ENGINEERING PLANNING & PROJECT MANAGEMENT
PRODUCTION AND OPERATIONS MANAGEMENT

By

Ambreen Shafique

2006-NUST-BICSE-77

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NUST Institute of Information Technology
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PROJECT APPROVAL

The following project "**Production And Operations Management**" as Engineering Management Project chosen by the students of Bachelor of Information and Communication System Engineering (BICSE) named Hira Khan and Ambreen Shafique has been approved.

Head of Department (Basic Sciences)

Wg Cdr(R) Maqsood-ul-Hassan

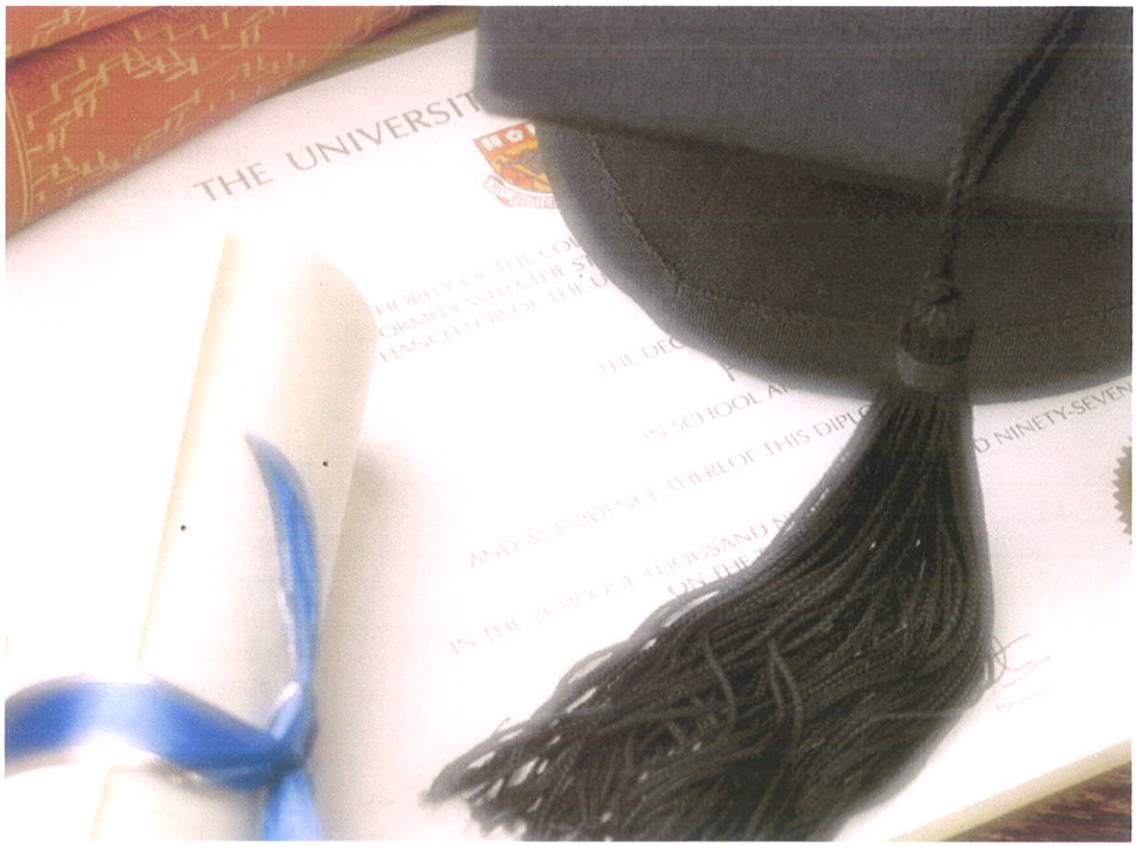
BICSE-4

Subject Instructor

Mr. Muhammad Yousaf

DEDICATION

To Our Parents And Teachers



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OVERVIEW OF OPERATIONS AND PRODUCTION MANAGEMENT

Operations management is defined as the management of the conversion process ,which converts land, labor, capital and management inputs into desired outputs of goods and services.

Operations management is an area of business that is concerned with the production of goods and services, and involves the responsibility of ensuring that business operations are efficient and effective. It is also the management of resources, the distribution of goods and services to customers, and the analysis of queue systems.

operations management is "the field of study that focuses on the effective planning, scheduling, use, and control of a manufacturing or service organization through the study of concepts from design engineering, industrial engineering, management information systems, quality management, production management, inventory management, accounting, and other functions as they affect the organization"

Operations also refers to the production of goods and services, the set of value-added activities that transform inputs into many outputs. Fundamentally, these value-adding creative activities should be aligned with market opportunity for optimal enterprise performance.

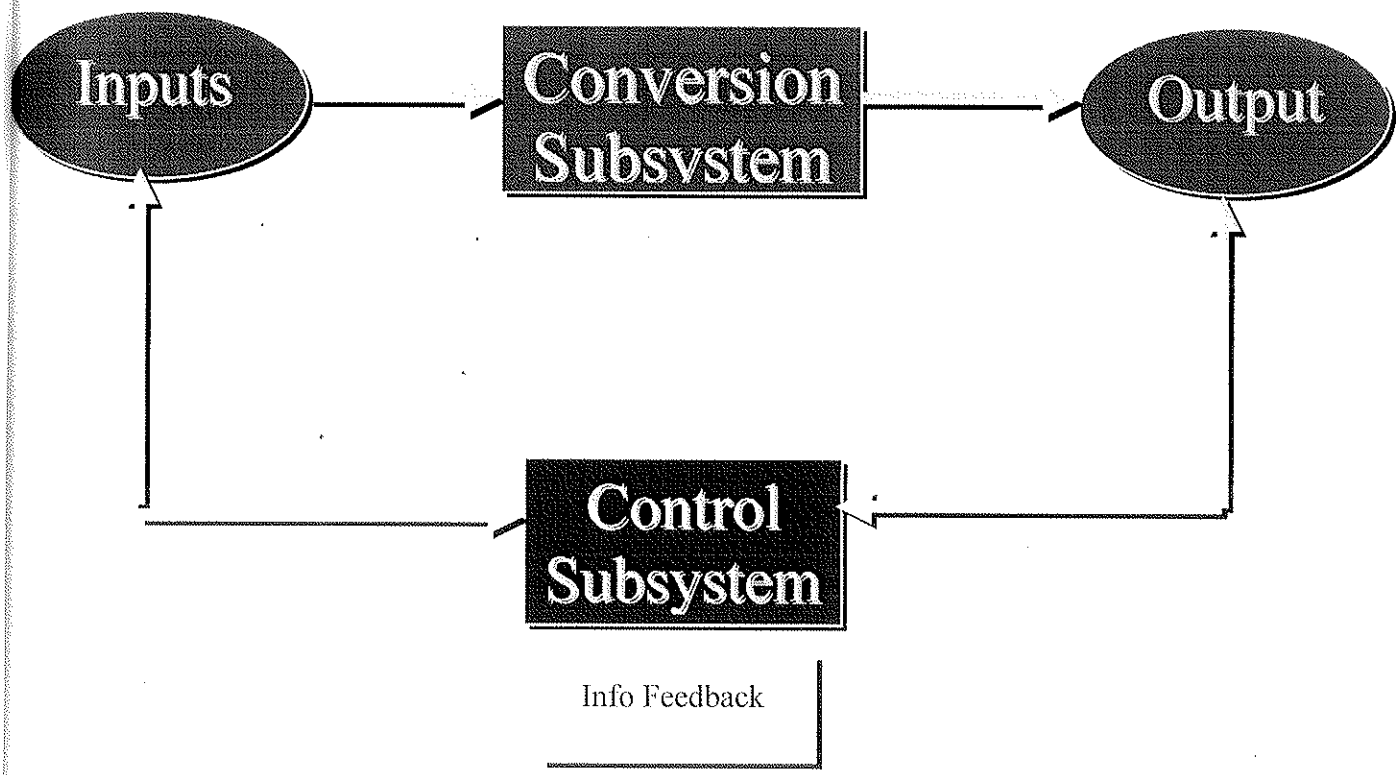
Operations Management Planning Criteria

- **Control** by creating and maintaining a positive flow of work by utilizing what resources and facilities are available
- **Lead** by developing and cascading the organizations strategy/mission statement to all staff
- **Organize** resources such as facilities and employees so as to ensure effective production of goods and services
- **Plan** by prioritizing customer, employee and organizational requirements
- **Maintaining** and monitoring staffing, levels,Knowledge-Skill-Attitude (KSA), expectations and motivation to fulfill organizational requirements
- **Performance Measures** for the measurement of performance and consideration of efficiency versus effectiveness

Operations and production Function

The operations function of an organization is the part that produces the organization's product. In some organizations the product is a physical good (refrigerators, eatables etc) while in others it is a service(insurance, health care etc). All the organizations providing either goods or services have in common within their operations system some basic elements. These common elements are :

- Conversion process
- Inputs (land. Labor, capital)
- Outputs (goods and services)
- Information feedback



Inputs of a Production System

- External
  Legal, Economic, Social, Technological
- Market
  Competition, Customer Desires, Product Info.
- Primary Resources
  Materials, Personnel, Capital, Utilities

Conversion Subsystem

- Physical (Manufacturing)
- Locational Services (Transportation)
- Exchange Services (Retailing)
- Storage Services (Warehousing)
- Other Private Services (Insurance)
- Government Services (Federal, State, Local)

Outputs of a Production System

- Direct
  Products
  Services
- Indirect
  Waste
  Pollution
  Technological Advances

Decision Making in operations Management

Three types of decisions are involved in production and operations management of an organization :

- Strategic Decisions
- Operating Decisions
- Control Decisions

Strategic Decisions

These decisions are of strategic importance and have long-term significance for the organization.Examples include deciding the design for a new product's production process,where to locate a new factory, whether to launch a new-product development .

Operating Decisions

These decisions are necessary if the ongoing production of goods and services is to satisfy market demands and provide profits. Examples include deciding how much finished-goods inventory to carry, the amount of overtime to use next week, the details for purchasing raw material next month

Control Decisions

These decisions concern the day-to-day activities of workers, quality of products and services, production and overhead costs, and machine maintenance.Examples include deciding labor cost standards for a new product, frequency of preventive maintenance, new quality control acceptance criteria.

What Controls the Operations System?

The operations function of organization is controlled by a number of factors. These factors are:

- Information about the outputs, the conversions, and the inputs is fed back to management.
- This information is matched with management's expectations
- When there is a difference, management must take corrective action to maintain control of the system

Organization success depends upon proper management of operations:

The success of an organization depends on the proper management of operations. The flow of operations and production of any organization should be flexible enough in order to change the flow of operations so that it could compete in the market to meet the forcasted demand. The organizations adopting the same flow of operations lag behind in future if the demand of the product increases. The flow of operations should be less time consuming in order to generate more and more finished products.

INTRODUCTION OF MURREE BREWERY COMPANY

Your Seal of Quality

Since 1860

MURREE BREWERY'S BIG APPLE

"We the people of Murree Brewery make personal commitment to first understand our customers requirements then to meet and exceed their expectations, by performing the correct tasks on time and every time through continuous improvement, alignment of our missions and goals, responsibility and respect for our jobs and each other, and educating one another."

(Company Mission Statement)

The Murree Brewery Company is one of the oldest public companies of the sub-continent. Its shares were traded on the Calcutta Stock Exchange as early as 1902, and are now the oldest continuing industrial enterprise of Pakistan.

After being a monopolistic leader in the market of alcoholic drinks, Murree brewery launched its first carbonated drink by the name of BiGG Apple in 2003. An idea in the mind of one manager is now a threat to large soft drinks industry players.

Operations Strategy:

BiGG Apple is amongst the major revenue generating units of Murree Brewery. The Company is determined to increase production capacity in this unit to increase its market shares. Currently, the profit margin from carbonated drink unit is 30%. By increasing production capacity, cash inflow will increase and company will be able to meet the market demand.

BIGG APPLE

When Murree Brewery started its new venture of entering the soft drink market, it never occurred to the management that a small "side business" will one day grow into their highest in demand product. Since its launch, the growth of market shares for this one product is raising at an astonishing pace, even for the makers themselves. Demands increased from a mere 2000 cartons/day to unbeatable limits like 70,000 cartons/day (all sizes). Rapidly increasing demands are providing the management with new challenges to increase capacity and efficiency, almost doubling them over fortnights. Production department was producing 4000-6000 cartons/day initially. As a side venture, no or little separate machinery was deployed for packaging and production of Bigg Apple and most of the operations were carried out in the same factory as used for the brewing products. However, because of increased demand, the plant was shifted to an entirely new location (about 800ft from the original plant).Some new machinery was purchased while many previously in use components were attached into a formal separate line of production. Capacity jumped from 5000 to

22000 cartons a day (average). Factory works in two shifts with 18 men working on production line.

However, this is still far behind the demand and management is again considering a plant upgrading. For the time being, 0.25 liter glass bottles are removed from the BiGG Apple packaging line and are handled inside the brewery along with other products. The Bigg Apple line only caters for 1.5 liter jumbo size plastic bottles and 500 ml pet bottle now.

For statistical ease, during the study and analysis of the process, all studies are made with reference to one product element (1.5 liter Plastic bottles). Company is producing approximately 12000 cartons of 1.5 liters daily while the sales department quotes the demand of 22000 to 25000 cartons a day.

OPERATIONS MANAGEMENT IN MURREE BREWRY COMPANY

PRODUCTION STATISTICS:

Production is carried out in two steps: Syrup Making and Packaging/Bottling. Factory works in two shifts.

Location:

BiGG Apple production department is located at almost 500ft from TOPS juices and 800ft from the original brewery plant. Factory adjoins Nala Lai and so waste handling is swift and smooth. Being next door to Army Staff House, the organization enjoys a lot of advantages in terms of electric facilities, low traffic problems and security issues. Labor at reasonable costs, is easy available from the local market.

Layout:

All the production facilities are placed under one roof to avoid waste in terms of movement and transportation. Syrup Making takes larger share of the area because of large tanks and machinery. Packaging Facility is arranged in a single line. Some space in the L shape hall is used for empty bottle inventory while no finished goods inventory is maintained. Cases are transferred to "Dispatching Department" as soon as they are 'taped' and sealed.

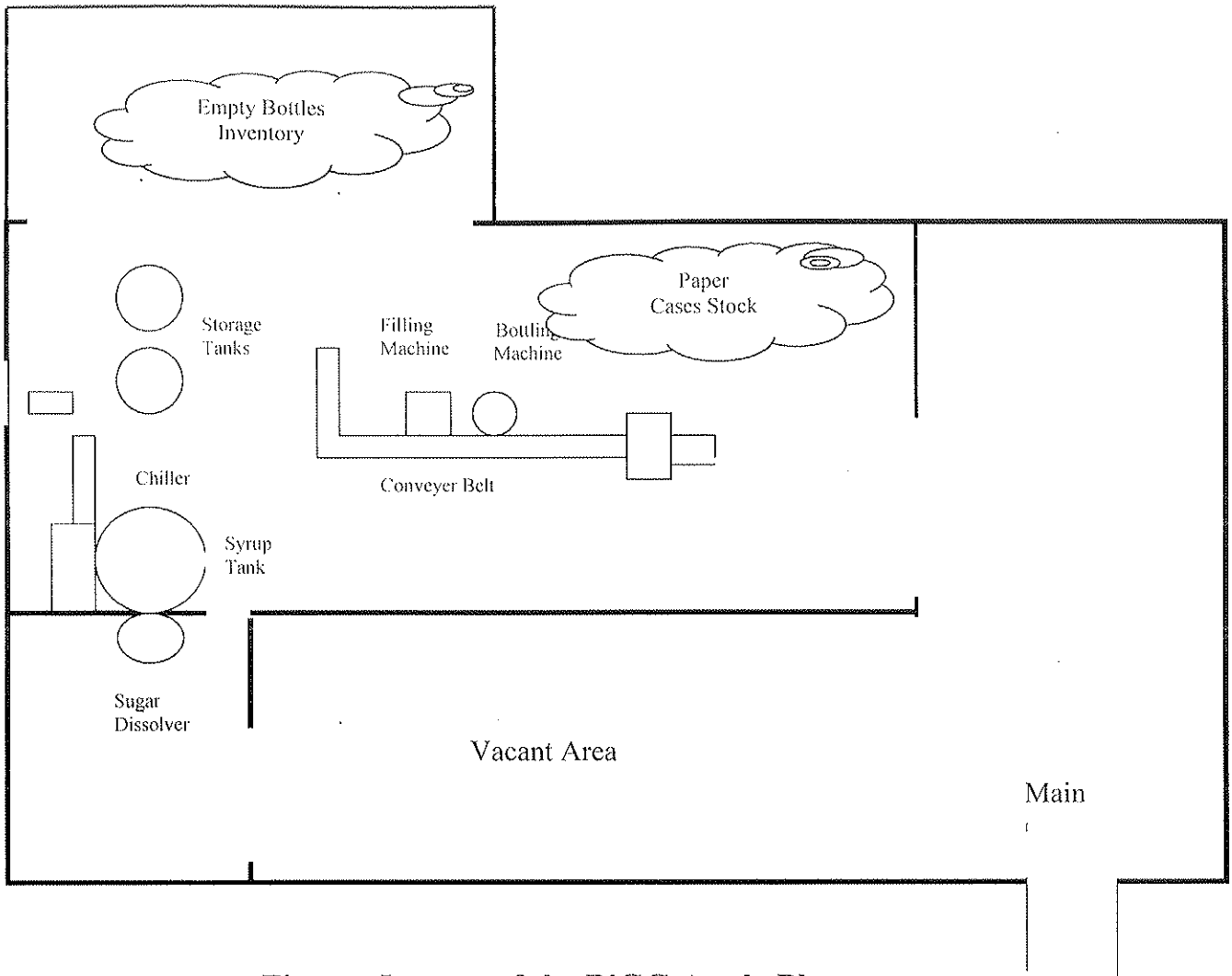


Figure: Layout of the BiGG Apple Plant.

Syrup making process also works at night and produces two extra batches of syrup to be filled next day at the start of first shift. . In the morning new syrup is set into production so that bottling of previous night syrup is immediately followed by the morning production.

Current Schedule of Shifts

Shift 1	**Start time: 8.00 A.M**	
Batch 1	Filling Time : 8.00 A.M. to 10.30 A.M.	
Batch 2	Filling Time : 10.30 A.M to 1.00 P.M.	
Batch 3	Filling Time : 1.00 P.M to 1.45 P.M.	
	Break : 1.45 P.M. to 2.30 P.M.	
Batch 3	Filling Time : 2.30P.M to 4.15 P.M.	
Batch 4	Filling Time : 4.15P.M to 5.00 P.M.	
Shift 2	**Start Time: 5.15 P.M**	
Batch 4	Filling Time : 5.15 P.M to 7.00 P.M.	
	Break : 7.00 P.M. to 8.00 P.M.	To Cater 60 Minutes Idle time
Batch 5	Filling Time : 8.00 P.M to 10.30 P.M.	
	10.30 P.M to 12.00 A.M.	90 Minutes Idle time
Batch 6	Filling Time: 12.00 A.M. to 2.30 A.M.	

Daily Demand:

Demand of 1.5 liters bottles are 22000 to 25000 cases per day.

PRODUCTION AND BOTTLING PROCESSES:

The entire process of BiGG Apple manufacturing is divided into two sub processes. The first sub process starts at the sugar dissolver and ends at storage tanks and the second sub process starts at bottle rinsing and ends at packaging.

A brief description of each process follows to capture a better sequence of activities.

Sub process # 1 – Syrup Making: This process has a total of five stages and follows a systematic sequence and lay out. Each stage performs a function that is necessary to carry out the next stage function and is connected.

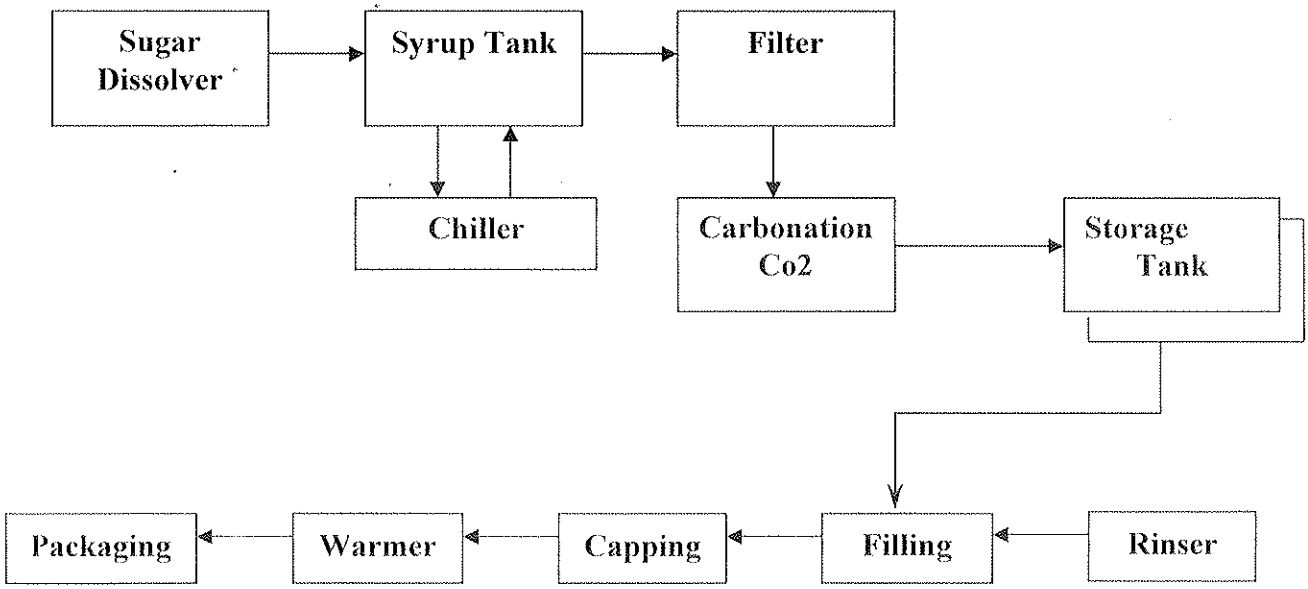
- **Sugar dissolver:**
  In this stage sugar, sodium benzoate and preservatives are added in advance to the start of the next process. This process takes almost 30 minutes and then the syrup waits in the same tank for 150 minutes. This is done to see any unfavorable reactions with in the liquid that may occur. Syrup dissolver tank has a capacity of 600 liters and it is filled approximately four to five times a day.
- **Chiller:**
  This process takes water from the syrup tank and reduces its temperature approximately four to five degree centigrade. It takes three hours to chill 20000 liters of water.
- **Syrup tank:**
  The syrup tank has a capacity of 20000 liters, but 18500 liter is brimmed. In this process sugar dissolved syrup is mixed with chilled water. It takes 25minutes to mix the syrup with water.
- **Filter:**
  This stage takes liquid from the syrup tank, filters it and passes it on to the next process of carbonation. There are 8 filter sheets used to filter the liquid.
- **Carbonation and Storage:**
  The filtered liquid is then carbonated while passing through the pipe. Then the carbonated liquid is transferred to the storage tank. The flavoring of the liquid is done at this stage. At the moment two tanks are used for this purpose as the liquid is stored in each tank till it is required at the filling stage.

Sub Process # 2 – Packaging/Bottling: The second sub process starts when the liquid is ready to be packed and the tanks or at least one tank is filled with the liquid that is ready to be bottled.

- **Placing:** Bottles that are kept in inventory are picked manually and placed on the conveyer belt that transports them to the rinser.
- **Rinsing:** The bottles are then rinsed with water on the conveyer belt.
- **Filler:** The filling is done by machines and the liquid stored in the tanks is filled in the bottles at an effective capacity of 5000 bottles/hr. Filled bottles are then transported on a conveyer belt to the capping machine.
- **Capping:** Filled bottles are then capped at a speed compatible with the filling machine and bottles are transported to warmer.
- **Warmer:** Since the liquid temperature is lower than the room temperature, it attracts moisture to the surface of the bottle. This moisture may affect the rapping on the bottle or may even affect the packing process and the container. The warmer is used to increase the temperature of the bottles so that no moisture appears on the bottles surface.
- **Packing:** After the warmer process, bottles are transported on a conveyer belt of increased width to the packing area. Here the bottles are hand picked and packed in cartons.

Manual checking is carried out at two points, once before filling and once before removing the bottles from the line.

BLOCK DIAGRAM:



PROCESS CHARTS

Date: 11-06-07

Location: MB Plant Time: 215 minutes
Process: Syrup Making Distance: 95 feet

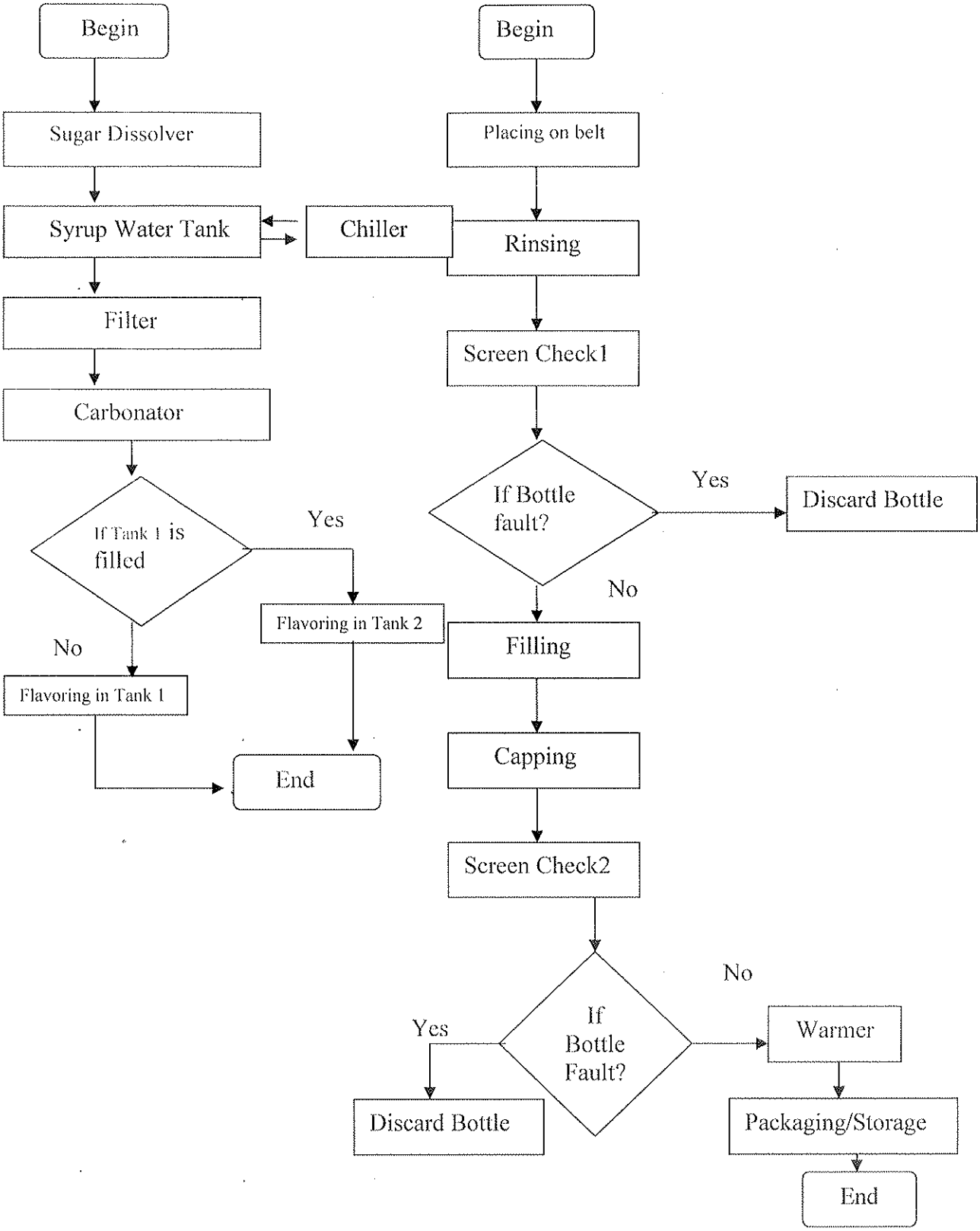
Step	● → □ D ▼	Description of Process	Time(mins)	Distance(feet)
1	x	Dissolve all ingredients to sugar	30	-
2	x	Wait until needed	150	-
3	x	Move to chilled water tank	-	40
4	x	Ingredient mixing with water	25	-
5	x	Move to filter	-	15
6	x	Move to carbonator	-	30
7	x	Move to tank 1	-	10
8	x	Flavoring	10	-
9	x	Wait until needed	-	-

Date: 04-06-07

Location: MB Plant
Process: Bottling Distance 70 minute

Step	● → □ D ▼	Description of Process	Time (mins)	Distance(feet)
1	x	Placing on conveyer belt	-	-
2	x	Rinsing of bottles	-	-
3	x	Move to screen check 1	-	15
4	x	Screen check 1	0	-
5	x	Move to Filling	-	10
6	x	Move to capping	-	8
7	x	Move to screen check 2	-	10
8	x	Screen Check	0	-
9	x	Move to warmer	-	12
10	x	Move to storage/packing	-	15
11	x	Storage for packing	-	-

PROCESS FLOW CHART



WASTE ANALYSIS:

Wastes or '*Muda*' encompasses seven areas according to TPS system of operations. However,Waste in terms of material is the only waste addressed in the plant when they make their estimations. This refers to the liquid wasted in the process of production. The managers at BiGG Apple plant maintain that material waste per day is estimated to be around 1% of daily production targets. This translates into 740 bottles or 124 cases daily.

During the team's visits to the factory, waste analysis was carried out for all the seven areas mentioned under the flag of *Muda*.

Observations and Findings:

1. Transportation: The team observed wastage in terms of transportation. Bottles are produced and packed in the BiGG Apple plant and then they are transported to the main brewery for dispatching. Therefore, every bottle travels a distance of 800 ft just to reach the truck. The reason behind this excessive workload is that the dispatching centre must record the number of cases loaded and dispatching of 1.5 liter bottles is done along with the.5 litter glass bottles. So all the bottles must reach the dispatching point to be registered in the records. The cost to eliminate this waste will be to set a separate dispatching unit right next to the plant and a regular merging of data for record keeping.

2.Over Production: No wastes were located in terms of over production. In fact, Company is continuously fighting to meet the demand margins.

3. Motion: Packaging of bottles is an area where waste in terms of motion can be observed. Labor has to bend and lift every bottle from the tin top. Uncomfortable height of the tin top slows down the work. However, this is not the only problem. An informal interview with some of the employees revealed that backache and RSI(repetitive Stress Injury) is frequent in packaging labor.

4. Waiting: Bottling line experiences wait state of about 150 minutes daily because of unavailability of syrup. Syrup is produced in 240 minutes because of slow chilling. To match the pace of syrup availability, the filling machine is operating at 5000 bottles/ hour instead of 6500 bottles/hour which is feasible and manageable.

5. WIP Inventory: No work in process inventory is maintained and liquid is filled in bottles as soon as it is made. Two excessive shifts of syrup are made at night and stored overnight for early morning processing. However this can not be completely termed as WIP inventory.

Defects:

Sales departments quotes no return of product once delivered. Customer complains usually deal with distribution network.

6. Material Waste:

This refers to the liquid wasted in the process of production. As mentioned earlier, waste in terms of material is only waste addressed in the plant when they make their waste estimations.

Material waste occurs in four different ways:

- **Liquid wasted at bottling**: Often the filling machine leaves bottles half filled or quarter filled. This is because the syrup is carbonated and because of high pressure, some liquid is spilled out of the bottles. These half filled bottles are then filled manually.

  The carbonated liquid overflows out of the bottles because of a time lag between carbonation and filling.

- **Bottles rejected by inspector**: There are three inspection points where an employee sits and scans every passing bottle on the conveyer for any problem. If a damaged or dirty bottle is traced, it is removed from the line before filling. Once the bottles are filled, another inspector checks the capping and liquid amount. Half filled or otherwise retarded bottles are disqualified and lifted from the line. Finally bottles are again scanned before packing. This is done to make sure no damaged product has escaped the inspection. A lot of bottles are taken off the line daily. This amount is estimated to be 40-50 per hour bottles according to Bottle Inspector.

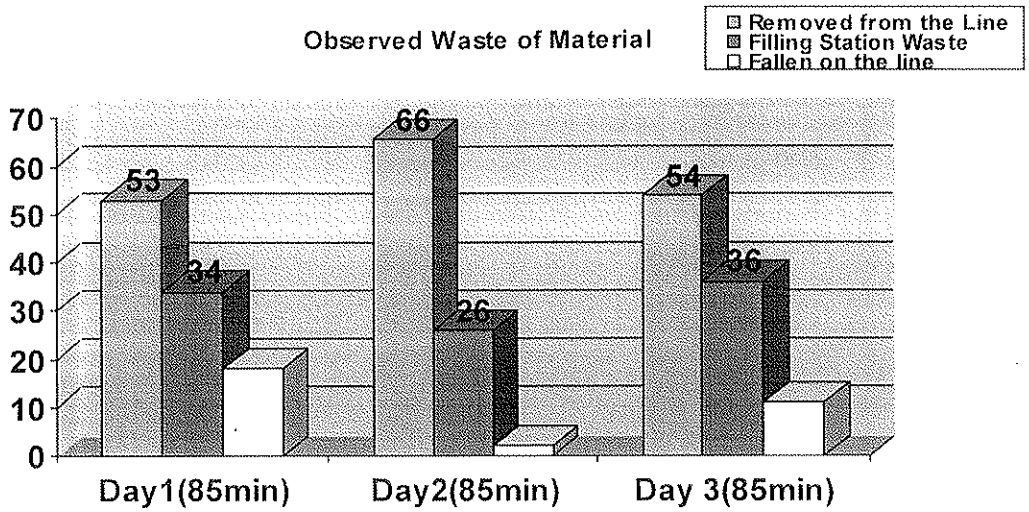
- **Bottles falling on the line**: Sometimes a few bottles tremble down on the line and fall. This results in liquid waste if the disaster occurs before capping. These can be because of a sudden halt at capping machine. The incidences are few and far between but they add a significant amount to the total waste and therefore can not be ignored.

- **Waste in syrup tanks**: 18,500 liters of syrup are set into production at the start of the process. However, as the liquid has to pass through a number of tanks one after the other; a lot of liquid is wasted. Tanks are not emptied completely and therefore in every 'transaction' a certain amount is wasted as the 'bottom amount'. This might be some un dissolved solute or high density particles from the liquid that settles down at the tank base.

In order to estimate material waste in areas mentioned, the team observed the process for 4 hours on different times and dates. Bottles removed from the line during that time and material wasted at filling station was calculated. At filling station, half filled bottles are refilled by manually adding the syrup from a filled bottle in the hand of operator. Number of filled bottles used in this process gives the half of waste at that point. Therefore, to calculate total waste at filling station, number of bottles used to refill were multiplied by two. Third area of study was the bottles falling on the line because of some line halts. On our first day of observation, the conveyer was stopped 3 times in 85 minutes. The inspector at the filling station declared this an unusual event. The packaging tin was overloaded and bottles on conveyer were pushed to a halt. A lot of bottles were tilted in this accident. Amongst them, few were on the line between capping and filling station and therefore material was wasted here. No such incident was observed on second day of observation. Line was stopped once on third day and little liquid was wasted this time. Data from these observations follows:

Date and time	Duration (in minutes)	Material wasted at filling (bottles)	Bottles removed from the line	Fallen Bottles
28-5-07 (11:35 – 1:00)	85	34	53	18
04-06-07(11:10 – 12:35)	85	26	66	2
11-06-07(2:35 – 4:00)	85	36	54	11

TOTAL	255(4 hours, 25 minutes)	96 bottles	173 bottles	29 bottles



About 32.9% of the bottles removed from the line had physical problems, like damaged bottom. 29.4% bottles had torn label. 28.3% bottles were rejected because they were not completely filled. 9.2% bottles had some impurity or unsettled particle in them.

Reason for Removal from line	No of bottles
Physical Damage	57
Torn or misprinted Label	51
Amount of liquid(under or above the desired level)	49
Impurity or particles	16

According to the observation data, however, 67 bottles are wasted per hour. The waste calculated from the observation data equals 1.44% for the total production. The amount suggests 178.8 cases as waste daily.

PROBLEM STATEMENT

"In the last three months, Demand for BiGG Apple 1.5 Lt exceeds its supply by 13,000 cases per day. The company is unable to meet this increased demand because of high batch production time and low production capacity. At the moment, the factory is producing 12,000 cases while the sales department quotes the demand for 25,000 cases per day. This affects the company's cash, market image and results in an increased pressure on the labor."

PROCESS ANALYSIS

In order to solve the problem, each process was evaluated and analyzed in detail. The team spent some time in the operations vicinity and studied each process to trace out the areas that can be potential culprits behind the problem. All the collected data was then listed together to draw a better picture of problems at hand. Group brainstormed on the processes to focus and a list of target areas was finalized.

5 whys Applied:

In order to reach the root cause of the identified problems, we carried out the technique of 5 whys. This helped us reach the core reasons behind the slow production and thus gave us an insight into the means and measures that can be utilized to solve the problem.

First Area under Question was the slow syrup making process. Bottle Superintendent Mr. Wasim answered our queries in the following dialogue:

Q: why is the bottling machine operating at 5000 bottles per hour?
A: because syrup is not available for bottling more often.
Q: why is the syrup not available in time?
A: it takes 240 minutes to prepare the solutions and it takes 150 minute only to fill this syrup.
Q: why is it taking 240 minutes to make the solution?
A: because chiller takes 180 minutes to chill the water.
Q: why is it taking 180 minutes to chill the water?
A: because water is at 35- 40 degrees and it takes long time to drop the temperature to 4- 5 degrees.
Q: why is water so hot?
A: because it is stored in roof top tanks and temperature is pretty high in summers which is our major production period.

Another set of Questions that was insightful in this domain was something like:

Q: why do you stop the line now and then?
A: to avoid tripping of bottles on line.
Q: why do bottles trip on the line?
A: because our labor can not take off the bottles quick enough from the line and so they start getting jumbled.

Q: why cannot your labor take off the bottles from the line more efficiently?

A: because there is not enough space for them to stand and take off the bottles. 8 of them are crowded around the line but they don't have enough space to work concurrently.

Q: why is there not enough space?

A: because the packaging top is not big enough and bottles are heaped at it.

Q: why are bottles heaped up and not taken off in time?

A: Because conveyer belt is short and the tin top where bottles are dropped for packaging is not wide enough. Labor has to bend down to pick each bottle.

We asked a few questions to the bottle inspector, who was busy in removing bottles from the line one after another.

Q: Why are you removing bottles from the line?

A: because they are not qualified for filling.

Q: why are they disqualified?

A: because they are damaged. They have dirt, scratches or torn and misprinted labels.

Q: why are they damaged?

A: I m not sure. They can get dust and damages from the floor where they were heaped. Or during unloading from the trucks. They come in plastic bags with 20 bottles in one. Or the supplier might have sent them damaged.

Q: why are they heaped and on the floor?

A: because we want them to be available as soon as we need them. So we heap a good stock in near the filling area.

Q: why don't you arrange them on some shelf or in a huge laundry bucket type thing?

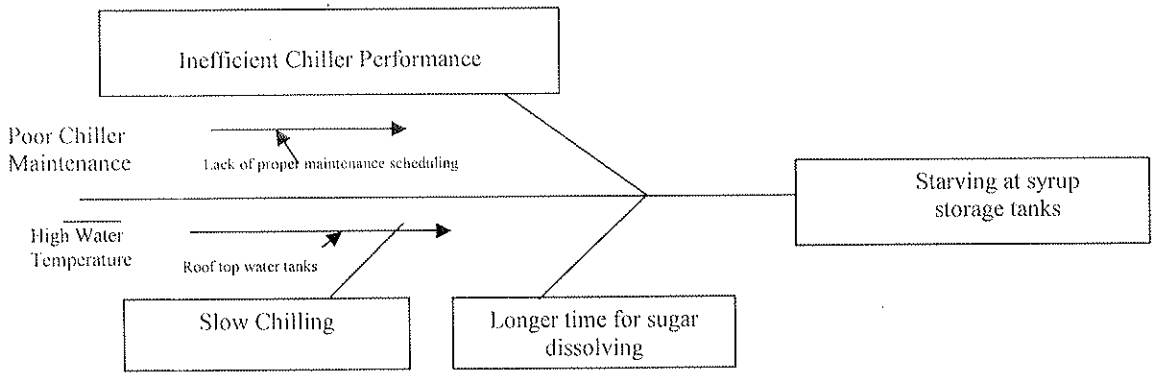
A: they are so many in number and t will mean extra work.

Brainstorming:

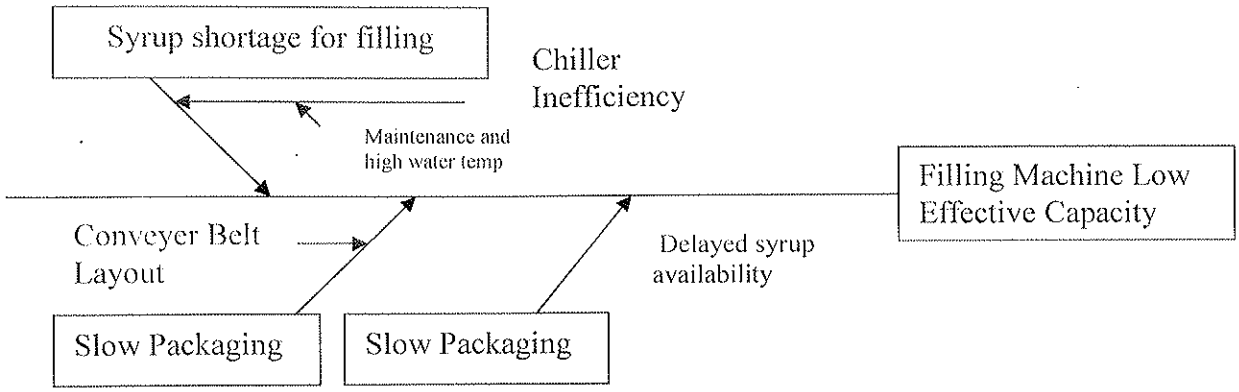
After a thorough study and in-depth understanding of the process, a number of improvement areas were diagnosed. The group brainstormed on all the options available and feasibility analysis for each suggestion was carried out. The focus is on improving production in numbers without compromising quality and disturbing the costs. Lead time needs to be decreased in order to meet the demand and this need addressing the bottleneck process to reduce cycle time. Following points were highlighted in the brainstorming session:

- The process is halted for 2 hours and 30 min every day because of unavailability of syrup. Labor enjoys a break of approximately 1 hour daily because of system idle time.
- Chiller is taking a lot of time to cool the water.
- Bottling machine is capable of handling 7000 bottles / hour. it is set to operate at 5000 bottles/hour because of slower syrup making process.
- Manual Packaging is slow and so the line needs to be stopped every once in a while in order to avoid the bottle jumble up at the end. The process therefore is causing a bottle neck.

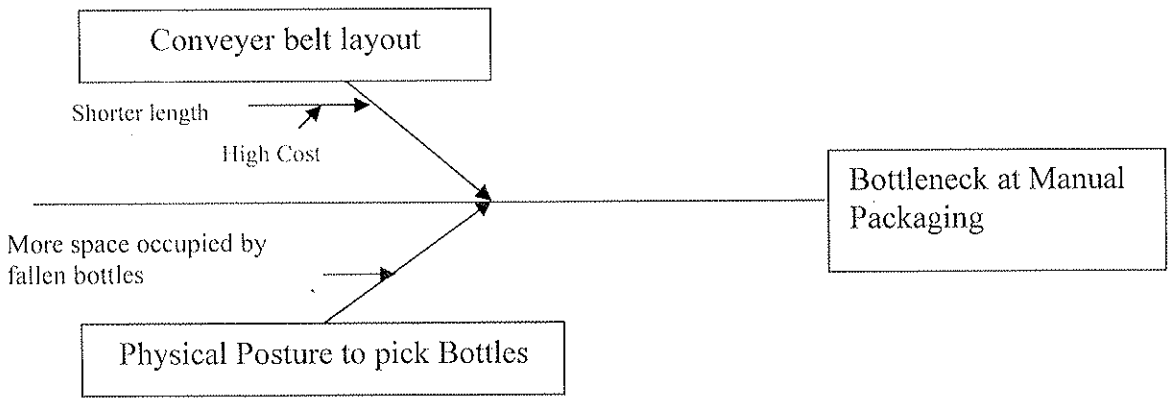
Problem Analysis:



Syrup making process takes 240 minutes to prepare one batch of 18,500 liters, while this batch is filled in 150 minutes. So except the start of first shift where two batches of 18,500 liters are already prepared and stored in storage tanks by the syrup making process there is starving at the storage tank stage. Filling process has to wait for 90 minutes at the start of each batch. The problem is due to more time taken by the syrup making process. The major time in this process is taken at the chilling stage. This is due to the inefficient chiller performance. Cooling grills of chiller absorbs dust, so their maintenance is required. At the time, grills are cleaned weekly. But because of the dust absorption the performance of the chiller decreases with every passing day. Another reason of chiller inefficiency is high temperature of the water that is to be chilled. Because the water supply tanks are open air and water is supplied in steel pipes, the temperature of the water goes higher by absorbing heat of the sun. Chiller requires more time to take this water back to 4 to 5 degree centigrade.



At the time, the effective capacity of filling machine is 5000 bottle/hr. Its design capacity is 7000 bottle/hr. The low effective capacity of filling machine is because of the shortage of syrup to be filled in storage tanks. This is because of the more time taken by the syrup making process to prepare syrup. Another reason is incompatibility of manual packaging with filling. In case the filling speed is increased more work will be piled up at manual packaging which will result in blocking at the filling machine.



Low packaging speed is incompatible with filling and capping is because of two reasons. First, the conveyer belt layout is inappropriate. Its shorter length is causing the bottles to fall at the conveyer belt. Second, the physical posture of the workers to pick those fallen bottles from the conveyer belt makes them tired. This results in more time taken to pack the bottles.

PROPOSED SOLUTIONS:

After the analysis of each problem area, the group decided on two possible areas to solve these problems:

- Quality at source
- Quick Response Management
- Five S of House Keeping

Quality at source refers to the phenomenon where inspection is minimized and replaced with prevention. The current system relies heavily on inspection at every point. With better means of quality assurance, the inspection overhead can be reduced especially at bottling machine.

Quick response Management is the philosophy of production for 21st century where the focus is to reduce lead time. Lead time reduction calls for minimizing idle time in the system. Once idle time is reduced and system works on maximum efficiency, the capacity can be increased.

Another major concept that can revolutionize the process is the adoption of 5 S (Scrub, Sort, Straighten, Standardize, systemize and sustain) of house keeping. Cornerstone of 5S is that untidy, cluttered work areas are not productive. As well as the physical implications of junk getting in everybody's way and dirt compromising quality, we are all are happier in a clean and tidy environment and hence more inclined to work hard and with due care and attention.

To practically implement these three concepts, the following recommendations are proposed by the team.

Recommendation 1:

Decreasing chiller time:
Two areas can be addressed to decrease the chilling time and increase chiller efficiency:

- Chiller Maintenance
- Water temperature reduction

Day	Chilling Time (approx data)
Monday	125
Tuesday	135
Wednesday	160
Thursday	210
Friday	240

Chiller Maintenance:

Currently chiller maintenance is carried out on weekly basis. Efficiency of chilling machine increases by 40 to 60 minutes after the maintenance. This is highlighted by the fact that, chiller takes lesser time on Monday as compared to Friday. On average the chilling takes 180 minutes.

*Data courtesy: Mr. Yasin Sadiq. Production Manager

Chiller maintenance is a simple process that takes around 10 minutes. Two air blowers are used to blow off the dust from the chiller grills. The process is not complicated enough to be postponed for a complete week and its effect on productivity cannot be ignored.
The team suggests that if the maintenance activity of chiller is carried out daily, the chilling time can be maintained at 120 minutes for 18,500 liters of water. In fact 10 minutes can be utilized from both the shifts to carry out the blowing activity twice and thus increase the performance. We do not actually have to stop the chilling machine to carry out its cleaning. This way we can save 60 minutes on every batch which will result in increased no of batches and hence increased productivity.

Water Temperature Reduction:

At present, one of the major factors contributing to high chilling time is the water temperature. Syrup needs the temperature to be maintained at 4 to 5 degrees whereas the water is available at 30 to 40 degrees depending upon the local temperature because of the roof top water storage tanks.

Two huge plastic water tanks of 10000 liters capacity each are used for water storage at the factory roof top. If water temperature can reduced to 15 to 20 degrees we can decrease the chilling time by one hour.
The group suggests that an underground water reservoir can b helpful to solve this problem.

Recommendation 2:

Increasing Filling Machine Effective Capacity:

At present the filling machine is operating at 5000 bottles/hour whereas the design capacity of the machine is 7000 bottles/hour. Machine is working at a very low capacity because of unavailability of the syrup on time. If recommendation 1 is effectively implemented, filling machine can be utilized at 6500 bottles/hour without creating any bottleneck and delay.

Recommendation 3:

Improving Conveyer belt Layout:

Another problem at hand is the bottleneck at the manual packaging. This problem is caused because packaging top is not wide enough to allow 8 workers work conveniently. The packaging top is a tin tray of 4x6 at about at about 3 feet from the ground. 8 people are responsible for picking up the bottles and putting them in cartons. About 84 bottles reach the tin top every minute. This means that every person has to pick and pack about 10 bottles per minute. The top is not wide enough and bottles get jumbled up in every other 5 minutes.

If the top is extended another 4 feet, the bottle clustering can be avoided.

Recommendation 4:

Empty Bottle Management:

Empty bottles are heaped on the ground and this results in damages and dirt. Sometimes, the bottle label gets torn during the unloading or inventory shifts. Scrap is a byproduct of inventories and with huge jumble of plastic bottles lying on plant floor,such scrap seems unavoidable. Moreover, as depicted in set 3 of 5 Why, some bottles arrive at the plant with misprinted labels.

Damaging and thus rejections of bottles can be avoided by:

- Checking the bottles on unloading of supply and returning the damaged material then and there.
- Keeping the bottles supply in huge cloth buckets instead of on floor. Or the bottles can be arranged on some shelves but this spells extra labor and work overhead.

Recommendation 5:

Creating a separate dispatching unit at new plant:

Bottles are dispatched from the main brewery. A dispatching department maintains the record of every order delivered along with delivery time and quantity. Two people are responsible for dispatch record maintenance and management. Truck loading force consists of 17 people. It takes approximately four hours to load one truck and set it on the roads. Often two or three trucks are loaded simultaneously. One order may contain a variety of cases in terms of bottle sizes. Therefore all the cases are dispatched from one location.

To facilitate this system, BiGG Apple 1.5 Liter bottles travel from the plant to main brewery. This 800 or so feet distance is covered using small carrier with capacity of taking 15 cases. 4 such carriers are used for bottle transportation.

If a separate dispatching unit is established inside the new plant, the company can save a lot of excessive traveling in the sun. A garage hall of about 15x30 is vacant and adjacent to Plant gate. The area is currently used as wastage store and guards room. This garage can be utilized as a dispatching unit. Company needs an employee with a computer terminal to update and manage dispatching data. If an order contains share of bottles from different sizes, 1.5 liter bottles can be loaded from this location and separate record can be maintained about their order. Moreover, both the dispatching units can be connected via a computer network and ERP system can be used to merge to data concurrently.

Recommendation 6:

Improvement of work place environment:

Clean and healthy working environment generates healthy thinking and positively effects employees. Right now BiGG Apple is produced in a factory that has an air of an untidy garage. Rough chip floor is seldom clean, a lot of syrup drips here and there making everything sticky. All the rejected bottles are piled on the floor. Uniform is not compulsory for the labors.

The team believes by improving the factory ambience a good positive influence can be created which will affect productivity by influencing employee motivation. 5S of housekeeping can be applied. Some system charts and drawings can be placed on the walls and a few new light fittings can be used to brighten up the environment. Floor can be scrubbed after each shift and things can sorted out and placed in organized manner.

IMPLEMENTATION FEASIBILITY AND COST ANALYSIS:

Implementation of some of these recommendations may look like an unnecessary or trivial investment to the organization, but every effort to reduce work overhead and excessive waste is fruitful in essence. Improvement is always good and continuous improvement is the need of the time. Quality is more of an attitude then a one time implementation. Management at BiGG Apple production plant needs to broaden its horizons in terms of quality. Investments to assure better production will pay back in terms of customer satisfaction and trust.

It is suggested that all the recommendations are implemented at a time in order to increase productivity while maintaining a good quality level.

The team suggests five areas of improvement following is the cost and benefit analysis of implementing the suggested recommendations. In order to estimate the returns from such investment, the total cost of the project must be known.

Estimated Investment:

As the five recommendations are to be implemented synchronously in order to improve total productivity, an integrated cost analysis is carried out.

Chiller maintenance costs nothing in terms of rupees. We need only two worker for 20 minutes maintenance activity per day. Labor, time, and equipment for such an activity is already available. The only missing link is the willingness and correct approach. What needs to be addressed is management's attitude towards maintenance activity.

Some investment of 120,000 rupees is needed for underground water reservoir. This estimation is based on data taken from Amjad Construction Islamabad. The cost includes labor, material and implementation charges.

Increasing filling machine effective capacity again needs no input in terms of money. However, an investment of 15,000 rupees can solve the conveyer belt layout issues. The tin top can be increased in size by welding a 2x8 sheet with it. This will increase the width and length by two feet. The conveyer belt can be lifted another ½ feet by adding welding additional steel legs.

The separate dispatching unit will need a computer terminal. Loading staff can be transferred from the main brewery to setup this new dispatching unit. We will need two computers on a network to synchronously update and maintain records. One terminal will be placed in the new dispatching unit whereas the other one will be placed in the parent unit. Records are maintained manually as yet. Not only will this facilitate the dispatching process. It will also make record keeping more secure and easy. Two professional computer operators will be needed in order to manage the network and computer records. Salaries of these computer operators will be Rs. 30,000. Other setup charges, if any, are trivial. Costs associated with this investment are:

Cost of networking and computer terminals	= Rs. 60,000
Cost of office setup including AC	= Rs. 50,000
Total cost of setup	= Rs. 110,000

Environment building and workplace improvement can cost management not more than Rs. 20,000.

With projected production increased from 6 batches to 8 batches and 6500 bottles produced per day, labor at packaging department needs to be increased by two.

Summary of these investments is as follows:

Total Estimated Investment

Area of Investment	**Amount in Rupees**
Underground Water Reservoir	120,000
Conveyer Belt Bottleneck Solution	15,000
Dispatching Unit (Setup Cost)	110,000
Environment Building	20,000
Total Cost	2,65,000

With projected production increased from 6 batches to 8 batches and 6500 bottles produced per day, labor at packaging department needs to be increased by two.
Projected increase in monthly expenses can be summarized as follows:

Increase In Monthly Expense

Area of Expense	**Amount in Rupees**
Salaries Packaging labor	2 x 4,000
Salaries Computer Operator	2x 15,000
Total Expense	38,000

EXPECTED INCREASE IN PRODUCTION:

Schedule of shifts after implementing solutions:

With the implementation of suggested recommendations, production will increase from 72,964 bottles to 98,666 bottles per day. This will be accomplished by increasing the number of batches produced pre day from 6 to 8 I the same time.

Shift 1	**Start time: 8.00 A.M**	
Batch 1	Filling Time : 8.00 A.M. to 9.55 A.M.	5 minutes idle time
Batch 2	Filling Time : 10.00 A.M to 11.55 A.M.	5 minutes idle time
Batch 3	Filling Time : 12.00 P.M to 1.55 P.M.	
	Break : 2.00 P.M. to 2.45 P.M.	
Batch 4	Filling Time : 2.45.M to 4.40 P.M.	
Shift 2	**Start Time: 5.00 P.M**	
Batch 5	Filling Time : 5.00 P.M to 6.55 P.M.	5 minutes idle time
Batch 6	Filling Time : 7.00 P.M to 8.55 P.M.	
	Break : 9.00 P.M. to 9.45 P.M.	
Batch 7	Filling Time: 9.45 P.M. to 11.40 P.M.	5 minutes idle time
Batch 8	Filling Time: 11.45 P.M. to 1.40 A.M.	

Expected Waste:

With implementation of layout solutions, waste from bottles falling and tilting on the line will be eliminated (29 bottles in 255 minutes). With increasing filling machines effective capacity, we can also control the liquid overflow on this domain. Liquid is usually spilled out of the bottles because of a long time lag between filling and carbonation. The more time syrup spends in storage tank, the more hyper carbonated it gets. With filling machine working out 6500 bottles per hour, the wait lag will decrease from 150 minutes per batch to 110 minutes. This will reduce

the carbonation problem and thus the related wastes by nothing less than 30 percent.

Proper bottle management will decrease the percentage of rejects remarkably. We assume this reduction to bring the bottle rejections to a level half the current rejections. With a tidy and organized management of empty bottles, chances of damages and dirt can be reduced as well.

Area of Waste	Observed Number of bottles	Contribution to waste	Expected Amount	Contribution to waste
Material wasted at Filling	96	32.2%	28	24.5%
Bottles removed from the line	173	58%	86	75.4%
Fallen Bottles	29	9.7%	0	
Total	298	100%	114	100%

Thus the waste percentage is reduced from 1.44% to 0.46%.

PAYBACK AND BENEFITS:

A critical factor in making decisions about any investment is the payback time and total benefit from the project. Payback period from this investment can only be calculated if the cash inflows from the project can be estimated.

Profit margin is the deciding factor which can help determine the payback inflows. Company earns a profit of 12 rupees on every bottle. This margin is calculated using company's income statements.

The calculations follow:

Current daily production target in bottles (6 batches) = 74,000 bottles
Current daily Waste (1.44 %) = 1,065
Total Production in bottles = 74,000 – 1,065 = 72,935 bottles

Proposed production target (8 batches) = (18500 x 8)/1.5 = 98,666 bottles
Expected daily Waste (0.46%) = 454
Total projected production = 98, 212

The calculation for profit increase follows:

Increase in production= 98,212 – 72,935= 25,277 bottles

Profit per Bottle = Rs 12
Current Profit per day = 12 x 72,935 = 8, 75,220
Expected Profit per day = 12 x 98,212 = 1,178,544
Increase in profit= 25,731 x 12= Rs.303, 324

The project will pay back within first month of implementation.

Constraints and Limitations:

One of the major constraints to implementation of suggested improvement strategies is the attitude of production management towards quality and improvement. It seems that the principle is only concerned about cash inflows and is not bothered about the mechanisms used to generate these inflows. As long as a sufficient amount is flowing in, nothing bothers them. Agency, on the other hand, is satisfied with conditions at hand and quality sounds like an extra overhead to them. No records are maintained to calculate and evaluate production wastes and no efforts are put into action to improve the work environment. Investing only time and thoughts to workplace conditions.

CONCLUSION

Operations and Production Management is the most important part of any organization. So these two areas must be managed properly. The flow of operations and production must be efficient enough in order to compete in the market. It must meet the forecasted demand and should be according to the budget. The cost benefit analysis should be balanced. The

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