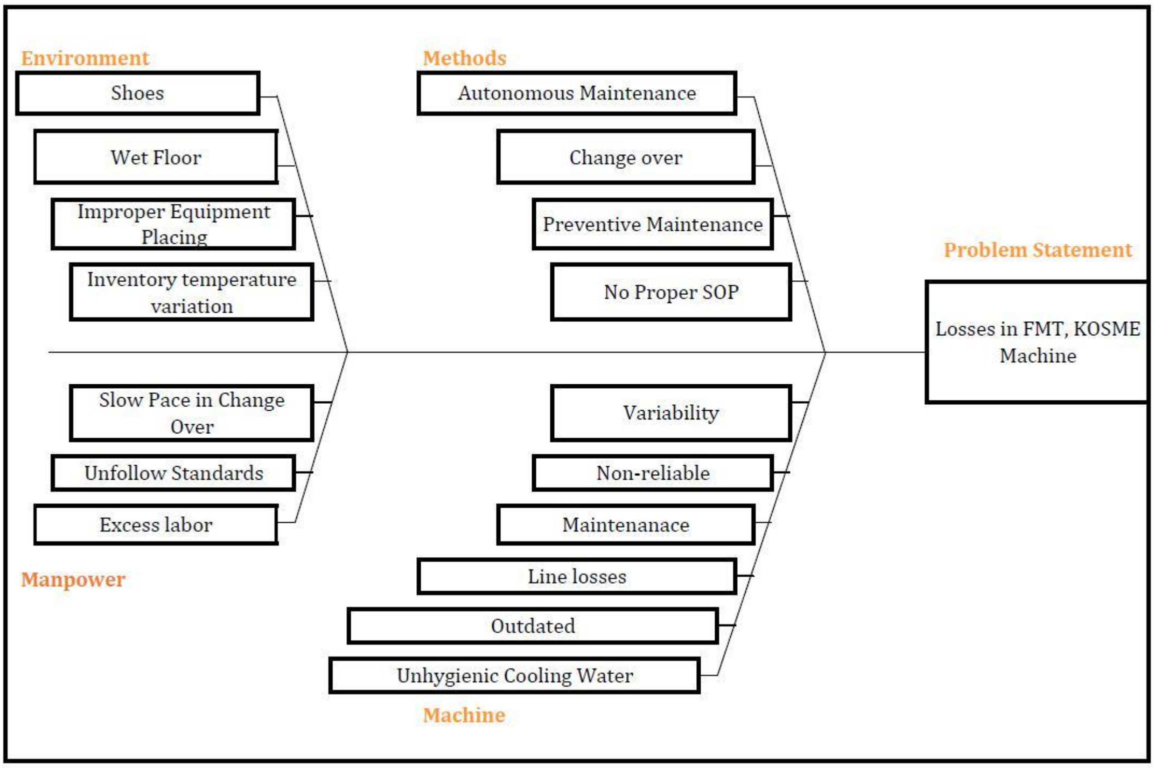


Figure 4.3: Cause and Effect analysis of Paste Plant.

4.4 PARETO ANALYSIS OF PASTE PLANT

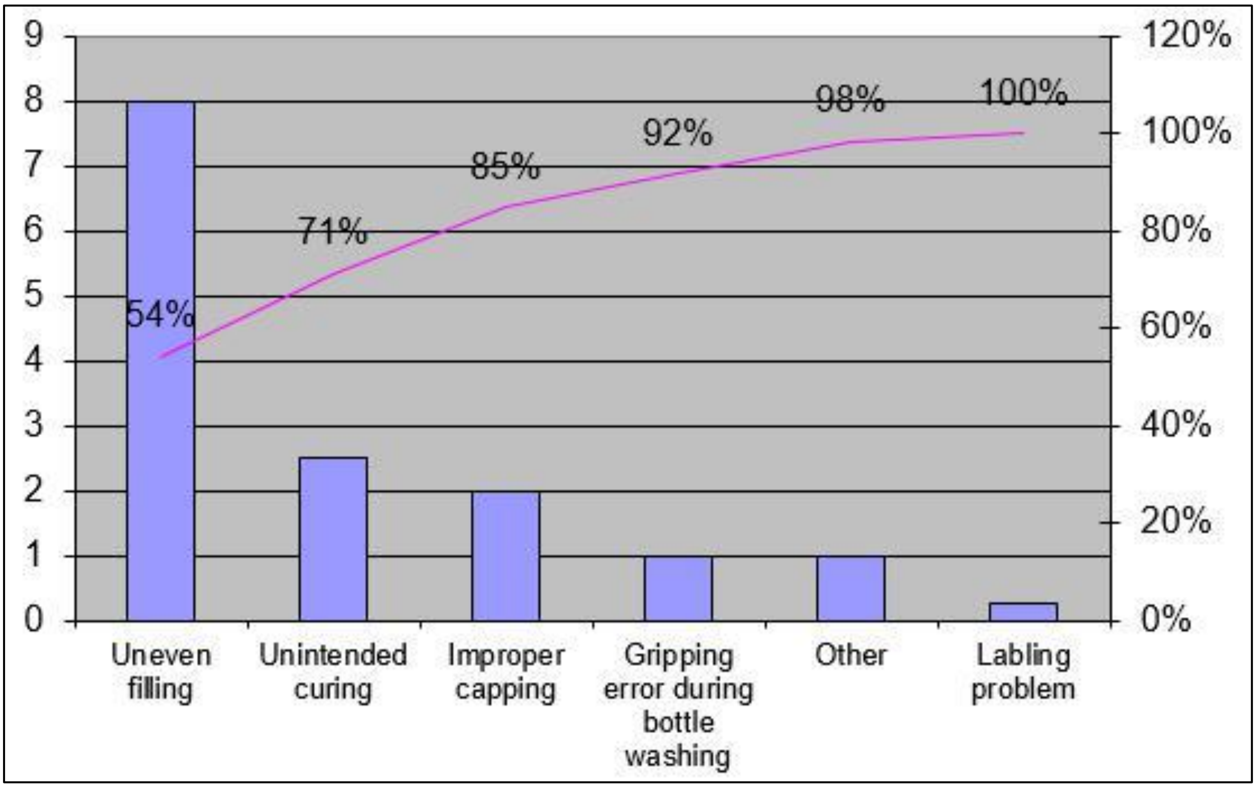


Figure 4.4: Pareto analysis of Paste Plant

Pareto analysis of paste plant shows that three causes are the vital few problems that are affecting 80% of total production. Namely these problems are:

1. Uneven filling in the Filling Machine
2. Unintended or undesired curing in the Pasteurization machine.
3. Improper capping in Capping machine.

The description of problem, defect rates and the possible solution to these problems in discussed in the following paragraphs.

4.5 MAJOR AREAS OF CONCERN:

After going through each process, we observe losses at different locations.

4.5.1 Filling Machine:

The major loss at this stage is due to following reasons:

- The filling valves is not properly working as it overfills and sometimes under fills the bottles every time.
- Some material comes out of the bottles due to transfer from filling base (circular motion) to conveyor belt.
- Piston are not adjusted properly due to wear and tear of piston assembly.

4.5.2 Capping Machine:

The major loss at this stage is due to following reason:

- The belt tension of the machine is not right due to which the bottles goes uncapped and because of which it requires continuous monitoring by the worker who must cap the bottle manually.
- The maintenance team is unable to establish a suitable Preventive maintenance plan. The decision of capping belt replacement is based on visual condition of belt rather than number of bottles capped.
- The belts used to tighten the caps is wears out.

4.5.3 Pasteurization Machine:

The major loss at this stage is due to following reason:

The conveyor from the Capping to Pasteurization Machine has a major turn at the inlet. Due to variation in speeds of both conveyors, the greater process time of Pasteurization machine and inappropriate transfer on bottles from conveyor to Pasteurization machine form a cluster of bottles at the start causing the bottles to fall and didn't cure(settle) properly as required by the process. Therefore, it must be either reworked or sometimes got wasted (depends on the product)

4.6 FAILURE MODE AND EFFECT ANALYSIS OF PASTE PLANT (FMEA):

4.6.1 Definition:

Failure Modes and Effects Analysis (FMEA) is a proactive and systematic method for evaluating a process to identify the root cause and which place the failure occurs and the reasons behind it which help to identify the parts of the process that are most in need of change. FMEA includes review of the following:

- Steps in the process
- Modes (What could go wrong in the whole process?)
- Causes (Actual reason/ Why would the failure happen?)

- Effects (Overall effect or each failure effect/ What would be the consequences of each failure?)

Different teams uses FMEA to evaluate processes for all kind of possible failures and to prevent them by sensing it first i.e. rectifying the processes proactively rather than reacting to events after failures have occurred. This counter method usually reduce risk of harm to the component. It is also useful in the evaluation of a new process prior to implementation and to visualize a proposed change to an existing process.

4.6.2 Benefits of FMEA

FMEA has a concept to assist the organization to improve the quality and reliability of design of the component/process. Using FMEA with perfection provides the organization several benefits. E.g;

- Improvement in product/process reliability and quality
- Increasing customer satisfaction
- Early identification and a chance of elimination of potential product/process failure modes
- Prioritization of product/process deficiencies
- Capture engineering knowledge
- Emphasizes all sorts of problem prevention
- Actions taken to reduce risk
- Provide more focus for improved testing and development
- Reduce late changes and associated cost
- Motivation for teamwork and idea exchange between functions

4.6.3 FMEA OF PASTE PLANT:

lean six sigma academy

Failure Modes Effects Analysis

Process or Product Name:	PASTE PLANT F.M.E.A
Process Owner:	N.F.P

Prepared by:	GROUP NO 3
FMEA Date (Orig):	10-Nov-16

Key Process Step or Input	Potential Failure Mode	Potential Failure Effects	Potential Causes	Current Controls	Actions Recommended	Resp.	Actions Taken
What is the Process Step or Input?	*In what ways can the Process Step or Input fail?*	*What is the impact?*	*What causes the Key Input to go wrong?*	*What are the existing controls and procedures that prevent either the Cause or the Failure Mode?*	*What are the actions for reducing the occurrence of the cause, or improving detection?*	*Who is Responsible for the recommended action?*	*Note the actions taken*
Washing of bottles	Bottles falls on ground	Line disbalance	The machine sometimes stops to handle the bottles	No current control	Proper shape and with proper feed rate should provide to the machine	The management staff	Machine belts sides have been made adjustable
Filling of bottles	Bottles over and under filled	Filling under/above the desired tollerence limit	Piston that fills the bottles causing problem	Piston part replacement	Whole pistons should be replaced	Management and Maintanence staff	Few pistons have been replaced
Capping of bottles	Bottles send without capping	Wastage of material inside bottles	Belt that tight the caps is loose	Belt tension increase	New belt replacement	Management and Maintanence staff	Belt has been replaced
Pasteurizer	Bottles falls inside the machine	Line disbalance	Clusturing of bottles at begining of Pasteurizing channel	No measures have been taken so far	Proper delivery of bottles to Pasteurizer shall be made possible	Management staff	No action taken so far
Rework on material	Finished product was not up to mark	Rework cost and time wastage	Treating with material improperly	No measures have been taken so far	Revising the Bill of Materials	Management staff	No action taken so far because inventory space is limited

Figure 4.5: F.M.E.A Analysis

4.7 PERCENTAGE WASTE (PRODUCT WISE):

After studying the production sheet, we calculate the average percentage variance of different products produced in paste plant along with loss in cost and control charts are given below:

Table 4.1: Orange Marmalade Loss Calculation

ORANGE MARMALADE						
MONTH	CONSUMED QUANTITY (KG)	REQUIRED QUANTITY (KG)	DIFFERENCE	VARIENCE %	MANUFACTURING COST PER KG (RS)	LOSS (RS)
15-Jul	43924.68	42055.2	1869.48	4.445300462	90.90909091	169952.727
15-Aug	5070.036	4087.2	982.836	24.04668233	90.90909091	89348.7273
15-Sep	12349.2	9345.12	3004.08	32.14597565	90.90909091	273098.182
15-Oct	18639.524	17166.722	1472.802	8.579401472	90.90909091	133891.091
15-Nov	25174.8	22992.482	2182.318	9.491441594	90.90909091	198392.545
15-Dec	18754.9	17138.88	1616.02	9.428970855	90.90909091	146910.909
16-Jan	15400	14447.04	952.96	6.596230093	90.90909091	86632.7273
16-Feb	16256.28	15421.921	834.359	5.41021446	90.90909091	75850.8182
16-Mar	36442.52	34362.721	2079.799	6.052486356	90.90909091	189072.636
16-Apr	19561.52	18902.4	659.12	3.486964618	90.90909091	59920
16-May	25195.92	23871.36	1324.56	5.548741253	90.90909091	120414.545
16-Jun	18492.56	17021.76	1470.8	8.640704604	90.90909091	133709.091
AVERAGE	21271.82833	19734.4005	1537.42783	10.32275948	90.90909091	139766.167

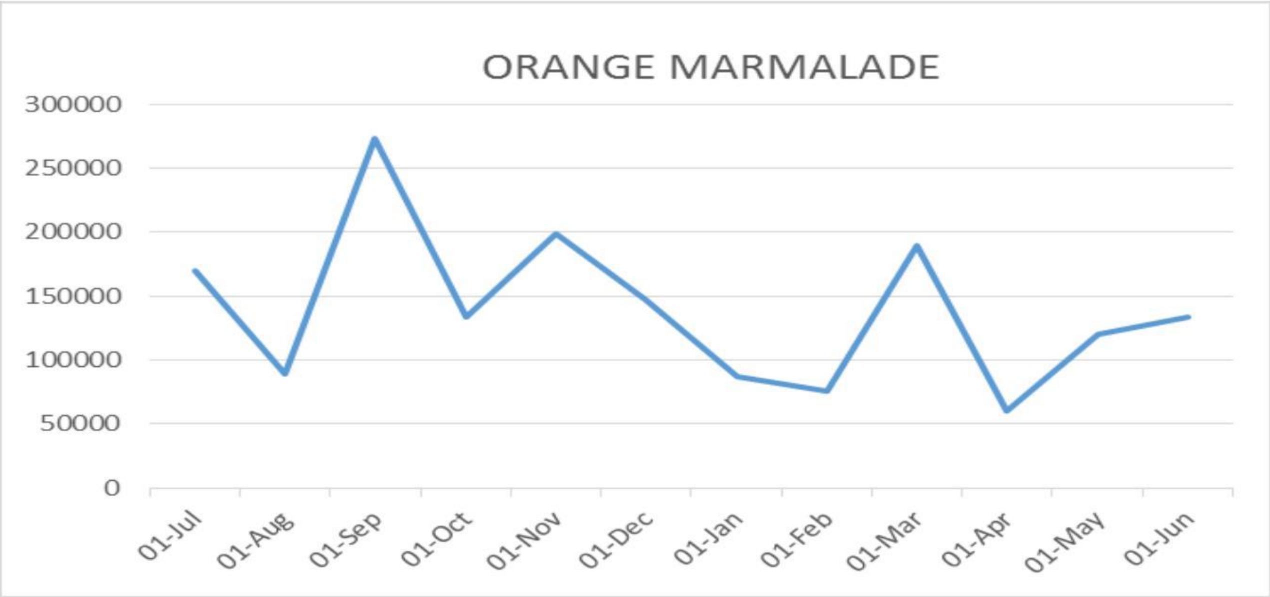


Figure 4.6: Graphical representation of Orange Marmalade 440g loss, (Loss in Rupees vs Month)

Table 4.2: Strawberry Jam 440g Loss Calculation

STRAWBERRY JAM 440g X 12						
MONTH	COMSUMED QUANTITY (KG)	REQUIRED QUANTITY (KG)	DIFFERENCE	VARIENCE %	MANUFACTURING COST PER KG (RS)	LOSS (RS)
01-Jul	**23,212**	**21,944**	1,268	5.78061656	90.90909091	115,316.36
01-Aug	3060.88	2698.08	363	13.44659906	90.90909091	32,981.82
01-Sep	10366.32	9620.16	746	7.756211955	90.90909091	67,832.73
01-Oct	12758.4	11705.76	1,053	8.992496002	90.90909091	95,694.55
01-Nov	17129.36	15438.72	1,691	10.95064876	90.90909091	153,694.55
01-Dec	11417.12	11563.2	(146)	-1.26331811	90.90909091	(13,280.00)
01-Jan	10568.8	10032	537	5.350877193	90.90909091	48,800.00
01-Feb	4181.76	3991.68	190	4.761904762	90.90909091	17,280.00
01-Mar	27049.44	26489.76	560	2.112816424	90.90909091	50,880.00
01-Apr	16500	16294.08	206	1.263771873	90.90909091	18,720.00
01-May	10450	9963.36	487	4.884296061	90.90909091	44,240.00
01-Jun	11550	11520.96	29	0.252062328	90.90909091	2,640.00
AVERAGE	**13,187**	**12,605**	**582**	**5**	**90.90909091**	**52,900.00**

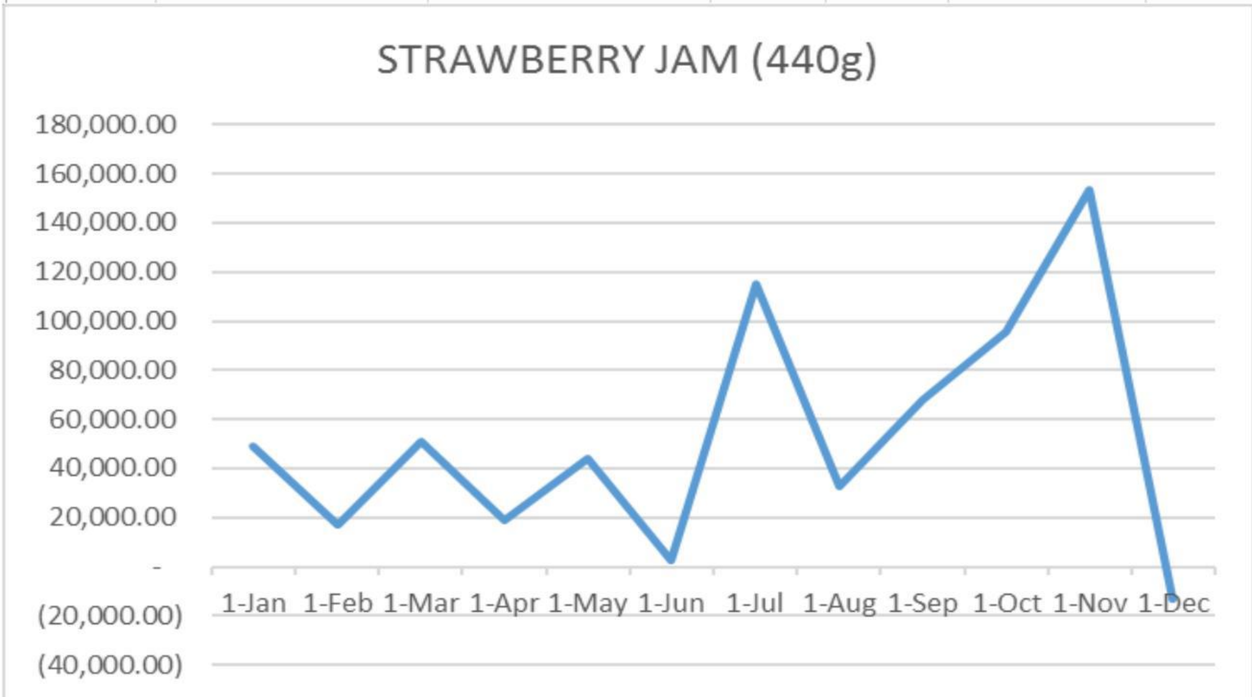


Figure 4.7: Graphical representation of Strawberry Jam 440g loss, (Loss in Rupees vs Month)

Table 4.3: Mixed Fruit Jam 200g Loss Calculation

Mixed Fruit Jam (200g)						
Month(2016)	Required Quantity (Kg)	Consumed Quantity(Kg)	Difference(Kg)	Variance %	MANUFACTURING COST PER KG (RS)	LOSS (RS)
January	12,288	12,370	*82*	0.67%	70.90909091	5814.54545
February	-	-	-	-	70.90909091	0
March	28,579	30,250	*1,671*	5.85%	70.90909091	118489.091
April	14,933	15,400	*467*	3.12%	70.90909091	33114.5455
May	-	-	-	-	70.90909091	0
June	16,392	16,520	*128*	0.78%	70.90909091	9076.36364
AVERAGE	18,048	18,635	587	0	71	41,624

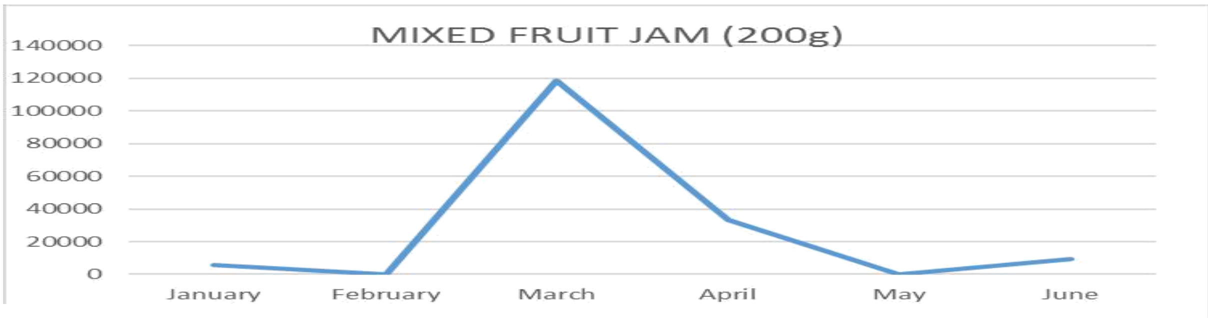


Figure 4.8: Graphical representation of Mixed fruit Jam (200g) loss, (*Loss in Rupees vs*

Table 4.4: Mixed Fruit Jam 400g Loss Calculation

Mixed Fruit Jam (440g)						
Month(2016)	Required Quantity (Kg)	Consumed Quantity(Kg)	Difference(Kg)	Variance %	MANUFACTURING COST PER KG (RS)	LOSS (RS)
January	31,115	32,320	*1,205*	3.87%	70.90909091	85445.4545
February	38,396	38,396	*0*	0%	70.90909091	0
March	106,339	110,855	*4,516*	4.24%	70.90909091	320225.455
April	31,136	28,600	*-2,536*	-8.14%	70.90909091	-179825.455
May	63,334	63,928	*595*	0.94%	70.90909091	42190.9091
June	30,936	32,449	*1,514*	4.89%	70.90909091	107356.364
AVERAGE	50,209	51,091	882	0	71	62,565

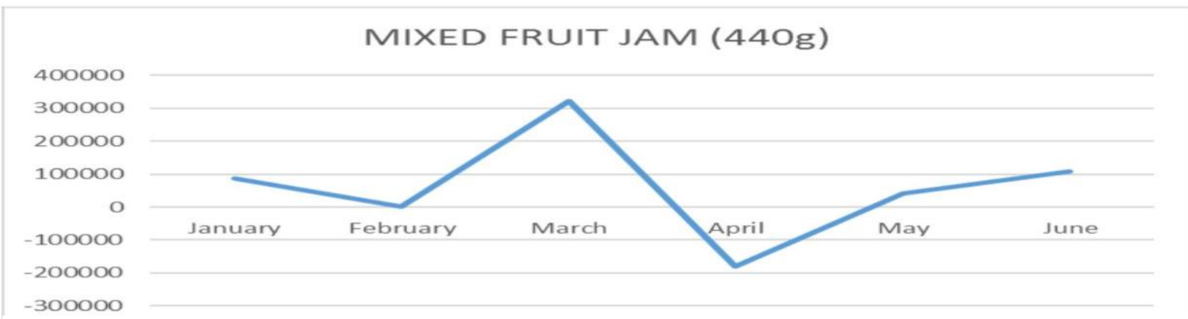


Figure 4.9: Graphical representation of Mixed fruit Jam (440g) loss, (*Loss in Rupees vs Month)*

Mango Jam (200g)						
Month(2016)	Required Quantity (Kg)	Consumed Quantity(Kg)	Difference(Kg)	Variance %	MANUFACTURING COST PER KG (RS)	LOSS (RS)
January	10,963	11,000	*37*	0.34%	83.63636364	3094.54545
February	10,517	10,570	*53*	0.50%	83.63636364	4432.72727
March	15,346	15,400	*54*	0.35%	83.63636364	4516.36364
April	31,838	30,800	*-1,038*	-3.26%	83.63636364	-86814.5455
May	0	0	*0*	0	83.63636364	0
June	23,078	22,550	*-528*	-2.29%	83.63636364	-44160
AVERAGE	**18,348**	**18,064**	**-284**	**0**	**84**	**-23,786**

Table 4.5: Mango Jam 200g Loss Calculation

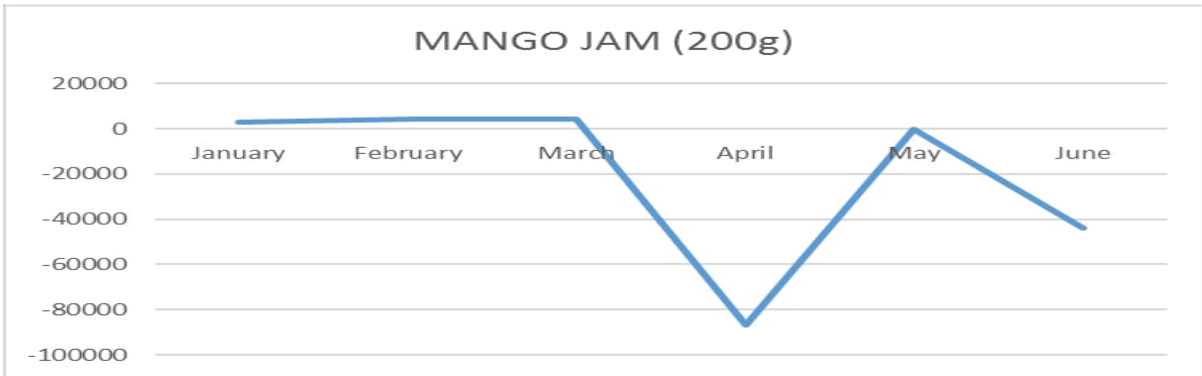


Figure 4.10: Graphical representation of Mango Jam (200g) loss, (Loss in Rupees vs Month)

Table 4.6: Mango Jam 400g Loss Calculation

Mango Jam (440g)						
Month(2016)	Required Quantity (Kg)	Consumed Quantity(Kg)	Difference(Kg)	Variance %	MANUFACTURING COST PER KG (RS)	LOSS (RS)
January	58,751	57,794	*-957*	-1.63%	83.63636364	-80040
February	72,199	71,284	*-914*	-1.27%	83.63636364	-76443.6364
March	69,025	66,101	*-2,924*	-4.23%	83.63636364	-244552.727
April	99,121	96,474	*-2,648*	-2.67%	83.63636364	-221469.091
May	34,014	33,000	*-1,014*	-2.98%	83.63636364	-84807.2727
June	49,416	48,206	*-1,210*	-2.44%	83.63636364	-101200
AVERAGE	**63,754**	**62,143**	**-1,611**	**0**	**84**	**-134,752**

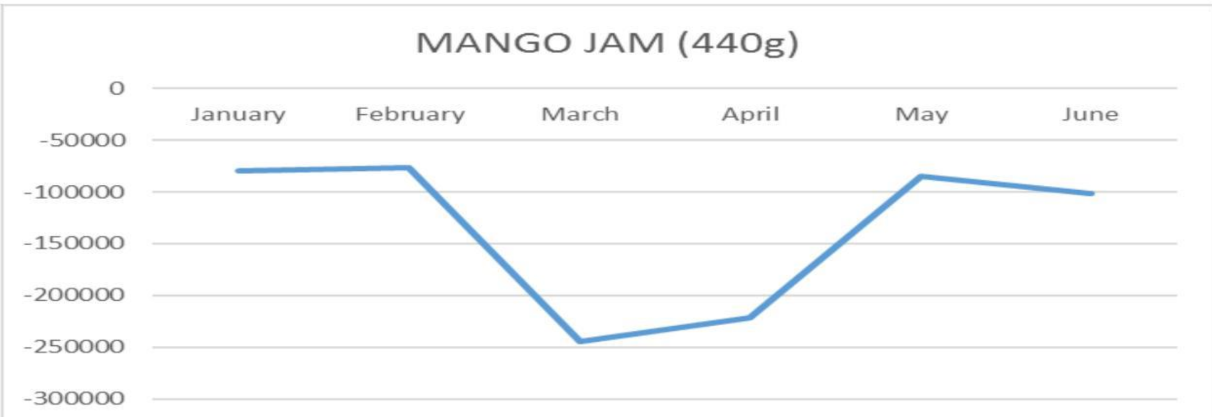


Figure 4.11: Graphical representation of Mango Jam (440g) loss, (Loss in Rupees vs Month)

Apple Jam (200g)						
Month(2016)	Required Quantity (Kg)	Consumed Quantity(Kg)	Difference(Kg)	Variance %	MANUFACTURING COST PER KG (RS)	LOSS (RS)
January	-	-	-	-		0
February	21,902	23,100	*1,198*	5.46%	60	71880
March	11,405	11,864	*459*	4.03%	60	27540
April	21,998	23,100	*1,102*	5.00%	60	66120
May	-	-	-	-	0	0
June	7,181	7,206	*25*	0.34%	60	1500
AVERAGE	15,622	16,318	696	0	60	41,760

Table 4.7: Apple Jam 200g Loss Calculation

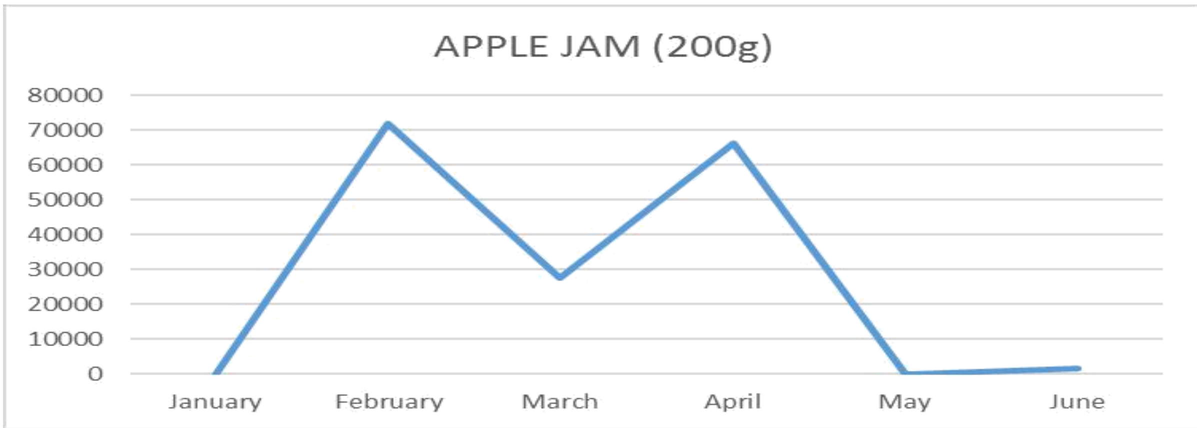


Figure 4.12: Graphical representation of Apple Jam (200g) loss, (Loss in Rupees vs Month)

Apple Jam (440g)						
Month(2016)	Required Quantity (Kg)	Consumed Quantity(Kg)	Difference(Kg)	Variance %	MANUFACTURING COST PER KG (RS)	LOSS (RS)
January	17,936	18,721	*785*	4.37%	60	47100
February	52,462	55,136	*2,673*	5.09%	60	160380
March	10,634	10,855	*221*	2.07%	60	13260
April	72,827	74,745	*1,917*	2.63%	60	115020
May	32,187	33,060	*873*	2.71%	60	52380
June	45,735	48,160	*2,425*	5.30%	60	145500
AVERAGE	38,630	40,113	1,482	0	60	88,940

Table 4.8: Apple jam 440g loss calculation

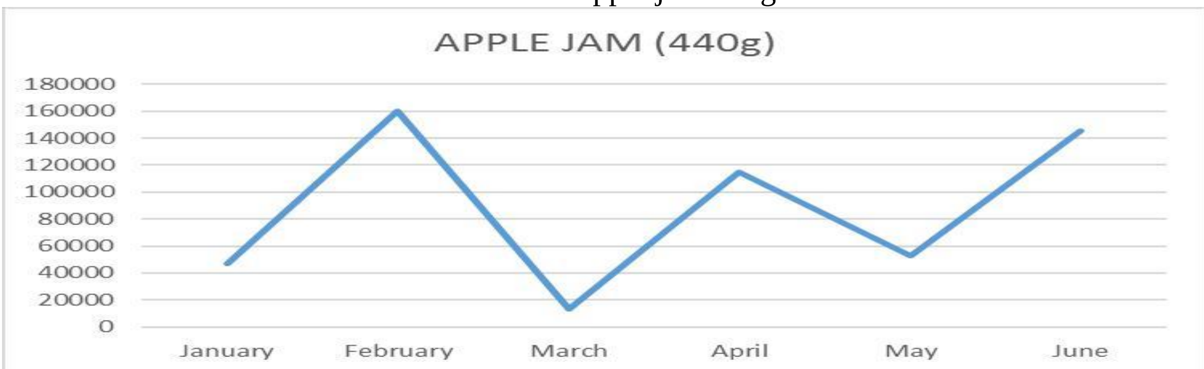


Figure 4.13: Graphical representation of Apple Jam (440g) loss, (Loss in Rupees vs Month

Table 4.9: Apple Jelly 440g Loss Calculation

Apple Jelly (440g)						
Month(2016)	Required Quantity (Kg)	Consumed Quantity(Kg)	Difference(Kg)	Variance %	MANUFACTURING COST PER KG (RS)	LOSS (RS)
January	9,097	9,900	***803***	8.82%	90.90909091	73000
February	792	792	***0***	0%	90.90909091	0
March	17,424	17,903	***479***	2.74%	90.90909091	43545.4545
April	1,373	1,373	***0***	0%	90.90909091	0
May	15,022	15,400	***378***	2.51%	90.90909091	34363.6364
June	2,529	2,710	***181***	7.13%	90.90909091	16454.5455
AVERAGE	**7,706**	**8,013**	**307**	**0**	**91**	**27,894**

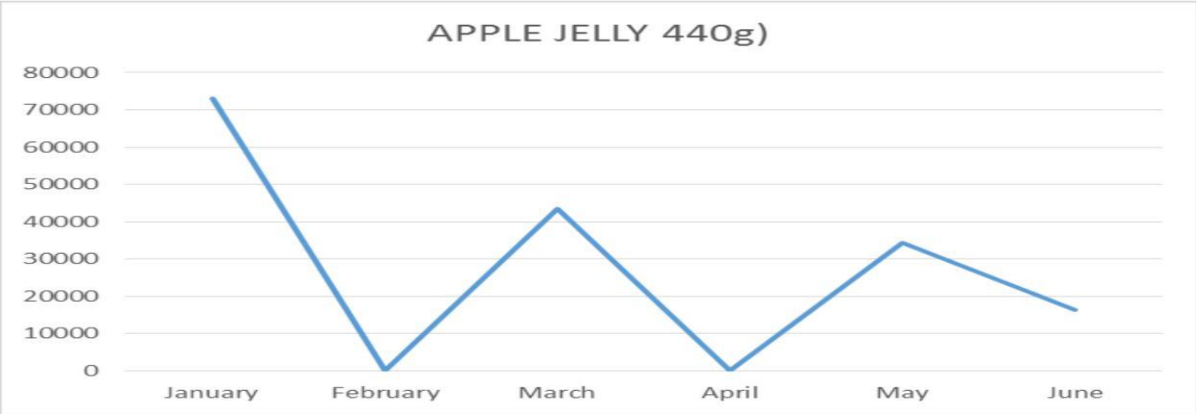


Figure 4.14: Graphical representation of Apple Jelly (440g) loss, (Loss in Rupees vs Month)

Table 4.10: Apple Jelly 200g Loss Calculation

Apple Jelly (200g)						
Month(2016)	Required Quantity (Kg)	Consumed Quantity(Kg)	Difference(Kg)	Variance %	MANUFACTURING COST PER KG (RS)	LOSS (RS)
January	1,968	2,200	***232***	11.78%	90.90909091	21090.9091
February	-	-	-	-	90.90909091	0
March	2,746	2,888	***142***	5.16%	90.90909091	12909.0909
April	2,866	2,888	***22***	0.76%	90.90909091	2000
May	2,645	2,950	***305***	11.53%	90.90909091	27727.2727
June	470	550	***80***	16.92%	90.90909091	7272.72727
AVERAGE	**2,139**	**2,295**	**156**	**0**	**91**	**14,200**

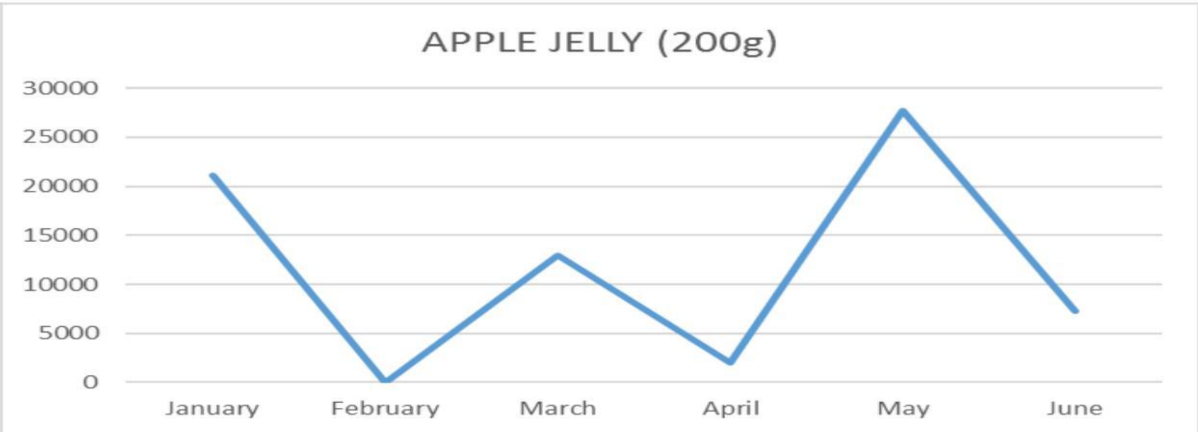


Figure 4.14: Graphical representation of Apple Jelly (200g) loss, (Loss in Rupees vs Month)

Summary:

S.NO	Products	Variance
1	Strawberry Jam (440g)	3.10 %
2	Orange Marmalade (440g)	5.95 %
3	Mix Fruit Jam (200g)	2.61 %
4	Mix Fruit Jam (440g)	0.96 %
5	Mango Jam (200g)	-0.87 %
6	Mango Jam (440g)	-2.53 %
7	Apple Jam (200g)	3.70 %
8	Apple Jam (440g)	3.69 %
9	Apple Jelly (200g)	9.23 %
10	Apple Jelly (440g)	3.53 %

Table 4.11 Defect rates of all Jam products.

As shown two products i.e. Apple Jelly (200g) and Orange Marmalade (400g) are the major bottleneck products and two products i.e. Mango Jam (200g) and Mango Jam (440g) requires upgradation in its BOM (Bill of material).

4.8 DEFECT RATES (PROCESS WISE):

From this observation, we calculated the possible defect rates of Filling, Capping and Pasteurization machines the major areas of concern (as discussed earlier).

4.8.1 Filling Machine:

There are two types of losses occurred at this machine:

i. An average of 15g per 12 bottles due to transfer from filling base to conveyor belt.[12]

ii. An average of 6g overfilled due valve no. 7 beyond the tolerance level of the firm. Production Rate of the Plant = 74 bottles/min.

Per hour Production (in Kilograms) = 74 × 60 × 0.440 (for 440g bottles)

Per hour Production (in Kilograms) = 1953.6 kg/hr.

(i) Waste in 12 bottles inside the machine = 15g

[12] Calculated by time motion study

- Waste in 1 bottle inside the machine = $\left(\frac{5}{12}\right)$

  Waste in 1 bottle inside the machine = 1.25 g/hr

- Production (in terms of bottles) = 74 × 60

  Per hour production (in terms of bottles) = 4440 bottles/hr.

- Waste per hour = 4440 × 1.25 Waste per hour = 5550g

  Waste per hour = 5.55 kg/hr.

  Waste per day[13] = 5.55 kg/hr × 22

  = 122.1 kg/day.

- One batch cost around **Rs. 50,000 for 550 kg. (Average)**

  Therefore, cost of manufacturing = $\left(\frac{50000}{550}\right)$

  = 90.90 Rs/kg.

- In terms of money the loss is = 122.1 kg/day × 90.90 Rs /kg

  = 11098.89 Rs /day

Total Loss in filling Machine

=11098.89 Rs /day or 85.37 €/day

(ii) Waste due to overfilling (outside the company's tolerance) = 6g

- No. of bottles over weight in 1 minute = $\left(\frac{74}{12}\right)$

  = 6 (approx.)

- Waste per hour = 6 × 6 × 60

  = 2160 g/hr.

  Waste per hour = 2.16 kg/hr.

[13] Two shift of 12 hours each with one-hour lunch/dinner time

- The defect rate at filling machine would be;

  = 5.55 + 2.16

  Defect Rate = 7.71 kg/hr.

4.8.2 Capping Machine:

On average 54 bottles were found uncapped. So, the defect rate at capping machine would be;

$$\text{Defect Rate} = \frac{\text{No. of bottles uncapped} * 100}{\text{Per hour Production}}$$

$$= \left(\frac{54 \times 100}{4440}\right)$$

Defect Rate = 1.2 %

4.8.3 Pasteurization Machine:

On average 80 bottles fell (per hour) in the machine due to it requires reworking.

So, the defect rate at pasteurization machine would be;

Time required for 1 bottle = 22 minutes

No. of bottles fell (per hour) = 80

No. of bottles fell (Per 22 minutes) = $\left(\frac{80 \times 22}{60}\right)$

No. of bottles fell (per 22 minutes) = 29.33

No. of bottles processed (per 22 minutes) = 74 * 22

No. of bottles processed (per 22 minutes) = 1628 bottles

Defect Rate = No. of bottles fell (per 22 minutes) $*$ 100/ No. of bottles processed (per 22 minutes)

$Defect\ Rate = \left(\frac{29.33 \times 100}{1628}\right)$

Defect Rate = 2% (approx.)

CHAPTER 5

5.1 SOLUTIONS AND RECOMMENDATIONS:

5.1.1 SALT PLANT:

After the complete understanding of operating procedures and their limitation project members starts to search for different techniques that can eliminate/ reduce the current problem i.e. salt waste during its transport, storing and processing. There are several different methods which are being adopted worldwide for proper salt handing and processing, but each method has its own benefits as well as drawbacks, so it is necessary to have a close monitoring, study and good knowledge of the process. Following are the different recommendations for SALT PLANT.

5.1.1.1 Recommendations for Raw Material Waste:

5.1.1.1.1 PP Woven Bags With Metal Rings:

The most common and cost friendly material for handling and storage of any cheap substance is Polypropylene Woven Sacks.[14]

They are vastly available and typical woven structure help to store any crushed or powdered material. It is equipped with steel rings at the four edges to make it labor friendly and provide specific location to use steel hook to move or drag it without affecting bags physical quality. Following are some merits and demerits of using Polypropylene.

Figure 5.1: Traditional PP woven bag

[14] Polypropylene Woven sacks: A bag made up of polymer flexible container with single opening

Woven Sacks as a possible solution.

Merits:

- Specific place for worker to insert metal S-shaped hook for dragging.
- Require less space for storing than any other material.
- Labor friendly design. Easy to fill and refill.
- Flexible Bags for salt Handling.
- Can drain water from salt during transport (sea salt).
- Insert with salt water and suitable for edible material
- Suitable for transport, doesn't required any special arrangements or configuration in vehicle design.
- Ease in handling, no need of electrical machinery or overhead crane.
- Vastly available in market and less expensive than other bag materials.

Figure 5.2: Metal Rings that can be attached with PP woven bag

Demerits:

- Poor strength than any other material.
- Woven structure can be deforming and becomes porous quickly.
- Simple PP Woven bags are not suitable with the current handling procedures.
- Bags tend to rupture during dragging.
- Extremely common so can easily be mixed with any other company's bags. (as salt suppliers are common among many firms)
- Same as currently adopted bags.
- A Non-Engineering approach to solve problem.

5.1.1.1.2 Wooden Containers:

To get the maximum reliability in terms of container material the team worked on wooden boxes with flapped open top which will eliminate major handling and transportation wastages.

Figure 5.3: Wooden Box

Merits:

- Provide much larger storing capacity than single
- Polypropylene bag.
- Wood has a very high specific strength due to its low density and reasonable strength.

- Non-reactive with salt and doesn’t affect its quality.
- Wooden structure doesn’t allow salt waste during handling.
- Require less time in filling and processing.
- Can be easy in storing because of rigid structure.
- Wood is an environmentally friendly and non-toxic material.

Demerits:

- Extremely rigid structure that causes many difficulties in handling and transportation.
- Wood is dimensionally unsettled, as water changes its dimensions.
- Not labor friendly.
- strength decreases of wood when wet.
- Wood also time-dependent deformation such as creep and viscos-elasticity occur in it
- It is also much expensive than plastics.

5.1.1.1.3 Fabric/ Synthetic Polyester Bags:

Polyester is that class of polymers that have compounds of chemicals and contain naturally occurring chemicals. It is mainly used to produce synthetic products and clothing and can provide advantages over natural fabrics. To get the combination bags reliability and flexibility fabric bags are the one of which team members starts to focus on as they can be easily adopted and manufactured in local market.

Figure 5.4: Fabric bag

Merits:

- Fabric provides strength and flexibly that are the necessary requirements for best alternative.
- It recycles well and can be used over again.
- Less expensive material than wood.
- It is more stable than cotton or wool, and less likely to wrinkle.
- Easily available in local market.
- It can be blended with natural fibers as means of combining the best of both capabilities.
- Synthetic fibers are known for their strength and environmental resistance.
- Much easier handling, transport and storing than any other bag material.
- Easy to wash, mildew-resistant. Can be dried on low heat cycle but must be removed as soon as finished.

Demerits:

- Fabric will absorb the moisture content from sea salt which adds unnecessary weight to the bag.
- Fabric bag will deteriorate with the passage of time due to brine action (salt dissolved water)
- Difficulties in filling and emptying of bag because of no proper shape of bag.
- It tends to bond quickly with oil-based spills.
- Bags tend to rupture during dragging.

5.1.1.2 Open Salt Transport:

All the above mention techniques would require a considerable amount of capital, time and effort for filling salt in bags that could be done either manually or machine aid and then to load these bags in trucks, again this can be done either manually or by folk lifter and the last step to unload them at inventory or processing area. So, all these are no value added to costumers hence they can be eliminated or shorten not only to save money but also to improve production rate and reduce workers stress. One of the method that has been implemented worldwide is to adopt open transport of salt i.e. (to directly load raw salt form supplier to trucks) or any other transport medium that will eliminate the use of bags and the associated efforts during filling, handling, lifting and processing of salt. However, this method of salt handling is recommended to use where supplier/salt source and processing plant are nearby. Following are some merits and demerits of using Polypropylene Woven Sacks as a possible solution.

Figure 5.5: Loading of salt in open salt transport

Figure 5.6: Piles of Salt at salt source

Merits:

- A cost and time efficient possible alternative.
- Labor friendly and easy to adopt.
- No sophisticated machine and labor skills are required for proper utilization.

Demerits:

- Dependency of featured vehicle.
- Difficult to transport (due to different truck configuration).

- Salt quality will be affected during transport.
- Preferable where salt source and salt processing plant are near.

5.1.2 Purposed Solution For Raw Material Waste:

5.1.2.1 FIBC Bags:

A Flexible Intermediate Bulk Container (FIBC) are the big or bulk bags or super sack, created from flexible fabric that is made for storing and transporting of various kind of dry products, For example sand, fertilizer etc.

FIBC are mostly manufactured by thick woven polyethylene material which could be coated or uncoated, and normally having a diameter of 110 cm or 45-48 inches and from 100 cm up to 200 cm or 35 to 80 inches to vary in height. Its space is normally around 1000 kg or 2000 lbs, but the biggest units can store even more. A bulk bag designed to transport single metric ton of material has weight of itself around 5-7 kg.

Warehousing and handling is done on either pallets or by lifting it from its threads/loops. Bags are made with one or multiple lifting loops. The one loop bag is suitable for one worker operation as no other worker required to fit the loops on the loader hook. Emptying the bag is made simply by a designated opening in the bottom such as a clearance spout.

5.1.2.2 Types of FIBC's:

1. **Corner Loops**

- Flat fabric (U-panel or 4-panel) FIBC
- Lifting loops sewn to the vertical seams

Safe Working Load	**Safety Factor**	**Design**
300-2000 kg	5:1	Single Trip
300-1500 kg	6:1	Multi Trip
300-1500 kg	6:1	UN Dangerous Goods

Fig 5.8: Corner loop FIBC

2. **Cross Corner Loops**
   - Circular or flat fabric
   - Lifting loops sewn cross corner

Safe Working Load	**Safety Factor**	**Design**
300-1500 kg	5:1	Single Trip
300-1500 kg	6:1	Multi Trip
300-1500 kg	6:1	UN Dangerous Goods

Fig 5.9: Cross Corner Loop FIBC

3. **Tunnel Loop**
   - Flat Fabric
   - Lifting loops formed out of fabric

Safe Working Load	**Safety Factor**	**Design**
300-2000 kg	5:1	Single Trip
300-1500 kg	6:1	Multi Trip

5. 10: Tunnel Loop FIBC

Other classifications include:

- Single Trip: An FIBC created and expected to be used for one filling only.
- Multi Trip (standard duty re-usable): An FIBC made to be used for a number of fillings and discharges. This category of FIBC if damaged, cannot be re-used again, i.e, result is not repairable.
- UN Dangerous Goods: designed to ensure safe transport with all goods to remain safe and sound and ensure no dangerous materials

  The key features are:
- FIBC is a standard method for bulk storage.
- Polypropylene with UV treatment possesses high strength and reliability.
- Manufactures are available.
- Overall time and effort required is reduced.
- Maximum Payoff.
- Easily recyclable.
- Highly cost effective.
- Chemicals, pigments, starch, Food products etc

5.1.2.3 Demerits:

- Since FIBC has load capability in between ½ ton to 2 ton therefore its handling requires proper set (lifter, hoist) both from truck unloading to inventory and from inventory to conveyor pouring.
- There functionality is highly dependent on proper equipment and electrical power supply and skilled labor.

5.1.3 Approach for Implementing FIBC:

5.1.3.1 Reason for Using FIBC over PP Bag:

Big bags are most commonly produced of woven polypropylene which is polymer is deteriorate by sunlight over time. This degradation process results the fabric to damage when exposed to strain and ultimately increase the danger for the product and handling worker. By adopting the UV stabilizers in the polymer and the applying standard handling of FIBCs, the risk of photochemical damage can be drop down to a negligible or at minimum level. However, FIBCs are covered or stored away from the sunlight during usage, transport and storage.

5.1.3.2 FIBC Bag Dimension:

After examining the dimensions and salt carrying capacities of commonly available FIBC bags the team member calculated the desired shape and dimensions of customized PIBC bag, that satisfied both the required quantity of salt needed on daily basis for producing and that can be transported by available trucks.

Length of bag = 30inch or 2.5ft

Breath of bag = 30inch or 2.5ft

Height of bag = 27inch or 2.25ft

By following these dimensions, the customized manufactured bag will have the capacity to carry 500Kg of salt without any risk of desired quantity or accident during lifting.

5.1.3.3 Manufacturer Finding:

After the project member have decided to change the bags using for filling and storing the major concern is finding he suitable manufacturer and supplier with reliable quality and most cost efficient. We search for various local industries and markets for the sake of reliable producer of bags but in Pakistan only few organization work on FIBC bags and limited configuration of bags are available locally. One of the local organization whom team members contact and ordered for sample bag is “GRIEF PAKISTAN”. For better quality and desired shape and dimension of bags we contact with many international supplier who have expertise in manufacturing FIBC bags. “SUNO INTERNATIONAL” an international manufacturer for FIBC bags, Headquarters in

China, offers many different sizes and configuration of bags and team members also import some bags and tested for the quality and strength.

5.1.3.4 Filling and Loading At Supplier End:

Currently the 50 Kg bags are pre-filled and as the order receive form any organization the workers at Khepro or Dhabeji manually lift the bags on their shoulders and back and store them in truck for transportation. But after shifting from 50 kg bags to FIBC 500 Kg bags, the working procedures and step chances alto gather. Being almost 10 times heavier from the current bags it is impossible for workers to lift the bag manually and place them in truck for supply. To address this problem the we propose that the FIBC Ton bags must be placed in truck in empty condition and then by using any appropriate container workers fill the bags. One key technique that is very necessary to adopt is that bags must be place in stairs form, so that worker find it easy and most time efficient to fill the bag with least effort to carry container having salt to be injected in FIBC bags.

5.1.3.5 Truck Dimension:

Many different sizes of trucks and Lorries being used with various configurations (with side walls and Flapped back gate), However majority of the trucks are almost same in dimension. The trucks required for FIBC bag must be of following dimension.

Size of FIBC = 30in x 30in x 27in

Capacity of single FIBC = 470 Kg (Approx.)

Area of Truck = 46ft x 10ft

Size of 1 Pallet = 5ft x 5ft

1 Pallet can carry = 4 FIBC

No. of Pallets in single row = length of truck/ length of pallet = $\left(\frac{46}{5}\right)$= 9 approx.

No. of Pallets in a single column = width of truck/ width of pallet = $\left(\frac{10}{5}\right)$ = 2

No. of Pallets in one level = no. of Pallets in single row x no. of Pallets in a single column

= 9 x 2

= 18 pallets/ level.

Current truck holds = 1600 bags x 40 kg

= 64,000 kg

Single level of pallets can hold = 18 pallets x 4FIBC/pallet x 470 kg/FIBC

$$= 33{,}840 \text{ kg}$$

No. of levels required = Current Truck load / amount per level in kg

$$= \left(\frac{64000}{33840}\right)$$

= 2 levels

No. of pallets required = No. of pallets in one level x No. of levels

=18 * 2

=36 pallets.

Total height of truck (to be used) = (height of 2 FIBC bags) + (height of 2 pallets)

= (2 * 2.3) + (2 * 0.75)

= 6.1ft

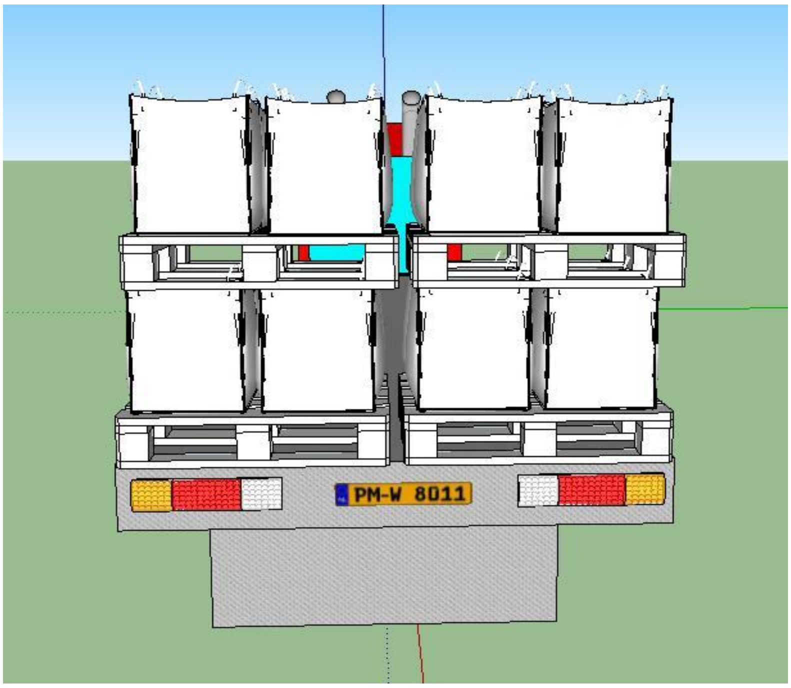


Figure 5.11(a): Number of Levels of FIBC on Truck

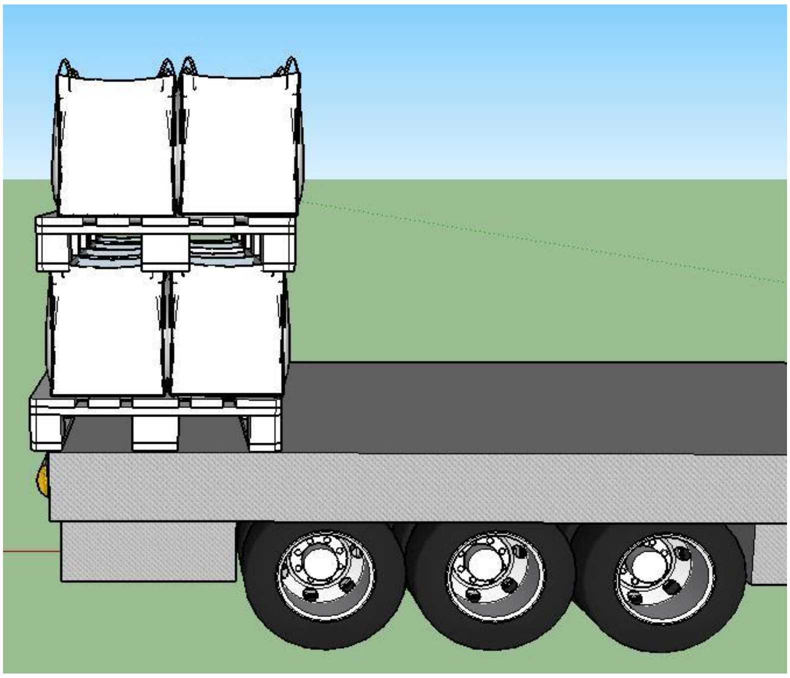


Figure 5.11(b): Number of Levels of FIBC on Truck

5.1.3.6 Unloading and Storing At National Foods Inventory:

The same procedure was followed by National Foods that is workers handled the bags on their shoulders and carry them to inventory. Obviously for FIBC bags it's impossible, for lifting from truck 2 Ton lifter can be used for quick and safe handling and temporarily place them on gate as an initial step, Now, from here till inventory assembly of overhead crane is proposed which will lift bags from gate to inventory with satisfactory of handling and almost eliminate salt waste during handling. Moreover, Overhead crane assembly also aid in processing salt with best efficiency regarding waste during handling till feeding conveyor belt.

5.1.3.7 Inventory Dimension:

Dimension of inventory = 25 x 15 x 144

$$= \left(\frac{54000}{30\times30}\right) = 60 \text{ bags}$$

Height of roof = 12 x 12/27 = 5.33 bags

The inventory portion of National food having two portions,

Bags contain in one portion = 60 x 5 = 300 bags

Entire inventory will contain = 300 x 2 = 600 bags

5.1.4 Purposed Solution for In Process Salt Waste:

To overcome salt waste during processing two strategies can be applied.

1. One possible way is to alter the salt concentration in brine solution which will reduce the further salt dissolution during washing and processing.
2. If alteration in brine solution in not desirable or can affect the salt properties after processing another way to encounter salt waste concern to washing is to reprocesses the brine solution instead to dispose it to garbage. Processing may involve any of the heating or evaporation operation that will evaporate water or any moisture content so that major portion of dissolved salt may be recover.

5.1.5 Solution Implementation Strategy:

The solution mentioned above can be implemented by a three step by step process.

5.1.5.1 Material Unloading at the gate

The 500 Kg FIBC bags can be unloaded directly on storing location or can be unloaded on a dolly cart with the help of fork lifter.

Challenge: To find a suitable FIBC bag manufacturer. Moreover, worker should be trained enough to operate the lifter and finally the stacking must be done according to an appropriate plan.

Equipment Required: FIBC bags, Fork lifter and Dolly cart.

Cost: Earlier to predict

5.1.5.2 Bags to storage

The FIBC bags can be lifted and placed on the desired location with the help of two hoists, one for each section.

Challenge: To find suitable supplier and technical team for hoist installation.

Equipment Required: Two hoists

Cost: Earlier to predict

5.1.5.3 Bags from store to conveyor for pouring

Bags can be lifted and unfilled on an extruded Hopper, attached with the conveyor with the help of hoist.

Challenge: To align the bag & Hopper and to control the feed rate.

Equipment Required: Industrial Hopper.

Cost: Earlier to predict.

5.1.5.4 Loss during conveyor roll back

A major amount of salt is wasted when the conveyor transfers the salt to crusher and travels rearward. This happens due to the presence of 1-inch opening between belt and conveyor bed. Salt sticks with the belt and travels with it during its return.

Solution:

A rubber strip can be fitted at the end of the conveyer which will reduce the gap between belt and crusher plate that increases the belt friction which will prevent major amount of salt waste.

5.1.6 Recommended Solution for FIBC lifting and storage:

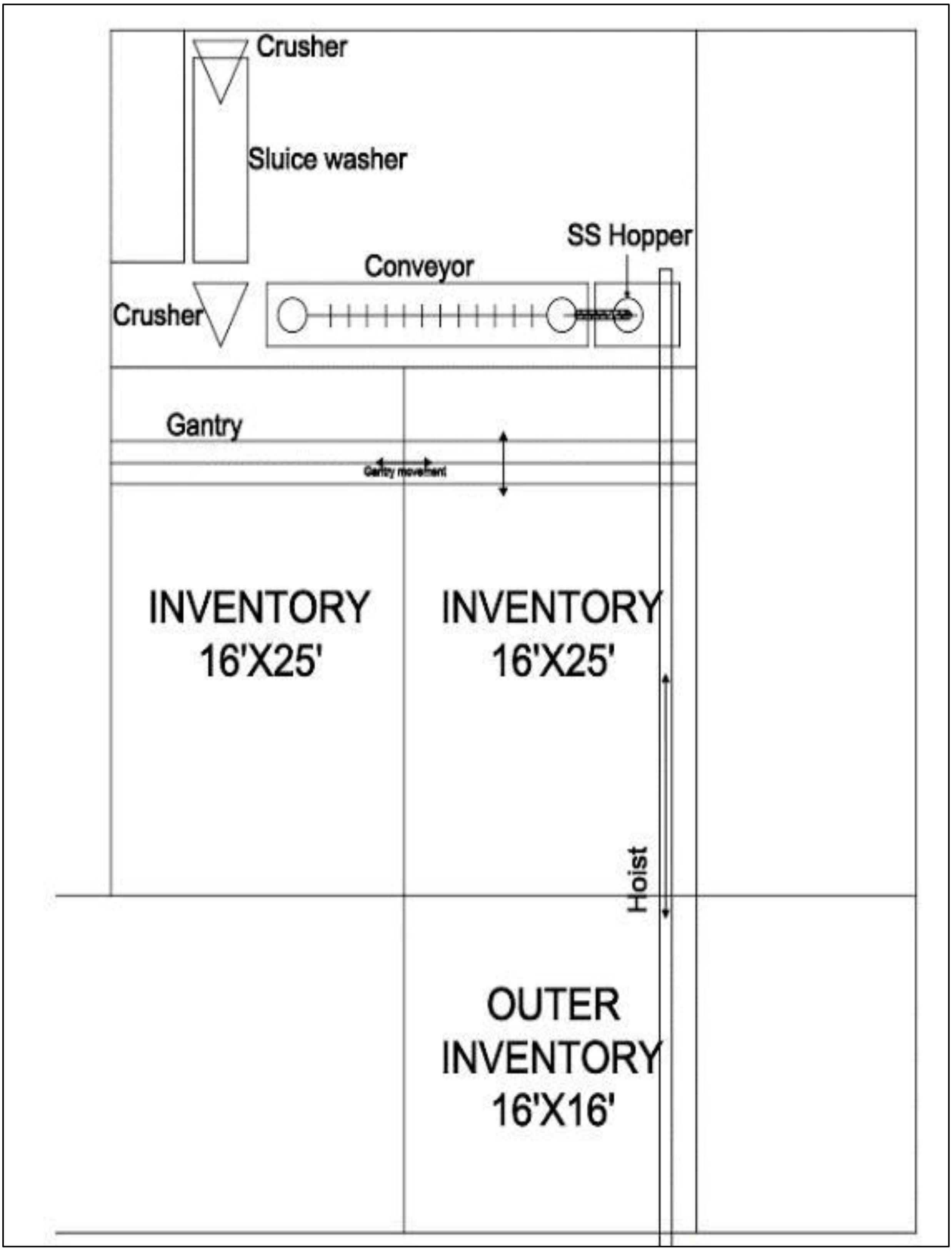


Fig 5.12: Recommended Solution for FIBC lifting and storage layout

5.1.7 Cost Approximation (Payback Period):

According to the data provided and based on our calculation following cost and payback period can be predicted.

- Inventory capacity = 300000 Kg
- FIBC bag capacity = 500 Kg
- Number of bags required = 600
- Cost of Single FIBC bag = Rs. 370

Cost for 600 FIBC bags= 600 x 370

= Rs 222000 or 1707.7 €

- Number of bags unloaded = (1600 × 2) = 3200 bags
- Wage of labor per bag= Rs. 2.5/bag or 0,019 €

Wages of Labor per day = (1600 x 2) x 2.5

= Rs 8000 or 61.53 €

- Hoist Cost = Rs.323,000 or 2484.61 €
- Steel Pallets = Rs.45,600 or 350.76 €
- Support frame = Rs.118,800 or 913.84 €
- Gantry crane = Rs.355,000 or 2730.76 €
- Support frame = Rs.154,000 or 1184.61 €
- Hopper = Rs.37,500 or 288.46 €
- Gear box = Rs.145,700 or 1120.76 €
- Electrical panel = Rs. 12,300 or 94.615 €
- Feeding platform = Rs.176,000 or 1353.84 €
- Installation and other charges = Rs. 175,000 or 1346.15 €
- Total Expense for lifting system= **Rs.154,2900 or 11868.46 €**
- Cost for 600 FIBC bags = 600×370 = **Rs.222,000 or 1707.69 €**

Total Expense for entire project = Rs.176,4900 or 13576.15 €

Expected Payback Period = Total Expense/ Salt loss per day

Expected Payback Period = Rs 176,4900 / Rs 10,830/day

Expected Payback Period= 163 working days (around 6 months)

5.2 PASTE PLANT

After identifying the problems through the detailed understanding of the processes at Paste Plant as discussed earlier, the project members looked for possible solutions of the identified problems in the major areas of concern i.e., Filling Machine, Capping Machine, and Pasteurization Machine.

5.2.1 Filling Machine

There are three different aspects in filling machine which can be improved and are discussed individually as follows:

5.2.1.1 Replacement of Pistons

The nozzles (part of piston assembly) through which the bottles are filled are not filling with same pressure, quantity and is not properly aligned with the bottles and combine with its wearing should be replaced.

There are two ways of replacing the pistons either by manufacture it locally or import from its manufacturer i.e. from Italy.

5.2.1.1.1 Local Manufacturing:

It has its following merits and demerits:

Merits:

- Manufacturing cost is very cheap.
- Transportation cost is reduced.
- The advantage of tax benefit.
- Procurement is very easy.
- Lead time should be reduced.

Demerits:

- Quality is not up to the Company Standard.
- Shorter life and it may have to be produced again.
- Type of material used for its manufacturing could be a major drawback.
- If the type of material is available, then it's grade could be a major issue as well.
- There will be a slight difference in the functionality of the pistons compared to the existing one which is again a drawback.
- One of the most challenging is to find a reliable manufacturer.
- Of all the demerits, the most difficult task is to have the advance technology to make the pistons as close to the existing one as possible.

5.2.1.1.2 Import from its Manufacturer:

It has its following merits and demerits:

Merits:

- Quality is very high as compared to local manufacturing.
- It has longer life and is very durable.
- There are no issues of finding the suitable manufacturer.
- There will be no issues regarding the functionality of the piston.
- Last but not the least there should be no such issues regarding the technology in manufacturing.

Demerits:

- Manufacturing cost is very high.
- It has its drawbacks of taxes and duties.
- Lead time will be longer as compared to local manufacturing.
- Transportation cost is very high.

5.2.1.1.2 Payback time if all the four pistons are changed

If the pistons are to import, then it's payback period will be:

- Approximate Cost of Total piston Assembly including all components= Rs.8,000,000 or 61538 €
- Total loss in Filling section = Rs. 15,418.46 /day or 118.60 €
- Payback Period = Approximate Cost / Total loss per day

  Payback Period = 8,000,000 / 15418.46

  Payback Period = 519 Days

  Or

  Payback Period = 21.6 Months

  Or

  Payback Period = 2 Years (approximately)

5.2.1.2 Replacement of Filling Machine

The second possible option is to replace the entire machine because the existing machine has been working for fourteen years due to which wearing and tearing takes place and is under constant monitoring and maintenance.

It has the following merits and demerits:

Merits:

- Defect rate would be reduced.
- Less maintenance is required.
- Reduction in overall production time due
  to less maintenance during operation.
- Improved Efficiency

Demerits:

- As the filling machine is the heart of plant, shutdown of this machine causes the stoppage of entire plant. New machine requires around 1.5-2 months in its installation and as there is no any other filling machine working in parallel, hence replacing the machine will cause a huge loss in production which is not appreciated at all.
- High investment is required.
- The current machine is 14 years old, filling machines available today vary in specifications, thus installation of new machine is a challenging task.

5.2.1.3 Adjustment of Filling Base and the Conveyor Belt

As this problem causing severe problems and about 5.55 kg/hr. is wasted and it can be adjusted by slightly altering the speeds of the filling base and the conveyor belt. For its monitoring;

- There should be a proper **Tachometer** so that the speeds of the filling base and the conveyor belt is checked properly.
- Another way is to install the sensor whose work is to make sure that the speeds of the filling base and conveyor belt is aligned properly and if there is a variation in the speeds it should inform the worker.

5.2.2 Capping Machine

There are two different aspects in filling machine which can be improved and are discussed individually as follows:

5.2.2.1 Changing of Belt

The belt of the capping machine is completely wear out due to which the belt tension is not right, and the bottle goes uncapped and it requires continuous monitoring by the worker. This problem can be solved by simply changing the belt. In this way, the worker is not required for its monitoring.

5.2.2.2 Preventive Maintenance Plan

The present maintenance of the belt depends on the number of shifts which are operating if one shift is working for the day then the belt is scheduled to be replaced after 24 working days and if there are two shifts operating then it's maintenance reduced to half i.e. after 12 working days. But after analyzing the process thoroughly we felt there are still problems in this regard that is due to loosening of the capping belt it should be monitored continuously by the worker and if is missed by him it goes into the Pasteurization Machine uncapped and hence result in the loss of the material so we suggest that there should be a weekly schedule even if there is no need of changing the belt to counter different problems regarding this area and have developed a preventive maintenance plan as shown below:

Table 5.1: Current and Proposed Maintenance Schedule of Capping Machine

Current Schedule (Suppose two shifts for entire month)						
Equipment	**Action Required**	**Current Changing Schedule**	**Date Changed**	**Due Date**	**Person Responsible**	**Sign**
Capping Belt	Based on visual inspection of belt	After 15 working days if two shifts are working (two times per month)	01 April 2018	30 April 2018	Maintenance Manager	Xyz

Proposed Schedule (Suppose two shifts for entire month)

Equipment	Action Required	Proposed Changing Schedule	Date Changed	Due Date	Person Responsible	Sign
Capping Belt	Based on number of units capped	After 8 working days whether condition appropriate or not (three times per month)	01 April 2018	11 April 2018	Maintenance	xyz

5.2.3 Pasteurization Machine

There are three different aspects in filling machine which can be improved and are discussed individually as follows:

5.2.3.1 Use of Thermocouples

Currently in Pasteurization Machine there are no such parameters or devices that measure the temperature within the machine so we don't exactly know the temperature which is actually required for the product to cure (settle) properly. So, to overcome this problem thermocouples should be installed and maintain properly so we know exactly what the temperature (required) is within the machine. It has the following advantages:

- The thermocouple junction may be grounded and brought into direct contact with the material being measured.
- Quick response for any temperature changes.
- It is relatively simple in construction.
- These are not very expensive.
- They are sensitive to very small changes in temperature. It has precision accuracy in temperature measurement.
- Thermocouples are not easily broken and offer good durability.

5.2.3.2 Weekly Maintenance

The main issue with this machine is that the water after washing the bottles is recirculated back to cooling tower so when the bottles fell within the machine wasted material is mixed with the water and after continuous recirculation it produces a highly unwanted smell so we suggested that it should be checked on weekly basis and if there is a need of changing the water and its maintenance it should be dealt with.

Current Schedule (Suppose two shifts for entire month)						
Equipment	**Action Required**	**Current Changing Schedule**	**Date Changed**	**Due Date**	**Person Responsible**	**Sign**
Changing of Water	Based on number of working days	After 12 working days if two shifts are working(two times per month)	01 April 2018	16 April 2018	Maintenance Manager	XYZ
Proposed Schedule (Suppose two shifts for entire month)						
Equipment	**Action Required**	**Proposed Changing Schedule**	**Date Changed**	**Due Date**	**Person Responsible**	**Sign**
Changing of Water	Based on major product change (e.g. Jams to ketchup)	If there is no major change of product then change the water after 7 working days, but for major product change the water accordingly	01 April 2018	09 April 2018	Maintenance Manager	XYZ

Table 5.2: Current and Proposed Maintenance Schedule of Pasteurization Machine

5.2.3.3 Suggestion for Bottles falling inside the Machine

As we can see in the figure that machine has a sharp turn and due to the fact that speeds of the belts of main conveyor and pasteurization belt (22 minutes for each bottle) the bottles fall in the region highlighted and due to this problem, a large portion of the machine remains empty.

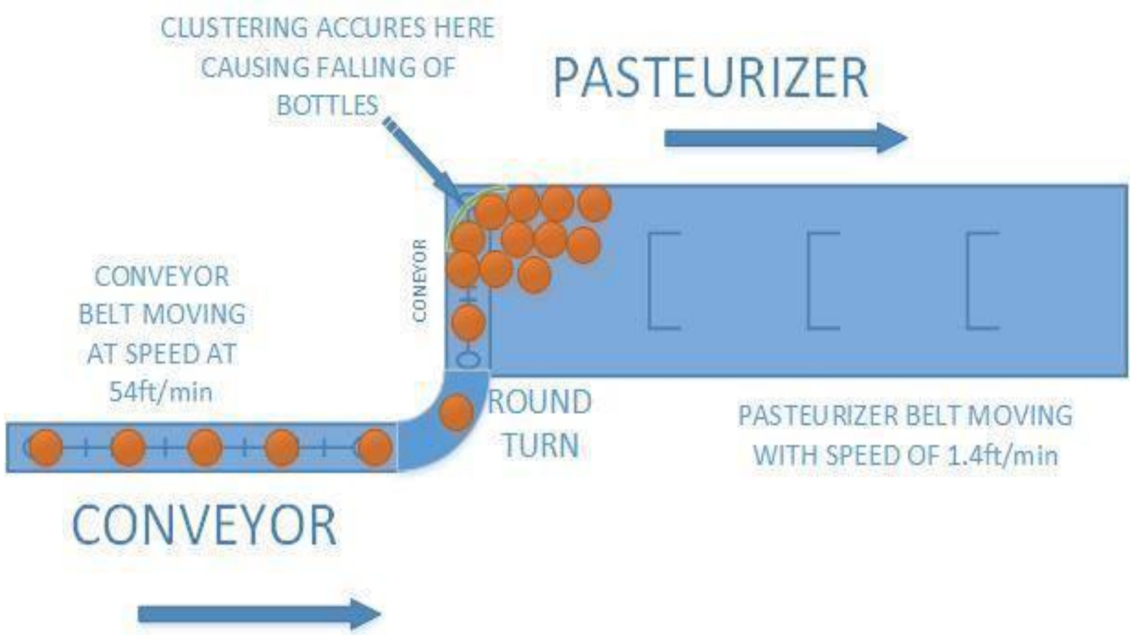


Figure 5.12: Problem inside the Pasteurization Machine

This problem can be solved by having an inclined diversion within the machine as we can see in the figure. This helps in minimizing the formation of cluster of bottles and hence this problem can be reduced. Further a portion of the machine which was not using can also be utilized in this process.

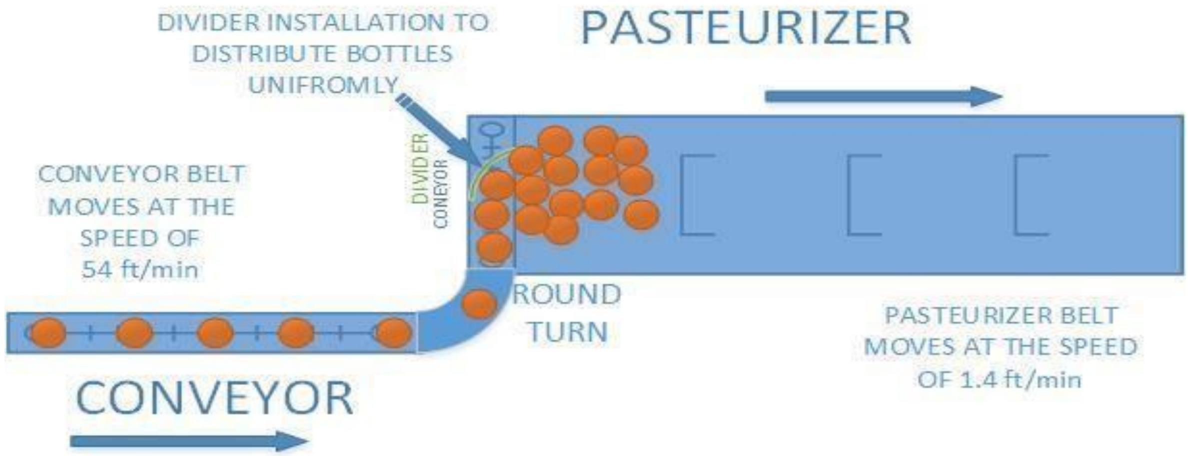


Figure 5.13: Solution to overcome the existing problem

Another possible way to solve the problem is to introduce the bottles from the right corner of the machine. This will prevent clustering of bottles and will provide a room to spread without colliding with the walls of the pasteurizer as shown in the figure below:

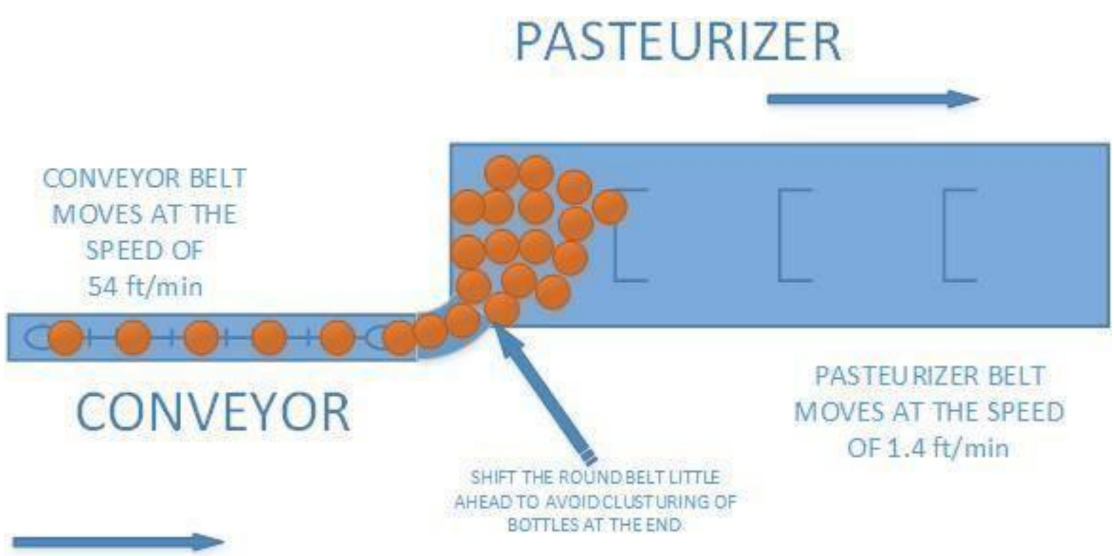


Figure 5.14 Solution number 2, bottles are introduced from the corner of the machine.

5.2.4 Redesign of Bottles

We suggest to re-design the bottles with broader diameter as it allows more space for filling and will not fall outside the bottle and it has been used worldwide as a common practice. The existing and the proposed bottles can be seen from the figures:

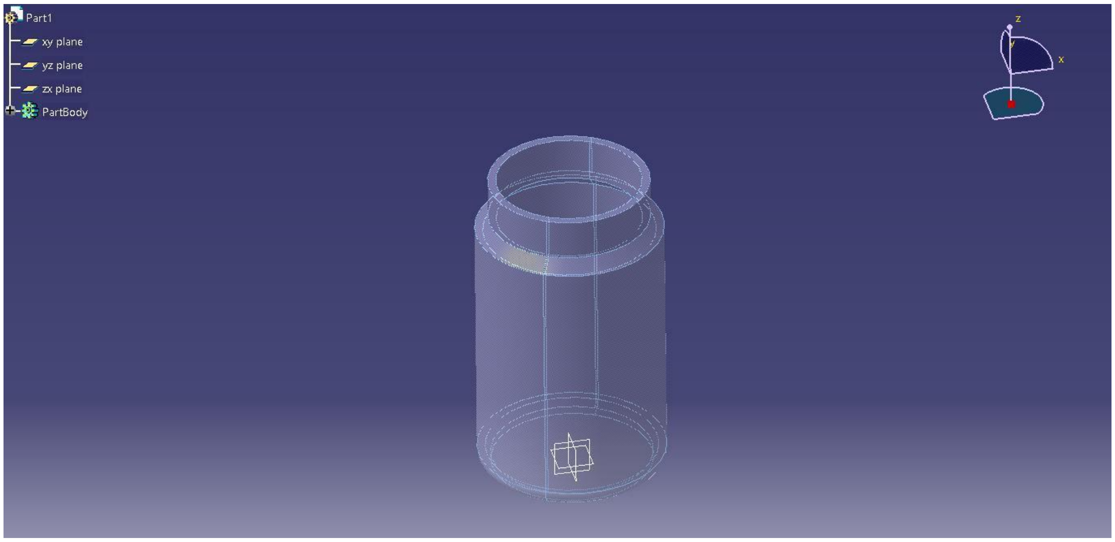


Figure 5.15 Current Jam bottle 440g

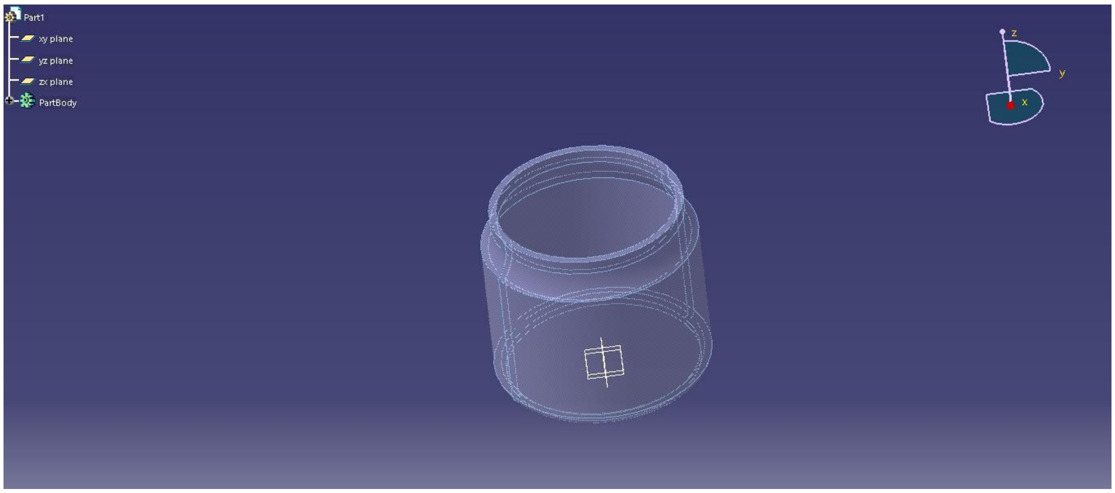


Figure 5.16 Proposed Jam bottle 440g

By switching to this proposed bottle, we can have the following benefits:

- Due to low center of gravity the chances of falling are least.
- No change in the overall volume of the bottle.
- Manufacturing cost is more or less remains the same as the existing one.
- Quality of bottles are as good as the existing bottles.
- No need of changing the cap of the bottle as it has the same diameter.
- There is no need of alteration in the Packing Machine.

CHAPTER 06

CONCLUSION AND FUTURE RECOMMENDATION

The project was initiated to improve the productivity of both Salt and Paste Plants. In Salt Plant, we highlighted major issues like improper material handling and rolling back of conveyor belt due to which major amount of salt got wasted, and in Paste Plant the basic problems were in Filling Machine, Capping Machine, and Pasteurization Machine.

We developed the standard method for material handling that is used world widely and that can be implemented in Salt plant to overcome material handling issues up to great extent. Objective was to overcome maximum waste during handling and transportation and we come up with bags of new design and lifting features, for productivity improvement overhead crane assembly was suggested to reduce all unrequired process time. We also share all these findings and information to the management of the company and they welcomed all these recommendations. Currently National Foods limited are in a process of procuring new salt plant of 10 ton/hour from Spain and they are delighted by the new proposal of big bags to introduce in new plant. The management promised us to discuss these recommendations with upper management and finance to allocate budget for the next year. They also shared these recommendations with the project and procurement department of NFL, so they can incorporate changes in a new project of salt plant and look for suppliers who can provide big bags and specialized crane for handling purpose.

In Paste plant, we estimate defect rate and efficiency of individual operating units and propose weekly preventive maintenance schedules for capping and pasteurization machines, replacement of malfunctioning pistons and redesign of bottles for stability during entire process. The current maintenance scheduling doesn't in-line with the plant requirement and usually base on corrective maintenance instead of preventive. Although company using SAP with maintenance module and they have a tolerance to create schedule and enter it into the system to get the maintenance order of each machine everyday but unfortunately, they don't use this facility. We recommend the management to first create the schedule of each machine in keeping view of our recommendation and then implement it into the system (SAP) and get maintenance order according to it. In this way all materials which is required by the maintenance will be available before the order date and machine performance and efficiency will increase. The company business unit manager accepted that there is gap in maintenance scheduling and they will try to implement the new maintenance plans for future specially in capping and pasteurization machines in keeping view of our recommendations.

Due to limitation of time, although we have done improvement at our level best, but we think that there are still many improvements on many areas of our project that can be made to achieve the goals in best practices.

As far as salt plant is concern, there is also the process loss, involving crushing and washing of salt, more than the material handling loss. So, process improvement in salt washing can be made possible to increase the production of salt. We also highlighted this point with the management about the process loss as it depends on the washing of the salt. If we wash it with the sweet water then it dissolves more salt and process loss rises and at the same time the quality of final product also increases, however if we wash the salt with high TDS (Total dissolved solid) then process loss fall along with the quality of final product. So, we need trade-off between the final product quality and water used for washing. This issue is also highlighted with the management of the company and they share it with company RND who are responsible for the process creation. They believed that they are currently working on the mentioned issue along with the production department and try to reduce the overall wastage and in addition to this, they are also exploring new techniques for the salt washing.

We also recommend that the inventory floor should be reconstructed and managed properly so that the fell over salt can be reused. In addition, the workers should be provided with gaiters that do not contaminate and affect the quality of salt.

As far as paste plant is concerned, proper Standard Operation Procedures (SOPs) should be followed when a major product change over occurs, to reduce and develop a Standard time it requires in a changeover. Currently there is no standard in the company to notify the actual time consume in change over compare to the standard. We initially recommend to determine the standard times for change over of each machine according to the product and enter it into the system and then note the actual realization time from which we can make a comparison and take appropriate decisions. Moreover, the Bill of Material (BOM) should be revised and checked of certain products on regular basis.

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