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# Production Planning & Control in Food Processing Plant

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**Abstract—***Apply the technical and managerial knowledge in real case scenario of food industry. The goal of the project is to benefit the company & society by the studies of food plant operations management. 5S, Kaizan and Kanban is the application of this knowledge in different sections of the system. It will benefit the production, quality & other department to maintain their seamless alignment and flow and hence overall significance of the study remains the same as stabilizing the system & continuous improvement. Is that Continuous improvement is the need of every industry in every aspect to rise & sustain in today's' highly competitive market this requires the regular study of the system, identifying the waste & inefficiency of the system. And then we need to eliminate such waste & bottleneck to create free flow of resources in the system. This study will benefit the production department, packaging department, quality assurance department, dispatch department & store department to manage their daily jobs & improving their efficiency. These small improvements in individual system will contribute in improving the global efficiency of the plants.*

**Keywords***: Operation Management, 5S, Kaizan, Kanban, Quality, Control, Efficiency.*

## 1. INTRODUCTION

The main intension of this survey is to correlate the concepts of mechanical and production engineering in the field of food industry. Here we search of the different types and area of work done for the growth and development of food industry. As the demand for packed food in increasing in modern times it creates a necessity for the implementation of technical knowledge in this field to meet the increasing alarming demand.

**Carmen et al. (2014).** the 5S methodology is a very appropriate way to initiate and achieve the process of continuous improvement. **Daniyan et al. (2014),** Material handling equipment are designed such that they facilitate easy, cheap, fast and safe loading and unloading with least human interference. **Wilson et al. (2010).** This work assumes that the physical layout of the unloading facility is fixed and examines the effect that changes in the arrival times of collection vehicles will have on queuing delays at the facility. **Tussolini et al. (2014)** a feedback strategy of drying control of mate leaves in a thin-layer conveyor-belt dryer were experimentally evaluated. Multiple queues use the shared-buffer and multiple functioning options are supported. In this way, there are increased demands for detailed queuing monitoring. **Modarress et al. (2007,** a number of advanced techniques, such as just-in-time, total quality management, lean manufacturing, flexible manufacturing systems, process improvement, and design for manufacturability, to name a few. **Manuel et al. (2012),** it shows that Kaizen from the angle of implementation of process innovation methods, and so the aim of this paper is to understand how these methods of process innovation are applied in the context of Kaizen in organizations operating in Ibero-American countries. **Raymond Mawson. (2008).** in Applications and opportunities for ultrasound assisted extraction in the food industry states that Ultrasound assisted extraction (UAE) process enhancement for food and allied industries are reported in this review. **Ning Wang et al. (2006),** in Wireless sensors in agriculture and food industry—finally, based on an analysis of market growth, the paper discusses future trend of wireless sensor technology development in agriculture and food industry.

**David Farr (1990),** at present, the available machines work only for batch processing and have very small working volumes. The problem of achieving high throughput, while minimizing cost and optimizing operational lifetime remains to be solved.

## 2. METHODOLOGY

This study includes more than one method to solve the problems. It is the problem solving activity which involves the process optimization. The methodology is described and decided as per the need of the scenario. Research methodology is well discussed in every chapter with its problems. These methods include LPP, Queuing Model, and Lean Tools etc., to use the resources optimally. The guiding methodology of the study at outer frame can be explained by the following flow chart:

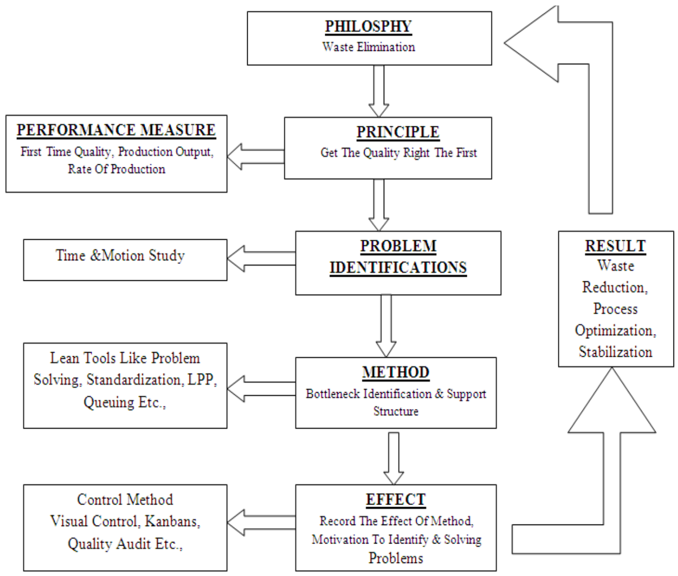



**Fig. 1: The guiding methodology of the study at outer frame**

The research methodology is much diversified as per the need of the problem, but the basic method remains the same as per the above flow chart. This study is carried out in different department which required different level of attention. The research method opted for different case aims to meet the objectives within given frame of time & constrains.

Utilization of the system is directly proportional to the arrival rate and inversely proportional to the service rate. It means with increase in arrival rate of the cartons, the utility of the system will increase.

If the service rate will be increased then the utilization factor will increase. This will help in decreasing the time for waiting by student in the mess. Opposite of it if the service rate is decreased then the length of queue will increase, hence, the time spent by the cartons in the system increase.

### 2.1 Assumptions in Ideal Case

1. All the machines & workers are working on their rated efficiency & capacity.
2. There is no breakdown or quality rejection is considered during the process.

### 2.2 Assumption in Real Case Scenario

1. This case follows the normal distribution & experiential distribution.
2. The mean average method can be used to identify the central tendency to system.
3. The production rate of packing section is based on previous data available & experience of the senior executive & workers.
4. The different SKUs like "export &market" considered as same for study.
5. Other packing system like packing of dispenses is not considered.
6. The study is carried out only for the day shift.
7. The production level is usual and packing demand & rate of production remains nearly leveled.
8. The study is carried out for the bottleneck in the system. So, it makes it an M/M/1 model.

## 3. PROBLEMS AND DISCUSSION

### 3.1. Problem 1: - Selection and Design of Proper Conveyor System

After the observation of the 90 days, we can understand the requirement of the different types of machines. Thus we can conclude that there is some hurdles to carry the gunny potato bags from the lift. So here we suggest and discuss with our project head to put here conveyor system to save the time, labor and capital. Through this conveyor system, we can put gunny bag continuously without any interruption.

So we place the requirement of conveyer system to different vendor companies. So the vendor companies give their quotation within 3 days. In this quotation, the vendor companies will give the specification of machine with service period time; guaranty month and total estimate include tax and transportation. Whose further details are attached in appendix [01].

### 3.1.1 Specifications of Conveyor System

**CONVEYOR A**

Type: Non Motorized Roller Conveyor / Flat Bed

Purpose: Loading / Unloading Goods

Structure: 100mm U Channel

Dimensions: 1200mm (length) X 775mm (width)

Roller: Arrangement Rollers fitted at 50mm gaps

Structure Height: From GF – 900mm to further attach with Inclined Conveyor – 'B'

**CONVEYOR B**

Type: Motorized Belt Conveyor / Inclined

Purpose: Move goods from GF to II$^{nd}$ Floor (Ht. 7000mm)

Structure: 127mm U Channel

Height: 900mm at Loading & Unloading point

Total inclination - 6000mm

Dimensions: 17500mm (length) X 775mm (width)

Arrangement: Rollers with MS support sheet

Structure Height: From GF – 7100mm to further attach with diverter Conveyor – 'C'

**CONVEYOR C**

Type: Motorized Belt Conveyor / Inclined

Purpose: 90 degree Diversion of goods from Conveyor 'B' to IInd. Floor (Ht. 9mts – Landing Point).

Structure: 100mm U Channel

Height: 7000mm at Loading & 9000mm at Unloading point. Total inclination – 2000mm

Dimensions: 3050mm (length) X 775mm (width)

Arrangement: Rollers with MS support sheet

Structure Height: From GF – 7000mm to further attach with Landing Conveyor – 'D'

**CONVEYOR D**

Type: Non Motorized Roller Conveyor / Flat Bed

Purpose: Loading / Unloading Goods

Structure: 100mm U Channel

Dimensions: 1200mm (length) X 775mm (width)

Roller Arrangement: Rollers fitted at 50mm gaps

Structure Height: From GF – 9000mm – Final Landing Point

**3.1.2 Cost Analysis for the Manual Handling of Potatoes (Ground floor to 2nd floor):**

Below given data observed carefully in the 90 days and after that I did some calculation to prove that manual handling is costly, time consuming and also it slows down the operation and it helped me to explain the importance and need of conveyor system.

Daily Total Consumption of Potatoes = 9 Tonne (9000 Kg)

One Bag of Potatoes Carries = 100 Kg

Total Number of Bags = 90

Workers Available (to carry potatoes bag from GF to SF) = 10

Total Time Consumption = 180 min = 3 hr

Consumption in 90 days = 8*90 = 720 Tonne (720000 Kg)

Charge of 1 Worker = 400 per day

Total Charges of 10 Workers = 10*400 = Rs 4000

Total Charges for 90 Days = 4000*90 = 360000 = Rs 360000

Above calculated amount of labor charges for 90 days is Rs 10000 more than the estimated amount of the conveyor system i.e. Rs 350000.

If we install the conveyor system for the loading and unloading of potatoes from ground floor to second floor which consumes less time, more efficient and removed all human error.


**Fig. 2: Plant layout with conveyor system**

**3.2 Problem 2: -Queuing Analysis for Bikanervala**

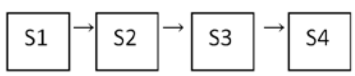
Manual Packing + I$^{st}$ floor Packing

**Fig. 3: Dispatch System**

*Ground floor packaging*
↓
*Evaluation of packingBar codes on cartoons*
↓
*Tapping*
↓
*Strapping*
↓
*On pallets & Dispatch*

This study is required because if service rate at dispatch is not able to meet the required arrival rate over the (tolerance) limit of 75 to 100 cartons then it will create a case of jamming in the whole packing section. This jamming could lead to stop of packing machine and loss of production capabilities & resources.

So, the major idea of this study is to elaborate the application of queuing theory in BFPL in real time scenario. In dispatch section, a packed carton has to go for the multiple services before dispatching.




On service station S1 the evaluator of product code & types & SKU is done. This takes hardly 2-3 sec.

On service station S2 an automatic machine automatically generates a Bar code as per evaluation from S1 as paste it on the carton. It takes hardly 1-2 sec.

On Service station S3, we have manually tapping of carton. This tapping is the actual bottle neck which can take average service time of 14 sec.

On S4 service station, we push the carton on automatic strapping machine which straps it and load it on pallet. This is a small process hardly taking 3-4 sec. per carton. So, this study helped us to formulate the problem and discuss the results.

### 3.2.1 Bikanervala Queuing Analysis

There are two cases that can be considered in Bikano:

First one is the ideal case scenario, where we expect that all packing machine are working fine & on their rated capacity.

Second case is the actual scenario, for which we have considered the actual packing capacity of the packing plant.

Let us discuss each case one by one:-

**I$^{st}$ Scenario**

In ideal case we consider that the entire packing machines are working on their rated capacity. So, we calculated the filling rate of each machine, and the time required by them to pack one carton.

This study revealed that, this two floor packing section has filling rate as following -:

Ground floor - 2820 cartons/shift

First floor - 2780 carton / shift

Manual packing - 400 cartons / shift

The company has the policy of 10 hours shift per day.

So, the case given the arrival rate of following from each floor per hour:-

Ground floor - 282carton/hour

First floor - 278 carton / hour

Manual packing - 40 cartons / hour

i.e., arrival rate of the carton comes out to be 600carton/hour (1)

But the services rate at the multi level platform remains same. The service rate can be decided by the bottleneck activity of the system, because all service stations are very nearby and connected by automatic conveyor.

We identified the tapping & closing of the carton takes nearly six seconds to process one carton.

So, time taken to service one carton = 6 Sec.

Number of cartons processed in 1 min. = 60/ 6 = 10

No. of cartons serviced in 1 Hrs. = 600carton

This show service rate is 600carton per hour (2)

Now evaluating statement 1 & 2

We found that service rate is equal to the arrival rate.

So, it is obvious that we will found queue in the system every time.

The value Ƥ = $\lambda / \mu$ = Average arrival rate/Service rate

Where

Ƥ = probability that system is busy

And it came out to be Ƥ = 600/600 = 1

So, we found that the system will remain busy any time in, ideal case.

**II$^{nd}$ Scenario**

Here, we considered the real case scenario. For this we used the experience of executive, and study of packing planning to identify the packing capacity of the system.

We concluded that the packing section has, on an average capacity as

Ground floor - 2000 carton/day

First floor - 1600 carton /day

Manual packing - 400 carton / day

The packing efficiency varies significantly during day shift and night shift (each of 10 Hours) so cartons packed during day shift of our study is:-

Ground floor - 1200 carton/shift

First floor - 960 carton /shift

Manual packing - 240 carton / shift

So, the net capacity per hour of the packing section (in day shift) comes out to be:-

Ground floor - 120carton/hour

First floor - 96 carton / hour

Manual packing - 24 carton / hour

The Average arrival rate (λ) of the system comes to be =120+96+24 = 240 carton /hour.

Now, the Service rate varies significantly with the type of cartons packing & operator.

The number of set of reading shows that taping operator can take 8 sec. to 20 sec. to service a carton. So we has considered average service rate to be 14 sec.

So, the Service rate per carton is 14 sec.

The carton serviced (μ) = 3600/14 = 257.14 say 258 cartons.

### 3.2.2 Queuing Calculations

1. Probability that System is Busy
$$P = \frac{\lambda}{\mu} = \frac{240}{258} = 0.93$$

2. Probability that System is Free
$P_o = (1 - P) = 1 - 0.93 = 0.07$

3. Waiting Time in Queue
$$W_q = \frac{\lambda}{\mu(\mu - \lambda)} = \frac{240}{258(258 - 240)} = 0.051$$

4. Length of Queue
$L_q = W_q * \lambda = 0.051 * 240 = 12.24$

5. Waiting Time in Service
$$W_s = \frac{1}{(\mu - \lambda)} = \frac{1}{(258 - 240)} = 0.056$$

6. Average Length of the System
$L_s = W_s * \lambda = 0.056 * 240 = 13.44$

Where,

λ = Average Arrival Rate

μ = Average Service Rate

$W_s$ = Waiting Time in Service

$L_s$ = Average Length of the System

$W_q$ = Waiting Time in Queue

$L_q$ = Length of Queue

Ƥ = Probability that System is Busy

### 3.2.3 Significance of Queuing Model

**Wq** signifies the average waiting time in the queue of any student, calculation shows that, on average, any carton have to wait for 0.051 hours (3.06 minutes) before getting served in the queue.

**Ws** signify the waiting time in service of a carton. It shows the time, a carton needs to spend in service. Calculation shows that a carton needs to wait for 0.056 hours (3.36 minutes) in the system.

**Ls** and **Lq** signifies the average number of cartons available in the queue and the system (queue + service) respectively. The total comes out to be 13+14= 27 cartons.

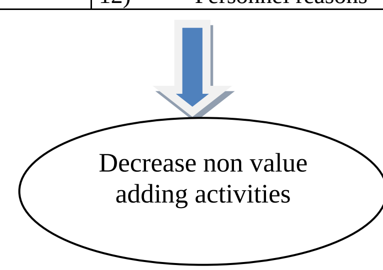
**Ƥ** shows the probability that system is busy. So, the above calculation shows that – it is 93% of probability that system is busy during day shift.

**Ƥo** shows the probability of the system is not busy. 7 % is the probability that system is not busy during the shift.

### 3.3 Problem 3: - Continuous Improvement (Kaizan) for Bikanervala Food Pvt Ltd

We observed the following activities performed by the operator and distinguished them on the basis of value adding and non value adding.

| Value adding activity | Non value adding activity |
|---|---|
| 1. Feeding in of dough | 1) Handling of dough making utensil |
| 2. Wait for temperature gain of oil in fryer | 2) Feeding oil in fryer |
| Increase value adding activities | 3) Cleaning up the nearby residue |
| | 4) Cleaning and changing of extruder's sieve |
| | 5) Putting oil in extruder and feeding pan |
| | 6) Tea and lunch break |
| | 7) Meeting with other workers and operators |
| | 8) Breakdown |
| | 9) Waiting for dough |
| | 10) Adjusting extra material feed in the extruder |
| | 11) Quality check of output |
| | 12) Personnel reasons |



We observed that the feeding time of one batch of dough in 4 minutes 30 seconds for an average operator. A single batch of dough (62 kg) gives the output of 50 kg base (and with all his efforts, operator cannot able to extend the output of fryer more than 350kg and average output remain 300 kg in current scenario).

We did the required calculations to indentify the output that can be taken out from the fryer if feeding remains continuous.

Standard output time per batch = feed time + allowances

Allowance time = 10% of actual feed time

Allowance time = $\frac{10}{100} \times 270 = 27$

Standard output time per batch = 270 sec+27 sec [4 min 30 seconds = 270 sec] = 297 sec

This shows only 297 sec. (consider them as 300 sec) are required to process one batch.

And we can take nearly 3600/300 i. e. 12 batches in an hour.

And the net output of the fryer comes out to be 12 (batches)*50 (kg) = 600 kg per hour. This is twice of our current average output.

Hence, we can increase the efficiency of the output to double by just eliminating non value adding activities from the account of the operator.

## 4. CONCLUSION

All the identified problems solved successfully by the Kaizan, 5S and Kanban application and recommendations based on that solutions are successfully implemented in the company so that they can achieve the expected production quantity and improved efficiency.

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