# USE OF TQM TOOLS FOR PRODUCTIVITY IMPROVEMENT

## *A PROJECT PROPOSAL*

***SUBMITTED TO***

## INDIAN INSTITUTION OF INDUSTRIAL ENGINEERING

**To be carried out at:**
**(XYZ INDIA PRIVATE LTD, CBD BELAPUR, THANE)**

**By**

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# INDEX


| Sr. No. | Title | Page No. |
|---|---|---|
| 1 | INTRODUCTION | |
| 2 | ORGANIZATION DETAILS | |
| 3 | PROBLEM STATEMENT | |
| 4 | LITERATURE REVIEW | |
| 5 | DATA COLLECTION METHODOLOGY | |
| 6 | DATA ANALYSIS | |
| 7 | COST BENEFIT ANALYSIS | |
| 8 | RECOMMANDATIONS | |
| | REFERENCES | |

# CHAPTER 1. INTRODUCTION

## 1.1 INTRODUCTION OF SUBJECT

The XYZ India private limited company is situated at Survey No. 1072, CBD Belapur, Navi Mumbai. The manufacturing capacity of the line is 8000 units per day or 2 Lakh springs per month with three shifts of operation. However the consolidated demand of Maruti, Mahindra, Volks Wagon, General Motors and Ford is 3.3 Lakh per month. The suspension line includes 14 workstations carrying out different processes. This project is related to improvement in the production capacity of the powder coating line.

## 1.2 PROBLEM ON HAND

Out of 14 workstations in the assembly line the production capacity of 12 work stations is already improved. Other 12 workstations can produce 14 to 16 jobs per minute whereas two workstations namely pretreatment and powder coating produce 8 jobs per minute. In order to cater the customers demand the monthly production is to be improved from 2.0 Lakh to 3.3 Lakh or by 65%.

## 1.3 IMPORTANCE OF THE PROBLEM

There are six issues which can be taken into hand for productivity improvement having potential saving in the present expenditure by Rs. 16.50 Lakh per month. The expected improvement in production with the implementation of this project is 1.30 Lakh per month (from 2.0 Lakh present to 3.3 lakh after March 2016). Considering the value added by the Powder coating process i.e. Rs. 5/- per piece, the total gain troth this project will be 6.50 Lakh. This is highest i.e. 39% of the saving in the expenditure. Therefore this problem is taken on the top priority among others.

Not only economic benefit but the customers demand will be fulfilled, therefore we can expect more growth in the future. Also existing resources can be better utilized with the improvement in the capacity of the powder coating.

## 1.4 AIM, OBJECTIVES AND SCOPE OF THE PROJECT

Aim: The aim of this project is to improve the capacity of the powder coating line by 65%. In other words 'to improve capacity of existing line for producing 3.3 Lakh jobs per month'

Objectives of the project are decided in advance on the basis of observation of the present situation and expected results. This will give direction to the project work. On the basis of above discussion the objectives of this project can be set as below:

1) To study in detail the present process of production and estimate the variables
2) To study the alternatives available and evaluate the same
3) To implement the recommendations in the period of one month after approval. And improve the productivity by 40 to 50% of the present.
4) To observe the functioning of the modified process for two months and record the production and consumptives.

# CHAPTER 2. ORGANIZATION DETAILS

## 2.1 INTRODUCTION

The Mueba Company established in 1916 in Germany; now operating as global partner for automobile industry. The Mubea Company has its exclusive Research and development, manufacturing and marketing facility for Automotive, Engine, Transmission, Body and Interior product segments. The company has existence in North and Middle America, South America, Asia and Europe. The overall employees in the company worldwide are 10200, having strong customer base i.e. 21 original equipment

manufacturers and 28 production and sales and development sites. The overall turnover of the company is 1.60 billion €.

## 2.2 THE ORGANIZATION

The plant of the company is situated about 25 Km from Thane station. Mainly chassis components like Suspension spring and stabilizer bars are produced in the plant. Plant is working in 3 shifts. Total plant is distributed in different department like Production, Maintenance, Quality, Engineering, Human resources, Sales and Finance. The company supplies 48% of production to Maruti-Udyog limited Plant. Maruti, Volkswagen and Tata Motors share is 20% of the total. This is revised business share as per 2016- schedule.

### 2.2.1 PRODUCTS

There are 3 basic products which are produced in this facility include a) Induction hardened and tempered wire ( ITW) , b) coil springs and c) stabilizer bars. ITW wire is used for manufacturing suspension coils which is used in suspension assembly for all type of cars. Stabilizer bars used for safety as well as balancing unit for cars. Suspension springs and stabilizers are mainly supplied to all OEM in India like Tata Motors, Mahindra Ltd, Volkswagen, Maruti, General motors, Ford India, Ashok Layland and Volvo Ltd.

### 2.2.2 PROCESSES

As our project is related to powder coating. It includes 13 processes and three inspection stages. Powder coating is carried out after pretreatment of the job. After that scragging, colour marking and packing are carried out. Two related processes are described herewith.

a) Pre- treatment process – The springs which are loaded on conveyor are passed through spray type tunnels where springs are passed through – Degreasing, Rinsing, Phosphating, activation, Rinsing and De-Mineralized water rinsing.

b) Powder coating process – After chemical process springs passed through Drying oven at 150 degree , Epoxy powder coating , Backing oven at 180 degree for 30 minutes and finally springs are unloaded for next operation at room temperature

### 2.2.3 FACILITIES

There is a complete automated Coil springs manufacturing line which consist Coiling machine, stress relieving oven, warm peener, stress peener powder coating plant and load checking machines. There is one more line for stabilizer bar manufacturing line which includes CNC bending machine, stress-relieving, hardening, shot blasting and powder coating. Details of the powder coating line will be furnished in the project.

### 2.2.4 ORGANIZATION STRUCTURE

The plant head is the chief person responsible for overall functioning of the plant. New project head, Production, Materials, Quality and Production planning and control are various departments handled by the functional heads. Our project is taken in the paint shop under the production department. It is handled by the shop in-charge. There are total 250 employees working in the company including 210 operators on permanent and contractual basis. Apart from operatives the staff is only 40 which include managers, engineers and line leaders. There is union in the company and 70% of the employees are members.

## 2.3 ORGANIZATIONAL BUSINESS PROFILE

The turnover of the company is growing steadily in double digit since 2012. In 2016 the growth is 15% of the previous year. The average growth of the company from year to year is 12%. The turnover of the plant is 92 Crores (target) in the year 2016.

## 2.4 OTHER RELEVANT INFORMATION

In the quality laboratory we have installed modern testing machines like UTM, 3D load checking, Nakamura test machine, Fatigue testing, salt test, Metallurgy lab, Microscopes. Powder coating is a hazardous process henece due precaution of the employees and resources is taken. All employees are wearing all personnel protection equipment. Fire extinguisher system and emergency plan are monitored in the company.

## 2.5 CONCLUSION

This chapter introduces company from various angles. Necessary figures of the spring and bar will be given in the project. On an average the company is growing 12% every year since 2012. Maruti-udyog limited consumes are 48% business share of the company. It is also highest purchaser of the suspension spring.

# CHAPTER 3. PROBLEM STATEMENT

## 3.1 INTRODUCTION

As per agreement between company management and clients we need to manufacture 3.30 Lakh suspension spring per month. Before implementation of the project this capacity was 2.0 Lakh per month for working in three shifts. Thus this project had been taken up to fulfil the aggregate customer's demand. The improvement from present 8 to at least 14 jobs per minutes is expected through implementation of this project.

## 3.2 DETAILS OF PROBLEM

The Coiling and Powder coating consists of 14 processes. The process name and production capacity of the each work station are given in the following table. All these workstations are arranged in straight line in the shop.

| Table 3.1: Workstation processes and their capacity | | | | | |
|---|---|---|---|---|---|
| Work stations | Coiling and Powder coating processes | Production Capacity jobs per min | Work stations | Coiling and Powder coating processes | Production Capacity jobs per min |
| WS1 | Eddy current testing | On line | WS8 | In-process Inspection | On line |
| WS2 | Cold coiling | 16 | WS9 | Pretreatment | 8 |
| WS3 | Stress relief | 14 | WS10 | Powder coating | 8 |
| WS4 | Warm Peening | 16 | WS11 | Scragging | 16 |
| WS5 | Presetting | 16 | WS12 | Colour marking | 16 |
| WS6 | Stress Peening | 16 | WS13 | Final Inspection | On line |
| WS7 | Laser marking | 16 | WS14 | Packaging | On line |

Here we locate the workstation WS 8 and WS 9 which are related to powder coating have production capacity of 8 jobs per minute only. Thus the problem is to improve the productivity of the powder coating process.

Following table shows available time for production and monthly production with existing situation.

| Table 3.2: Available time and Production in shifts | | | | |
|---|---|---|---|---|
| 1 | Shifts | I | II | III |
| 1 | Net available time for production in minutes | 420 | 420 | 330 |
| 2 | Production in Nos per minute | 8 | 8 | 8 |
| 3 | Theoretical daily production in Nos | 3360 | 3360 | 2640 |
| 4 | Actual production with 87.50 % efficiency | 2940 | 2940 | 2310 |
| 5 | Monthly production in Nos considering 25 working days | 204750 | say | 2 Lakh |

The demands of the clients are shown in the following table. This clearly indicates due to increased demand of Maruti Udyog and Ford we need to improve the capacity of the existing line.

| Table 3.3: Present and future demand of the spring | | | | |
|---|---|---|---|---|
| S/N | Companies | Location | Present Demand | Demand from March 2016 |
| 1 | Maruti Udyog | Gurgaon, India | 80000 | 150000 |
| 2 | Mahindra | Kandiwali and -, Thane | 30000 | 30000 |
| 3 | Volks Wagon | -, Thane | 50000 | 50000 |
| 4 | General Motors | -, Thane | 20000 | 20000 |
| 5 | Ford | Chennai and Sanand | 20000 | 80000 |
| | | Total | 200000 | 330000 |

### 3.2.1. HISTORICAL PERSPECTIVE

The production scenario is obtained from the production department for the 10 months ( April to November 2015) shown in the following table.

| Table 3.5: Production history ( April 15 to Jan2016) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Months | Working days | Production | Average daily production | Months | Working days | Production | Average daily production |
| Apr-15 | 25 | 200125 | 8005 | Sep-15 | 26 | 206000 | 7923 |
| May-15 | 25 | 200000 | 8000 | Oct-15 | 25 | 199300 | 7972 |
| Jun-15 | 26 | 207550 | 7983 | Nov-15 | 22 | 178300 | 8105 |
| Jul-15 | 26 | 208000 | 8000 | Dec-15 | 26 | 208500 | 8019 |
| Aug-15 | 25 | 200350 | 8014 | Jan-16 | 25 | 208000 | 8320 |
| | | | | Average | 25 | 200703 | 7998 |

The historical data indicates on an average production of the line is 2.0 Lakh per month or 8000 per day in three shifts.

### 3.2.2. CAUSE AND EFFECT RELATIONSHIPS

Less number of spray guns in the system, Design of the hanger and insufficient flow of various resources such as phospheting, water and powder are responsible for lower capacity of the powder coating process. Present setting of the pumps and movements, PLC programming and powder coating guns are necessary for coating 8 springs at a time. The present set up and design therefore it is necessary to improve present setup in terms of

phospheting flow, hanger design, pump setting and other relevant changes in order to improve productivity.

### 3.2.3. CRITICALITY OF THE PROBLEM

This problem is critical because all other workstations are modified for the increased demand of the clients. Due to the lower capacity of the powder coating the capacity of other workstations cannot be utilized property. Therefore the project is necessary for improving production and utilizing available resources. Also it is responsibility of the company to fulfil increased demand of the client. It will also increase revenue of the plant by 65% (of suspension spring only). Thus company will get Rs. 17 Lakh per month (1.30 Lakh springs x Rs. 13) additional business from this initiative. Thus from economic viewpoint also this project is important.

## 3.3 CONCLUSION

At present the line is capable to produce and supply 2 Lakh suspension springs per month. Now the demand is increased to 3.3 Lakh per month, this initiates the project. In the historical perspective we have furnished production for the period of 10 months. In a month the company works for 26 days average. This project intends to fulfil the shortfall in the demand by improving capacity of the powder coating line by 65%.

# CHAPTER 4: LITERATURE REVIEW

## 4.1 INTRODUCTION

In this chapter we are going to present previous studies in the field of productivity improvement and powder coating. This will provide us theoretical background which will be useful us for the finding out the alternatives and implementation. At this moment we have used five references form books and journals. As the title of the project implies we will take review of three key words namely: productivity improvement, powder coating process and suspension spring.

## 4.2 PRODUCTIVITY IMPROVEMENT

Productivity improvement is one of the core strategies towards manufacturing excellence and it also is necessary to achieve good financial and operational performance. It enhances customer satisfaction and reduce time and cost to develop, produce and deliver products and service. Productivity has a positive and significant relationship to performance measurement for process utilization, process output, product costs, and work- in-process inventory levels and on-time delivery. Improvement can be in the form of elimination, correction (repair) of ineffective processing, simplifying the process, optimizing the system, reducing variation, maximizing throughput, reducing cost, improving quality or responsiveness and reducing set-up time. In our case the improvement in the productivity pertains to reduce time and cost associated with the powder coating process. It will utilize the existing setup optimally and also end to reduce product cost per unit.

## 4.3 POWDER COATING

Powder coating is an advanced technology for industrial application of paints on metal and glass objects. Powder coating gives a more attractive finish, superior corrosion resistance and protection, better mechanical properties and is more economical than conventional liquid paints. It gives a protective coating to the articles and also it improves their aesthetic

appearance. The powder coating can be done on metals and glass objects.

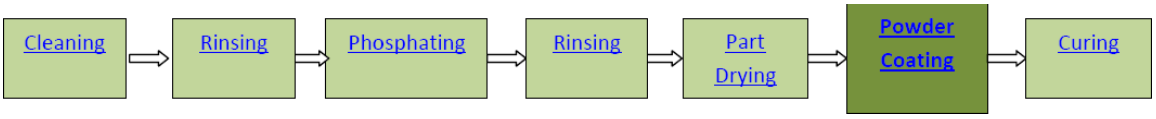



Fig 4.1: Powder Coating Process

## 4.4 POWDER COATING PROCESS IN BOOTH

MEME, 2011 [1] explains the powder coating process in the booth. First the surface which is to be coated is cleaned perfectly by giving a pretreatment i.e. degreasing, chromating so that the oil, grease, dust and rust should not remain there. Now give a phosphate coat on the surface by phosphating process, wash and dry the object. Dry powder is filled in a hopper where it is fluidized by low pressure gas. Then it comes to the gun through a flexible hose where it is electro-statically charged by a high voltage generator. An electrostatic field is produced between the gun nozzle and the earthed object, which is already kept in spry booth. The powder particles get uniformly deposited on the object. Now remove the objects from the spray booth and keep it in the oven at the temp. Approximately 150 degree C for 10 to 15 minutes the powder metals get polymerized and form a solid hard film. The over sprayed powder is recovered by a separate recovery system attached with the spray booth. Now remove the object from the oven and it is the finished goods.

Akzo Nobel, 1999, [2] stated that the cleaning method consists of chemical or mechanical process. Depending upon characteristics of the surface it is planned. Rinsing with fresh water is necessary to 'drag-out' the effect of previous wash and neutralize the surface. It should not be contaminated with alkali, acid or any other compounds. Water quality plays important role in the rinsing

## 4.5 SAFETY AND PRECAUTIONS

In this section we have taken review of the hazards of the powder coating process. Explosion, health hazards and environmental pollution are possible by the use of powder

coating process. Here we have described the same along with necessary precautions to be taken to avoid it. In general terms the powder is combustible and within certain defined limits of powder-air concentration will form a potentially explosive mixture. The inhalation of powders, even inert ones, should be avoided. It is recommended to maintain in the atmosphere of workshops as low a concentration of powder. The average concentration of powder in the spray booth should be below 50% of the value of the lower explosion concentration.

**4.6 RELEVANT CASE STUDIES**

This research paper Jadhav, 2015[3] is most relevant to our case. The aim of this paper was to improve process structure and work stations by implementing lean principles. The company was in the business of manufacturing of Hot coil springs, Stabilizer bars, Torsion Bars and Strut bars for the automotive industry in line with customer expectations. In this project the author changed the hanger design and made more jobs coated. Implementation of this project resulted in economically feasible solutions. Powder coating station reduced the rework of coil springs by 4% and operator motion reduced by 50%. Powder wastage due to deposition on hanger was reduced 2kg /day saving and hanger life improvement in 4 months. The net cost saving per year was Rs. 4, 50,000/-.

In our case also there is scope for changing hanger design to accommodate more suspension springs at a time. This will improve the productivity.

Pongchanun Luangpaiboon, 2010 [4] carried out study for powder coating process improvement. The quality measures of interest are the metallic paint thickness values. Because of these lower quality levels, the manufacturer has spent more on the cost of restudy or scrap as well as the longer production time. The new settings improved the paint thickness values in terms of both the average and the standard deviation on all critical areas except the window between spoke. As expected, the implementation brings the reduction of the

metallic paint consumption and the mismatch level of color shade. The new levels of process variables bring the 13 % reduction on the metallic paint usage in

each wheel during the manufacturing process and improve the first time quality from 75% to 88%.

**4.7 SUSPENSION SPRING**

N. Lavanya, 2014 [5] explained design of the suspension spring. The complete suspension is to absorb road shocks and vibrations otherwise it is transferred to the passengers and load. It must keep the tires in contact with the road, regardless of road surface. A basic suspension system consists of the parts springs, axles, shock absorbers, arms rods and ball joints. The spring is the flexible component of the suspension. Coil springs are used on the front suspension of most modern light vehicles. Then the spring act as an elastic object used to store mechanical energy. They can twist, pulled (or) stretched by some force and can return to their original shape when the force is released. A coil spring is made from a single length of special wire, which is heated and wound on a former, to produce the required shape. The load carrying ability of the spring depends on the diameter of the wire, the overall diameter of the spring, its shape, and the spacing of the coils.

Fig 4.1: Suspension Spring



Suspension spring is made up from 54 SiCr6 material having diameter from 90 mm to 150 mm. The length of the spring varies from 200 to 500 mm in 6 to 8 turns.

**4.8 CONCLUSION**

In this chapter we will refer more case studies and books in the project. The

general concept of productivity and measures is attempted at first. The powder coating process and various parameters related to it are explained. This project has been carried out to improve the powder coating process of suspension springs. Thus the product spring is explained in detail along with functions and loading. Health and safety associated with the process is very informative. It also explained various precautions to be taken in the process to avoid risks. For this purpose in Mubea Company we use powder coating booth.

# CHAPTER 5. DATA COLLECTION METHODOLOGY

## 5.1 THE TYPE OF DATA NEEDED

Primary and secondary type of data needed to carry out the project. Primary data collected by observation, measurement while secondary data collected by from company record. This record is maintained by the quality and rework departments. Also websites, books and journals will be used to get required related theoretical information. Production, time of the powder coating and specifications will be collected. Also consumption of various resources for the pre-treatment and powder coating are necessary.

## 5.2 THE SOURCES FOR THE COLLECTION OF DATA

Data for the purpose of this proposal is collected by me from internal sources. It is from the production, HR, Quality and maintenance department. Observations will be taken for the time elements. For the project primary data will be observed for the period of three months after implementation of the project. A log book record of the rework will be maintained at the rework section. We will also collected data from external sources such as suppliers.

## 5.3 METHODS OF THE DATA COLLECTION

First of all the Plant Head will be contacted with detailed information and data. The presentation of the fact will clear the problem. Data will be collected and used with due permission. Data will be collected using observations, measurements and interview.

The team members will be involved for the collection of data. Log book record will be used. Time and quality of the powder coating will be observed. Meter readings of the consumption of resources will be recorded.

**5.4 PROCESSING OF THE DATA FOR ANALYSIS (TYPE OF ANALYSIS)**

In this project we are going to use qualitative as well as quantitative techniques. In the qualitative analysis experienced personnel will be interviewed to find out the causes behind the problem. Why-why analysis, cause and effect diagram will be used for this purpose. Histogram, Scatter plot, difference in numbers and percentage will be used to show the results. Benefit cost analysis and payback period will be used for economic analysis. Comparison will be done in the data before and after implementation of the recommendations.

**5.5 CONCLUSION**

Two types of data namely primary and secondary will be presented in the project. The data will be collected from authentic sources. Observation, measurement and interviews will be used to collect data after implementation. Processing of the data will be carried out in the Excel spreadsheet. Necessary industrial engineering, economic and statistical techniques will be used for the analysis.

# CHAPTER 6. DATA ANALYSIS

## 6.1 CHOICE OF TECHNIQUES

In this chapter we have proposed to use methods of problem analysis on the basis of experience of the employees. Also statistical analysis will give detailed idea about various parameters which need to be controlled during the powder coating process. Pareto diagram and 7 QC techniques will be used in separate section.

## 6.2 PARETO ANALYSIS

In this section we will describe the basis behind selection of the problem using Pareto analysis. The highest critical problem will be resolved. The criticality of the problem will be decided on the basis of secondary data. This will helps us to select top priority of the problem. Bar diagram will be used for this purpose. Cost and inconvenience to the company are basis behind the problem selection.

## 6.3 4W-1H ANALYSIS

In this analysis we have discussed on the powder coating productivity improvement five questions where, what, who, when and how are explained in this exercise. This is primary analysis we have carried out in the team members about the requirement of the productivity improvement. The result of this analysis is conveyer loading, hanger design, consumption of resources and modification in the spray system are required. For this we need to check the quality of the powder coating on the basis of trial and error. The detailed analysis will be given in the project.

## 6.4 CAUSE AND EFFCET ANALYSIS

We will categorize various causes behind lower productivity into five major classes i.e. Man, material, method, machine and Mother Nature. After that each cause will be discussed among the group members and identify its relationship in our case. The most impacting causes will be identified and marked as key for implementation. The

recommendations and corrective actions will be decided on this basis.

**6.5 PRODUCTION BEFORE AND AFTER**

In this section we will present production before and after implementation of the project. We have already given 10 months data before implementation of the project. The post implementation production will be compared in this section. Scatter plot and bar diagram of the average will be used to show production. It indicates the improvement after implementation of the project. However magnitude of the improvement will be calculated on the basis of average production.

**6.6 IMPROVEMENT IN THE PRODUCTIVITY**

In this section we productivity improvement per day and per minute will be compared. At present the powder coating of 8000 jobs (average) is possible per day in three shifts. This is expected to increase by 40 to 60%. Comparison will be done on the basis of percentage and number of production per day.

**6.7 CONSUMPTION OF ELECTRICITY**

In this section we will explain Electricity consumption before and after implementation of the project. The data of 10 months electricity consumption in Kwh (units), production and electricity consumption per Lakh jobs will be given in the chapter No.3. Post implementation observations will be taken and recorded. At present the electricity consumption is on an average 63736 Kwh per Lakh which is expected to reduce. As usual bar diagram of the average will be used for comparison.

**6.8 CONSUMPTION OF LPG**

The consumption of liquid petroleum Gas ( LPG) is necessary for heating the oven, drying oven and baking oven is required. Similarly hot water generator station working hours will be increased due to excess heating of water. This is necessary for increased number of jobs. The effect of all these will be increase in the total consumption of the LPG. Before

implementation the LPG consumption is 3737 to 4071 Kg per month. This is expected to reduce. This will be increased after implementation of the project. However the LPG consumption in Kg per Lakh Jobs will be reduced.

### 6.9 CONSUMPTION OF DEMINERALIZED WATER

The Demineralized water is required to maintain PH of the chemicals. Due to higher number of jobs at a time job rinsing process need to be increased. Higher level of operation of spray is necessary for this. DM water consumption in kilo Litres will be recorded after implementation of the project. The record before implementation of the project will be considered for a period of 10 months whereas after implementation we have maintained it for at least 3 months.

### 6.10 CONSUMPTION OF INDUSTRIAL WATER

Consumption of Industrial water will also increase on account of higher number of jobs are rinsed at the final stage. As given in previous section the consumption industrial water in KL before and after implementation of the project will be shown in the tabular form and average will be shown using bar diagram. Similar comparison will be done for this section also. At present 82 to 90 KL industrial water in required for this purpose.

### 6.11 CONSUMPTION OF EPOXY POWDER

The epoxy powder required for powder coating of the jobs. Additional guns are required for spraying of the Epoxy powder. The consumption of this will be increased due to this and reduced conveyor speed (higher time for spraying). The summary of 10 months before and at least 3 months after implementation of project will be presented and compared. At present about 4.1 to 4.5 M.T epoxy powder is required for powder coating.

### 6.12 CONSUMPTION OF CHEMICALS

There are degrease, activation, passivation and phospheting chemicals required for powder coating. Consumption of these also will increase due to increased processing of

the jobs. On an average 28 litres/day chemical in liquid form is necessary now. Monthly about 700 liters chemicals are required. The record of consumption after implementation will be presented and compared with the previous consumption.

### 6.13 ESTIMATION OF THE PROJECT COST

This includes material cost, labour cost, transportation cost required for the project implementation. Administration cost at the rate of 16 percent will be added to arrive at final cost of project. This cost will be utilized for finding out economic feasibility of the project. At present our rough estimate indicates this cost will be about 12-13 Lakh.

### 6.14 CALCULATION OF SAVING FROM RESOURCES

In this section we will calculate saving from the implementation on the basis of our explanation in previous sections. The electricity, LPG, DM water, Industrial water, Epoxy powder and chemicals are consumed less with different magnitude. Here we will find out the reduction in the consumption of the resources and cost saved. This aggregate cost saved will be calculated in this section. This will indicate gross saving from the project.

### 6.15 LABOUR PRODUCTIVITY

There are three measures of labour productivity as mentioned in the book Production and Operations Management by K. Aswathappa and Bhat [6]. Output per man hour, labour hours per unit of output and added value per unit of labour cost will be calculated herewith and compared. The improvement in the labour productivity will be reported.

### 6.16 REDUCTION IN THE PRODUCTION COST PER UNIT

The production cost per unit will be reduced after implementation of this project. The saving per unit will be calculated in both situations and the benefit per unit will be calculated. The reduction the production cost will be reported using bar diagram and percentage. At present Rs. 5 per job cost is required for the powder coating. This will be reduced after implementation of the project on account of saving in the consumption of resources.

## 6.17 GENENRAL OBSERVATIONS

General observation will cover the situation of the before and after implementation. The implementation of the project will bring some changes in the production process (pretreatment and powder coating). The results of the analysis made under this chapter will be summarized in this section. The general observation will be made on the basis of opinions of the team members and personnel involved in the production process.

# CHAPTER 7: COST BENEFIT ANALYSIS

**Problem in hand**

**Proposed solutions**

**Feasible solution**

**Policy Decisions Required (If Any)**

**Cost of Poor Quality (If exists)**

**Investment proposed**

**Proposed Savings calculation**

**Payback Period**

# CHAPTER 8: RECOMMENDATIONS

## 7.1 BRIEF DESCRIPTION OF RECOMMENDATIONS TO BE EMERGED

We will undertake critical study of the pretreatment and powder coating processes. Various alternatives will be found out and evaluated. The most suitable alternative will be adopted for action. In order to increase the productivity of powder coating process we have first examined the headway available for job loading and feasibility to design the hangers carrying more springs.

As number of springs loaded at time has doubled accordingly we need to add spray guns at both sides. A stand will be fabricated for standing on it for loading springs at upper level. Process parameters will be increased accordingly. Sample jobs will be loaded on 8 modified hangers. The quality parameters of the powder coating will be tested in the laboratory. If it found as per standard then other hangers will be fabricated. Necessary on- the-job training is given to operators. Each recommendation will be explained in separate section in detail.

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