USE OF TQM TOOLS FOR PRODUCTIVITY IMPROVEMENT

A PROJECT REPORT

SUBMITTED TO

INDIAN INSTITUTION OF INDUSTRIAL ENGINEERING

FOR THE PARTIAL FULFILLMENT OF THE GRADUATESHIP CERTIFICATE

in

INDUSTRIAL ENGINEERING

By

RUPESH SAWANT (S-12345)

INDIAN INSTITUTION OF INDUSTRIAL ENGINEERING
NAVI MUMBAI, INDIA

2026

DECLARATION

I hereby declare that this project entitled: **"USE OF TQM TOOLS FOR PRODUCTIVITY IMPROVEMENT"** has been prepared by me under the guidance of Dr. Nikalaje P, in fulfillment of the requirement for award of Graduateship in Industrial Engineering of the Indian Institution of Industrial Engineering, Navi Mumbai. I hereby declare that this project is based on my personal work and has not been submitted at any time to any other university or Institution for the award of any degree or diploma.

Place: CBD Belapur, Navi Mumbai

Date: 04 /01/2026 Signature

Student's Name:

Rupesh Sawant (S-12345)

CERTIFICATE

This is to certify that, the project work titled **" USE OF TQM TOOLS FOR PRODUCTIVITY IMPROVEMENT"** is bonafide work carried out by: Shri: Rupesh Sawant (S-12345) a student for the Graduateship Examination of the Indian Institution of Industrial Engineering, under my guidance and direction.

Signature of the Guide:

Name: Dr. Nikalaje P

Designation: Manager

Date: 4th March 2026

Place: CBD Belapur

PROJECT REPORT APPROVAL

This project report entitled **"Productivity Improvement of Powder Coating Process for Suspension Springs" by Shri. Rupesh Sawant (Membership No.: S:12345)** is approved for the degree of **IIIE Graduateship** in **Industrial Engineering.**

Examiner Name and Signature with Date

1. _____

ABSTRACT

1. INTRODUCTION

This project has been carried out in the XYZ private limited company's plant located at CBD Belapur, Navi Mumbai, India. Our project is related to the suspension spring production. The suspension line includes 14 workstations carrying out different processes. Due to higher customers (MarutiUdyog and Ford) demand it was necessary to improve the productivity of the line by 65%. Accordingly company has already improved capacity of other 12 work stations. The pretreatment and powder coating workstation needed improvement. This project has taken necessary steps to improve the same.

2. PROBLEM ON HAND

On an average 2 Lakh springs per month (8000 per day in three shifts) had been manufactured in the previous set up of the powder coating booth. The aggregate demand from 5 customers is 3.3 Lakh suspension springs per month. The plant is operating in three shifts on a working day. Thus the need was to improve productivity by 65%.

3. CORRECTIVE ACTIONS (RECOMMENDATIONS)

In this project we have modified the design of the hangers to accommodate 8 springs at a time instead of previous 4 Nos. Accordingly we fabricated 200 new and modified 1300 existing hangers. Additional 4 spray guns for the epoxy powder are installed. A stand is fabricated for loading the springs at upper level. Various pump flow are increased by changing setting. This was necessary to process 8 springs at a time. Necessary training is given to operators.

4. OVERALL RESULTS OF THE STUDY

The production of the springs has increased from 2.0 lakh to 3.30 Lakh per month in three shifts of working. Saving from lesser consumption of the consumables is Rs. 2.7/- per job. Deducting the manpower expenses and price discount to the clients the net benefit to the company is Rs. 5.37 Lakh per month or Rs. 64 Lakh per year. The cost of the project is Rs. 12.0 Lakh which is one time cost. 10 additional employees are appointed for this purpose. The project is implemented in the month of February 2016 and the production with increased demand has been started from March 2016.

CONTENTS

P. NO.

CHAPTER No. 1: PREAMBLE

1.1 **INTRODUCTION** 1-2

1.2 PROBLEM ON HAND 2

1.3 IMPORTANCE OF THE PROBLEM 2-3

1.4 SCOPE OF THE PROJECT 3-4

CHAPTER No.2: DETAILS OF THE ORGANISATION

2.1 INTRODUCTION OF ORGANIZATION 5-6

2.2 THE ORGANIZATION 6

2.2.1 PRODUCTS 6-8

2.2.2 PROCESSES 8-10

2.2.3 FACILITIES 10-12

2.2.4 ORGANIZATION STRUCTURE 12-13

2.3 ORGANIZATIONAL BUSINESS PROFILE 13-15

2.4 OTHER RELEVANT INFORMATION 15-16

2.5 CONCLUSION 16

CHAPTER No.3: PROBLEM IN HAND

3.1 INTRODUCTION 17

3.2 DESCRIPTION OF THE PROBLEM 17-18

3.3 DETAILS OF PROBLEM 18-23

3.3.1. HISTORICAL PERSPECTIVE 23

3.3.2. CAUSE AND EFFECT RELATIONSHIPS 23-24

3.4. CRITICALITY OF THE PROBLEM 24

3.5 CONCLUSION 25

CHAPTER No. 4: RELEVANT LITERATURE REVIEW

4.1 INTRODUCTION 26

4.2 PRODUCTIVITY 26-27

4.3 IMPROVEMENT MEASURES 27-30

4.4 POWDER COATING 30-37

4.5 SAFETY AND PRECAUTIONS 37-40

4.6 SUSPENSION SPRINGS 40-42

4.7 RELEVANT CASE STUDIES 42-49

4.8 CONCLUSION 50

CHAPTER No. 5: DATA COLLECTION AND ANALYSIS

5.1 THE TYPE OF DATA NEEDED 51-52

5.2 THE SOURCES FOR THE COLLECTION OF DATA 52-53

5.3 THE DETAILS OF THE DATA COLLECTED 53-57

5.4 PROCESSING OF THE DATA FOR ANALYSIS 57

5.5 CONCLUSION 58

CHAPTER No. 6: ANALYSIS OF DATA

6.1 CHOICE OF TECHNIQUES 59-60

6.2 BASIS OF PROBLEM SELECTION 60-61

6.3 4W-1H analysis 61-63

6.4 CAUSE AND EFFCET DIAGRAM 63-64

6.5 PRODUCTION BEFORE AND AFTER 64-65

6.6 IMPROVEMENT IN THE PRODUCTIVITY 65-66

6.7 CONSUMPTION OF ELECTRICITY 66-67

6.8 CONSUMPTION OF LPG 68-69

6.9 CONSUMPTION OF DEMINERALIZED WATER 69-70

6.10 CONSUMPTION OF INDUSTRIAL WATER 71-72

6.11 CONSUMPTION OF EPOXY POWDER 72-74

6.12 CONSUMPTION OF CHEMICALS 74-76

6.13 COST OF THE PROJECT 76-77

6.14 CALCULATION OF SAVING FROM RESOURCES 77-78

6.15 IMPROVEMENT IN THE LABOUR PRODUCTIVITY 78-79

6.16 REDUCTION IN THE POWDER COATING COST PER JOB 79-80

6.17 GENERAL OBSERVATIONS 80-81

CHAPTER NO 7: RECOMMENDATIONS

7.1 BRIEF DESCRIPTION OF RECOMMENDATIONS 82

7.2 CHANGE IN HANGER DESIGN 82-85

7.3 ADDITIONAL SPRAY GUNS 85

7.4 FABRICATION OF STAND 86

7.5 CHANGES IN PROCESS PARAMETERS 86

7.6 ON THE JOB TRAINING 87

7.7 TECHNICAL SUITABILITY 87-88

7.8 ECONOMIC JUSTIFICATION 88-89

7.9 FEASIBILITY OF IMPLEMENTATION 89

7.10 MONITORING SYSTEM 90

CHAPTER No. 8: DISCUSSION OF THE RESULTS

8.1 INTRODUCTION 91

8.2 OVERALL RESULTS OF THE PROJECT 91-92

8.3 OVERALL EXPECTED BENEFITS 92

8.4 OVERALL EXPECTED TIME, COST AND EFFORTS 92-93

8.5 SCHEME OF IMPLEMENTATION 93-94

8.6 PRECAUTIONS 94-95

8.7 CONCLUSION 95

CHAPTER No. 9: CONCLUDING REMARKS

9.1 SUMMARY 96

9.2 GAINS OF THE STUDY 96-97

9.3 LIMITATIONS OF THE STUDY 97-98

9.4 SCOPE FOR FURTHER WORK 98

Bibliography 99-100

Appendix

Acknowledgement

Project Proposal **126**

LIST OF TABLES

		P. NO.
1	Table 1.1: The production capacity of workstations per month (in Nos.)	2-3
2	Table 2.1 : Profile of Employees	13
3	Table 3.1: Workstation processes and their capacity	18-19
4	Table 3.2: Available time and Production in shifts	20
5	Table 3.3:Shiftwise production of the Suspension Springs (in Nos) for the Month of January 2016	21
6	Table 3.4: Present and future demand of the spring	22
7	Table 3.5: Production history (April 15 to Jan2016)	23
8	Table 3.6: Cause and effect relationships	24
9	Table 4.1: Productivity improvement measures	28
10	Table 4.2: Loadings on suspension springs	42
11	Table 4.3: Seven Wastes and their short definitions	45
12	Table 5. 1: Workstation processes and their capacity (After)	53-54
13	Table 5.2: Production data (After)	54
14	Table 5.3:Shiftwise production of the Suspension Springs (in Nos) for the Month of September 2016	55
15	Table 5.4: Consumption of process resources (Before)	56
16	Table 5.4: Consumption of process resources (After)	56-57
17	Table 6.1: Projects and their Expected improvement	60-61
18	Table 6.2: Prospective benefits from projects	61

19	Table 6.3: 4W-1H analysis	62
20	Table 6.4: Consumption of electrical energy (in Kwh)	66-67
21	Table 6.5 : Consumption of LPG per month in Kg	68
22	Table 6.6: Consumption of Demineralized water per month in Kilo Litres	69-70
23	Table 6.7: Consumption of Industrial water per month (In KL)	71
24	Table 6.8: Consumption of Epoxy powder (in Kg) per month	73
25	Table 6. 9: Consumption of Chemicals (in Litres) per month	75
26	Table 6.10: Cost of the project	76
27	Table 6.11: Saving from less consumption of productive resources (Average)	77
28	Table 6.12: Employees before and after	79
29	Table 7.1: Changes in process parameters	86
30	Table 8.1: Overall results of the project	91-92
31	Table 8.2 : Schedule of implementation of the project	94

LIST OF FIGURES

		P. NO.
1	Fig 1.1: Demand line and production capacities of workstations in Lakh jobs per month	3
2	Fig 2.1: Mubea Mission	6
3	Fig 2.2: Suspension spring and stabilizing bar	7
4	Fig 2.3: Process flow diagram of suspension spring	10
5	Fig 2.4: Organizational Chart	12
6	Fig 2.5 : Turnover in Crores	14
7	Fig 2.6 : Business share of the company	15
8	Fig 2.7 : Suspension Spring Supply	15
9	Fig3.2: Demand before and after in Nos per month	22
10	Fig 4.1: Powder Coating Process	31
11	Fig 4.2: Hand application of powder	34
12	Fig 4.3: Powder coating booth	34
13	Fig 4.4: Relationships in Operation	45
14	Fig 5.1: Sources of data	53
15	Fig 6.1: Cause and effect diagram	63
16	Fig 6.2: Monthly production before and after (in Nos)	64
17	Fig 6.3 : Average production per month (in Lakh Nos)	65
19	Fig 6.4: Daily Production (Powder coating)	65
20	Fig 6.5: Jobs per Minute time	66
21	Fig 6.6: Average Electricity consumption in Kwh per Lakh springs	67

22	Fig 6.7: Average consumption of LPG in Kg per Lakh springs	69
23	Fig 6.8 : Average Consumption of Demineralized water (KL) per Lakh Springs	70
24	Fig 6.9 : Average Consumption of Industrial water (KL) per Lakh Springs	72
25	Fig 6. 10**:** Consumption of Epoxy powder (in Kg) per Lakh Springs	74
26	Fig 6. 11: Average Consumption of Chemicals (in Litre) per Lakh springs.	75
27	Fig 7.1a: Hanger (Before)	83
28	Fig 7.1b: Hanger (After)	83
29	Fig 7.2 : Spacer bar bending fixture	85
30	Fig 7.3: Spray Guns	86

ABBREVIATIONS

1	mm	Milimetre
2	Mtr	Metre
3	Kg	Kilogram
4	LPG	Liquefied Petroleum Gas
5	Rs.	Indian Rupees
6	Fig	Figure
7	Nos.	Numbers
8	Co2	Carbon Dioxide
9	OEM	Original Equipment Manufacturer
10	ITW	Induction hardened and tempered wire
11	CNC	Computerized Numerical Control
12	WS	Work Station
13	g/m3	Gram per Cubic Metres
14	O.E.L.	Occupational Exposure Limits
15	mg/m3	Milligram per Cubic Metres
16	L.E.L.	Lower Explosion Limit
17	VOC	Volatile Organic Compound
18	AC	Alternating Current
19	DC	Direct Current
20	°C; °F	Units of temperature degree Centigrade and Fahrenheit
21	Kwh	Kilo Watt Hours (Unit)

`CHAPTER No.1: PREAMBLE

1.1 INTRODUCTION

This project has been carried out in the Mubea suspension private limited company's plant located at India. Our project is related to Mubea suspension which has product range of Spring band clamps (suspension spring), stabilizer bars, tailor rolled products, tailor tubes, headrest rods, transmission disc springs, tubular shafts, automobile components, automobile machines and Carbon Reinforced Fiber products. Our project is related to the suspension spring production. In the company there are 300 employees are working including operators and management. There are special facilities for the manufacturing of each product.

The suspension line includes 14 workstations carrying out different processes. The manpower at this line includes 7 operators and 1 manager and a supervisor in a shift. I have been working in the plant since 2010 and presently working as a Senior Project Manager. I am responsible for productivity improvement of the productivity of the lines and expansion.

Before implementation of the project the monthly about 2 Lakh suspension springs were manufactured in three shifts of working. However due to higher customers demand it was necessary to improve the productivity of the line. In accordance with the increased demand the company has already improved capacity of other 12 work stations. The pretreatment and powder coating workstation need now improvement. This project has taken necessary steps to improve the same.

In this project we have incorporated primary as well as secondary data for comparison of the both situations before and after implementation of the project recommendations. All

recommendations are implemented in the month of February 2016 and thereafter the production as per improved capacity is started.

1.2 PROBLEM ON HAND

On the basis of secondary data on an average 2 Lakh springs per month have been manufactured in the six months August to January 2016. The manufacturing capacity of the line is 8000 units per day or 2 Lakh springs per month with three shifts of operation. Now the two customers Maruti, Gurgaon and Ford (Chennai and Sanand plant) India and have increased their demand by 70000 and 60000 respectively. Thus now we need to produce 1.30 Lakh additional suspension springs per month. In other words the present capacity of the line should be increased from 2 Lakh to 3.3 Lakh per month. Accordingly we have increased the capacity of the other workstations by adding facility or carrying out productivity improvement projects. The capacity of the powder coating station was the needed to be improved for overall improvement in the capacity.

1.3 IMPORTANCE OF THE PROBLEM

In the following table we have presented designed capacity and production with efficiency of 85% and 90%. The designed capacity is based on the individual process time of the workstations. In these workstations we have deleted on line inspection work stations because of their higher capacity.

Table 1.1: The production capacity of workstations per month (in Nos.)

Work stations	Coiling and Powder coating processes	Designed Capacity	Production with 85% efficiency	Production with 90% efficiency	Average in Lakh
WS2	Cold coiling	468000	397800	421200	4.1
WS3	Stress relief	409500	348075	368550	3.6
WS4	Warm Peening	468000	397800	421200	4.1

WS5	Presetting	468000	397800	421200	4.1
WS6	Stress Peening	468000	397800	421200	4.1
WS7	Laser marking	468000	397800	421200	4.1
WS9	Pretreatment	234000	198900	210600	2.0
WS10	Powder coating	234000	198900	210600	2.0
WS11	Scragging	468000	397800	421200	4.1
WS12	Colour marking	468000	397800	421200	4.1

The average production at 87.5%efficiency is taken herewith for presentation. In the last column we observe that the production capacity of workstation except pre-treatment and powder coating is higher than the consolidated demand of 3.30 lakh per month. Therefore we needed to improve the capacity of these two workstations in order to improve productivity of the whole line.

The following figure shows production capacity and demand line. To fulfil the shortfall we have proposed improvement in these two bottleneck workstation.

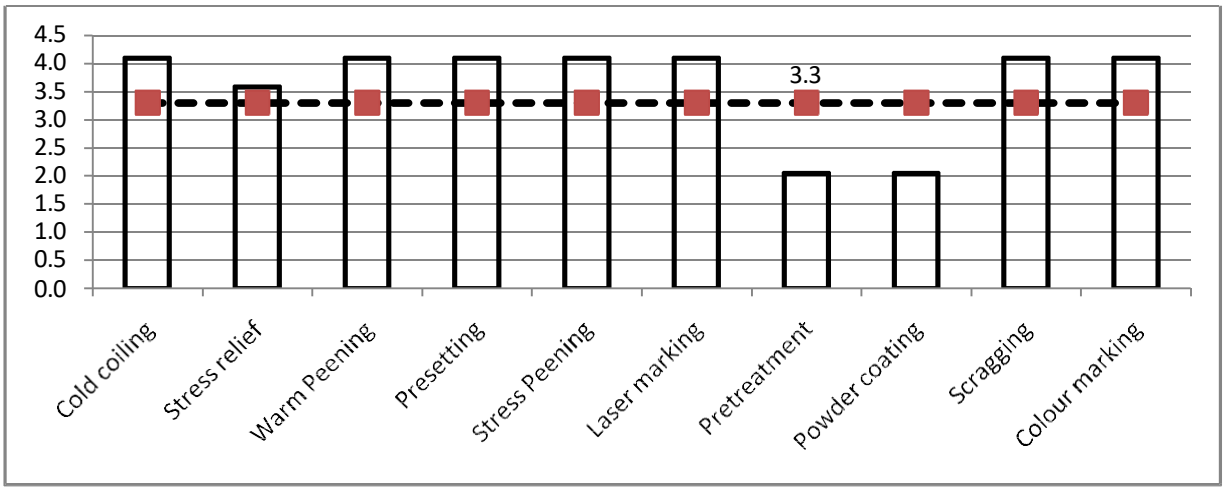


Fig 1.1: Demand line and production capacities of workstations in Lakh jobs per month

1.4 SCOPE OF THE PROJECT

As we have already stated that there are 14 workstations in the suspension spring line. Out of these 4 are devoted for inspection which is carried out on line. In the remaining 10

workstation the production of 8 stations at 87.5% efficiency is more than demand. Only two workstation namely WS9: pre-treatment and WS10: powder coating are bottleneck. Therefore our scope is limited to the improvement in the process related to these two bottleneck workstation.

In this project we are going to change the design of the hangers in order to accommodate more jobs. At first the trial on eight modified hanger has been carried out. After inspecting quality of the powder coating it is then extended to all hangers.

This project doesn't increase the speed of the powder coating or additional unit. It proposes design of the existing system to some extent. The additional unit will be costly affair and it is beyond scope of this project. However it revisits existing process parameters for improving effectiveness is considered in this project. Instead of 4 jobs now the line is processing on 8 jobs at a time accordingly some modifications in the parameters such as speed, phospheting and nozzles are necessary. Necessary trial and errors of the same have been conducted to make final decision. The details of the corrective actions carried out under this project are elaborated in the chapter No. 7 as per guidelines.

CHAPTER No. 2: DETAILS OF THE ORGANIZATION

2.1 INTRODUCTION OF ORGANIZATION

Mubea Group (Mhur und Bender) is a Family owned company established in year 1916 having headquarter in Attendon , Germany. Mubea Group consists of worldwide 30 production and development centers. It is pioneer in the field of Making Suspension and engine components. Group turnover is about 2 Billion Euro having total employees strength about 12000 employees across the globe.

In 1916 – the company started with manufacturing a spring. Today it is a global partner for the automotive industry and as an innovative lightweight construction specialist providing heavy duty spring components and related products. As an owner-operated family company with a high degree of flexibility and the ability to make quick decisions, loyal and satisfied customers are our top priority.

The company is organized into product-related business units. All other functions that benefit from the synergies of a large company have been brought together and organized into central units. Decreasing energy resources and the reduction of CO2 emissions are an important motivation for innovation in the automotive sector. Mubea as a lightweight design specialist also contributes to this theme: By consequently using Mubea lightweight innovations, we realize weight reductions of around 20 kg per vehicle and a CO2 reduction of 3-6 grams per Km.

The mission of the company is presented in the following figure: The basis of the Mubea Way is Innovation and development, Execution excellence, Leadership and collaboration and Healthy , Safety and Environment. On which the growth and success are dependent. The ultimate aim is Customer Satisfaction.



Fig 2.1: Mubea Mission

2.2 THE ORGANIZATION

Mubea Suspensions India Limited has its plant in India at Post no 1072 , Thane. It 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. There are about 300 employees are working which includes Managers, Supervisors, Company employees and temporary employees.

There are one 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.

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.

A) Suspension spring: It 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. Coil springs and a few other suspension components are statically and dynamically very High stressed. In case of a fully new suspension design, coil springs are the initial Indicators for package requirements. Most passenger cars are equipped with four coil Springs. Therefore a big volume of coil springs has to be manufactured. Due to high Quality requirements and for economic reasons, coil springs are manufactured on fully automated production lines, at least in highly industrialized countries. Suspension coils and stabilizer bars are also supplied to other tier-one suppliers who are assembling suspension assembly.



Fig 2.2: Suspension spring and stabilizing bar

B) ITW wire: It is anInduction hardened and tempered wire. It is a raw material for making suspension bars. Soft wire rods are drawn in required sizes and it is passed through ITW process where soft material is hardened at 980 degree, water quenched and tempered at 480degree Celsius.

C) Stabilizer Bars: Stabilizer bar is a safety parts installed at front and back wheel which keep balance of the car while turning at high speed .This is used in all passenger cars, all light and Heavy commercial vehicle. We are supplying ITW wire to some other local suppliers also who are making springs for other purpose

2.2.2 PROCESSES

As our project is related to powder coating, we have herewith shown the process flow diagram of the same. 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 is carried out after inspection. The details of the powder coating are given in the chapter No.4: Review of relevant literature. At this stage brief description of the processes is furnished herewith.

a) **Coiling** – Basically coiling process done on CNC controlled coiling machine where suspension springs are made as per required diameter and length, load and some special characteristic required.
b) **Stress reliving**– It is walking beam Gas fired furnace working at 400 degree temperature with a speed of 1.2 mtrs/ min. In this process all the stress developed in coiling is relieved.
c) **Warm peening** – In this process a stress relieved springs at 300 degree is treated with shot blasting process where it's residual stress are removed in hot condition

d) **Presetting machine** – On this machine spring is set as per load & length required at room temperature.

e) **Stress peening** – On this machine springs are presses near to solid length and shot blasted in closed chamber. All the stresses developed in process are removed and surface is also cleaned.

f) **Laser marking** – On this machine spring batch size and customer logo is marked by laser for 100 micron depth

g) **Powder coating plant** – springs are chemically pretreated and powder coated by black epoxy powder for long life and prevent corrosion

h) **Load checking** – As per customers requirement final load capacity of springs is checked and only approved springs are send for dispatched on conveyor

Powder coating process –

It is a surface treatment process consists of two main processes

1) Pre- treatment process – The springs which are loaded on conveyor are passed through spray type tunnels where springs are passed through – Degreasing, Rinsing, Phospating, activation, Rinsing and De-Mineralized water rinsing.
2) 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

Inspection is carried out at for eddy currents, in-process inspection after laser marking and at final stage before packing.

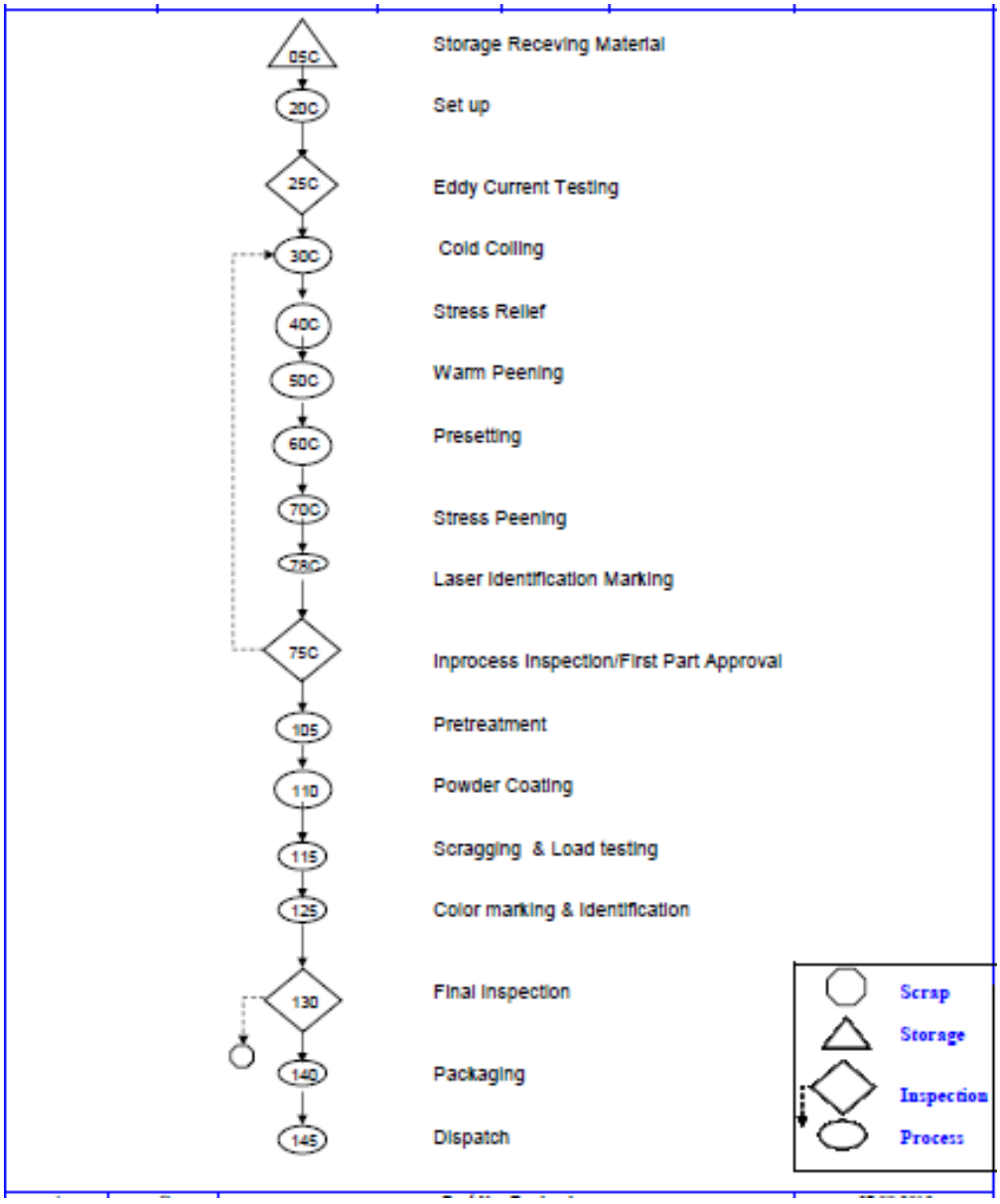


Fig 2.3: Process flow diagram of suspension spring

2.2.3 FACILITIES

Various types of Machines and utility equipment are installed in the plant for complete Coil spring manufacturing process like

i) **Coiling machine** – Wafious Germany make model No. FUL 10 and FMB installed in March 2010 , Capacity – 18 springs / min per machine with wire dia. 9 to 17 mm and length max 500 mm

ii) **Stress reliving furnace** – IpsenGermanymake installed in March 2010 operating at 400 degree, Gas fired, and 4 zones independently controlled by meters, 2 burners per zone with walking beam conveyor of speed 0.8 to 1.2 mtrs / min speed. Machine output is 18 springs/ min

iii) **Warm peener** – Wheelebrator Germany make installed in August2015, double channel , 4 wheel with sand flow control , Inlet and outlet pusher , conversed control etc. Machineoutput is 14 – 18 springs/min

iv) Presenter – Wafious Germany make, Double cylinder, hydraulic operated, load display. Capacity 16 springs/min

v) Stress peener (2 nos) – Wheelebrator Germany make , 5 Zone , auto operated , Capacity – 8 springs / min

vi) Laser Marking machine , depth – 100 micron , capacity – 16 springs/ min

vii) Powder coating & pretreatment plant – Imax make, fully automatic conveyor processing, load carrying capacity – 100 kg/ mtrs , speed – 2.1 to 2.mts/ min , Total length of conveyor – 400 metres , Made in India.

viii) Load setting / checking machine , ATESI Germany make , double load cell, linear cylinder , digital load display & control , speed – 16 springs/min

ix) Transformer - 2000 Kva capacity , 22kv/ 415 V AC , Oil cooled , Outdoor duty with auto tap changer , safety protection as per IE rules

x) Diesel Generator - 2000 Kva capacity , Auto mains fail panel , Auto voltage regulation , with acoustic enclose as per BIS IV norms

xi) High Tension& Low Tension lines , main and power distribution panel , Siemens make with all safety protection for HT and LT as per Industrial Engineering rules

xii) Compressors - 250 CFM with drive for energy saving , Auto lading & unloading as per lone pressure requirement , Maintenance and safety alarm on display etc. (3 no's)

xiii) Cooling towers - 200 TR , Forced draft type , Delta – 4-6 degree , Natural cooled

xiv) Forklift - 3 T capacity , Diesel operated with standard safety features

xv) EOT Cranes – 5 T and 3.2 T cranes , overhead with Long travel , cross travel , Lifting Height at 5 metres

xvi) Quality checking machines like UTM, 3d checking, Metallurgy lab equipment, Fatigue testing, Pill test, thickness test etc.

2.2.4 ORGANIZATION STRUCTURE

The typically hierarchical arrangement of lines of authority, communications, rights and duties of an organization is called organizational structure. Organizational structure determines how the roles, power and responsibilities are assigned, controlled, and coordinated, and how information flows between the different levels of management.

The following figure shows organizational chart of the plant. 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. The organizational lines of authorityespecially production department are shown in the following figure.

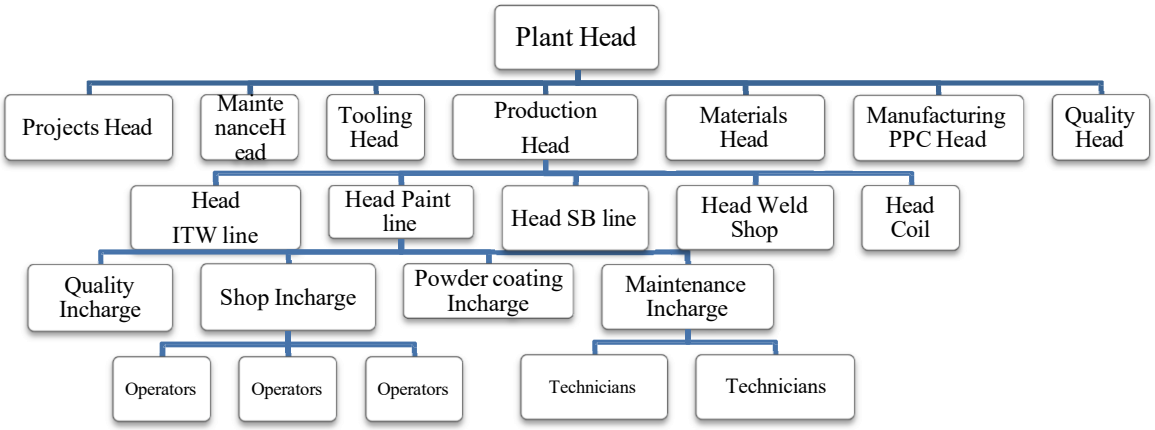


Fig 2.4: Organizational Chart

Profile of Employees –

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 includes managers , engineers and line leaders. There is union in the company and 70% of the employees are members.

Table 2.1 : Profile of Employees	
Managing Director – 1	Staff – 16 %
General manager- 1	Operators – 84 %
Managers – 5 nos	Temporary /Casuals – 57 %
Engineers – 20 nos	Total Male employees – 90 %
Line leaders – 12 nos	Total Female employees – 10 %
Operators – 90 nos	Total unionized employees – 70 %
Temporary / Contract – 121	
Total Strength = 250 Nos	

2.3 ORGANIZATIONAL BUSINESS PROFILE

The organization business profile is described with respect to sales turnover and business share with various original equipment manufacturers. In the following figure we have presented turnover of the company in Crores since year 2011. This turnover includes

sales of all products manufactured in the plant of the company including Suspension Springs. Thus it is an aggregate turnover.

It is collected from the internal documents and information supplied. As figures are mentioned in Crores.

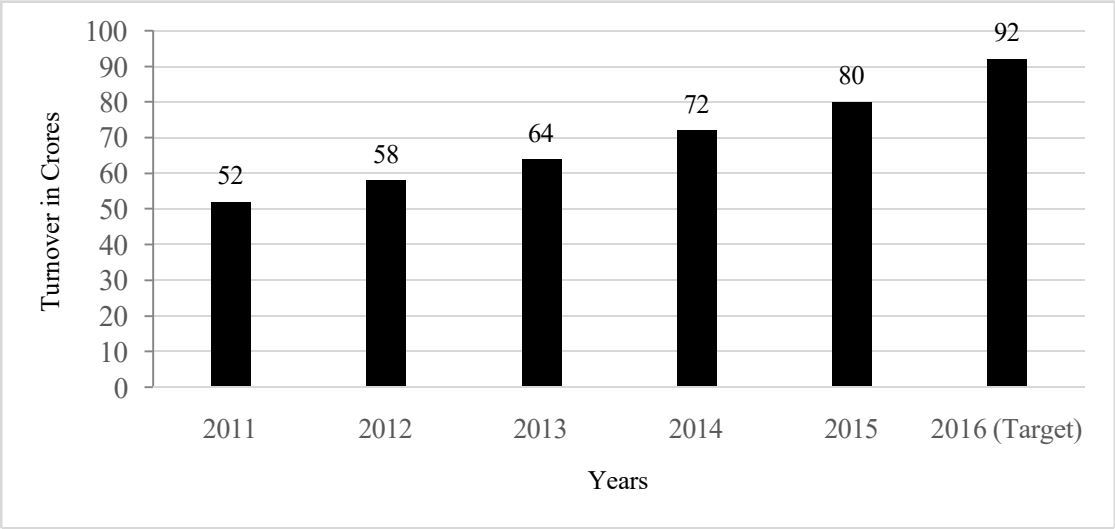


Fig 2.5 : Turnover in Crores

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.

Following figure shows business shares of the five key manufacturers of automobile vehicles. The highest 48% share is from Maruti-Udyog limited Plant. Next to Maruti, Volkswagen and Tata Motors share is 20% of the total. This is revised business share as per 2016- schedule.

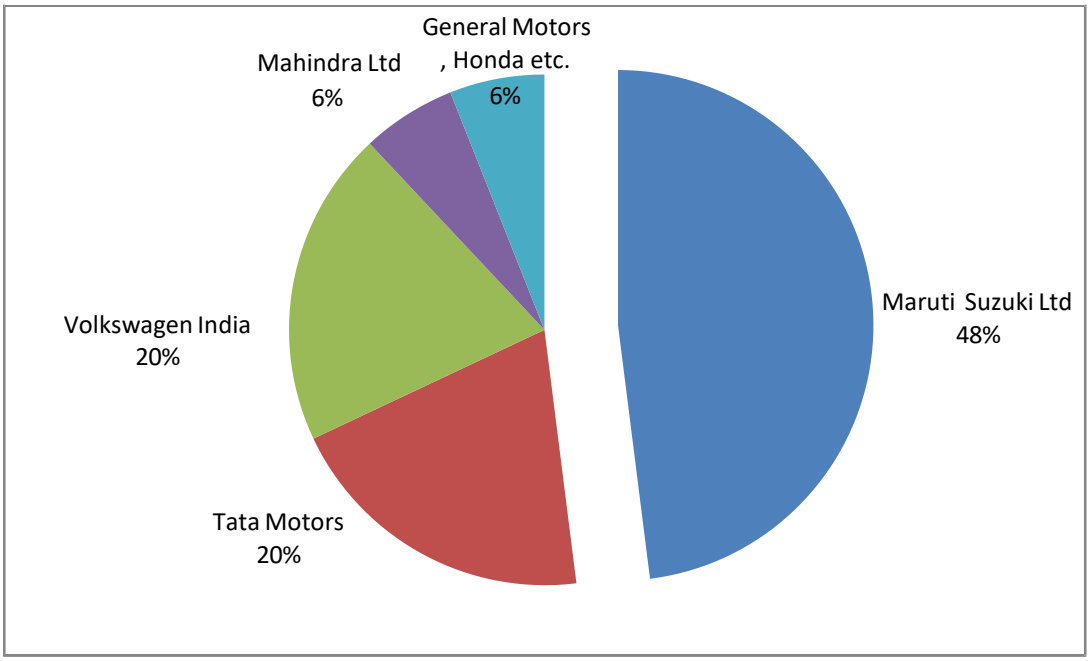


Fig2.6 : Business share of the company

2.4 OTHER RELEVANT INFORMATION

We are supplying suspension springs to five Car manufacturers in India. The highest supply of 46% is to the Maruti-Udyog Limited followed by the Ford motors 24%. This is as per revised schedule to be followed in the year 2016.

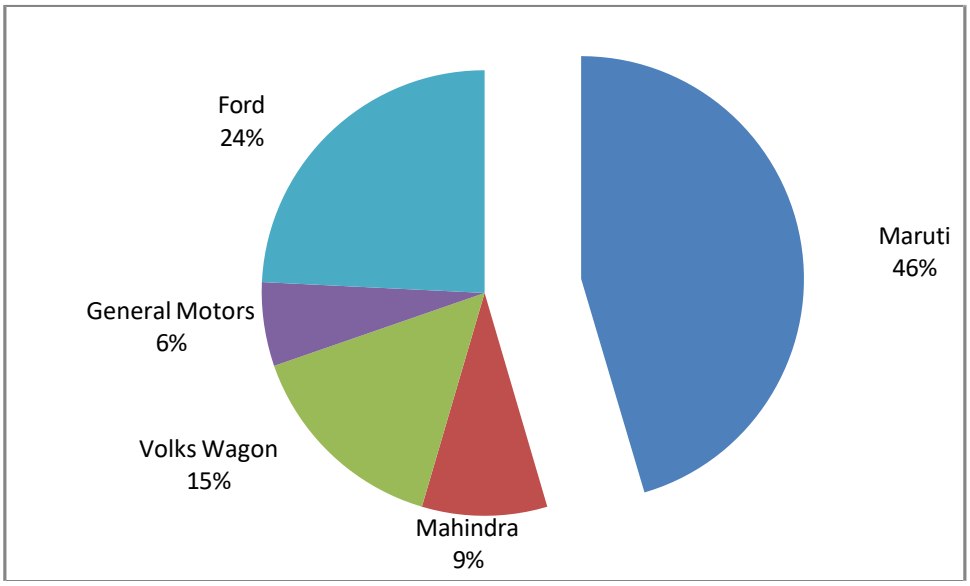


Fig 2.7 : Suspension Spring Supply

Support functions –Production department is the main core function in the plant. There are other departments which support productions are –Maintenance, Quality, Human resources, Administrations, Accounts and Finance, Logistic, Purchase and Sales and engineering.

Quality Lab - We have installed a modern testing machines like UTM, 3D load checking, Nakamura test machine, Fatigue testing, salt test, Metallurgy lab, Microscopes.

Safety equipment – All employees are wearing all personnel protection equipment. Also we have installed Fire extinguisher system, emergency plan etc.

2.5 CONCLUSION

This chapter introduces company from various angles. As per guidelines we have structured this chapter contents. The plant of Mubea suspension India limited is situated in Thane. These are total 250 employees are working on various positions. The company (plant at Thane) produces three components namely-Induction hardened and tempered wire, suspension spring (coil spring) and stabilizer bars. Necessary figures of the spring and bar is given in the section. Various processes related to powder coating and suspension spring manufactured are described. Coiling machine, furnace, warm peener, presenter, stress peener, and laser marking machine are available in the company. In the operatives about 57% of the employees are temporary and contract basis remaining 43% are permanent.

The turnover of the company for year 2016 is targeted as 92 Crores. 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 No. 3: THE PROBLEM ON HAND

3.1 INTRODUCTION

This chapter describes problem in hand in detail. It is based on secondary data which we have obtained from the production department. This project is basically related to meet the increased demand of the customers for suspension springs. As per previous directives from these clients we have improved our line capacity. Accordingly the various processes such as cold coiling, stress relief, warm and stress peening, pre-setting and laser marking have been improved to cater the revised demand of the customers. However the pre-treatment and powder coating were to be improved. 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 satisfaction.

This chapter contains a brief description of the problem followed by details of the problem. With the help of data collected. We have also presented historical perspective for the period 10 months before implementation of the project.

The consumption of resources for the production of 2.0 Lakh suspension springs as per previous method is given. These resources are Electricity, LPG (in kg) Demineralized water, Industrial water, Chemicals and Epoxy powder. At the end conclusion is given on overall chapter contents.

3.2 DESCRIPTION OF THE PROBLEM

Now the company is planning for expansion of the manufacturing capacity to fulfil the rising demand from the customers as well as market across the world. Accordingly the individual workstations are improved and at present have manufacturing capacity of 14 to 16 jobs per minute. The powder coating process became stumbling block in the overall capacity of the line as its present manufacturing capacity is 8 springs per minute.

This project is started with an objective to improve the productivity of the powder coating process to match with other workstations. Pretreatment and powder coating are two workstations where we have to concentrate in this project. The improvement from present 8 to at least 14 jobs per minutes is expected through implementation of this project.

3.3 DETAILS OF PROBLEM

The suspension spring Flow chart for Coiling and Powder coating process 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
WS1	Eddy current testing	On line
WS2	Cold coiling	16
WS3	Stress relief	14
WS4	Warm Peening	16

WS5	Presetting	16
WS6	Stress Peening	16
WS7	Laser marking	16
WS8	In-process Inspection	On line
WS9	Pretreatment	8
WS10	Powder coating	8
WS11	Scragging	16
WS12	Colour marking	16
WS13	Final Inspection	On line
WS14	Packaging	On line

In the 14 workstations there are 4 work stations namely WS1, WS 8, WS13 and WS 14 which have online processes of inspection and packaging. Out of remaining 10 workstations 7 have production capacity of 16 jobs per minute and one has production capacity of 14 jobs per minute. 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.

The company is running in three shifts a day and utilizing its capacity at the rate of production of 8 jobs per minute. The balance capacity of other 8 workstations is not yet utilized due to hurdle of WS 8 and WS9. This necessitates the improvement in the capacity of

the powder coating process. The line already operates in the three shifts a day, Therefore there is no scope for the further utilization.

The time available in three shifts and production with average efficiency of 87.50 % line efficiency are furnished in the following table.

Table 3.2: Available time and Production in shifts

1	Shifts	I	II	III
2	Shift time in hours	8.5	8.5	7
3	Shift time in minutes	510	510	420
4	Lunch Break (Statutory)	30	30	30
5	Tea time 2 x 10 minutes	20	20	20
6	Breakdown time	10	10	10
7	Setting time, quality issues and others	30	30	30
8	Total loss of time	90	90	90
9	Net available time for production in Nos.	420	420	330
10	Production in Nosper minute	8	8	8
11	Theoretical daily production in Nos	3360	3360	2640
12	Actual production in Noswith about 87.50 % efficiency	2940	2940	2310
13	Monthly production in Nosconsidering 25 working days	204750	say	2 Lakh

The above table is self explanatory. Thus the company is producing about 2 Lakh jobs per month with about 2940, 2940 and 2310 jobs in Ist, IInd and IIIrd shifts respectively. This is as per demand of the customers at present stage. It is also noticed that about 40 minutes per shift are lost in the breakdown, setting and quality issues. However our project doesn't reduce this as our improvement expectation is about 55% higher than the previous.

In the following table we have presented the shiftwise production for the month of January 2016. The total production in this month was 2.08 Lakh suspension springs. We have taken this data from the production record as a part of this project.

Table 3.3:Shiftwise production of the Suspension Springs (in Nos) for the Month of January 2016

Day	Shit I	Shift II	Shift III	Day	Shit I	Shift II	Shift III
1	2800	2700	2140	16	3000	2830	2170
2	2950	2800	2010	17	2840	2950	2250
3	2700	3000	2130	18	2800	3010	2130
4	2900	2900	2300	19	2940	3240	2240
5	3000	2800	2120	20	3000	3200	2130
6	2700	2750	2150	21	2700	3240	2370
7	2850	2860	2080	22	2780	3100	2290
8	2960	2900	2130	23	2700	3180	2150
9	2800	2800	2050	24	3010	3070	2160
10	2900	2860	2340	25	3080	3020	2180
11	2600	2790	2190	26	2600	2800	2150
12	2900	2680	2160	Total	74970	76750	56280

13	3160	3210	2080	Average	2883	2952	2165
14	3200	3200	2050	Total production in Jan 2016			208000
15	3100	2860	2130	Production per day			8000

The demand of suspension springs from five automobile companies is given below:

Table 3.4: Present and future demand of the spring

S/N	Companies	Location	Present Demand	Demand from March 2016
1	MarutiUdyog	Gurgaon, India	80000	150000
2	Mahindra	Kandiwali and Chakan, 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

The present demand of 2 Lakh per month is going to increase 3.3 Lakh per month since March 2016. Accordingly Maruti and Ford Company have approached to us for supply of increased supply. Since April 2014 we have completed the expansion of 8 workstations. The company has to urgently improve the capacity of powder coating process to match with the other workstations and fulfilling the demand of the customers. The following figure shows present and future demand of the customers which became driving force for expansion of capacity of the plant and execution of this project. We need to improve our productivity by 65% to produce additional 1.3 Lakh jobs per month.

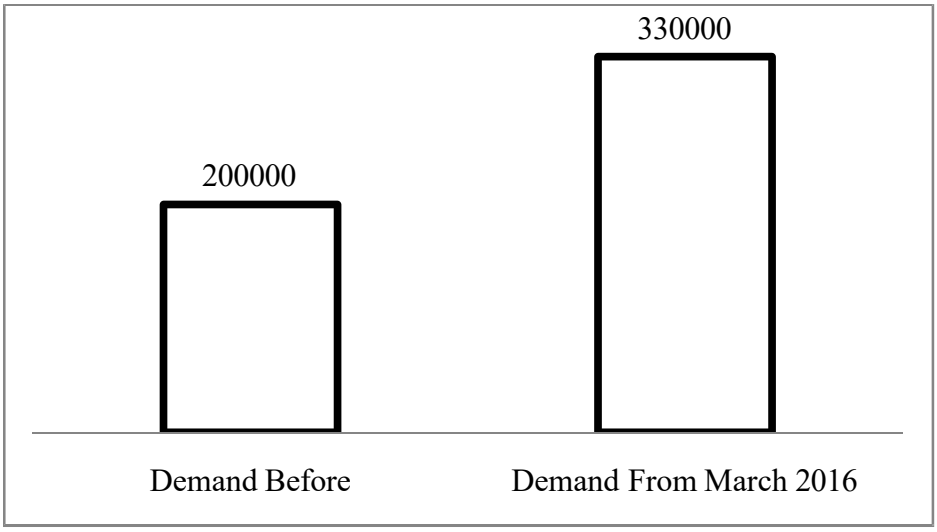


Fig3.2: Demand before and after in Nos per month

Thus we have to improve the capacity of the powder coating process from present 8 jobs per minute to at least 14 jobs per minute to produce the target production.

3.3.1. 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
Apr-15	25	200125	8005
May-15	25	200000	8000
Jun-15	26	207550	7983
Jul-15	26	208000	8000
Aug-15	25	200350	8014
Sep-15	26	206000	7923
Oct-15	25	199300	7972
Nov-15	22	178300	8105
Dec-15	26	208500	8019

Jan-16	25	208000	8320
Total	25	200703	7998

The company runs for 25 to 26 days in a month with Sunday as holiday. Daily 8000 jobs are produced in the line which goes to about 2 Lakh per month. The line is operating at 85 to 90% efficiency. In a nutshell the present set up of the powder coating is capable of fulfilling demand of 2.0 Lakh suspension springs per month.

3.3.3. CAUSE AND EFFECT RELATIONSHIPS

Cause and effect- In this analysis we have focused on what are the factors responsible for lower performance of powder coating process. The aim behind this is improvement in this will tend to improve productivity of the process. As this process is bottleneck to the production line it will improve overall productivity.

Table 3.6: Cause and effect relationships

1. Less number of spray guns in the system	1.Lower number of jobs coated
2. Design of the longer	2. Only four jobs can be accommodated.
3. Phospheting flow	3. Sufficient for present setup.
4. The system design	
5. Present setting of the pumps and movements	
6. PLC programming	

Because of causes mentioned in the above table the effect is lower number of jobs can be coated with 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.

3.4. 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. The mission of the company is growth through customer satisfaction. The hurdle in this process is now powder coating, hence it is critical.

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.

3.5 CONCLUSION

In this chapter we have furnished secondary data which we have collected from the production department for this project. At first the type of data collected is given in the first section. Primary and secondary data are collected from authentic sources. In the manufacturing of suspension spring there are 14 workstations. The capacity of other 12 workstations is increased to cater increased demand of the client. WS9: Pre-treatment and WS10: Powder coating had less capacity as (50%) compared to others. Therefore improvement in these two workstations will improve overall capacity of the line. In a day the

networking time for production is about 1170 minutes in three shifts. The line is working with 87.5% efficiency.

The production in shift I, II and III is 2940, 2940 and 2310 jobs respectively. Before implementation of the project the line was 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 No. 4: RELEVANT LITERATURE REVIEW

4.1 INTRODUCTION

In this chapter we have explained various concepts and case studies from 5 books and 10 journals and case studies. These books and journals are taken from library as well as from websites. The intention behind this is to understand theoretical background behind the project. This will give us idea about how various tools and techniques are used in the productivity improvement. It also gives us direction for corrective action.

At the outset concept about productivity is explained. It explained on the basis of input and output resources. Productivity improvement and measures are explained after that. The type of output and input and their measures are mentioned. Today's increasingly competitive world, it is important to constantly improve productivity. Various measures are adopted by researchers for improving productivity. The powder coating process is explainedin detail along with various steps, advantages and disadvantages. Hand application and booth are explained with pictures. In the separate section safety and precautions to be taken during the process of powder coating is explained. There is possibility of health, environment and damages if it is used improperly. The product suspension spring is explained with necessary details. In the relevant case studies are presented to improve productivity of the powder coating. In some cases it is explained with general examples which are applicable to our case also.

4.2 PRODUCTIVITY

Productivity is one of the keys to financial success of the enterprise. At the same time one of the key performance indicators of the enterprise is labor productivity, which characterizes the fraction of output or services produced per unit of labor input, the ratio of the results to the labor costs incurred. There are two components which can increase output: first, the growth of increasing in production input and the growth of increasing productivity.

The relation between output and input is unchanged because characteristic of the growth is by an input increase. Increasing in output means some improvementin the production function with changes in the output or input relation. Increasing productivity is characterized by a change of the production function and a consequent change to the output relation and input relation. The formula of total productivity is normally written as follows:

Total productivity = Output quantity / Input quantity

Single-factor productivity relates to the measuring of productivity that is one input factor and a ratio of output. Single-factor productivity relates to the measuring of productivity that is one input factor and a ratio of output. Measuring of output per work input which describes work productivity. Actually, it is practical to use the value added as output. Measuring of productivity in this case is called Value-added productivity. Also, productivity may be examined in cost accounting using unit costs. The partial productivity measures are nominal price value measures, physical measures and fixed price value measures. These measures different between from each other by the variables excluded from measurements and by the variables they measure.

4.3 IMPROVEMENT MEASURES

In general, measure of productivity can be divided into multi-factor productivity measures and single-factor productivity measures. One more distinction is between measures of productivity that apply gross output to one or several inputs and those that use a value- added concept to capture output movements

<table>
<tr><td colspan="5">Table 4.1: Productivity improvement measures</td></tr>
<tr><td colspan="2">Type of output measures</td><td colspan="3">Type of input measures</td></tr>
<tr><td>Labor</td><td>Capital</td><td colspan="2">Capital and Labor</td><td>Capital, labor and intermediate inputs (energy, material, services)</td></tr>
<tr><td>Gross output Value-added</td><td>Labor productivity (based on gross output)</td><td>Capital productivity (based on gross output)</td><td>Capital – Labor MFP (based on gross output)</td><td>multi-factor productivity</td></tr>
<tr><td>Labor productivity (based on value-added)</td><td>Capital productivity (based on value-added)</td><td colspan="2">Capital – Labor MFP (based on value added)</td><td>-</td></tr>
<tr><td colspan="2">Single factor productivity measures</td><td colspan="3">Multi-factor productivity (MFP) measures</td></tr>
</table>

Source: OECD Productivity Manual (OECD, 2001a)

Different levels of productivity require different ratios of output and ratios of inputs between two or more countries. One of the common simplest ways to get output ratios is to compare physical output measures, such as volume, weight, area.

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.

B. Naveen and T. Ramesh, 2012 [i] mentioned in their research paper use of industrial engineering tools in the productivity improvement. In today's increasingly competitive world, it is important to constantly improve, be it a manufacturing or service industry. Quality with quantity is a main characteristic which helps a company stay in the competition. The main aim was to study the current capacity, analyze it to find areas of improvement and make an improvement proposal to meet the forecasted increase in demand.

From the collected data it has been identified that the cycle time is more than the takt time for the case study organization hence in order to meet the demand it is important to implement the suitable industrial engineering tools. By implementing, it can reduce the cycle time and work-in-progress. Reduction of waste can also improve productivity. Improving quality at the source will not affect any station, but reduces scrap and rework. Manufacturing defect less product will help to meet the demand. After collection of data the bottleneck station was identified. Cause and effect diagram was used to identify the causes which reduce the production rate and the remedial measures has been noted to reduce the causes.

In our case we have reduced the cycle time at increased the input rate. The ultimate result is improvement in the productivity of the overall line. To match the increased rate of

input the spray arte should be increased and at the same time the time to cover overall area by the gun should be increased. Specifically in case of the phospheting it is important to maintain the quality of the job.

Increasing machine production rate Mark A. 2004 [ii] improvement in the productivity of the facility or machine**. M**achine constrained means that the equipment is operating for all the available time at this best spend, while the operations have some idle time, one possibility that was suggested earlier is to increase preventive maintenance so that downtime due to machine failure will be reduced or eliminate, another approach to develop procedures that more efficiency utilize existing machine, the concept of continuous process improvement starts that there is always a way to improve a machine production rate.

In our case we are not going to work upon improving the efficiency of the line. The utilization of the line is 87.5% which remained same after implementation of the project. We have worked on the input rate and accordingly modified all parameters to match with it.

4.4 POWDER COATING

The powder coating process is very similar to a painting process except that the "paint" is a dry powder rather than a liquid. The powder sticks tothe parts due to electrostatic charging of the powder and grounding of the parts. Any substrate can be used that can tolerate the heat of curingthe powder and that can be electrically grounded to enhance charged particle attachment. The powder flows and cures during the application ofheat.

Several advantages of powder coating over paints are:

a) Powder recovery for reuse

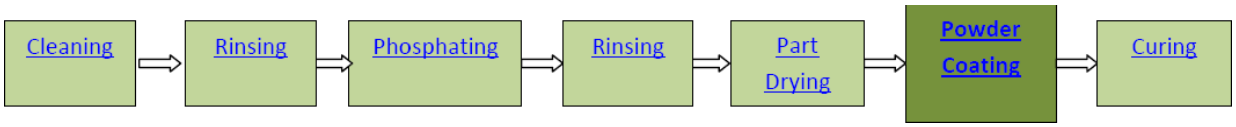
b) No VOC generation therefore no VOC destruction required

c) Can be more durable than paints (powder chemistry dependent)

d) Several disadvantages of powder coating over paints are:

e) Can have less leveling than paint (more orange peel)

Curing is typically more energy intensive than paint drying due to higher temperature requirementsSurface preparation before powder coat application is still critical for adhesion and defect avoidance.Typical steps in a powder coating process for metal parts:



Gig 4.1: Powder Coating Process

I. Cleaning (typically an alkaline cleaner, but substrate dependent)

II. Rinsing

III. Phosphating (optional step to improve corrosion protection and adhesion)

IV. Drying

V. Powder Coating

VI. Curing (typically energy intensive since relatively high temperatures are required to get the powder to liquefy and flow*)

*Powder coating formulators have been working to reduce the cure temperatures to allow the process to be used on temperature sensitivematerials.

Drying and Curing

The energy intensive operations in the powder coating operation are drying and curing. Typical drying and curing operations are with the use ofconvection ovens. The use of convection heating can be very slow and very costly if the parts are large and heavy since the evaporation or curingwill be dependent on the bulk temperature of the part. Essentially the whole part must be hot enough to cause the part surface to either dry orthe powder coat to

cure. Therefore, large volumes of air need to be heated and exhausted from the convection oven to effectively dry or curethe parts.

This is much less of a problem for thin walled or low mass parts since the hot air can heat the parts relatively quickly with a resultant fasterdrying or curing process.

Depending on the part geometry, simple geometries can be dried and cured using infra red heating. The heating occurs at the part surface withlittle air heating of bulk heating of the part. Therefore the heat energy is going where it is needed, to the surface. It is also a very rapid heatingprocess, again since there is instant infrared light absorption.

Another advantage of infrared heating is in the powder coat curing process. The rapid part surface heating results in better powder flow andless chance of dust or dirt defects since there is very little air flow to deposit particles compared to convection heating.

As a side note, the use of infrared curing for liquid paints has an interesting and helpful effect. The infrared light heats the part surface and notthe paint, resulting in paint drying from the inside out. The paint does not skin over and trap solvent or water inside the paint as can sometimeshappen with convection curing. All the volatiles are driven out of the paint, starting at the part surface and progressing to the paint surface.

In the BIS, 1993 [iii] specifications of powder coating the following types, particle size, relative density and testing are mentioned.

The material shall be of three grades depending uponits finish as given below:

i) Grade A - Glossy finish,

ii) Grade B - Semi-glossy finish, and

iii) Grade C - Matt finish.

Thematerial shall be free flowing powder based on synthetic resins, hardeners, pigments, fillers and additives suitable for application by standard methods, for example, electrostatic spraying, tribostatic spraying, fluidized bed coating, etc. It shall give a continuous, smooth and hard film when applied by one of the above methods and stoved as per schedule prescribed by the supplier. The powder application parameters will be as agreed between the supplier and the user.

Particle Size Distribution**:** It shall depend on the method of application, type of equipment, etc, as agreed between the supplier and the user.

Relative Density:It shall be within 3% percent of the approved sample. The reactivity of the powder shall be as per the approved sample. The curing schedule should be followed as agreed to between the purchaser and the supplier. The cured film shall also conform to the requirements given in

Testing of the powder coated material:

A) Immersion: Suspend the test specimens vertically in the container so that at least one half of the surface area is submerged in the solutions in the order nitric acid, sulphuric acid, hydrochloric acid and sodium hydroxide for a period of 12 h each. Separate the test specimens so that they are not in contact with any metal and are no closer together than 25 mm at any point in the bath. Replace the test solutions with fresh solutions every 168 h. If successive tests are to be correlated, use reference panels coated with a control paint.

B) **Examination of Specimens:** When the specimens are ready for transfer and/or examination, carefully remove, gently wash or dip in clean running water not warmer than the temperature of the test solution to remove the excess solution from the surface, and then carefully dry by blowing with air or blotting with absorbent paper. Examine the test

coating for blisters, flaking and corrosion. The sample shall be treated as passing if there is no blistering, flaking and corrosion.



Fig 4.2: Hand application of powder



Fig 4.3: Powder coating booth

Powder coating in booth process:

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. When it comes to the gun through a flexible hose where it is electro-statically charged by a high voltage generator. An electrostat 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.

The Powder Booth

Generally the purpose of a powder booth is to ensure that powder sprayed from theelectrostatic guns stays within its confines. Then overspray can be transferred to a powderrecovery system. For a manual booth the construction is box shaped, with an aperturethrough which operators can spray manually. In the booth system, the samebooth type can also accommodate automatic spray-guns. Where this happens there is anaperture on either side. Components are either manually loaded into the booth or conveyedthrough the sides.

Materials of construction of the spray booths vary from stainless steel to patentedsandwich plastic materials used to improve transfer efficiency and cleaning down. Different powder recovery systems take over-sprayed powder away and provide special systems for recycling it. The plastic powder spray booth plays a valuable part in maximizing transfer efficiency by not attracting charged powder or even by repelling powder. Added to this is the fact that less powder on the booth wall is much easier to clean off. This is provided that the correct cleaning techniques are used, i.e. air guns for the first step and mops for the fine cleaning. It is particularly important in the case of manual booths to safeguard the health and safety of the operator by making sure that air passes from the operator into the booth, diverting powder away from the spraying area. On all booths, manual or automatic, air velocities should be sufficient to prevent powder escaping and causing contamination of the work area. As a thumb-rule the velocity of the air streaming into the booth should be 0.5m/sec or higher at every opening of the booth. The conveyor and other auxiliary equipment should also be kept free of powder.

The booth and extraction equipment must be designed to keep powder from building-up too high concentrations. At high concentrations this could result in an explosion if the powder toair concentration is incorrect and a source of ignition added. The spray booths together with extraction systems guarantee that powder concentrations are kept ina safe range.

In addition, the powder / air mixture velocity in ductwork should be sufficient to ensure the ductwork is self cleaning. For every new installation exact calculations of engineers guarantee that the powder / air mixture in any part of the booth and recovery units does not exceed 50% of the specified lower explosion limit. In case the lower explosion limits not specified by the powder manufacturer the concentration is kept below 10g/m3.

There are various types of powder booths. Nonetheless, deciding factors affectingthe suitability of a booth for particular types of powder coating work are simple: Stainlesssteel booths are best suited to the application of single, or at most, a few colors only. Plasticbooths are ideal for companies using a wide color range. Clean down and change criteria aremajor factors in deciding for choosing a plastic booth with an automatic cleaning system.

The sizes of spray booths vary from big enough to powder coat a car body, to small systems for coating for example toy car bodies. In all cases the same general principles apply. The booth must be large enough to accommodate the component and the spray-guns required to coat the work. Efficient transport of over-sprayed powder into the recovery unit is essential, without incurring high velocities of air within the actual spraying area. The question of the fastest possible method for color changes is according to the specific situation either answered with multiple booths that can be used and then moved offline for cleaning, or as in the advanced plastic booth designs, the user is enabled to clean down automatically and change within a few minutes.

Partial list of infrared equipment manufacturers: Casso-Solar, CCI Thermal Technologies, Fannon Industries, Fostoria Industries, Honesom, InfasourceInc.,Innovative Industries , ITW-BGK, Protherm Solar Products , Thermal Designs and Manufacturing

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.

Explosion Hazards

In general terms the powder is combustible and within certain defined limits of powder-air concentration will form a potentially explosive mixture. The lower explosion limit of most commercially available powder coatings has been determined to be in the region of 35 – 90g/m3 (DIN 55990 - 6 or ISO 8130-4). Providing the concentration of powder in air is maintained below this value, there is no risk of explosion. Equipment should be designed such that, in operation, half this concentration is not exceeded. In the absence of specified values, a figure of 10 g/m3 is taken. In order to prevent any risk of powder ignition in the vicinity of the guns, there is the thumb -rule to install a maximum of one gun per cubic metre of booth volume. Spray booths designed and operated according to the technical specification ENELEC SC Q31/8, will not cause any explosive hazard.

Health Hazards

Following the decision of the European Committee on Powder Coatings of CEPE, Brussels, the French "Institut National de Rechercheet de Sécurité" (I.N.R.S.) has carried outtoxicological investigations on different powder coatings. Results of this study are

publishedin a brochure edited by the CEPE, "Results of the experimental toxicological studies onthermosetting powders", and the conclusion, as well as the advice for hazard prevention is given hereafter.

On the basis of this toxicological study, "it has not been possible to find any sign of local orsystemic toxicity which can be attributed to the different samples". However, the inhalation ofpowders, even inert ones, should be avoided and it is recommended to maintain in theatmosphere of workshops as low a concentration of powder in air as possible, especially inthe immediate vicinity of the workers, by means of efficient ventilation. According topublished information, the respirable dust concentration in the breathing zone should notexceed 5 mg/m3 (O.E.L. - Occupational Exposure Limits for respirable dust). Allergicpersons and workers with difficulty in breathing should not be employed in powderapplication. When the concentration of powder in air is higher than 10 mg/m3, it isrecommended to supply personnel working there with efficient dust masks in conformity withlocal regulations.

The above mentioned tests have only been carried out on powders not containing anyproducts classified as dangerous or poisonous. In such cases where suchproducts may be present, all the regulations relating to their use will apply without restriction.

For liquid paints, the labeling regulations have been adopted in the directive.Manufacturers of powder coatings must equally conform to them and make reference to thehazards involved and the means of reducing them. The internal plant regulations mustinclude the prohibition of smoking, eating and drinking in the workshop. In addition, all normalhygiene measures required by local regulations must be observed.

10.5 Safety

The average concentration of powder in the spray booth should be below 50% of the value ofthe lower explosion concentration. Where a figure for the lower explosion concentration is notavailable a figure of 10 g/ m3 of powder in air for the maximum concentration in the boothand the recovery equipment should not be exceeded. The concentration must be calculatedby excluding the weight of powder already deposited. Powder deposits should not be allowedto accumulate in the booth, as dust clouds could be formed and cause mixtures capable ofexplosion which could lead to an explosive chain reaction. For that reason some companies offersand recommends the use of a moving floor belt in each spray -booth which automaticallyremoves all powder deposits from the booth floor.

The following rules should be observed:

i) The calculation of the concentration must be based on the total amount of powder introduced into the spray booth. The equipment should be constructed to minimize explosion and fire hazard.

ii) The intensity of a possible explosion should be minimized by explosion panels discharging to atmosphere and thus reducing the risk of any fire or explosion for personnel in the working area.

iii) The basic causes of ignition should be eliminated or controlled.

iv) Suitable fire fighting equipment as well as extinguishers must be installed. The most likely ignition hazard is located in the vicinity of the sprayguns, because there, two important parameters may play a role: concentration of inflammable material and a source of energy. It is advised to install safety equipment allowing instant detection and fire extinction, avoiding further propagation.

v) Powder leakage from the coating area should be avoided.

vi) The ventilation system should be so constructed that the concentration of powder in air does not exceed the L.E.L. (Lower Explosion Limit).

vii) It is impossible entirely to avoid deposits of powder, but this should be minimized by having smooth surfaces easily accessible for cleaning. All powder should be removed regularly and as often as possible. A continuously running extraction floor belt is ideal to prevent deposits from building up.

viii) Recommendations related to maximum respirable dust concentration are found in paragraph "Health Hazards".

ix) The high voltage equipment must be installed and protected in accordance with the regulations of the individual country.

4.6 SUSPENSION SPRINGS

Lawanya, 2014 [iv] has described design and analysis for the suspension springs. The complete suspension is to observe the vehicle body from 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 play important role in the life of the suspension spring.

The function of the suspension spring in the vehicle is given below:

A) To provide good ride and handling performance –

a) Vertical compliance providing chassis isolation

b) Ensuring that the wheels follow the road profile

c) Very little tire load fluctuation

B) To ensure that steering control is maintained during maneuvering –

–wheels to be maintained in the proper position with respect to road surface

C) To ensure that the vehicle responds favorably to control forces produced by the tires during i) longitudinal braking ii) accelerating forces, iii) lateral cornering forces and iv) braking and accelerating torques

This requires the suspension geometry to be designed to resist squat, dive and roll of the vehicle body

D) To provide isolation from high frequency vibration from tire excitation

a) requires appropriate isolation in the suspension joints

b) Prevent transmission of 'road noise' to the vehicle body

Acrane, 2014 [v] has analyzed the loading pattern on the suspension spring. As our project is related to powder coating process only we do not want to go into technical details of the spring. Following table shows loading on the suspension spring in different satiations. Three kinds of loadings: Longitudinal, Transverse and Vertical are expected to come on the spring.

Table 4.2: Loadings on suspension springs

Load case	Load factor		
	Longitudinal	Transverse	Vertical
Front/rear pothole bump	3 g, at the wheel affected	0	4 g, at the wheel affected, 1 g at other wheels
Bump during cornering	0	0	3.5 g at wheel affected, 1 g at other wheels
Lateral kerb strike	0	4 g front and rear wheels on side affected	1 g at all wheels
Panic braking	2 g front wheels 0.4 g rear wheels	0	2 g front wheels, 0.8 g rear wheels

4.7 RELEVANT CASE STUDIES

The aim of this paper by Jadhav 2015 [vi] 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. Present plant layout divided in three areas i.e. initial area, bending area, final area. In initial area raw material storage, cutting machines, end heating furnace, forging press, walking beam furnace, new continuous tempering furnace, muffle furnace, tool crib area, maintenance area are covered.

In bending area CNC bending machine, correction presses, tempering furnace, pit furnace, offset grinding are covered. In final area shot peening, pre-treatment tank, powder coating, final inspection and packing are covered. In present plant layout it was observed that work in process (WIP) between each station was excessive and improper material flow. After studying the present plant layout it is found that work in process (WIP) between stations is excessive and lead time also excessive due to which plant utilization is not done properly for detail material flow of stabilizer bar and coil springs.

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.

Implementation of this project at ABC resulted in economically feasible solutions which are shown below:

a) Powder coating station reduces the rework of coil springs by 4% and operator motion reduced by 50%.
b) Powder wastage due to deposition on hanger is reduced 2kg /day saving and hanger life improvement in 4 months
c) In powder coating station net cost saving per year is 4, 50,000.00 Rs.
d) In Pit furnace modification reduce cycles of heating three per day and reduce electric consumption 2.92 per piece.
e) Pit furnace station cost saving per annum is 2,10,600.00 Rs.

PongchanunLuangpaiboon, 2010 [vii] described in his research paper improvement in the powder coating process. It is carried out by signal to noise response. The selections of aluminum alloy wheels are based on the performance, the feature and the appearance. The first two are the perceived quality for each company. Electrostatic Powder Coating Process (EPCP). Powder coating is mainly applied for coating of metals, such as aluminum extrusions, medium-density fiberboard and automobile or bicycle parts. It is used to create a hard finish that is tougher than the conventional painting process. The selected machines or

devices would provide a good appearance, good leveling rate of spraying, good metallic paint effect. With the high technology, the problem has still existed.

In a coating process, the master plate referenced brightness or color shade was critical to the exterior appearance on aluminum alloy wheels. The quality measures of interest are the metallic paint thickness values on four areas. 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.

Approach: An expert system revealed seven process variables affecting those quality characteristics.A constrained response surface optimization method and a modified complex method were performed to move the current operating condition towards the optimum. **Results:** 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.

Conclusion: 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%.

Kelvin Chan [[viii]]explained productivity methodologies, tools, and techniques for increasing productivity through reducing “seven wastes” in operations. In our case the processing and design itself was insufficient to process more number of jobs in the given time. The machine set up, speed and hanger design were capable to process only 8 jobs per minute. Thus in a broad we can say that the conversion process was time consuming. The input must be increased to process more jobs at a time.

The following figure shows conversion process which includes Input, Process and Output. In our case we need to increase input material and manpower to increase the output.

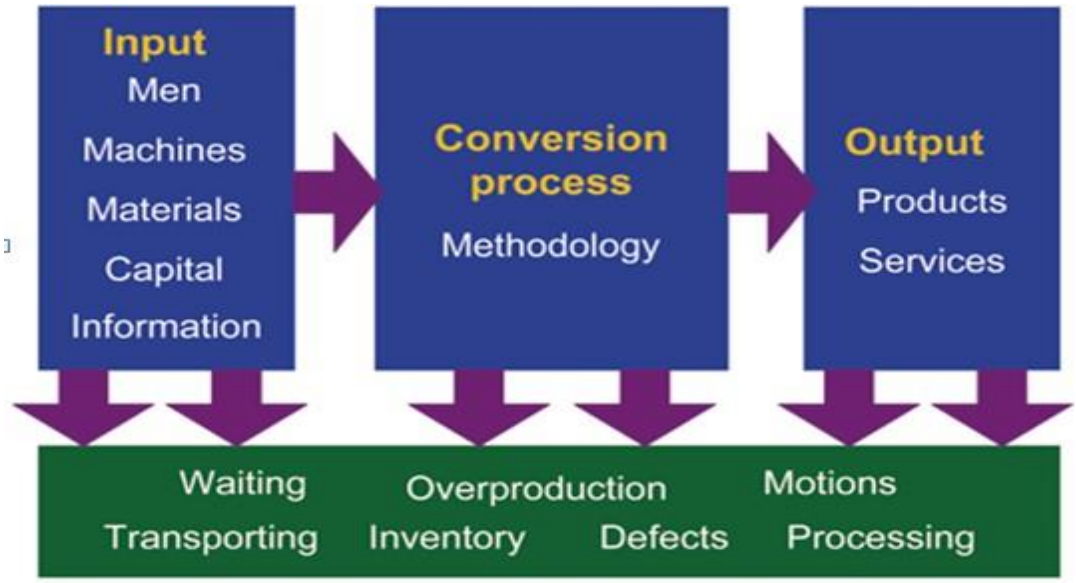


Fig 4.4: Relationships in Operation

The seven wastes and short definitions are given in the following table. In our case the wastage of space in the powder coating booth is important to improve the productivity.

Table 4.3: Seven Wastes and their short definitions

Type of waste	Definition
Waiting	Resources waiting during operations
Transporting	Moving materials unnecessarily in the workplace
Processing	Wastes inherent in the process or design itself
Inventory	Keeping high inventory or work in process
Motions	Unnecessary movements of workers during operations
Defects	Producing defective parts or poor service
Overproduction	Producing more than necessary

A simple, proven technique known as “seven wastes” developed by the famousToyota Motor of Japan has been used by many companies all over the world toimprove the

productivity of their operations. This technique is based on the“non-cost principle” that emphasizes reducing costs to achieve higher productivityfor a company:

In our case waste is related to the space of accommodating the suspension springs. With 20% improvement in the phospheting spray and 20% reduction in the speed we can increase our production by 80%. Thus process and cost calculations are done in this project to show the profitability. The productivity in our case is based upon efficient use of the existing facility. In the industry the projects are taken according to the need of the customers or demand. This project is also outcome of the higher demand from the clients.

Akzo Nobel, 1999 [ix] in his ‘complete guide to Powder coating’ written various aspects of the process in detail. The general activities involved in powder coating include parts loading, pretreatment, dry-off, cooling, powder coating, curing, cooling and unloading. The objectives of the pretreatment are 1) removal of the impurities including soil, welding splatter, scale, grease and oil. 2) Conditioning of the surface for optimum adhesion of the coating film and 3) Obtaining uniformity throughout entire surface. The complete pretreatment process consists of cleaning, rinsing, conversion coating, seal rinsing and drying. 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.

Roger and Michael, 2014 [x] carried out audit of the powder coating line in H.B. Fuller Company. The conveyor is an integral part of the total powder coating system. The

smoothness of the conveyor travel, grounding, speed control, hook spacing, lubrication and cleanliness are all factors necessary to insure an efficient overall system operation.

The load / unload operation is an important area that is often overlooked. Considerations in this area include grounding, hanger configuration, part orientation in the washer and part presentation to the guns, line density, and speed of load/unload. Access to this area needs to be maximized in order to insure an efficient overall system operation.

Without the proper powder delivery to the guns, the coating operation will not spray theproper amount of powder. These pumps will alsoinsure that the powder is delivereduniformly in order to coat with as little powder as the powder specifications will allow.This area also sets the balance of the powder delivery air pressures and iskey for thebest and uniform powder deliveries.

The powder hoses can also affect the efficiency of the powder system if they are toolong, have too great an angle or bend, are worn and/or are not the right inside diameterfor the most efficient powder system delivery.

Jeff Hall and Gema,2013 [xi] carried out strengthening of the powder coating line by using atomization and robotics in Cybex International company. The company installed a powdercoating system in its Massachusettsplant that was intended to accommodatethe spraying and recoveryof multiple colors.

Powder Coating Issues

a. Reject rate as much as 25%
b. As much as $250,000 a year in wasted powder materials
c. Heavy orange-peel finish on products
d. Light coating in some faraday areas

e. Contamination associated with color change

Company personnelbegan looking for ways toincrease automation of thepowder coating process.Their concept was to utilizerobotic machines withautomatic powder coatingguns to replace the existingautomatic and manual guns.

Benefits Realized

a) Lowered reject rate by eliminating orange-peel finish

b) Reduced powder waste as a result of increased transfer efficiency

c) Eliminated color contamination issue

d) Improved productivity by consistently performing color changes in 8 to 10 minutes

e) Reduced manual coating labor required from 2 to 1 person

In a study carried out by Hoswalt and Muric, 2013 [xii] the finishing efficiency of the process in increased by powder coating. The company used air-drying liquid enamelsfor coating the products, a very labor – intensiveprocess. Parts were manuallycleaned before painting, allowed to air-dryand then manually coated with air-atomizedspray guns. After painting, the parts wereplaced on drying racks and cured in ambientconditions.

After careful observation it was decided that powder coating and electric ovens, for pretreatment dry-off and curing thepowder coating, were the best alternatives forhis company. Liquid painting systems weredismissed because a considerable amount ofsolid waste would still be generated from oversprayedmaterial. Powder coatingminimized solid waste disposal, eliminated VOC (Volatile Organic Compound) emissions and provided an increase inthe quality of the finish.

The new system has improved productquality, increased productivity, provided asafer and cleaner workplace, eliminatedVOC emissions, reduced solid wastedisposal. As our project is related to productivity improvement we have mentioned the same herewith.

Improved productivity: With parts hung from an overhead conveyor,the new line runs at 4 feet per minute in acontinuous process versus the old "batch"method of painting. About 400 racks of partscan now be coated in one 8 hour shiftcompared to only 40 to 50 racks per day withthe previous method, resulting in a ten-foldincrease in productivity.

Mitsuba Systems India [xiii] has given some Tips on how to spray metallic powders With different guns the metallic particles in relation to the ground object may orientthemselves differently. The orientation of the aluminum particles will determine the finalfinish.

a. Reduce dosing air, as low as possible to get a smooth soft flow.
b. Preferably use Dipstick or gravity cup so that fluidization air flow does not disturb particle size distribution.
c. Increase distance between gun and object to at least 8 inch or more.
d. Try with different nozzle especially soft flow nozzle.
e. Make sure that the powder coated material is put straight in an oven temperature of 200ºC if the oven will be at room temperature, the coating will flow at 150° and disturb the texture thus creating a smooth finish.

In our project we have provided 4 powder coating guns for spraying additional jobs. Brief specifications of the Gun provided by the companyEaisen Berg[xiv].are below

Weight 555 g; 1.22 lbs

Electrical: Input voltage max. 22 Vpp , Input current max. 0.9 A , Frequency 19 - 30 kHz , Output voltage max. 100 kV DC, Polarity negative. Construction type in accordance with DIN EN 50177, type A-P Protection class IP 54

Pneumatic: Input air pressure (atomizing air volume) - max. 3 bar; 0.3 MPa, 43.51 psi, Powder output quantity max. 450 g/min; max. 0.99 lbs/min.

Ambient conditions: Operating temperature range - 5 - 45 °C; 41 - 113 °F, Relative humidity < 75 %

A - Flat spray nozzle (deflector cone), B – Electrode, C - Cap nut, D - Gun body, E - Electrical connection, F - Atomizing air connection, G - Powder hose connection, H - Type plate

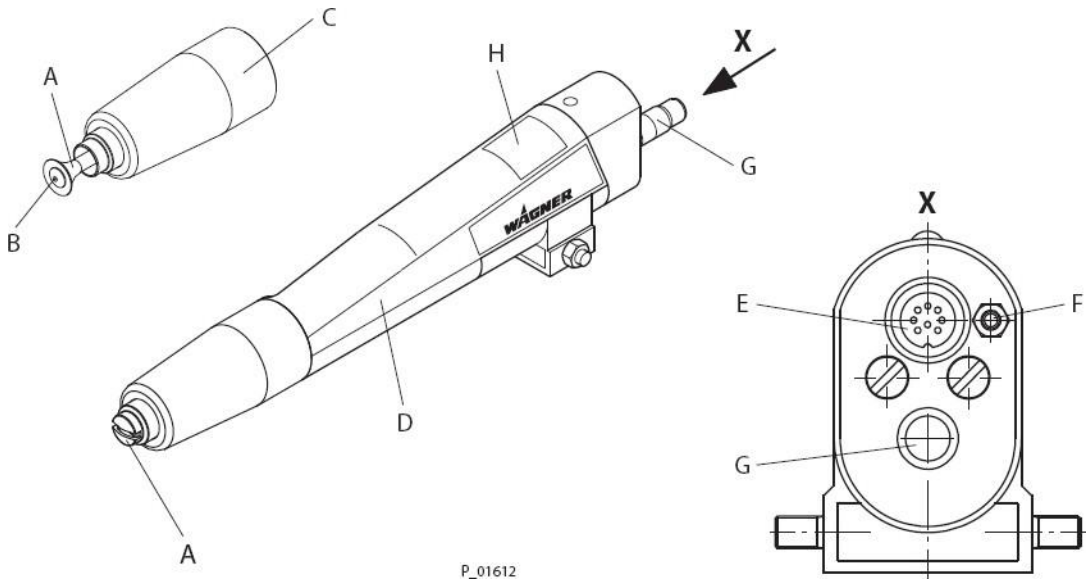


Fig 4. : Powder coating gun details

4.7 CONCLUSION

In this chapter we have referred 5 books and 10 journals and case studies. Related excerpts are taken from the literature created by various authors. All literature is published in books and journals bearing ISBN and ISSN. The general concept of productivity and measures is attempted at first. In our case the productivity with higher level of input and output is explained. It is to be powder coated in specific time period to improve output in specific time. 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. The testing of the coated job is also explained briefly from the BIS code. In a nutshell, this literature is very useful to get theoretical background behind the related project work.

CHAPTER No. 5: DATA COLLECTION AND ANALYSIS

5.1 THE TYPE OF DATA NEEDED

Data are observations, facts, events and opinions. Primary and secondary data are used inthis project. Primary data: Data collected by the investigator himself/ herself for a specific purpose. In our project following primary data are used. It is maintained for the purpose of this project.

Primary data-

1. Consumption of Electricity, LPG, Demineralized water and Industrial water after implementation of project.
2. Production of suspension springs after modification.
3. Data related to corrective actions (Cost, design)

Secondary data: Data collected by someone else for some other purpose but being utilized by the investigator for another purpose. We have collected this data from company for the use in this project. Following secondary data has been incorporated in this project.

Secondary data-

1. Workstation capacity
2. Production in three shifts and net available time for production
3. Present and future demand of the suspension spring
4. Production scenario for the period of 10 months i.e. from April 2015 to Jan 2016
5. Consumption of various resources.
    i. Electricity consumption in (kwh)

ii. LPG consumption in kg

iii. Demineralized water consumption in kilo litre.

iv. Industrial water consumption in kilo litre

All these consumption are taken for the period of 10 months (i.e. April 2015 to Jan 2016).

5.2 THE SOURCES FOR THE COLLECTION OF DATA

We used various sources for data collection for the project. There are internal and external sources of data collection. We have used following sources for data collection. The secondary data have been collected from books and journals bearing ISBN and ISSN. It is also collected from the various sources in the plant as mentioned below. The data available in the company is in the soft format. Primary data is accumulated by the team members in order to meet up the objective of the project. Secondary data is available effortlessly, rapidly and inexpensively. The following figure shows types of data used for this project.

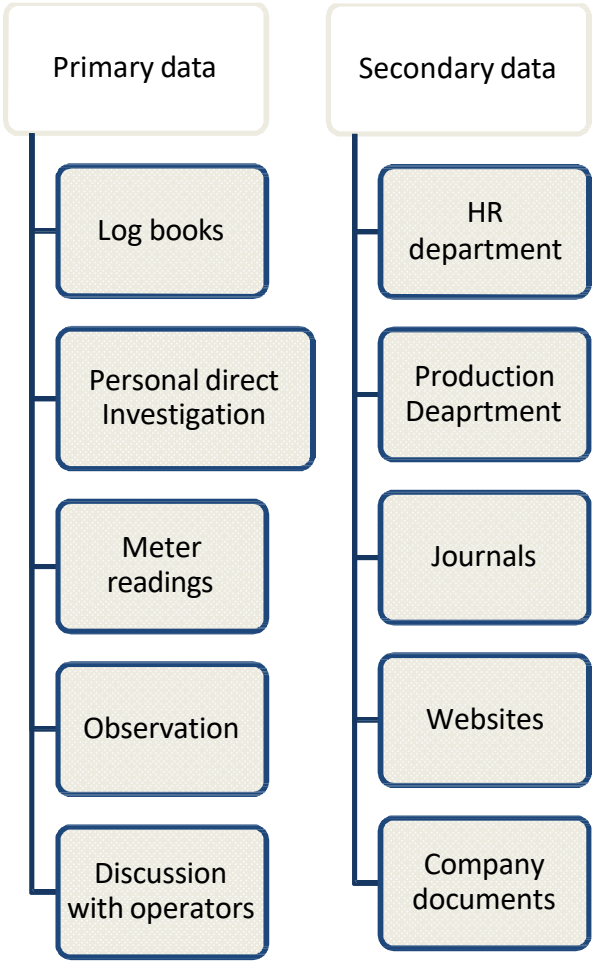


Fig 5.1: Sources of data

5.3 THE DETAILS OF THE DATA COLLECTED

In the following table we have presented production capacity of the various workstations. Our project is related to WS:9 and WS:10 i.e. pre-treatment and powder coating respectively. In this table we have improved the production capacity of these two bottleneck workstations from 8 to 11.2 jobs per minute.

Table 5. 1:Workstation processes and their capacityin Jobs per minute (After)

Work stations	Coiling and Powder coating processes	Production Capacity	Work stations	Coiling and Powder coating processes	Production Capacity
WS1	Eddy current testing	On line	WS8	In-process Inspection	On line

WS2	Cold coiling	16	WS9	Pretreatment	11.2
WS3	Stress relief	14	WS10	Powder coating	11.2
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

In above the lowest production capacity is for workstations WS9 and WS10. However it is sufficient to fulfil the demand of the clients. With this we have been working since March 2016. The following table shows production scenario for the suspension spring. It is for 7 months after implementation of the project. Total production in the month and average production per day in three shifts is given.

Table 5.2: Production data (After)

Months	Working days	Total production in Nos.	Average per day in Nos.
Mar-16	27	332000	12296
Apr-16	25	328000	13120
May-16	26	333000	12808
Jun-16	26	330000	12692
Jul-16	26	329000	12654
Aug-16	27	330000	12222
Sep-16	26	328000	12615
Average		330000	12630

The average production of the powder coating plant is 3.3 Lakh suspension springs per month. On an average 12630 springs are powder coated with the new method.

In the following table we have captured data of production for the month of September 2016. Shift wise data are presented herewith.

Table 5.3:Shiftwise production of the Suspension Springs (in Nos) for the Month of September 2016							
Day	Shit I	Shift II	Shift III	Day	Shit I	Shift II	Shift III
1	4300	4300	3560	16	4500	4520	3320
2	4500	4530	3470	17	4300	4630	3560
3	4600	4350	3500	18	4630	4660	3640
4	4300	4520	3600	19	4670	4530	3350
5	4500	4600	3750	20	4560	4710	3500
6	4550	4650	3830	21	4530	4630	3610
7	4530	4530	3750	22	4520	4650	3520
8	4620	4720	3670	23	4630	4550	3430
9	4560	4300	3670	24	4720	4500	3200
10	4730	4320	3540	25	4200	4670	3500
11	4620	4530	3580	26	4300	4380	3730
12	4650	4600	3400	Total	117410	118240	92350
13	4630	4630	3620	Average	4516	4548	3552
14	4560	4650	3580	Total production in September 2016			328000
15	4200	4580	3470	Production per day			12615

The powder coating process is carried out in three shifts every day. The net time available for the production is 1170 minutes as before. We have not worked on improving the idle time. The improvement in the input level in a specific time (cycle time) has brought the result. In the first and second shift about same quantity of jobs are processed; whereas in third shift 80% jobs are processed. In the September 2016 we have produced 3.28 Lakh springs are produced. This is about 12600 springs are processed per day. The plant is operated for 26 days in this month.

Now hereafter we are presenting consumption of resources for the powder coating both before and after implementation of project. Various resources are Electricity, LPG (kg), Demineralized water (kilo litre), Industrial water (kilo litre) and chemicals (in litre. This is presented to analyse the consumption of their resources (consumables) is presented in the Appendix. Here we are going to present summary of the data before and after implementation of the project.

The detailed consumable wise analysis is given in the chapter no.6 as per scheme. However it is noticed that the consumption of all these resources is increased with increase in the production level. We used to process about 2.0 Lakh jobs before implementation which has increased to 3.30 Lakh per month. The analysis of the each case is carried out in the next chapter as per guidelines.

Table 5.4: Consumption of process resources (Before)

Date	Working Days	Electricity (Kwh)	LPG (Kg)	DM water - KL	Industrial water - KL
Apr-15	26	124835	3730	125.4	84.4
May-15	25	122923	3726	124.5	82.7
Jun-15	26	128546	3883	130	87.7
Jul-15	27	134515	4025	134.4	90.9
Aug-15	26	129877	3898	130.2	88.2
Sep-15	26	123555	3738	124.5	85.5
Oct-15	27	132633	4046	133.1	90.6
Nov-15	25	124977	3737	125.4	83.6
Dec-15	27	132975	4071	134.4	90.9
Average	26	128315	3873	129.1	87.2

Table 5.4: Consumption of process resources (After)					
Month	Electricity (Kwh)	LPG (Kg)	DM water - KL	Industrial water - KL	
Mar-16	27	146293	4760	170.9	124.2
Apr-16	25	136294	4378	159.3	114.2
May-16	26	139841	4555	166.2	119.5
Jun-16	26	126905	4638	167.1	125.8
Jul-16	26	134744	4657	167.8	129.0
Aug-16	27	141868	4916	168.7	131.0
Sep-16	26	129081	4780	165.6	130.4
Average	26	136432	4669	166.5	124.9

5.4 PROCESSING OF THE DATA FOR ANALYSIS

The data we received in the form of soft and hard (on paper). In this section we have described processing of the data to convert it into useful information. For this we have taken following steps for data on paper.

Data Entry: First of all the data is collected internally and externally. This data collected is related to breakdown and production. Various causes and time consumption for them are collected from the records available in the system. All data are entered in the MS Excel spreadsheet.

Data Validity: After receiving of the data required data is sorted and then validated by the respective department. This validation is required to check it correctness of the data for further processing.

Data Tabulation: All the validated data is then structured in to the table. These structured tables give precise information about the data. After entering the data in table it became easy to handle the data and to use it.

Data Calculation: Once the data is in table then it is easy to do calculation of the data. Data in this project have undergone Addition, Subtraction, Multiplication, Division and Percentage. Excel sheet can perform various calculations. Example of Addition; =sum (A20: A30) + Enter. Multiplication = A20*A30 + Enter. Similarly it is done for Subtraction, Division and to find out percentage of the data.

Data Presentation: The calculated data in the table is then further processed for data presentation. The data is utilized to prepare Histogram, bar chart and scatter diagram. Data presentation gives a very clear picture of the data and is also easily understandable. Excel graphic presentation is used for this purpose.

5.5 CONCLUSION

In this chapter we have explained the type of primary and secondary data used in this project. We have presented historical data and data before implementation of the project in chapter No.3. In this chapter we have presented data post implementation of the project. The sources of the data collection are authentic and approved by the guide as well as company management.

The details of data collected are given in the section 5.3. This covers capacity of the various workstations, production for the 7 months (March to September 2016), daily and shift wise production and consumption of resources are given. In the consumables the summary related to Electricity, LPG, Demineralized and industrial water and chemicals are given. It is observed that total consumption of the resources has increased with improvement in the production. However, increment in the production is higher as compared to consumption of resources.

At the end processing of data is explained on the basis of data entry, validity, Tabulation, calculation and presentation. We have used Excel spree sheet for the analysis of data.

CHAPTER No. 6: ANALYSIS OF DATA

6.1 CHOICE OF TECHNIQUES

In the project we have adopted various productivity improvement techniques for the analysis of the situation and data. For the problem selection and analysis we have used 1) Pareto analysis 2) 4W-1H analysis and 3) Cause and effect diagram and 4) brain storming. The comparison of the data is carried out by 4) Histogram 5) Scatter plot andCheck sheet and Gantt Chart are used for project monitoring. These techniques are described in brief as below.

i) Pareto Analysis: - It puts data in a hierarchical order, which allows the most significant project to become first. In our project, it is used for the selection of this project.

ii) 4W-1H analysis: - Why is an iterative and interrogative technique used to explore the root cause behind a particular problem. In our project, it is used to get complete details of the problem in hand.

iii) Cause-and-effect diagrams: - Common use of the cause and effect diagrams isproduct design and quality defect prevention to identify potential factors causing an overall effect. Each cause or reason for imperfection is a source of variation. Causes are usually grouped into major categories to identify these sources of variation. The categories typically include People, Methods, Machines, Materials, Measurements and Environment.

iv) Histogram: - It showing different Bulge formation prevention and after implementation scenario. It is helps for presenting effectively a) Reduction in consumables in a month and b) Improvement in productivity.

v) Scatter diagram: - It helps for a) Showing before and after situation of the project in month wise, b) Reduction in consumables in terms of respective units .

vi) Check sheet: - A checklist is a type of informational job aid used to reduce failure by compensating for potential limits of human memory and attention. It helps to check and record the arrival of defective in a lot or shift.

vii) Gantt's chart: - It is used for scheduling of implementation of program, which shows number of activities to be carried and respective time. It gives plan and actual implementation of project.

6.2 BASIS OF PROBLEM SELECTION

In this section we have explained basis behind selection of the problem. In the company there are six problems associated with the powder coating line. In this investigation we have mentioned present issues related to various problems. The possible improvement in the productivity and its amount is given. There were six problems as mentioned below which the company was thinking to correct.

Table 6.1: Projects and their Expected improvement

S/N	Present Issues	Description	Nos	Per
P1	Improvement in the productivity of powder coating process	It is possible to improve the same from present 8 to 16 jobs per minutes as per present demand of the customers.	1.30 Lakh	Lakh
P2	Reducing the maintenance cost of the line	The maintenance cost of the line is Rs. 11220 per hour. It is assumed 10% reduction in the maintenance cost.	25 days	15 Hours /day
P3	Reducing energy consumption of the line	The energy consumption of the LPG and Power accounts for Rs. 5353 per hour.	25 days	15 Hours /day
P4	Improving the availability of the suspension spring line	Presently the line is operating for 1300 minutes in total 1440 minutes. A reduction of 50 minutes will increase the availability of the line.	50 minutes	8 jobs per minute
P5	Reducing the set up time of the line	Presently the set up time for various models of the springs is 120 minutes.	60	480 jobs per minute

P6	Improving the productivity of the stress relief station	Present capacity is 14 Jobs per minutes. It is necessary to increase the same to 16 Jobs per minutes	10%	1800

In this table six projects along with their potential for the improvement in the problem is given. Total Rs.16.54 Lakh per month earning from these six projects is expected. The share (contribution) of first project i.e. improvement in the productivity of powder coating process is 39%. Thus we expect Rs.6.50 Lakh benefit from this project. Being highest benefit we had decided to take up this project on priority.

Table 6.2: Prospective benefits from projects

S/N	Potential for improvement	Rate	Unit	Amount	Percentage
P1	1.30 Lakh	500000	Rs/Lakh	650000	39%
P2	375 Hours	1122	Rs./Hour	420750	25%
P3	375 Hours	533	Rs./Hour	199875	12%
P4	200 jobs	25	Rs./Job	150000	9%
P5	28800 Jobs	5	Rs/Job	144000	9%
P6	45000 Jobs	2	Rs/ Job	90000	5%
			Total Rs.	1654625	100%

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.

We need to check the manual and manufactured data sheet for this purpose. Necessary inspection should be carried out before actual implementation.

Proposed Productivity improvement in Powder coating processes

Table 6.3: 4W-1H analysis

Where	What	Who	When	How
The conveyor loading	Load carrying capacity to be checked	1)Project Manager (Myself)	In the month of February	Finding weight in 100 Meters
Hangers design	To accommodate 8 springs	2)Team members 3) Operators 4) In house manpower – welders, workers	Fabrication in February	By fabricating new and extension of existing hangers
Check for the setting	To improve pump flow		Based on previous results	Check for quality -tests
Check for consumables	For additional springs		After Maintaining record	Monitor data

This project is discussed among the cross function team (CFT). A detailed discussion about Conveyor capacity and speed, soaking time, process requirement and chemical process in pretreatment specially prospecting and passivation has been carried out. Team has agreed upon following points –

Powder coating hangers design for suspension Springs has to be change to accommodate 8 springs instead of previous 4 sprigs at a time.

1) Conveyor load carrying capacity to be kept in mind for above change.

2) Energy conservation parameters like electricity , LPG , Chemical and other consumable to be monitor and set according to additional load.

3) Quality tests : Pill off test for coating quality, Colour glair test and coating thickness test – It should be 150 Micron

6.4 CAUSE AND EFFCET DIAGRAM

An interview with production manager and workers was conducted and some of the causes were identified through the interview. The method assists in identifying the causes of the problems within the plant. These causes contributed in the identification of the main causes of the inefficient production plant. CS – Coil spring SB- Stabilizer bar. In this exercise we have categorised various causes obtained for productivity improvement of the paint line. Material, manpower, mold, method and machine are to be involved in the improvement in the productivity. In this case we need to work upon 1) loading of jobs 2) conveyor speed 3) consumables and synchronizing various factors affecting powder coating process.

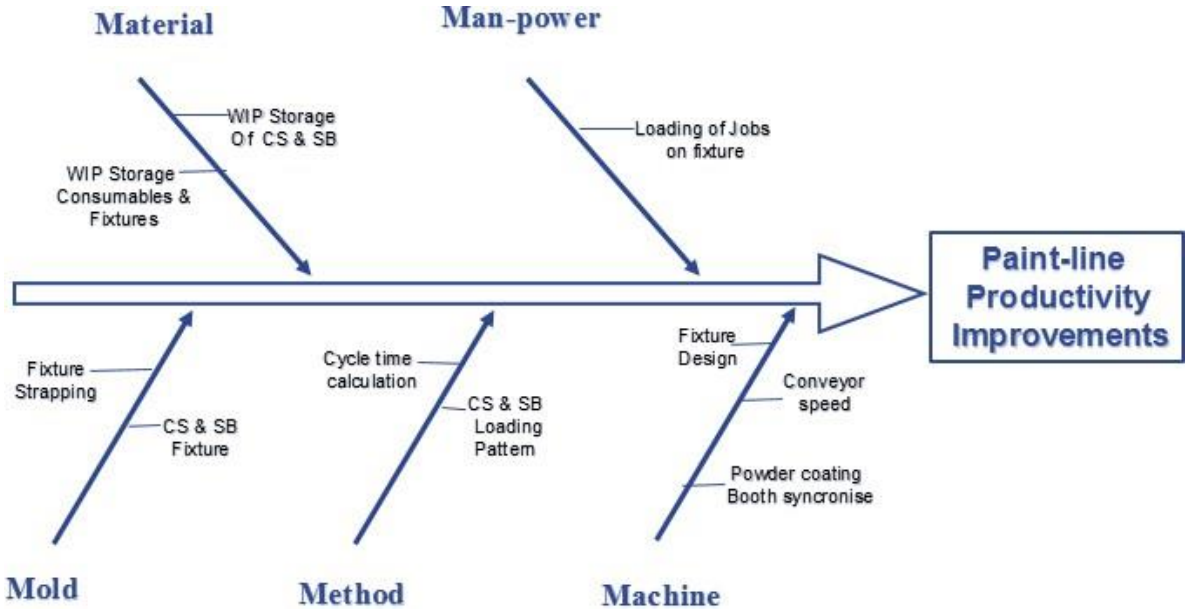


Fig 6.1: Cause and effect diagram

In this analysis it is observed that the loading pattern of the spring should be improved. Accordingly the manpower for the loading jobs will be increased. Necessary consumables shall be maintained at the store to cater revised consumption. Fixture (hanger) strapping time is also increased with this project. Other factors shall be adjusted to coat the 8 springs at a time in the powder coating booth.

6.5 PRODUCTION BEFORE AND AFTER

In this section we have presented production before and after implementation of the project. We have already given 10 months data before and 7 months data after implementation of the project. The following figure shows scatterplot of the production. It indicates the improvement after implementation of the project. However magnitude of the improvement is calculated on the basis of average production.

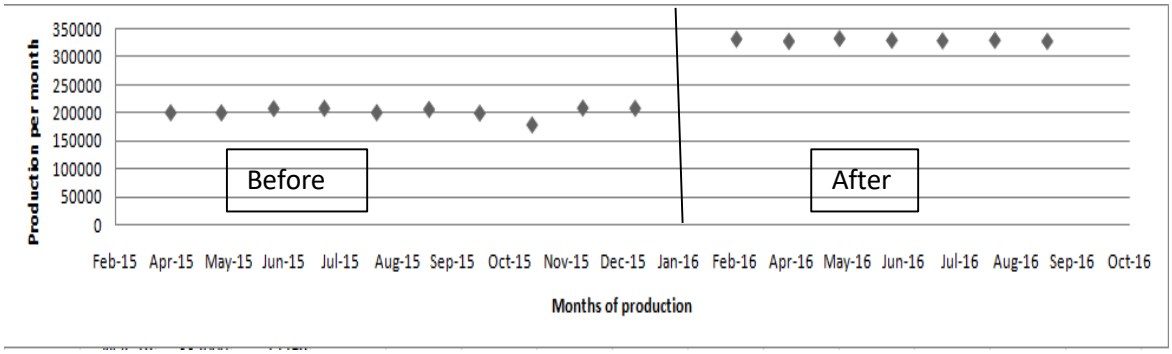


Fig 6.2: Monthly production before and after (inNos)

The following figure indicates average production of the suspension springs before and after. Before implementation the company used to process 2.0 Lakh jobs per month which has increased to 3.3 lakh.

Thus there is 1.3 lakh more production in a month, which is 65% of eth previous production. This production is as per aggregate demand of the clients.

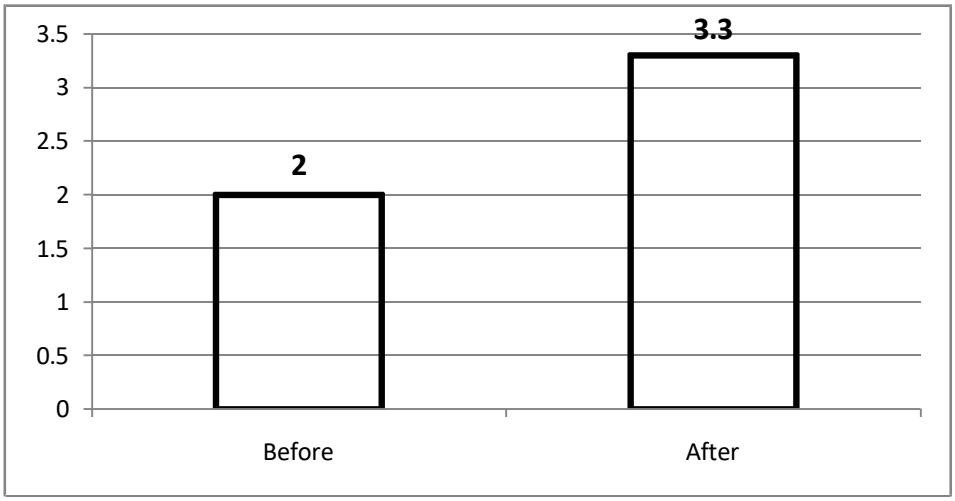


Fig 6.3 : Average production per month (in Lakh Nos)

6.6 IMPROVEMENT IN THE PRODUCTIVITY

In this section we have described productivity improvement per day and per minute. The following figure shows before implementation the powder coating of 8000 jobs (average) was possible which has increased to 12630 jobs (average) per day. This production is carried out in three shifts of working.

In other words we can say that before implementation 6.8 jobs per minute was being produced which has increased to 10.80 jobs. This improvement is about 60% of the previous.

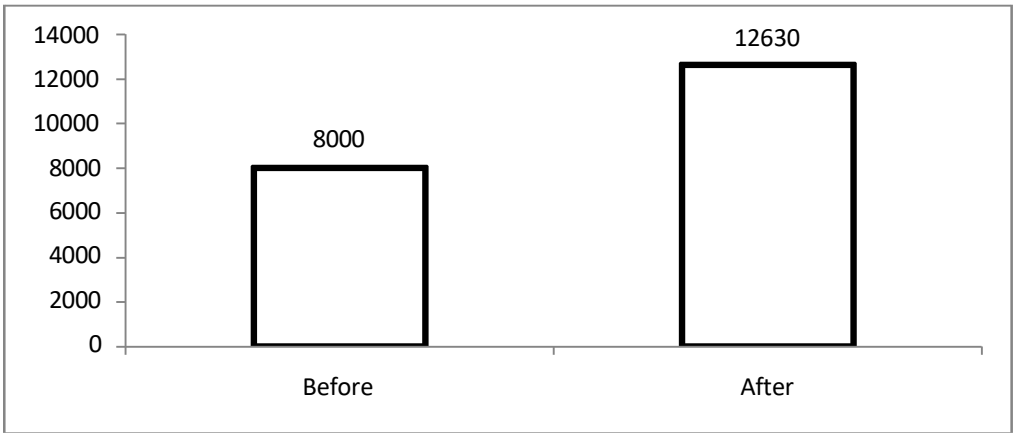


Fig 6.4: Daily Production (Powder coating)

In the following figure before and after implementation production per minute is given. The demand line to fulfil the requirement of the clients is given in dotted line. Now the capacity of all workstations including WS9 and WS10 is sufficient to process jobs as per requirement of the client. The line is operated at 87.50% efficiency therefore it is matching with demand. The higher capacity is always necessary in the industry to cater 20% overloading (excess demand) from the clients. Also there are other components which can be powder coated in this line.

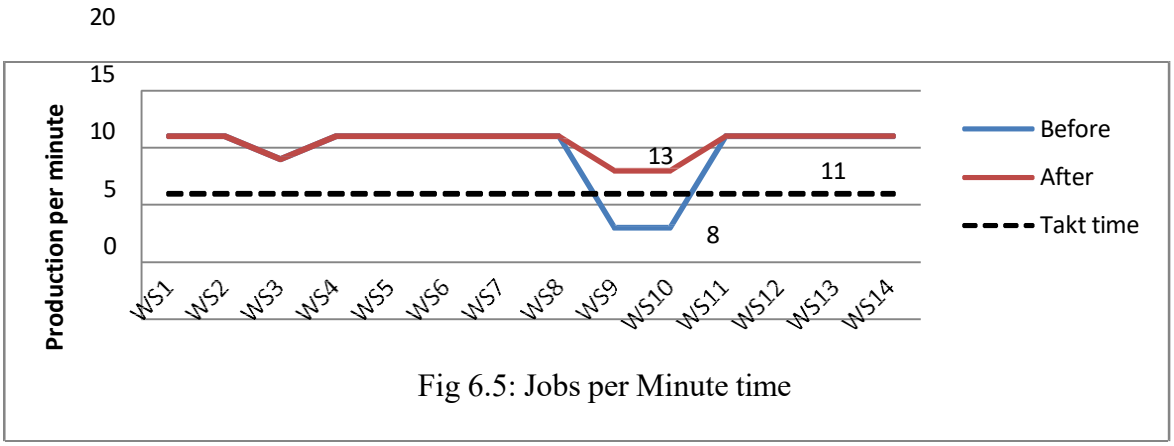


Fig 6.5: Jobs per Minute time

6.7 CONSUMPTION OF ELECTRICITY

In this section we have explained Electricity consumption before and after implementation of the project. It gives 10 months electricity consumption in Kwh (units), production and electricity consumption per lakh jobs.

Table 6.4: Consumption of electrical energy (in Kwh)							
Before				After			
Months	Electricity (Kwh)	Production in Nos	Electricity in Kwh per Lakh Jobs	Months	Electricity (Kwh)	Production in Nos	Electricity in Kwh per Lakh Jobs
Apr-15	130065	200125	64992	Mar-16	146293	332000	44064
May-15	122923	200000	61462	Apr-16	141634	328000	43181
Jun-15	128546	207550	61935	May-16	139841	333000	41994
Jul-15	134515	208000	64671	Jun-16	132223	330000	40068
Aug-15	129877	200350	64825	Jul-16	134744	329000	40956
Sep-15	128344	206000	62303	Aug-16	141868	330000	42990
Oct-15	132633	199300	66549	Sep-16	129081	328000	39354
Nov-15	124977	178300	70094				
Dec-15	132975	208500	63777				
Jan-16	129428	208000	62225				
Average consumption (Before) =			64283	Average consumption (After) =			41801

The same data for post implementation is given herewith to compare. These data are obtained from the detailed report which is appended in the Appendix. The electricity consumption per lakh implementation ranges from 60000 to 70000 Kwh, it has reduced to 38000 to 44000 Kwh. In the following figure we have given average of the consumption per lakh suspension springs.

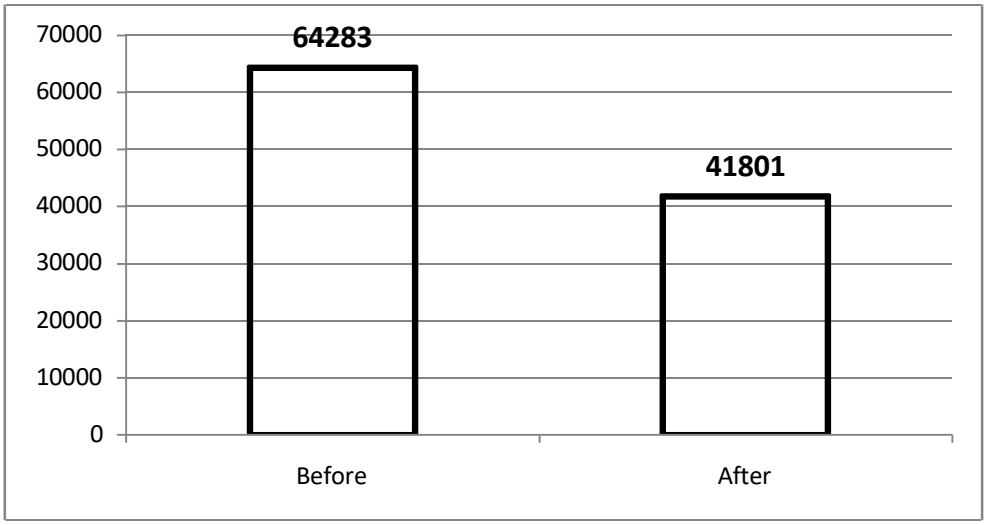


Fig 6.6: Average Electricity consumption in Kwh per Lakh springs

Before implementation the electricity consumption was average 63736 Kwh per Lakh which has reduced to 41338 Kwh per lakh. Thus there is reduction of 22400 Kwh (units) per lakh springs. This has reduced the cost of electricity consumption by 22400 X Rs.8/- per unit = 1.80 Lakh per Lakh suspension springs.

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 increased due to excess heating of water. This is required for increased number of jobs. The effect of all these is increase in the total consumption of the LPG. The scenario before and after is shown below:

Table 6.5 : Consumption of LPG per month in Kg

Before				After			
Months	LPG (Kg)	Production in Nos	LPG (Kg) per Lakh Jobs	Months	LPG (Kg)	Production in Nos	LPG (Kg) per Lakh Jobs

Apr-15	3876	200125	1937	Mar-16	4760	332000	1434
May-15	3726	200000	1863	Apr-16	4554	328000	1388
Jun-15	3883	207550	1871	May-16	4555	333000	1368
Jul-15	4025	208000	1935	Jun-16	4638	330000	1405
Aug-15	3898	200350	1946	Jul-16	4657	329000	1416
Sep-15	3892	206000	1889	Aug-16	4916	330000	1490
Oct-15	4046	199300	2030	Sep-16	4780	328000	1457
Nov-15	3737	178300	2096				
Dec-15	4071	208500	1953				
Jan-16	3906	208000	1878				

Before implementation the LPG consumption was 3737 to 4071 Kg per month which has increased to 4554 to 4916 Kg. The average consumption per Lakh springs has reduced from 1940 to 1423 Kg. Thus there is reduction of 517 Kg per Lakh springs is the saving we have obtained from the implementation of this project. The scenario is shown in the following figure.



Fig 6.7: Average consumption of LPG in Kg per Lakh springs

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. The following table shows DM water consumption in kilo Litres. It is taken from the record maintained by the in-charge of powder coating. The record before implementation of the project is considered for a period of 10 months whereas after implementation we have maintained it for 7 months.

Table 6.6: Consumption of Demineralized water per month in Kilo Litre

Before				After			
Months	DM water - KL	Production in Nos	DM water (KL) Per Lakh Jobs	Months	DM water - KL	Production in Nos	DM water (KL) Per Lakh Jobs
Apr-15	130.2	200125	65	Mar-16	170.9	332000	51
May-15	124.5	200000	62	Apr-16	165.2	328000	50
Jun-15	130	207550	63	May-16	166.2	333000	50
Jul-15	134.4	208000	65	Jun-16	167.1	330000	51
Aug-15	130.2	200350	65	Jul-16	167.8	329000	51
Sep-15	129.5	206000	63	Aug-16	168.7	330000	51
Oct-15	133.1	199300	67	Sep-16	165.6	328000	50
Nov-15	125.4	178300	70				
Dec-15	134.4	208500	64				
Jan-16	130.2	208000	63				

As production of the jobs (i.e. powder coating process) has increased the total consumption of DM water also increased. Previously about 130 KL water was required for rinsing 2 Lakh

springs. It has increased to 167 KL for rinsing 3.3 Lakh springs. In the last column of each month we have calculated DM water consumption per Lakh jobs.

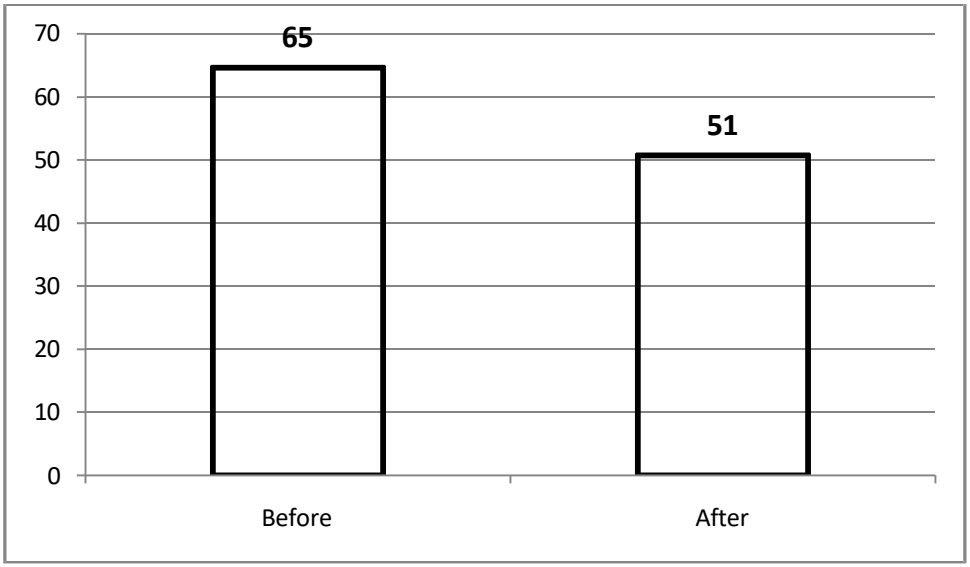


Fig 6.8 : Average Consumption of Demineralized water (KL) per Lakh Springs

Previously about 65KL water was required for one Lakh spring rinsing which has reduced to 51 KL after implementation of the project. In other words the consumption of DM water has reduced by 14 KL per Lakh jobs or about 22% of the previous consumption. This has saved the cost of DM water also.

6.10 CONSUMPTION OF INDUSTRIAL WATER

Consumption of Industrial water has also increased 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 is shown in the following table.

Table 6.7: Consumption of Industrial water per month (In KL)							
Before				After			
Months	Industrial water - KL	Production in Nos	Consumption of Industrial water in KL/Lakh jobs	Months	Industrial water - KL	Production in Nos	Consumption of Industrial water in KL/Lakh jobs
Apr-15	84.4	200125	42	Mar-16	124.2	332000	37
May-15	82.7	200000	41	Apr-16	114.2	328000	35
Jun-15	87.7	207550	42	May-16	119.5	333000	36
Jul-15	90.9	208000	44	Jun-16	125.8	330000	38
Aug-15	88.2	200350	44	Jul-16	129.0	329000	39
Sep-15	85.5	206000	42	Aug-16	131.0	330000	40
Oct-15	90.6	199300	45	Sep-16	130.4	328000	40
Nov-15	83.6	178300	47				
Dec-15	90.9	208500	44				
Jan-16	87.2	208000	42				

Consumption of industrial water per Lakh jobs is calculated in the last column before and after implementation of project. Before implementation it was 41 to 47 KL per Lakh jobs powder coating which has reduced to 35 to 40 KL. The following figure shows average reduction in the consumption of water after implementation.

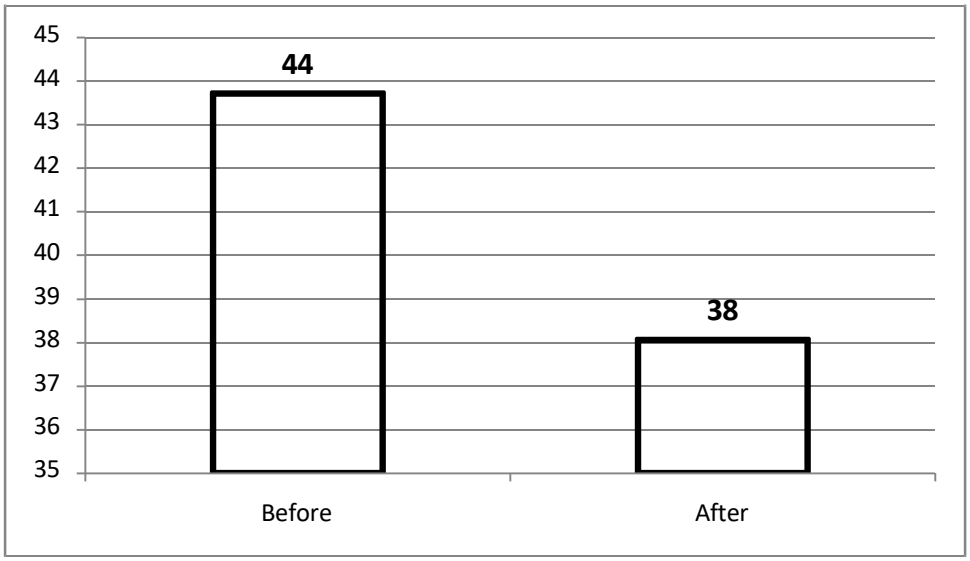


Fig 6.9 : Average Consumption of Industrial water (KL) per Lakh Springs

The above figure shows previously 44 KL industrial water was required for rinsing springs which has reduced to 38 KL. Thus there is reduction of 6KL industrial water or 14% water as required before.

6.11 CONSUMPTION OF EPOXY POWDER

The epoxy powder required for powder coating of the jobs. The consumption of this has increased due to four additional guns are provided for the spray of the Epoxy powder. The summary of 10 months before and 7 months after implementation of project is given in the following table. It is measured in kg. It is powder coating material and its consumption (overall) has increased due to increased spray and reduced conveyor speed (higher time for spraying).

Table 6.8: Consumption of Epoxy powder (in Kg) per month							
Before				After			
Months	Epoxy Powder in Kg	Production in Nos	Epoxy powder (Kg) per Lakh jobs	Months	Epoxy Powder in Kg	Production in Nos	Epoxy powder (Kg) per Lakh jobs
Apr-15	4328	200125	2163	Mar-16	5656	332000	1704
May-15	4115	200000	2058	Apr-16	5568	328000	1698
Jun-15	4279	207550	2062	May-16	5753	333000	1728
Jul-15	4486	208000	2157	Jun-16	5584	330000	1692
Aug-15	4274	200350	2133	Jul-16	5593	329000	1700
Sep-15	4294	206000	2084	Aug-16	7783	330000	2358
Oct-15	4383	199300	2199	Sep-16	5555	328000	1694
Nov-15	4115	178300	2308				
Dec-15	4468	208500	2143				
Jan-16	4530	208000	2178				

Previously about 4.1 to 4.5 M.T. Epoxy powder required for the powder coating of 2 Lakh jobs. It has increased to 5.5 to 7.8 MT after implementation of the project for coating about 3.3 Lakh jobs per month. Per Lakh job the Epoxy powder was required about 2148 kg which has reduced to 1796 kg. Following figure shows the average reduction in the epoxy powder.



Fig 6.10**:** Consumption of Epoxy powder (in Kg) per Lakh Springs

The epoxy powder consumption has reduced by 352 kg per Lakh jobs(2148 – 1796 Kg) or it has reduced by 352 X 100/2148 kg = 16.4% of the previous consumption. Thus it saved the cost of powder coating significantly. It is a costly item having Rs. 155 /kg cost of purchase. Thus the saving per Lakh powder coating of springs is Rs, 55,000/-.

6.13CONSUMPTION OF CHEMICALS

There are degrease, activation, passivation and phospheting chemicals required for powder coating. Consumption of these also has increased due to increased processing of the jobs. On an average 28 litres/day chemical in liquid form was necessary before implementation of the project. Monthly about 700 liters required before which has increased to 1000 litres. The record of consumption is presented in the following table.

Table 6. 9: Consumption of Chemicals (in Litres) per month							
Before				After			
Months	Chemicals in Litre	Production in Nos	Chemicals (Litre) per Lakh Jobs	Months	Chemicals in Litre	Production in Nos	Chemicals (Litre) per Lakh Jobs
Apr-15	717	200125	358	Mar-16	969	332000	292
May-15	674	200000	337	Apr-16	1001	328000	305
Jun-15	690	207550	332	May-16	1043	333000	313
Jul-15	726	208000	349	Jun-16	1011	330000	306
Aug-15	704	200350	351	Jul-16	976	329000	297
Sep-15	687	206000	333	Aug-16	1026	330000	311
Oct-15	732	199300	367	Sep-16	994	328000	303
Nov-15	680	178300	381				
Dec-15	729	208500	350				
Jan-16	712	208000	342				

Monthly about 342 to 381 litres/lakh jobs chemicals was necessary before implementation of the project which has reduced to 292 to 313 litres Lakh. Thus there is reduction in the consumption. Following figure shows the average consumption of chemicals in both i.e. before and after cases.

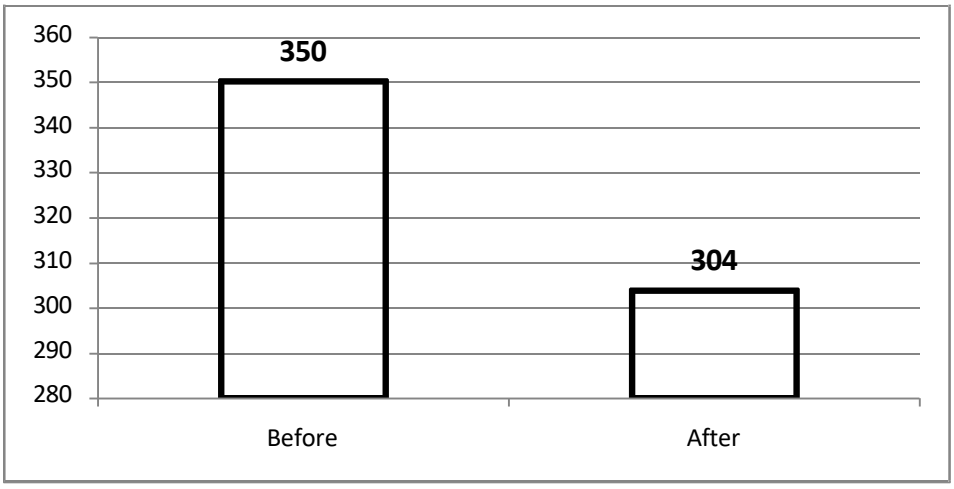


Fig 6.11: Average Consumption of Chemicals (in Litre) per Lakh springs

On an average 350 litres / Lakh consumption of chemicals has reduced to 304 litres / Lakh. The reduction is 46litres / Lakh jobs or 13% of the previous. Obviously it has reduced the cost of processing job also.

6.13 COST OF THE PROJECT

In this section we have estimated the cost of project implementation. It includes manpower, material and administrative cost at 15%. The details of the cost are as below.

Table 6.10: Cost of the project

S/N	Particulars	Nos	Hours	Total Hours	Charges in Rs. per hour	Total
1	Managing Director	1	5	5	1000	5000
2	Project Manager (Self)	1	30	30	300	9000
3	Senior manager	2	30	60	275	16500
4	Technician	1	18	18	200	3600
5	Operators	2	32	64	125	8000
6	Helpers	3	32	96	80	7680
7	Training	1	2	2	1000	2000
8	Miscellaneous					3000
9	Total cost (Net)					54780
10	Administrative cost					9860

11	Total manpower cost					**64640**
S/N	Material	Quantity	Rate	Unit	Amount	
1	Cost of New Hangers	200	600	Nos	120000	
2	Modification of existing hangers	1300	245	Nos	318500	
3	Spray Guns make: Eaisen Berg, Germany	4	145000	Nos	580000	
4	Stand modification in MS including angles, flats and fabrication work	2	8000	Nos	16000	
5	Total cost (Net)				1034500	
6	Add 10% Administrative cost				103450	
7	Total material cost Rs.				**1137950**	
	Total cost of the project Rs.					**1202590**
	Say Rs. 12.00 Lakh					

The total cost of the project implementation is Rs.12Lakh. This is one time cost. It includes manpower cost of about Rs. 65000/- for decision making, training and implementation cost. The material cost is about Rs.11.38 Lakh. The major amount required for purchase and fitting of Eaisen Berg, spray guns 4 Nos i.e. 2 Nos each side. The modification of existing 1300 hangers by extending its lower portion is also Rs. 3.18 Lakh. The cost of complete new hanger is Rs.600/No whereas for modification it took only Rs.245/No. The total cost Rs.12.00 Lakh we have considered for calculation of economic feasibility.

6.14 CALCULATION OF SAVING FROM RESOURCES

In this section we have calculated 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 as given below. In this table we have taken average figures for consumption before and after implementation.

Table 6.11; Saving from less consumption of productive resources (Average)						
Resources	Before	After	Difference	Rate	Unit	Amount
Electricity in Kwh	64283	41801	22482	8.0	Rs/ Kwh	179856
LPG in Kg	1940	1423	517	52	Rs/ Kg	26884
DM water in KL	65	51	14	125	Rs / KL	1750
Industrial Water in KL	44	38	6	90	Rs / KL	540
Epoxy powder in Kg	2148	1796	352	155	Rs/ Kg	54560
Chemicals in Litre	350	304	46	145	Rs/ Litre	6670
Total Amount saved per lakh springs powderRs.						270260

The rates of the consumables are actual and same before and after implementation to show true result of this project. Thus on above mentioned six consumables we saved Rs. 2.70 per Lakh processing of springs. The contribution of each consumable is given below in pie chart.

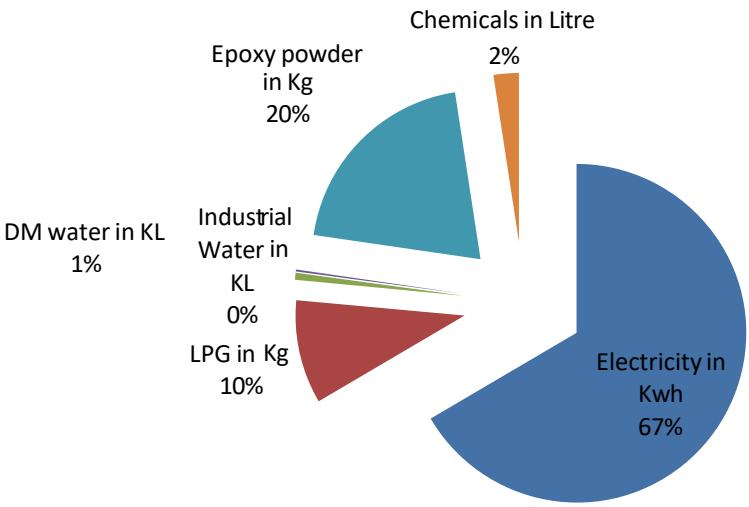


Fig 6. 12 : Contribution of resources in the total saving

The highest saving of 67% is obtained from reduced consumption of Electric power.

6.15 IMPROVEMENT IN THE LABOUR PRODUCTIVITY

As per Chari, 2000 p.505 [[xv]] : The labour productivity is expressed in terms of percentage of number of jobs produced to the labour hours employed. In our case before implementation there were 21 employees were working in three shifts we have to increase by 10. Thus total 31 operators are working in the three shifts. These operators are for additional loading, unloading and transport of the 65% higher springs. The details of the operators before and after are given in the following table. Here we have given them according to their functions.

Table 6.12: Operators employed before and after

Functions	No. of operators (Before)		No of operators (After)
Cleaning	0		1

Loading the jobs	3		6
Unloading the jobs	6		6
Transport towards loading point	3		6
Transport away from unloading point	3		6
Observation and setting	6		6
Total	21		31

Man-hours before = 26 days X 24 hours X 21 = 13104 man hours

Man-hours after = 26 days X 24 hours X 31 = 19344 man hours

Output of the powder coating process before was 2.0 Lakh jobs per month which has increased to 3.3 lakh / month.

Thus thelabourproductivity before was =

= 200000 job / 13104 man-hours = 15.3 jobs per man-hour.

The labour productivity after is = 330000 jobs /19344 man-hours = 17.1 jobs per man-hour.Thus the labour efficiency has increased from 15.3 to 17.1 jobs per man hour or by 12 %.

6.16 REDUCTION IN THE POWDER COATING COST PER JOB

In this section we are going to estimate effect of the project implementation on the reduction in powder coating cost. From 6.14 Section we have calculated the saving from less consumption of resources per Lakh jobs. In the previous section we have mentioned the cost of labour has increased due to employment of 10 operators for loading, transport and cleaning jobs at higher level. The result is given herewith. The cost of 10 additional operators is given herewith in the following table.

Table 6.13: Manpower before and after					
	Before			After	
Operator category	Nos	Monthly payment Rs	Amount in Rs	Nos	Amount in Rs
Operator-I	3	28000	84000	3	84000
Operator-II	3	25000	75000	3	75000
Operator-III	6	22000	132000	6	132000
Operator -IV	3	18000	54000	7	126000
Transport	6	18000	108000	12	216000
Total	21		453000	31	633000
Add 10% welfare expenditure			45300		63300
Total Amount Rs.			498300		696300

The difference in the labour cost before and after Rs. 198000

Thus Rs. 198000 /- per month is required for the handling excess work load from the line. With this additional manpower it is possible to process on an average 3.30 Lakh jobs per month. Thus Rs.60000/- (Rs. 198000/3.3 Lakh jobs) per Lakh job is additional labour expenditure.

The saving from lesser consumption of Resources (6 Nos) = Rs. 2.70 Lakh/Lakh jobs. The net saving is Rs. 2.7 Lakh - Rs. 0.6 Lakh= 2.10 Lakhper Lakh jobs. This will become Rs. 2.10 /- per job saving due to implementation of this project. This is excluding the price discount offered by the company to the clients for additional business.

6.17 **GENERAL OBSERVATIONS**

In this project we have improved productivity of the powder coating process. Before implementation of the project we system was capable to process 2 Lakh jobs per month. It was according to demand of the clients. Now after March 2016 two clients have increased their demand by 1.3 Lakh suspension springs per month. In the whole processing the powder

coating and pre-treatment had lowest capacity of processing. Therefore we had selected these two for improvement. We have carried out cause and effect, why-why analysis to find out the causes behind lower productivity of the line. Simply improving efficiency of the line would not increase the expected level of production, which is 65% of the previous production.

This chapter compares data before and after implementation of the project. It is observed that seven key resources are reduced due to improvement in the productivity. The saving from Electricity, LPG, Demineralized water, including water, Epoxy powder and chemical is about Rs. 2.70 Lakh per lakh processing of jobs. For additional loading at upper level 10 more operators are required in a day. Thus it has employed 31 operators against 21 previous. The productivity has increased from 15.30 to 17.10 Jobs per man-hour. Overall the saving from this project is Rs. 2.10 per job. However it is gross saving.

CHAPTER No.7: RECOMMENDATIONS

7.1 BRIEF DESCRIPTION OF RECOMMENDATIONS

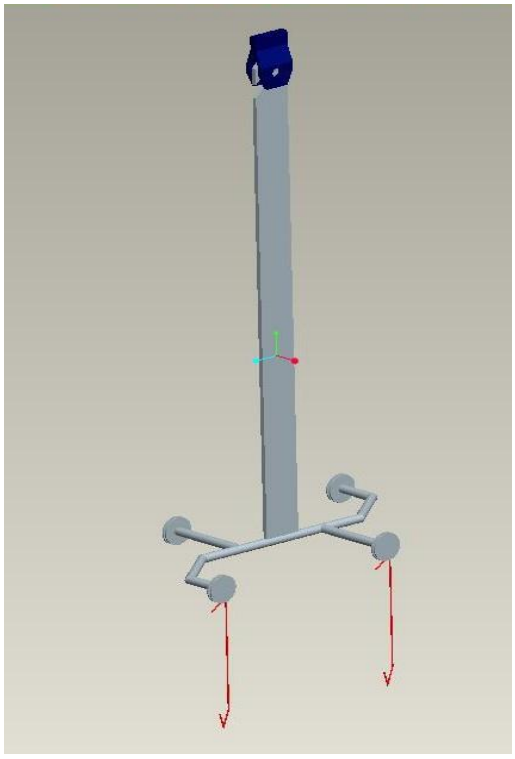
In this chapter we have described the details of corrective actions which are recommended during the project work. All these actions are carried out in the month of February 2016 and project is implemented. Necessary drawings and concept behind it is explained. Each section is devoted for a recommendation.

In order to increase the productivity of powder coating process we 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 is fabricated for standing on it in order to load springs at upper level. Process parameters are increased accordingly. At first we have carried out sample jobs loaded on 8 modified hangers. The quality parameters of the powder coating are tested in the laboratory. It is found as per standard and then other hangers are fabricated. Necessary on-the-job training is given to operators. Hereafter each recommendation is explained in a separate section in detail.

7.2 CHANGE IN THE HANGER DESIGN

In this exercise we have modified hanger design to accommodate 8 suspension springs at a time instead of previous 4 Nos. Previous length of the hanger rod was 0.80 metre which has increased to 1.20 metre. 10 mm MS plain flat is used for hanging of springs as shown in following figure.



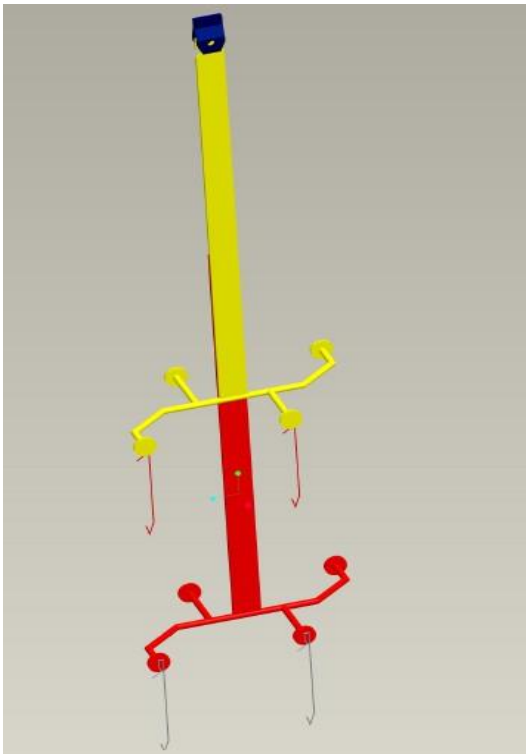


Fig 7.1a: Hanger (Before) Fig 7.1b: Hanger (After)

This length is as per headway available and spray gun positions in the powder coating booth. Envelop size of the booth is 1500 mm (Height) X 400 mm (Width). Out of 1.2 metre hanger rod length 300 mm is required for hanging to conveyor belt which is above the Envelop. Previous weight of hanger was 8kg which became 10kg after modification. The weight of springs now is 8 springs X 1.5 kg/spring = 12kg. Total 1500 hangers are required for powder-coating booth, out of which we have modified 1300 Nos by extending bottom portion to the existing hangers. Other 200 new hangers fabricated in the plant as per modification. Total Rs.3.38Lakh cost is required for this. The details of this work carried out are given below:

The work is carried out in following manner.

1. Finalization of drawing of the new hanger with details

2. Procurement of material required for this.

i. 60 mm X 10mm M.S. Flat – having weight 4.71 Kg/m.

For modification of old hangers = 1300 X 0.4 M = 520m

For new hangers = 200 X 1.2 m = 240 mtr.

Total length = 760 m +10% wastage = 836 mtr.

Weight = 836 mtr X 4.71 kg/m = 3938 kg.

ii. 10mm Mild steel plain rod for spacers 0.80 m for each stand. For old hangers 1300 spacers and for new hangers 200X2 = 400 spacers are required. Thus total 1700 Nos x 0.80 mtr. = 1360 mtr length + wastage 140 mtr(10%) = 1500 mtr length 10mm plain rod is ordered. The weight is = 1500m X 0.62kg/m = 930 kg.

iii. End plugs 4 Nos for each spacer bar i.e. 1700 Nos X 4 = 6800 Nos plugs required.

iv. For hanging purposed 3mm diameter hard steel bar is required. 20 cm (including bends 2 Nos) for every corner where spring is hanged it is necessary. For old hangers 1300 X 4 Nos = 5200 nos hooks are necessary. Whereas for new hangers 200 X 8 Nos (4 top + 4bottom) = 1600 nos are necessary. Accordingly the total length of 3 mm dia bar is 0.20 X (5200 + 1600) = 1360 mtr + 140 mtr. Wastage = 1500 mtr bar is required. The total weigth is = 1500 mtr X 0.06 kg/mtr = 90 kg.

v. Welding rods (Adormake welding electrode – 5 mm dia and 450 mm length) – 3 Boxes of 480 pieces. (Rate Rs. 2600/- per box.)

3Processes required:

i) Cutting the flat and MS bars and hard steel bars for required length as per drawing.

ii) Bending the spacer rod – 10 mm diameter as per drawing. For this we made a fixture in MS angles available from scrap.

iii) Welding work – for spacer bar, End cap and hanger rod is carried out with the help of welders. These welders are made available in-house. They have carried out cutting, bending and welding work.

Fig 7.2 : Spacer bar bending fixture

4. Machines spared:

i) Cutting machine – For cutting M.S. flat and rod to the required size. It is available in the plant.

ii) Welding machine – The machine (Ador welding equipment's, Chinchwad) – 1No.

5. **Manpower spared:**

i) Welder – 4 Nos for cutting, bending and welding work in daytime, general shift.

ii) Helpers - 2 Nos for carrying material and other.

7.3 ADDITIONAL SPRAY GUNS

Now with additional four suspension springs are mounted on the newly designed hanger it is necessary to install spray guns at higher height. Previously there were four guns on each side now we put 2 additional guns at higher level on each side of the booth. Therefore

total 12 guns are working now at a time. The arrangement of the guns is shown below. These guns (4 nos) manufactured by M/S Eaisen Berg, Germany are installed. All these guns are moving from bottom to top position as shown in the figure. For covering the complete area we have decreased the speed of the conveyor from 2.0 mtr/sec to 1.67 mtr/sec.

Fig 7.3: Spray Guns

7.4 FABRICATION OF STAND

As discussed before we have mounted springs at two levels (top and bottom).This change has increased the manpower at the loading point. An operator has employed to load springs at top level. Bottom level springs are loaded by another operator. Thus two operators are working at spring loading point. For this we have fabricated a stand of size 1.0 X 0.60 X0.60 mtr. It is fixed at bottom. It is prepared in-house using MS flats of 60mm X 10 mm and 75 X 75 X 6mm angles at four sides.

7.5 CHANGES IN PROCESS PARAMETERS

In order to maintain quality of powder coating we have changed parameters of the process as shown below. This is carried out by changing setting of the pump.

Table 7.1: Changes in process parameters		
Parameters	Before	After
1. Pump flow for Activation	1350 LPM	1410 LPM
2. Pump flow for phospheting	2050 LPM	2200 LPM
3. Temperature	190^0 C	210^0 C
4. Passivation pump flow	1350 LPM	1410 LPM
5. Time required for one cycle	200 Minutes	240 minutes
6. Speed of the conveyor	2 mtr/sec	1.67 mtr/sec

The flow ratings of the pumps are increased to cover all 8 springs at a point. For this necessary setting is carried out. The decreased speed of the conveyor also has increased the retention period of the jobs in the powder coating booth by 82% of the previous. The spry and speed are decided on the basis of calculations and trial and run for maintaining the quality of the powder coating. At first we have carried out this experiment with 8 modified hangers and 64 loaded springs. The quality of the coating is checked in house. I) pill off test for coating quality ii) colour glair test and iii) Coating thickness test. All tests shown quality of the newly coated springs is as per norms. Therefore we have taken up carrying out of the recommendations for the entire system and at full load.

7.6 ON THE JOB TRAINING

On the job training is given to operators especially for loading and unloading purpose. The unloading spring rate is now increased by 65% of the previous. The operator has to unload double springs in 20% more time of the previous. Similarly synchronization of loading by first and second operator is also important. The conveyor speed cannot be changed/stopped for loading or unloading purpose.

Two operators are moving to the entire length to-and fro for observing the powder coating process. They are informed about changed parameters and logic behind it. No one is allowed to change the setting without permission. The consumption of chemicals, epoxy powder, coverage of area and monitoring on consumption are informed.

The in-charge of powder coating line was part of the team hence he is also involved in training. New instruction boards are painted with modified parameters. The training for one hour was sufficient to them for working according to revised instructions.

7.7 TECHNICAL SUITABILITY

In this section we have explained the technical justification behind revised parameters. How these parameters help to maintain quality of the powder coating? At first we have changed the hanger design to accommodate 4 additional springs (total 8 springs) on the hanger. This has increased the load on conveyor by 8kg/hanger (spring and self-weight). The conveyor of the line is capable of carrying 35MT load. In our case the load is 18 kg per hanger X500 nos = 9000 kg or 9 MT. hence it is just 26% of the conveyor capacity.

The envelop size is also taken into consideration for designing the hangers. About 0.3 m part of the hanger is out of the envelop attached to the conveyor belt. The height of envelop is 1500 mm whereas the bottom part of the hanger is at 900 mm from top or 600 mm from bottom. The springs of length 400 mm are attached to the lower potion thus there is yet space of 200 mm from bottom. This is technically feasible.

The change in parameters of the powder coating is as per specifications. In order to maintain the quality of the process it is necessary to increase these parameters. As the load (8 instead of 4) has doubled the speed of the conveyor is decreased to 83% for processing work. Similarly phospheting, epoxy painting, water flow for rinsing are increased.

The temperature is an important parameter in the powder coating. It should be in the range 190 to 240^0c. In our case because of less load it was set at 190^0c before which has increased to 210^0c. Due to increased surface area to be heated it is increased.

Thus all aspects of the powder coating are looked into before implementation of the project. The quality of the powder coating is checked in-house on sample springs by increasing parameters before implementation. Also we have examined it after implementation of project which is found acceptable. Therefore the changes are technically suitable.

7.8 ECONOMIC JUSTIFICATION

As per agreement the MarutiUdyog and Ford company have given additional order of 70000 and 60000 suspension springs per month. However it is at the discount rate of Rs1.20 per job. Thus the company has to pay discount of Rs. 130000 x Rs. 1.20 /- = 1.56 Lakh per month the clients.

Thus the net benefit to the company is as below: it is for one Lakh springs

a) Saving of lesser consumables = Rs. 2.70 Lakh
b) Cost of employment of 10 Additional employees = Rs. 0.60 Lakh
c) Benefit from saving = Rs. 2.70 – Rs. 0.60 Lakh = 2.10 Lakh
d) For on an average 3.3 Lakh prings per month the benefit is = 3.3 x Rs 2.10 = Rs. 6.93 Lakh per month
e) Deduct discount for bulk quantity = Rs. 1.56 Lakh per month
f) Net benefit from this project = Rs. 6.93 – 1.56 = Rs. 5.37 Lakh per month

The investment in the project is Rs. 12.0 Lakh, which is one time cost. The payback period is Just 2.50 Months. The cost - benefit ratio is 45% per month, which is very high. The yearly benefit from this project is expected to be Rs. 5.37 x 12 months = 64 Lakh.

7.9 FEASIBILITY OF IMPLEMENTATION

The implementation feasibility of the project is described from the viewpoint of time, cost and technology. In this project the time required for carrying out corrective actions is one month. The fabrication of hangers, installation of additional spray guns and change in parameters are key corrective actions we have taken. For this we needed Rs.12.0 Lakh investment. Considering benefit and increased productivity by 65% it is viable to invest the amount. Also in the present setting in was possible to modify the situation. Thus the duration of project was appropriate to carry out and observe the results. The cost was not such issue as increased profitability through supplying 1.3 Lakh suspension springs per month. In this project we have not improved any kind of technology. Thus the existing technology is modified to process more jobs at a time. No manpower from external source or consultant was required to implement the changes under this project. In-house manpower is sufficiently trained and experienced for this project work. Therefore this project was feasible for implementation.

7.10 MONITORING SYSTEM

In this section we have described how we have monitored the overall process of execution of project. Our five team members have acted alternatively on the supervision of the progress. Maintenance, production, store department and quality personnel were involved in the project. Duties of each member were well defined previously and approved. The time for execution of the project and activities needed to be carried out are mentioned in the project charter.

I was responsible for the data collection, analysis and supervision on carrying out corrective actions. As I wanted to take this project for submission to IIIE I have taken

significant involvement in the project. The calculation of the parameters for deciding the same for overloading was a critical task. The manufacturing of hangers was simple but repetitive type task. Supervisor has engaged for this purpose. In the trial and first setting I have taken active part in the observation. After positive results of the quality department our work started confidently.

Hereafter it is responsibility of the powder coating line in-charge to monitor the process whether it is running as per preset norms or not. The quality department checks quality of the coating which is an indication of the process is under control. Training is given to six employees carrying out observation of the process throughout the line and responsible for setting.

CHAPTER No. 8: DISCUSSION OF THE RESULTS

8.1 INTRODUCTION

This chapter discusses in detail the overall results of the project. It includes the reduction in consumption of the electrical energy, LPG, Demineralized and Industrial water, Epoxy powder and Chemicals. It also saved the cost of manpower required for the manufacturing the per Lakh springs. The cost saved from this project is Rs. 64 Lakh per year at the present level of demand. The overall economic and non-economic benefits from the project, Time, cost and efforts of the personnel worked on this project are described in detail. It also contains the plan and actual execution schedule of the recommendations. Precautions taken during implementation of the project are elaborated herewith. At the end conclusion of all these sections has been written in short.

Mainly it focuses the achievement from this project and methodology adopted during its implementation. We have already assessed costs and benefits from the project but here we want to describe it in detail. Following sections are written as per guidelines of the IIIE.

8.2 OVERALL RESULTS OF THE PROJECT

Overall results of the project are given in the following table. It includes production before and after the implementation of the project. Other aspects of the project are also covered in it.

Table 8.1: Overall results of the project		
Criteria	Before	After
Production per month in Nos	2.0 Lakh	3.3 Lakh
Saving of consumables per Lakh powder coating springs	Rs. 2.70 per spring	
Additional Labour cost Rs.	Rs. 0.60 /- per spring	
Price discount for additional quantity to the clients	Rs. 1.56 Lakh per month or Rs. 1.20 per spring for 1.30 Lakh springs	
Net benefit from this project	Rs. 5.37 Lakh per month or Rs. 64 Lakh per year	
Cost of the project implementation	12.00 Lakh	
Duration of the project	1 month for implementation	

8.3 OVERALL EXPECTED BENEFITS

We have already discussed in section 7.8 of the chapter No. 7 that economic benefit from this project is Rs. 5.37 Lakh per month on the production of 3.3 Lakh springs. This benefit takes into account cost of saving from consumables, additional cost of labours and price discount to the Maruti- Udyog and Ford Company.

Thus net benefit from the project is Rs. 5.37 Lakh per month which will accumulate Rs. 64 Lakh in a year. However it depends upon the quantity of the demand of the client companies. If the demand reduces in the future the economic benefit will also reduce and vice versa.

Other non-economic benefits include customer satisfaction, business growth and scope for future orders. However all these benefits are not taken into consideration in this project and are not predictable at this stage.

8.4 OVERALL EXPECTED TIME, COST AND EFFORTS

This project has reduced the cost of processing of the job as well as increased the productivity of the powder coating process. Previously the time required for processing one lakh springs was 13 working days which has reduced to less than 8 working days. Thus there is reduction in the time of powder coating process. The cost of the powder coating is also reduced by Rs. 2.10 per spring. This includes the consumables and resources required for the process. Also additional manpower cost is reduced for the production of springs. It has got employment of 10more employees. The overall benefit to the company from this project is Rs. 5.37 Lakh per month for 3.3 Lakh springs. In other words it is Rs. 1.63 per spring (5.37/3.3=1.63). The cost required for implementation of this project is Rs. 12.00 Lakh. It is one time investment. The payback period of the investment is 2.5 months.

Efforts required for completion of this project include decision making, study, analysis, finding out alternative, training and observation. All team members, seniors and operators have co-operated for this project. The names of the team members and those who have supported for this project are mentioned in the acknowledgement. The in-house employees are enough trained and experienced to carry out the project hence no any assistance from outside specialist found necessary.

8.5 SCHEME OF IMPLEMENTATION

In this section we have enlisted various activities carried out in this project and their planned time in days. Actual time is also shown against it. Major activity in this project is fabrication of hangers and stand, which took 8 days. The setting of the guns and other flow

parameters is important to maintain quality. All supervision on the activities help of team members is taken.

Table 8.2 : Schedule of implementation of the project

Sr/No	Activities	Duration	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29
1	Study of the parameters to be changed	2															
2	Manufacturing Sample 8 hangers	2															
3	Testing the process quality	1															
4	Ordering the spray gun	1															
5	Ordering other material for fabrication	1															
6	Fabrication of hangers and stand	8															
7	Electrical work for additional guns	1															
8	Fixing guns	1															
9	Setting the pumpflow	1															
10	Trial of the guns	1															
11	Reducing the conveyor speed	1															
12	Observation of the process with new hangers and guns	1															
13	Testing the quality of process	1															
14	Training	1															
15	Production for one week	6															
16	Reporting the management	1															
		30															

8.6 PRECAUTIONS

In this project we have taken necessary precautions to complete it within a period of one month.

a. The material order is given in advance to receive the M.S. steel at right time to start fabrication work. The details are given in the chapter No.7.

b. The store department's experience about supplier is capitalized to get the quality material at minimum cost and lead time.

c. The welders, machines (cutting, welding) are booked in advance so as to start work at pre-decided time.
d. The transportation and movements of material are increased so additional 2 employees are employed for that purpose in three shifts.
e. Store department are informed to procure additional material for the processing. As this project has increased overall productivity by 65%.
f. Revised instructions are given to the operators and concerned personnel for the changes in their functions.
g. Arrangement of storage and transportation are changed accordingly to deal with higher quality of products.
h. Usual instructions of safety and health are given to the concerned personnel.
i. The setting of the valves, pump flow is finalized in this project and it should not be changed.
j. Scrapping out of powder coating material has also increased with this improvement. It is outsourced activity carried out in the Pirangut itself.

8.7 CONCLUSION

In this chapter we have discussed the result of the implementation of the project. Overall results are improvement in the productivity of the powder coating process. This has brought the saving from the less consumption of the consumables. The manpower required for the carrying of excess workload is increased.

Overall this project has increased 10employees (for loading + transportation and cleaning). The time cost and efforts required for the processing of the springs are saved. This

has increased delivery system and ultimately demand fulfillment of the clients. We have carried out this project in the month of February 2016 with planning. The plan of activity was approved by the plant head. Accordingly all works are carried out. We have taken necessary precautions to complete the work in a period of one month. The demand of the clients was to be fulfilled from March 2016; hence there was emergency.

CHAPTER No. 9: CONCLUDING REMARKS

9.1 SUMMARY

In this section we have described overall summary of the project. This project is a capacity improvement program based on customer demand. The increased demand was informed by the clients (2 Nos) well in advance. Accordingly the capacities of other 10 workstations were improved step-by-step. The same for pre-treatment and powder coating process is carried out in this project. Previous demand of 2.00 Lakh suspension springs has increased by 65% to 3.3 Lakh per month.

The process of pre-treatment and powder-coating was bottleneck in the overall productivity of the line. Therefore we have taken up this project on top priority.

In this project we have changed hanger design to accommodate 8 suspension springs instead of 4 Nos (Increased by 100%). This has increased the spray of consumables by about 20 to 30%. The manpower increased by 10 Nos and the conveyor speed is reduced by 20%. This arrangement has improved the productivity by 65% of the previous.

This project has fetched economic benefit of Rs. 5.37 Lakh per month from saving of consumables. The cost of implementation of the project is Rs.12 Lakh which majorly includes fabrication of hangers and additional spray guns – 4nos. It is implemented in the month of February 2016. The production accordingly to increased demand started from March 2016.

9.2 GAINS OF THE STUDY

The gains of the project implementation are described from the viewpoint of economic and non-economic benefits. We have already discussed about economic benefit from the

project. It has fetched Rs. 5.37 Lakh per month saving. It has reduced the consumption of productive resources such as machines and manpower. The reduction in consumable is also important from the economic as well as environment viewpoint. Industrial water and Demineralized water consumption per Lakh springs is reduced. Electricity consumption is also reduced by 35 %. It has increased employment of 10 workers. Thus it is also a part of social obligations.

From the individual development aspect we have earned experience from the implementation of this project. The use of various industrial engineering techniques, systematic data collection, analysis, interpretation and presentation are carried out by the team members. I had major role in this because it has been taken for academic project.

This project has given me through knowledge of the powder coating process. Especially the study of relevant literature made me theoretically able to explain things. This background has helped to take decision related to corrective actions and setting. A gain in my career is expected from this project. Also most awaited and respected in the industry the graduate ship degree is possible through implementation of this project. Therefore from my personal viewpoint this project is memorable and giving turning point to industrial career.

9.3 LIMITATIONS OF THE STUDY

This project is carried out within the economic and time limitations. The approved budget was Rs.12.00 Lakh including expenditure on manpower. Therefore we have used old hangers also. Necessary attachment to it is carried out. Only 200 new hangers are manufactured. We have completed our project successfully in the estimated amount. The spray guns – 4 nos are installed (2 guns at a side) as per demand of the clients. Additional – 8

guns also can be increased with the same speed of conveyor. But due to lower requirement of the client we have modified the system to increase 20% overloading on existing demand.

The time limitation was we have to complete the work along with testing, training and commissioning in a period of one month only. It is because of from March 2016 we have to produce jobs as per their higher demand (65% more or 3.3 Lakh per month). Thus we have planned and completed the project in stipulated time.

9.4 SCOPE FOR FURTHER WORK

If the demand of the client increased in the future the present system is able to cater it up to 4.70 Lakh per month if the company became successful to utilize the capacity of the 14 jobs per minute. This means at the present stage with 100% efficiency. At present 87.5% efficiency it can produce 4.14 Lakh springs powder coating per month in 26 working days. Thus there is enough scope for catering the products to the clients.

For further increase in the demand we need to increase spray guns for epoxy powder and accordingly improved the setting of the pumps. This may further increase the speed of the conveyor. Thus there is scope for improvement till 5 Lakh springs power coating per month. Other workstations will not become hurdle up to this production level. The system efficiency shall be improved after that. Thus there is scope for improvement in the present system.

Secondly the plant also carry outs powder coating forstabilizer bar. The Horizontal deployment is possible for this line also. However the project is based on the demand of the clients. Otherwise the shift reduction also can be thought considering company level benefits.

BIBLIOGRAPHY

[i]] B. Naveen, T. Ramesh Babu, Productivity Improvement in Manufacturing Industry Using Industrial Engineering Tools, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X PP 11-18

[ii]] Mark A Vonderembse, Operation Management, Publishing by Johan Wiley & Sons ISBN 9812-53-163-7 2004, pp196-197

[iii]] BIS, IS 13871, 1993, Powder Coatings CHD 20: Paints, Varnishes and Related Products (Reaffirmed in 2002), Bureau Of Indian Standards ManakBhavan, 9 Bahadur Shah ZaparMarg, New Delhi, 110002, pp. 1, 5

[iv]] N. Lavanya et.al, Design and Analysis of A Suspension Coil Spring For Automotive Vehicle, Int. Journal of Engineering Research and Applications, Vol. 4, Issue 9, Version 5, September 2014, pp.151-157

[v]] Acrane , 2014, The Analysis of loading pattern on suspension spring, Techmech, Erik Publications, USA, pp. 83-89

[vi]] Jadhav M.R., June 2015, The improvement in Powder Coating Station and Pit Furnace Station in ABC industry, International Journal of Informative and Futuristic Research, Vol. 2, Issue10, pp. 38-42.

[vii]] PongchanunLuangpaiboon , 2010, Improving an Electrostatic Powder Coating Process via Signal to Noise Response Surface, American Journal of Applied Sciences, Science Publications, Vol. 7 Issue 11, pp. 1521-1527

[viii]] Kelvin Chan,October 2010, Productivity methodologies, tools, and techniques, Increasing productivity through reducing “seven wastes” in operations, Singapore, pp. 1-4

[ix] Akzo Nobel, 1999,Complete Guide to Powder Coatings, Interpon Powder Coatings, Issue-1, pp. 8-9

[x] Roger D. Cummings and Michael R. Huddleston, 2014, A Powder Coating Line Audit, H.B. Fuller Company, Industrial Coatings Division, p. 469-472

[xi] Jeff Hall and Gema,2013, Strengthening a powder coating line, Cybex International, Products Finishing Magazine, Cincinnati, Ohio, pp. 21-22

[xii] Hoswalt and Muric, 2013, Electric IR for Curing Powder Coatings on ATV Accessories, Techapplication, Electric Power Research Institute, Columbus, pp. 34-38

[xiii] Mitsuba Systems India Pvt. Ltd. 2015, Metallic Powder Coating Special Effect Systems, Andheri (West), Mumbai, Source: www.powdergun.com, p. 2

[xiv] Eaisen Berg, 2012, Automatic powder spray gun, The product specifications, p. 17

[xv] Chary S.N. 2000, Production and Operation Management, Tata McGraw –Hill Publishing company, New Delhi, Second edition, p. 505

Project Proposal