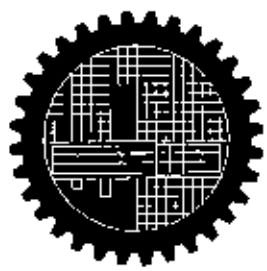
PRODUCTIVITY IMPROVEMENT IN MOTOR CYCLE PLANT OF SINGER BANGLADESH LIMITED AND ITS SUPPLY CHAIN

By

ABU SADAT SAYEM



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February, 2009.

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Submitted to the Department of Industrial & Production Engineering, Bangladesh University of Engineering & Technology Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF ENGINEERING** in Industrial & Production Engineering.

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CERTIFICATE OF APPROVAL

The thesis titled – **"Productivity Improvement in Motor Cycle Plant of Singer Bangladesh Limited and its Supply Chain"** submitted by **Abu Sadat Sayem,** Student No. 040408006P, session April 2004, has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **MASTER OF ENGINEERING** in Industrial & Production Engineering on 24 February, 2009.

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I do hereby declare that this work has been done by me and neither this thesis nor any part of it has been submitted elsewhere for the award of any degree or diploma except for publication.

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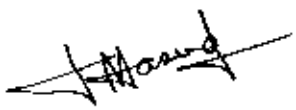

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This dissertation is dedicated to my late father

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NOMENCLATURE

MC	Motor cycle
QC	Quality control
SST	Special service tools
PDI	Pre delivery inspection
ILO	International labor organization
WHO	World health organization
QMS	Quality management system
CDI	Capacitive discharge ignition
HTC	High tension coil
TPM	Total preventive maintenance
CKD	Complete knocked down
AIW	Air impact wrench
SMC	Singer manufacturing complex
PQC	Pre quality control

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Abstract

Production is concerned with the activity of producing goods and/or services that means production is the quantity of output produced, while productivity is concerned with the efficient utilization of resources (input) in producing goods and/or services (output), so productivity is the ratio of the output produced to the input used.

The objective of this thesis work is to improve productivity and the quality of the product of SINGER motor cycle plant. To achieve this goal few phenomena and techniques are applied. Such as improvement of the process of the production first. That's why time study, line balancing, production design and the development assemblers multi-skilled at different stages are essential To eliminate materials waiting and minimize production loss for model change, the supply chain has been studied. Secondly to achieve the quality of the product applied quality management system, pre quality control and analyze service complaint feedback for which a performance committee has been formed. Finally to attain minimum production few techniques are applied. Such as, proper storing of raw materials to prevent breakage the parts, proper utilization of man power, cannibalize damaged parts to make good one, attempt to sale damage parts in local workshop and moreover increase productivity, thus man hour cost decrease automatically.

Experimental values obtained for improvement of productivity and quality and minimization of production cost. It is experimentally found that productivity improved due to time study, line balancing, auto production belt, time economy working process and used some specific technical operations. The quality of the product improved due to proper in-house training, service complains analysis, proper maintenance and timely calibration of the machineries and accessories. And production cost has reduced due to proper follow up of the internal and external supply chain.

As a result in same man power, Productivity improved by 13.3% in 2006-2007 and 17.8% in 2007-2008, quality improvement of the process lead to reduced service complains by 5% in 2006-2007 and 12% in 2007-2008 and attained minimum production cost by curtailing overtime of the assemblers

CHAPTER 1

INTRODUCTION

Incremental improvements to operating plants are a major opportunity for improving profitability in production. How effectively such improvements are identified and implemented is a key measure of a plant's and its owner company's long term capability. Changes to an operating plant require the identification and screening of opportunities, followed by detailed engineering and construction of changes. There are regular opportunities to make minor modifications to equipment These modifications can increase capacity by removing a "bottleneck", i.e. a limitation that affects the overall capacity of the production line. They can also correct quality and reliability problems

The ability to make changes to production lines on an ongoing basis allows engineering work to be "leveled", i.e. spread out so that engineering resources are always productivity utilized Lower priority projects can be deferred or moved up to create a constant engineering effort. Engineering work would peak only in rare cases of a complete major change in a production line. This kind of production facility lends itself to an "in house" engineering group, since workload can be made constant.

Productivity Concept (Management aspect)

From the management perspective, productivity has been equated with efficiency and effectiveness. Efficiency and effectiveness are both management concerns to ensure that desired products and services are done in the right manner all the time. This concept of productivity provides a working definition to manage and improve productivity at organization levels.

Productivity Concept (Integrated aspect)

As an integrated concept, productivity can be viewed in two ways: as an objective and as a means. Productivity as an objectivity is explained by the social concept of productivity As a means, productivity pertains to the technical, economical and management concept of productivity.

1.1 Objective

The core objective of this thesis work is to evaluate the production loss in each and every sector of Singer Motor Cycle Plant and to minimize them. Then productivity gain automatically, definitely smooth supply chain is to obtain. Product quality is another concerned Product quality depends on two ways. One is manufacturing fault which is recovered by local repairing instantly and informed to supplier for correction next and another is assembling process fault which is recovered plant management To achieve the main objective, the following steps are also the integral parts of these thesis objectives'

a) To improve quality of the process
b) To reduce production cost.
c) To develop assemblers multi-skilled at different stages.
d) To take initiative to assemble imbalance motor cycle at schedule time.
e) To analyze service complaint feedback report
f) To eliminate the material waiting time, study the supply chain from overseas supplier to factory end.
g) To minimize production loss for model change, study the supply chain from raw materials stare to production floor
h) To improved productivity of SINGER motor cycle plant.

1.2 Outline of Methodologies

This thesis will be carried on:

a) Observing time loss at different stages of the production floor

b) Time study and set up line balancing (applying production system analysis technique).

c) Improving supply chain management

d) Giving more quality knowledge to the assemblers (applying quality control technique).

e) Arranging spare parts from supplier. If possible then fabricate them local sourcing time to time

f) Creating more checking point to maintain proper quality (applying quality control technique)

There are some identified problems in Motorcycle production that's why the production target can't achievable. The problems are as follows:

There was a material waiting in overseas supplier and store also which was hamper in continuous mass production. That means the supply chain of the kits were improper. So proper supply chain management needs to be established [1]

Lower productivity due to improper use of production management So perfect production management needs to be applying. [2]

Lake of schedule maintenance, continuous production also hampers. So proper maintenance schedule can avoid the waiting time. [3]

Literature review is the proper definition of the thesis work and the method of improvement of productivity is very important part of this thesis. [4-7]

1.3 Organization of Thesis

Chapter 1: general Introduction with productivity concept, background of singer motor cycle plant and its present activities, detail objectives of this thesis work and discussion about its outlines.

Chapter 2. highlights literature data available on singer motor cycle plant, description about production and productivity, efficiency and effectiveness, wealth and welfare. To achieve production target discuss occupational health hazards with preventive and quality management systems. After implemented quality management system discuss their benefits also

Chapter 3: brief information about the history of singer Bangladesh ltd and singer motor cycle plant with its flow chart, introduce every stage in the plant with parts list and figure.

Chapter 4: detail describes about the problems of motor cycle production floor, pin-point its identification and then find out the solution with figures, then verified the solution.

Chapter 5: detailed results and their relations are discussed. Result predictions are then compared with experimental data foe various orientations

Chapter 6: conclusion and recommendations for future work are presented.

CHAPTER 2

LITERATURE REVIEW

2.1 Production and Productivity

Production and productivity is not same. The term "Productivity" often confused with the the term 'Production". Many people think that greater the production, the greater the productivity. This is not necessarily true. Production is concerned with the activity of producing goods and/or services while productivity is concerned with the efficient utilization of resources (input) in producing goods and/or services (output). If viewed in Quantitative terms, production is the quantity of output produced, while productivity is the ratio of the output produced to the input used For example, in 2005 Singer Bd. Ltd produced 1993 pcs motor cycle by employing 14 people for 285 days at 8 hours each day

Then production = 1993 pcs motor cycle.

$$\text{Productivity} = \frac{1993}{13 \times 8 \times 285} = 0.067 \text{ motor cycle per man-hour.}$$

Suppose this company in 2006 produced production to 4461 motor cycle by hiring 03 additional worker sat 8 hours per day for 285 days.

Then production = 4461 pcs motor cycle.

$$\text{Productivity} = \frac{4461}{16 \times 8 \times 285} = 0.122 \text{ motor cycle per man-hour}$$

01. MEASUREMENT OF PRODUCTIVITY:

Purpose of productivity measurement

a To monitor performances.

b. To reveal problem area.

c To appraise how well resources reutilized.

d. To improved productivity situation.

02. FACTORS OF PRODUCTION OR INPUT USED

a. **Land:** Land is wealth created by GOD and help to production. For example, Earth, Minerals, Sea, Forestry, Hills, Light, Air, Water, Weather etc

b. **Labor:** Physical and mental use of a man for production purpose in exchanges of money is labor.

c. **Capital:** The resources which are created by men and invested for production purposes not consumed directly. For example, Mill-Factory, Machinery, Raw Materials.

d. **Organization:** To organize land, labor and capital with a view to production and profit

03. INPUT AND OUTPUT

Input: Input is resources or goods and service used as a means for production.

Type of Input (Example)

	Physical	Value
Land	Acre of land	Value per acre, rent per acre
Labor	No. of person & man-hour	Wages per worked & man-hour
Capital	Fixed asset by type, number	Value of fixed asset
Raw material	Quantity of material (Motor cycle kits in CKD form)	Value of kits
Energy	KW electricity	Value of electricity per KW

Output: Output is production of goods and services by employing input resources

Type of output

a) Physical = Physical measure = Type of physical product

b) Value = value measure = Quantity x Price

05. GAINS OF IMPROVED PRODUCTIVITY

Gains of improved productivity benefits employers, employees, consumers and also Govt. some of the main gains of productivity are indicated below:

a) Reduction of production cost.
b) Promotion of sale.
c) Price and inflation.
d) Taxes
e) Minimization of labor unrest and creation of congenial atmosphere.

Thus, productivity creates a congenial atmosphere where employers can optimize profit. While employees get high-test remuneration, consumer gets goods at the cheap price and govt. gets opportunity to do wale fare and development activities. As a result the company will be attaining self sustained economic growth.

2.2 Efficiency and Effectiveness

Efficiency is the ratio of actual output attained to standard expected For example, if output an operator is 7.65 hour per motor cycle while standard rate is 6.00 hour per motor cycle then the operator efficiency is 6.00/7.65 = 78 43 percent.

$$\text{Efficiency} = \frac{\text{Actual output attained}}{\text{Standard output expected}}$$

Effectiveness is the degree of accomplishment of objectives. How well a set of result is accomplished reflects the effectiveness

2.3 Wealth and Welfare

Wealth: The goods having utility, limited supply, transferability and externality is wealth. Wealth is a source of welfare

Welfare: Satisfaction and happiness from goods and services is welfare.
Welfare is a physical concept. It is related with mental satisfaction. Wale fare can be measured by utility There are two types of utility which are as follows.

Ordinal Utility – Measurable.

Cardinal Utility – Scale of Preference.

Welfare Arrangement:

Washing Arrangement

- Opportunity for sufficient and proper washing arrangement.
- Separate arrangement for male and female.
- Clean and easy facilities.

Preliminary Treatment

- Box/Cupboards provision with specific instruments in easy movement space
- One box/Cupboards need to be provided for 100 labors.
- Doctors, Nurse and Ambulance provision for 500 labors or more than that.

Canteen

- Proper canteen facilities for than 100 labors
- Formation of organizi8ng committee with representation of labor.

Shelter/ Rest Room

- Rest room and lunch room for more than 100 workers.

Welfare Announcement

- Welfare announcement in yearly occasion like annual picnic, get together, sports day with present of his/her family's member.

Working Hours of Adults

- 48 hours/week.

2.4 Occupational Health Hazards and Preventive Measures

Occupational health is essentially preventive medicine The joint ILO/WHO committee on occupational health in the course of its first session, held in 1950, gave the following definition. " Occupational health should in at the promotion maintenance of the highest degree of physical, mental and social well-being of workers in all occupations, the prevention among workers departures from health caused by their working conditions, the protection of workers in their employment from risks resulting from factors adverse to health, the placing and maintenance of the worker in an occupational environment adapted to his physisiological equipment, and to summarize, the adoption of work to man and of each man to his job. Such as:

To preserve the physical assets from unsafe conditions.
To prevent the human resources from unsafe act resulting injuries or death.
To reduce the operating costs/losses resulting from compensation paid or cost property damages

Reasons of Accidents

Lack of knowledge
Careless attitude
Working without authority or instruction
Lack of ability
Poor tools and equipment
Taking shortcuts

Cost of Victims

Suffering
Loss of earning
Medical bills
Continuing disability
Possible loss of life
Incapacity
Effects on family – friends & colleagues.

Financial Aspects

Loss of skilled & experienced workers

Loss of production

Loss of profit

Expense of retraining

Incapacity

Time loss by effect on other workers

Increased insurance premiums.

Occupational Health Hazards

Industrial workers may be exposed to five types of hazards, depending upon his occupation:

a) Physical hazards
b) Chemical hazards
c) Biological hazards
d) Mechanical hazards
e) Psychosocial hazards

These hazards cause a great fatigue for the assemblers, that's why the plant loss its productivity. In motor cycle production floor of Singer Bd. Ltd faces some occupational hazards. So the production may fall The preventive measures are as follows:

(a) Physical hazards

Title	Cause	Effect	Prevention	Outcomes
Noise	- Grinding - Air impact wrench - Motor cycle inspection	-Hearing problem - Fatigue	- Use ear plug	- Less fatigue - More concentrate
Vibration	- Air impact wrench - Quality control tester	- Fatigue	- Use proper jig - Use gloves	- Work faster
Ark light	- Welding	- Eye fever	- Use eye protector glass	- Reduce absenteeism
Heat	-Welding - Grinding	- Hand burn	-Use specific hand gloves - Eye protector glass	- Work faster - Reduce fear

(b) Chemical hazards

Title	Cause	Effect	Prevention	Outcomes
Battery Acid	- To handle Sulfuric Acid	- Hand burn	-Use special hand gloves & apron	-Work faster -Reduce fear the work

(c) Biological hazards

No biological hazards in Singer Motor Cycle Plant

(d) Mechanical hazards

Title	Cause	Effect	Prevention	Outcomes
Unexpected Parts repair	- Manufacturing fault	-Low Productivity	- Repaired the parts before assemble (inhouse/outsourse) - Inform to supplier	- Smooth operation - Productivity high
Machine break down	-Lack of routing servicing	-Low Productivity	- Continue routing servicing (after production/holiday)	- Smooth operation - Productivity high

(e) Psychosocial hazards

No psychosocial hazards in Singer Motor Cycle Plant because of high salary leave facilities, salaries paid in due time, fixed working time & good working environment.

(f) Ergonomic hazard

Study on Eye Strain

Ergonomics is the relationship between people and their occupations, talking into consideration the interactions of individuals, equipment, and environment and practically applying anatomical, physiological and psychological knowledge. Ergonomics strives toward fitting the workstation to the individual, not fitting the human body to the workstation, and aiming for increased worker comfort and productivity

Visual Display terminals (VDTs) have become a major element in the modern work environment as an interface between the operator and the computer The introduction of VDTs into workplace has not been without its problems Some of the subjective

complains of the VDT users are pain in the eyes, headache, blurred vision, dry and irritated eyes, sensitivity to light, double vision, boosted fatigability, back pain, neck pain and pain in the wrists and fingers. Considering the above, it is obvious that a study on eyestrain caused due to continuous VDT exposure is done. The various steps involved in this work are.

a) Statistical design of experiments and measurement of eyestrain at different viewing angles, viewing distances, exposure time, illumination levels.
b) Statistical analysis of the measurements taken.
c) Discussion of results to optimize the ergonomic factors.

Injuries in Joints

The various injuries during lifting are:-

a) The muscles and ligaments of the joints can fail under excessive tension.
b) There may be dislocation of joints due to excessive force acting on the joints or due to instable position while lifting.
c) Another reason may be joint instability caused due to weakness of ligaments which play a vital role in the stability of joints.

Lifting Methodology

a) Postural analysis for lifting.
b) Square lift
c) Plane analysis of squat lift.

Comments

Health and safety management primarily requires safe place of work and safe system of work. It benefits the workers and the employers. Cost-benefit equation in prevention of accidents and diseases can give a clear picture of benefits and controlling losses

Safety	High	Low
Cost	Low	High
Productivity	High	Low

2.5 Quality Management Systems

To describe the policies and company-wide control structure of the quality management system (QMS) used to achieve the goals and quality objectives of Singer Bangladesh Limited is customer satisfaction. Because customer satisfaction and the quality the products are and will continue to be the keys to competitiveness for years to come, it is increasingly vital for Singer Bd. Ltd to understand use quality management system to do a good job in every time. To ensure the quality management system will continue to provide a solid foundation for success, it is essential continually improved quality management system and related processes.

Quality Policy

Singer Bangladesh Limiter's quality policy and objectives for quality are displayed openly as a sign pride and commitment and as a clear re maunder of company's focus and direction. The quality policy statement for Singer Bangladesh Limited is as follows;

a) Singer Bangladesh is committed to improve the life of the people by providing highest quality products at an affordable price to be the most respected and admired family company
b) The company is devoted to improve the quality of human resources by providing adequate resources and trained manpower who strictly ahead to the producers of ISO 9001 2000 quality management system.
c) All this are achieved by treating the employees with respect in recognition of their contributions, ensure high standards and quality in every sphere of activities and taking every effort to honor and maintain high ethical standard.

Quality Improvement Techniques

A detailed assessment of the quality of operations at the department was made by comparing the "absolutes", i e. key activities which must be done well to achieve the objectives of the department, with the "issues", i.e. important areas of deficiency that limit the performance of the department

Ten "absolutes" were widely identified during the interviews in the organization audit.

a) Human resource management

b) Management of department and environment.

c) Communication of business purpose

d) Communication – external, interdepartmental, interdivisional.

e) Level of programming and resource allocation.

f) Fundamental scientific investigation.

g) Project management.

h) Creativity and innovation.

i) External awareness and gathering of information.

j) Integrated performance of system.

Eight "issues" were identified indicating important areas of deficiency.

a) Human resource management.

b) Culture and environment.

c) Communication of reasons for projects and scientific information.

d) Level programming i.e. programmed versus resources available

e) Direction and organization of implementation department.

f) Planning and objective setting.

g) Balance of short-term to long-term implementation.

Quality Objectives

All quality objectives are measurable The measurement of quality objectives provides a consistent basic for the monitoring of continual improvement The objectives for quality at Singer Motor Cycle are as follows:

Year 2006

a) To achieve production target of 5000 units of motor cycle.
b) To reduce process related service complaints from 10% to 5%.
c) To assemble imbalance motor cycle at least 10%.

Year 2007

a) To achieve production target of 5000 units of motor cycle
b) To increase productivity of motor cycle assembly by 15% over last year through proper utilization of automatic belt and increasing efficiency of the work.
c) Provide necessary in-house training to increase the efficiency of motor cycle's assemblers.
d) To assist the "motor cycle improvement committee" to detect fault nature and minimize service complains by 2%.

Year 2008

a) To achieve production target of motor cycle for the year 2008 as set by the management
b) To maintain quality policy of ISO 9001:2000 (Quality Management System) properly to face audit.
c) To analyze service feedback report and take necessary and corrective actions for the quality improvement of motor cycle.
d) To take initiatives to assembly the unbalanced motor cycle by arranging spare parts from overseas supplier and locally sourcing
e) To implement necessary maintenance schedule of the equipments of motor cycle for its proper and trouble free functioning.

Requirements

a) Scope
b) Normative reference
c) Terms and conditions
d) Quality management system
e) Management responsibility
f) Resource management
g) Product realization
h) Measurement, analysis and improvement.

Quality Management Standard

The QMS standards are internationally recognizes management concept, practices that have been formalized into a set of standardizes requirements for management system. These standardized requirements define controls the improving an organization's ability to deliver products or services that.

a) Consistently meet customer's quality requirements
b) Meet applicable regulatory requirements
c) Enhance customer satisfaction
d) Achieve continual improvement of its performance in pursuit of these objectives.

2.6 Benefits of Productivity to Implement Quality Management System

To initiate and implement a quality improvement programmed successfully, management must be convinced that improvement is necessary Evidence is usually found in customer complaints, loss of market share and high cost. Failure to meet agreed time, cost and performance targets on specific projects is often quoted, as well as a more general feeling of lack of contribution to the business strategic direction Implementing a quality improvement process that can be identified in the experts systems. There are'

a) Top management commitment.

b) Organizing for the quality improvement process

c) Communication and awareness.

d) Education and training.

e) Measurement.

f) Cost of quality

g) Corrective action.

h) Goals.

i) Continuity.

These factors give clear goals for the planning of the implementation of quality system;

a) Management must be convinced that improvement is necessary.

b) People must be aware of quality principles.

c) People must be committed to improving in a systematic way

External Benefits

a) Improves customer confidence and satisfaction in an organization's quality management system capabilities consistency in meeting requirements.
b) Improves conformity to quality requirements.
c) Increases competitive edge and market share.
d) Increasingly recognize as a requirements for contractual relationships in the global arena

Internal Benefits

a) Improves business efficiency and productivity.
b) Reduces organizational waste, inefficiencies and defects
c) Improves process consistency and stability.
d) Facilitates continual improvement in business process and customer satisfaction
e) Facilitates employee competence and consistency of performance.
f) Improves employee motivation and empowerment through improved participator communication and interaction.
g) Generates objectives evidence to support assessment of quality management system conformity and effectiveness.

2.7 Supply Chain Management

The central idea of the present research has been oriented with the simulation of an industrial system that means the process of exactly imitating a real system using discrete event simulation Based on delivery of material delivery system modules and simulation experiment based study the following conclusions can be drawn.

a) Modeling of supply chain or portion of the chain continues to be a difficult task and needs to be carefully studied because of the conflicting nature of the operating rules
b) The main benefit of simulation, the process used here, over the traditional simulation is it eliminates the need to rewrite code.

Benefits of improving supply chain

The supply chain is the network of autonomous and semi-autonomous business entities which are involved through upstream and downstream linkages in the different process and activities that produce value in the form of physical products and services in the hands of the ultimate customers. Explain with a line diagram as shown:

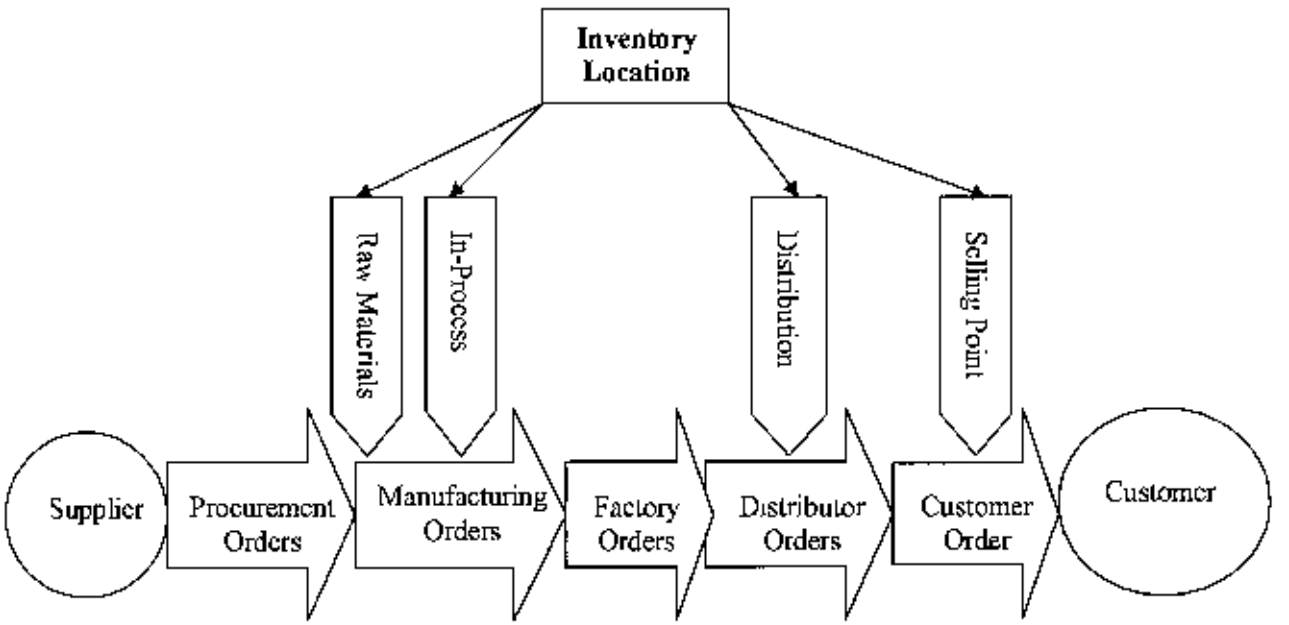


Figure 2 1: The scope of Supply Chain Management

Benefits of supply chain management

Supply chain management has become one of the most important sources of competitive advantage in various fields specially in assembling plant. The key to success in this dynamic business environment is the ability to introduce innovative, customized products with short time to market without sacrificing logistical efficiency The 'supply chain' term is being extended to international / global perspective. In this concept, this is common in industries which have global customer / supplier base, for example textile, pharmaceuticals, automobile, electronics etc The inclusion of distribution as a key link of the supply chain makes it scope quite wide and extended. Overall the benefits of supply chain management improvement include.

a) Reduce operating cost.
b) Improved responsiveness and reduced cycle time
c) Improved customer service
d) Simplified operations
e) Improved quality
f) Significant volume growth.
g) Improved return on capital.
h) Effective support of growing or diverse customer base
i) Effective offer of a grater variety of products and focus on core competencies.

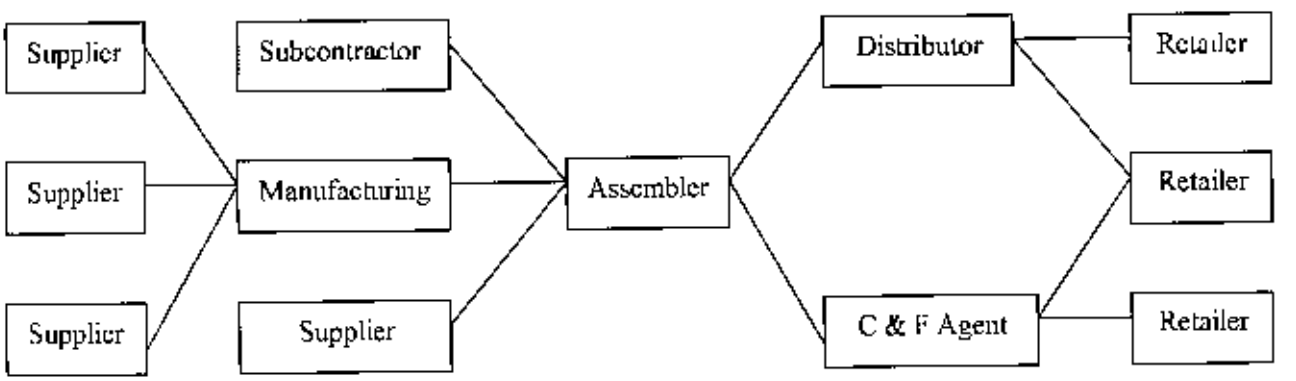


Figure 2.2. Single layer supply chain

Using simulation for supply chain management

If a company wants to be in lead then this model for their own purpose. This is proposed for five years planning in the following fields.

a) Product allocation.

b) Factory expansion.

c) Factory closing

d) Major resource planning.

e) Foundry management.

This can be helps make decision is by finding the best answers to the following fields.

Meet demand – Minimum cost.

Relax demand – Minimum cost.

Meet demand – Add resources.

Meet demand – Add / Expand facilities

Relax demand – Add / Expand facilities.

Meet demand – Minimize cycle time.

Add resources - Minimize cycle time.

Add / Expand facilities - Minimize cycle time.

I have attempted to address all those issues and tried to expand its periphery to assembling / manufacturing industries i e the problem which is going to discuss are based on packing problem in a material delivery system.

There are three areas where optimization and simulation compete – scheduling, tactical planning and strategic planning. These three areas have different advantage and disadvantages when it comes to use simulation. As in case of scheduling, the time horizon has a limit scope, possibly in one plant. So optimization is a better option over simulation But in case of tactical planning or strategic planning, time horizons are ever longer, even up to several months or years in length

CHAPTER 3

COMPANY PROFILE

3.1 History of SINGER

The Singer Saga began in 1851 by Sir Isaac Merritt Singer, who invented the world's first sewing machine The revolutionary product was the first offering and formed I M Singer and company. In 1867, Singer became the first multinational industry company and established its first overseas manufacturing facilities in England.

Singer Bangladesh Limited was first established in 1905, the company was a part of the Indian sub continent. Later in 1910 two shops were set up in Dhaka and Chittagong. Singer Bangladesh Limited Top Management, Directors, Executives and Engineers are all Bangladeshi After Emergence of Bangladesh on December 16, 1971 the company continued its operation and in 1979 the company registered itself as operating company In 1983 the company got listed with Dhaka Stock Exchange and offered 20% of its share to public keeping 80% hold by Singer Sewing Machine Company (the present company).

In 1980, Singer Bangladesh Limited established a sewing machine factory in Chittagong with production capacity of 10,000 units per year This was raised to 25,000 units in 1984. Although sewing machines are Singer's core business, the management realized that these products alone could not substantiate growth for long periods. This realization led to diversification into numerous product ranges. In 1985, Singer began transformed from a single product into a multi-products consumer durable company for future growth and expansion. In 1993, the company established its new audio video plant and in 1996 washing machine assembling section. Later in 2001, the company initiated assembling of motor cycle and in 2006, manufacturing of various kind of wires and cable (domestic and power cables)

The company's Corporate Office is situating in Gulshan-1 and Dilkhusha. The factory is situating in Savar and Narayangang.

3.2 Introduced Singer Motor Cycle Plant

Singer Motor Cycle started its journey in 2001. Basically it's an assembling plant The parts came from China in CKD (Complete Knocked Down) form Only eight assemblers and one supervisor recruited then Four/five pcs motor cycle were produced per day Only two models (SM80 cc & SM100-3 cc) were introduced in testing purpose. These production areas were merged on Singer Washing & Sewing Machine Plant. The Production Manager of these projects was look after the motor cycle production. After two years on experiment the company planed to create a large project. In 2003, recruited more six assemblers and first time introduced a separate Officer especially for motor cycle Then the production rate was eight to ten per day. Production area also enlarges. Because of limitation of space In 2004 the whole production unit was shifted in a separate new production floor Dew to market demand the company introduced two different models (SM125 cc & SM100-4 cc). The market demand is continuously grown up And at present it has a Factory Manager, one Production Officer, one Supervisor and sixteen assembly crew. The production capacity per day is eighteen to twenty (it depends on model). And produced seven different models with three different colors (red, black & blue) with stylist models and effective hydraulic brakes and alloy wheels.

3.3 Production flow chart of Singer Motor Cycle

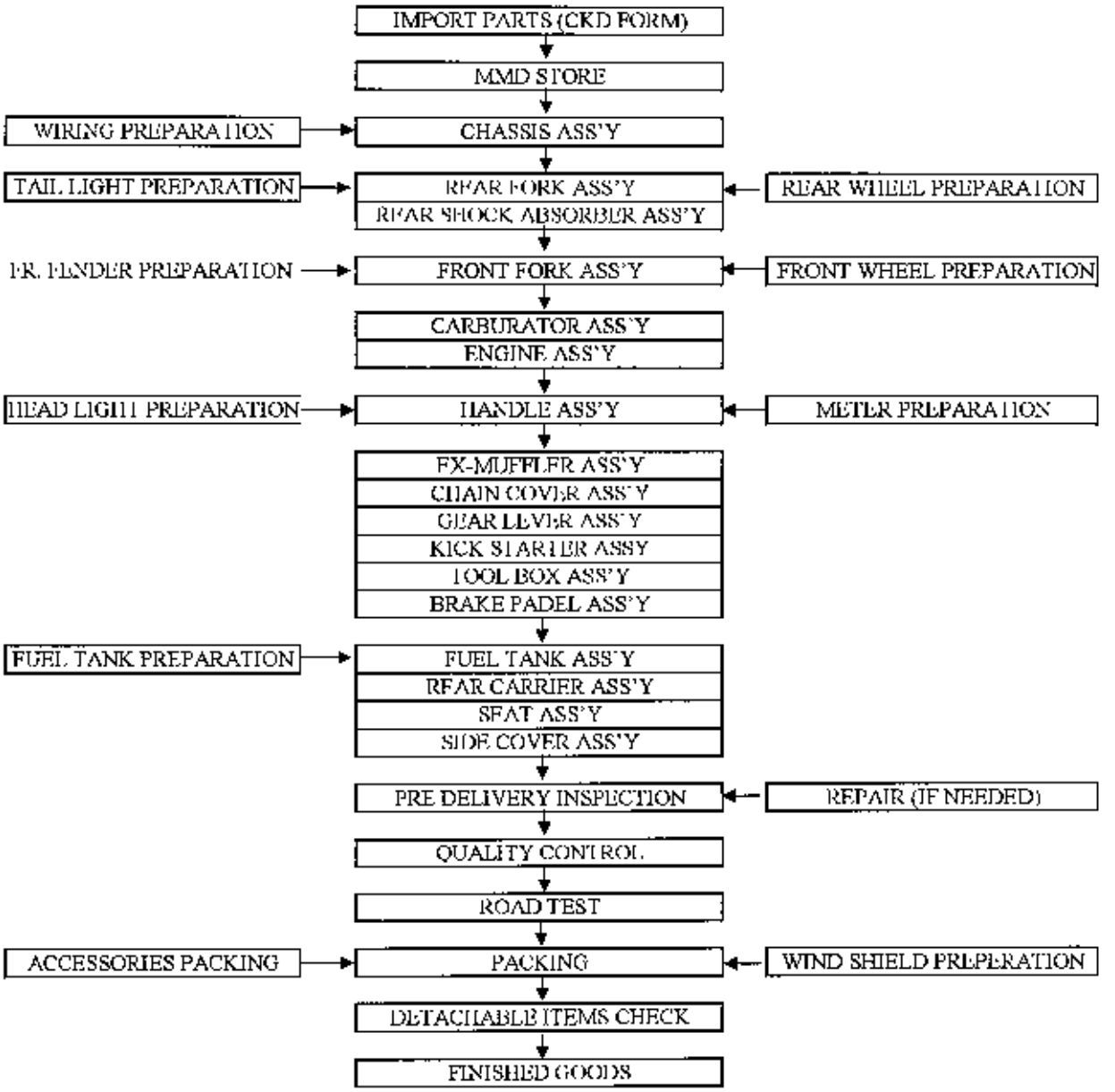


Figure 3.1: Production flow chart of Singer Motor Cycle Plant

3.4 Stage Wise Information

01. CHASSIS PREPARATION

Parts List

CDI unit ---------- 01
Fuse (15A) ---------- 01
Flasher ---------- 01
Ignition coil ---------- 01
Rectifier ---------- 01
Main wire ---------- 01
Air cleaner ---------- 01
Battery bracket---------- 01
Chassis ---------- 01

Figure 3.2: Chassis preparation

Work Direction

01. Main wire assembles in chassis.
02. All electronic items assemble in their respective place.

Pre-caution

01. When these electronic items assemble then need to take extra care for their accurate position.

02. WHEEL ALIGNMENT

Parts list

Front tube ---------- 01

Rear tube ---------- 01

Front tire ---------- 01

Rear tire ---------- 01

Front rim ---------- 01

Rear rim ---------- 01

Figure 3.3: Wheel alignment

Work Direction

01. Dis-assemble tire from rim (with the help of wheel machine)

02. Wheel rim align properly (with the help of wheel align set up)

03. Compressed air pour into the tube (with the help of nozzle)

04. Tube & tire assemble in the rim.

Pre-caution

01. Checking here rusting problem of wheel rim & sprocket.

02. Checking here tire & tube leakage.

03. Ensues the accurate pressure in both tire tubes

(Front tube=3.5 kg/sq.cm & Rear tube=4.5 kg/sq.cm)

03. REAR FORK ASSEMBLY

Parts List

Rear fork	---------- 01
Rear shock absorber	---------- 02
Rear wheel	---------- 01
Rear brake panel	---------- 01
Drive chain	---------- 01
Rear indicator light	---------- 02
Rear fender	---------- 01
Tail cover	---------- 01
Tail light	---------- 01

Figure 3 4: Rear fork assembly

Work Direction

01. Back light & both rear indicator attach with tail cover.

02. Rear fork preparation.

03. Rear fender preparation.

04. Rear wheel assemble with fork.

Pre-caution

01. Rear fork alignment checking.

02. All plastic items handle with care.

04. FRONT FORK ASSEMBLY

Parts List

Front fender----------01

Front wheel----------01

Front brake panel----------01

Head light support----------01

Head light case----------01

Reflector----------01

Ball racer----------01

Front fork----------01

Front shock absorber------02

Figure 3.5: Front fork assembly

Work Direction

01. Front fender & Reflectors attach with front shock absorber.

02. Steering lock attach with front fork.

Pre-caution

01. As front fender is a plastic item so carefully handling is essential.

02. Before assemble front fender please check the color of the tail cover.

05. ENGINE ASSEMBLY

Parts List

Engine with gear box----------01

Carburetor----------01

Foot rest----------01

Engine wiring----------01

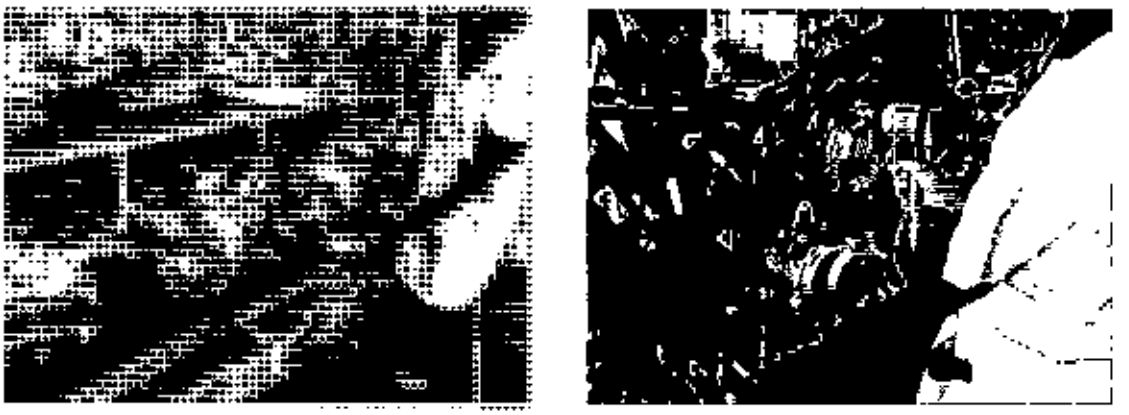


Figure 3.6: Engine assembly

Work Direction

01. Engine assembly with chassis.

02. Ground wire connected with engine.

03. Carburetor fixing in between engine and air cleaner.

Pre-caution

01. Check carefully that same number of engine in same number of chassis.

06. HANDLE ASSEMBLY

Parts List

Handle bar----------01

Head light----------01

Upper bridge----------01

Main meter----------01

Gripper----------02

Throttle cable----------01

Clutch cable----------01

Meter cable----------01

Brake cable----------01

Switch set----------02

Figure 3.7: Handle assembly

Work Direction

01. Switches & gripers are attached with handle bar.

02. Upper bridge & main meter also attach with handle bar.

03. All cables connected their respective places.

Per-caution

01. Carefully check that cables are assembling their respective places.

07. EX-MUFFLER ASSEMBLY

Parts List

Chain cover----------01

Magnet cover----------01

Gear lever----------01

Kick starter----------01

Brake paddle----------01

Horn----------01

Ex-muffler----------01

Brake switch----------01

Figure 3.8: Ex-muffler assembly

Work Direction

01. Ex-muffler prepare with its clamps

02. Driving chain cover covered with chain cover

03. Magnet cover & gear lever attach their respective places.

04. Ex-muffler assembled with the help of its collar.

05. Brake paddle, horn & brake switch assemble their respective places.

Pre-caution

01 Check here ex-muffler & chain cover dent & nickel problem.

02. Also check the nickel problems of brake paddle, kick lever & ex-muffler collar.

08. SEAT & FUEL TANK ASSEMBLY

Parts List

Seat----------01

Fuel tank----------01

Rear carrier----------01

Side cover----------02

Fuel valve----------01

Fuel tank rubber---------01

Fuel tank lock----------01

Figure 3.9: Seat and fuel tank assembly

Work Direction

01. Fuel tank lock & rubber attach with fuel tank.

02. Side covers fixing with side cover frame.

03. Assemble rear carrier, seat & fuel tank.

Pre-caution

01. Check here fuel tank & rear carrier dent & paint problem.

02. Verify here side covers paint & damage.

03. Color matching is essential.

09. PRE-DELIVERY INSPECTION (PDI)

The following items are check in these section

01. Lock operation
02. Fuel tank defect. Such as painting, denting, stickers & logos.
03. Rear wheel alignment
04. All painting parts & its shining
05. Wheel treatment (Front & Rear wheel)
06. Ex-muffler leakage
07. All lights, switches & horn operation
08. High & low beam function of head light
09. Techno & Speedo meter function
10. Chain operation
11. Brake operation
12. Fork check
13. Engine oil
14. Kick & self starter operation
15. Gear shifting operation
16. Clutch adjustment
17. Tire pressure check
18. Accelerating test
19. Tools check
20. Shock absorber test
21. Turn light test
22. All electrical items
23. Visual broken check
24. Cleaning of the motor cycle

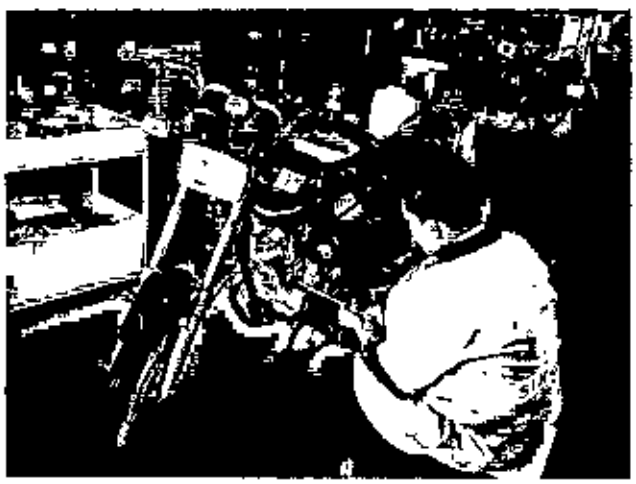


Figure 3.10: Pre-delivery inspection

10. QUALITY CONTROL TEST

It's a computerize testing machine. The following parameters are check here

01. Exhaust gas analysis (the % of CO & ppm of HC)

02. Acceleration test (how many second it needs from 20-50 km/hr)

03. Speedometer test (when meter speed 40 km/hr then what's the real speed)

04. Brake force (front & rear wheel)

05. Alignment (front & rear wheel)

06. Brightness of headlight (cd)

07. Sound intensity of horn (dB)

08. Visual inspection.

Figure 3.11: Computerize quality control test

If all the parameters pass satisfactory then the motor cycle goes for packing. Otherwise it goes for repairing.

11. WIND SHIELD PREPARATION

Parts List

Organic/ wind shield glass----------01

Wind shield cover----------01

Decorative cover----------02

Connecting block----------02

Strip----------02

Show light----------02

Figure 3.12: Windshield preparation

Work Direction

01. Wind shield glass, strip, connecting block, show light all are attaching with wind shield cover.
02. After PDI and before packing it assemble in motor cycle.

Pre-caution

01. All are plastic items, so handle those items carefully.

12. PACKING AND DELIVERY

Parts List

Off tape----------As required
Packing paper---------As required
Packing rope----------As required
Polish cream--------- As required
Battery----------01 pc
Battery water---------01 bottle
Tools----------01 set
Looking mirror-------02 pcs

All documents--------01 set (Owner's manual, warranty card, emergency card, L/C document, registration form)

Figure 3.13: Motor cycle packing and delivery

Work Direction

01. Fixing battery to its accurate place.
02. Looking mirror, battery water packing.
03. Clean fuel tank, meters, head light and indicator lights using soft cloth then polish.
04. All paper documents hang on motor cycle.

Pre-caution

01. Check carefully all detachable items. Like logos, key, battery water, tools, kick lever, looking mirror, reflector and lube oil.
02. Check carefully all paper documents.

CHAPTER 4

PROBLEMS IDENTIFICATIONS AND SOLUTIONS

4.1 Time Study

PROBLEMS

Time study is very essential in a production plant. Time study means how many standard time needs for a specific job. If we don't know the actual time for specific job then we can't forecast our production schedule.

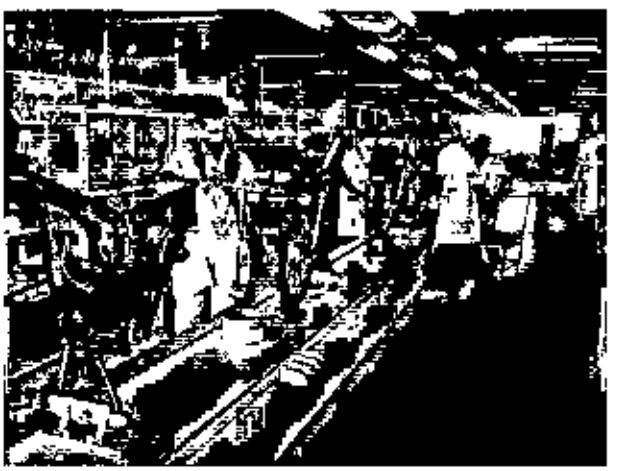


Figure 4.1.a: Time study analysis

SOLUTION

Study every operational time. 'A' grade assemblers (03 persons who have 12-15 years experience) operational time is Idol, 'B' grade assemblers (07 persons, who have 4-6 years experience) operational time is standard & 'C' grade assemblers (06 persons, who have 1-3 years experience) operational time is below standard Try to 'C' grade assembler's move into 'B' grade assemblers.

Say, 'B' grade assemblers take 15 mins for a specific job but'C' grade assemblers take 22 mins for the same job. The following actions take for bust-up him

a) Use special service tools

b) Introducing automation concept

c) Reduce his movement time

d) Take extra care about his performance

REMARKS

Due to smooth production the whole plant need to move in a same frequency. So the above corrective action turns'C' grade assemblers to do the specific job in 16-17 mins from 22 mins.

Table 4.1: Productivity analysis

Operation (start/off)	Motor cycle comp./hr.
Automation	5
Manual	4

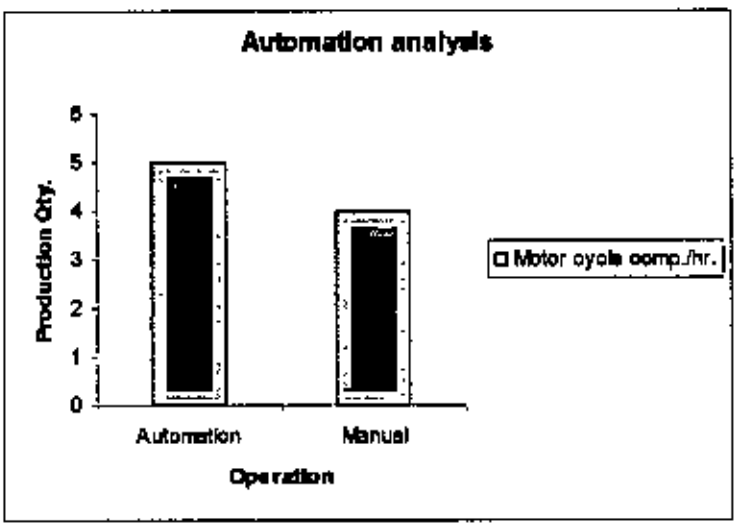


Figure 4.1.b: Operation mode analysis

4.2 Line Balancing

PROBLEM

It's a step by step line production. That means one assembler done a specific job then he pass through the next. If the line is not proper balance then the smooth production can't come out. So in a line production, line balancing is essential.

Figure 4.2.a: Line balancing study

SOLUTION

The production line divided into six different stages. Such as, a) Rear fork assembly, b) Front fork assembly, c) Engine assembly, d) Handle assembly, e) Ex-muffler assembly, f) Fuel tank assembly. If the operational time of each section is not uniform then smooth production can not occur. So the line has to be balanced.

The following actions take to balance the production line

a) Counting the operational time of every stage
b) Distribute equal time consuming parts for assembling in every stage
c) Using partial helper in critical stage (like rear fork, handle assembly) & hard labor stage (like engine assembly).
d) Distribute same grade assemblers at different stages in production belt
e) Damagod & wrong supply parts never array in production line.
f) Introduce overlapping work to save time.

REMARKS

Proper line balancing can ensure smooth production.

Table 4.2: Productivity Improvement

Year	Improvement (%)
2005-2006	15.81
2006-2007	12.48
2007-2008	9.79

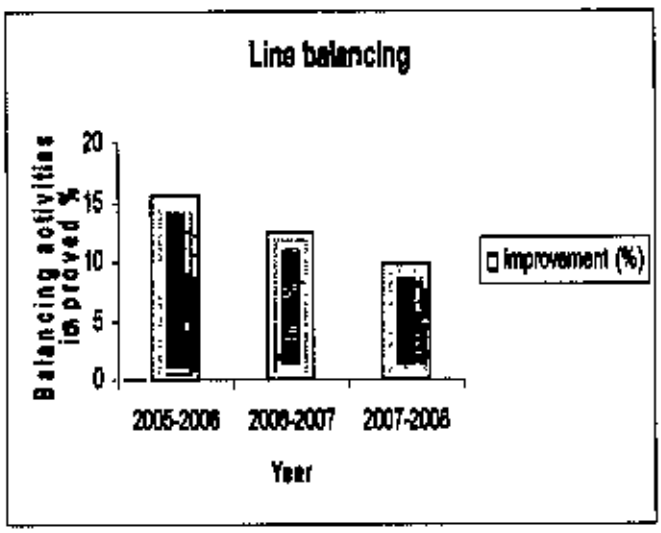


Figure 4.2.b Productivity improvement status

Before balancing the production line

							Total
Time Req. (min)	14.18	9.25	10.39	9.12	13.53	11.45	67.92
Operational Stage	Rear Fork	Front Fork	Engine	Handle	Ex-muffler	Seat & Tank	
No. of operators	1	1	2	2	1	1	8

After balancing the production line

							Total
Time Req. (min)	9.14	9.25	9.28	9.12	9.05	9.18	55.02
Operational Stage	Rear Fork	Front Fork	Engine	Handle	Ex-muffler	Seat & Tank	
No. of operators	2	1	2	2	2	1	10

4.3 Automation of Production Belt

PROBLEM

Automatic production belt guar rented a smooth operation. If the production belt manual operated then comparatively a slow production rate than auto belt.

Figure 4.3.a: Auto production belt

SOLUTION

a) Adjusted the production belt at running condition.

b) The belt runs at few minutes and then stops at few minutes automatically.

c) Stopping and running time also adjusted at certain slow speed.

REMARKS

Assemblers work efficiency higher so output comes at schedule time.

Table 4.3: Auto belt production

Operation (start/off)	Time (min)
Automation	55
Manual	68

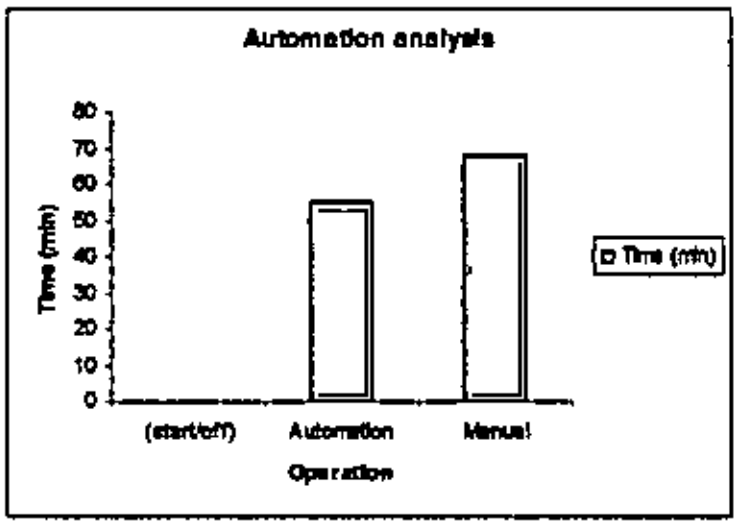
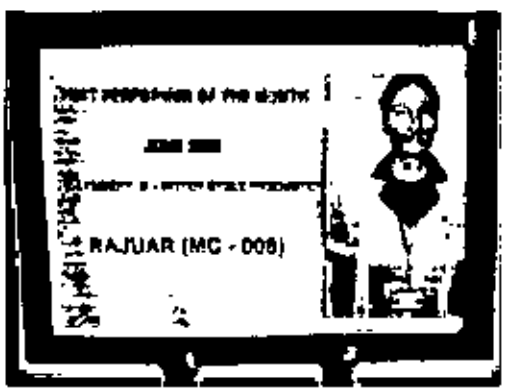


Figure 4.3.b: Automation analysis

4.4 Assembler's Grading

PROBLEM

Due to achieve high production assembler's enforcement is necessary. If we can't extract the full working capacity from assemblers then it is very difficult to reach goal with limited manpower.



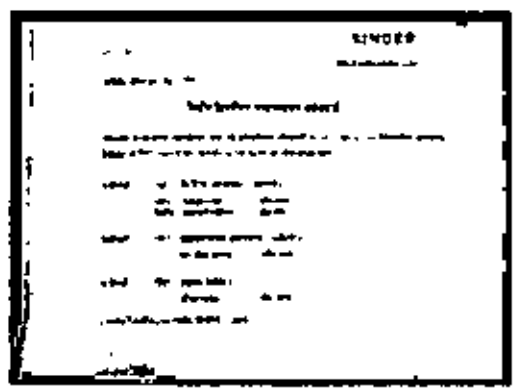


Figure 4.4: Assemblers assessment notice

SOLUTION

In every end of month we do assemblers performance assessment. Top five performers announce in official notice board. In quarterly the best performer will get a prize. The performance based on following parameters:

a) Knowledge of work
b) Accuracy & reliability
c) Quality of work and speed
d) General intelligence
e) Punctuality & attendance
f) Acceptance of responsibility
g) Job attitude
h) Team work

REMARKS

The efficiency of work force is high. Very effective policy to motivate assemblers.

4.5 Working Time Control

PROBLEM

Our working time start from 8.00 am and end at 5.00 pm (10.15 am to 10.30 am is tea break and 1.00 pm to 1.30 pm is lunch break). Total 8.00 hour working time is our hand. So proper utilization of working time can improve the productivity.

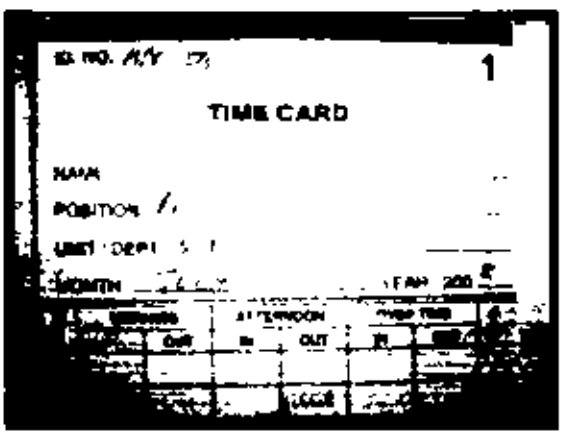


Figure 4.5.a: Time card

SOLUTION

Very strictly controlled assembler's entry & exit time. Tea & lunch break also. If their card punching time is after 8.10 am or before 4.50 pm then scratch a red mark against his name. And three red makes cartel his one day leave.

REMARKS

So everybody is in punctual his duty. And we get maximum amount of time to work.

Table 4.4: Assemblers leave status

Year	Leave Hour
2005	3104
2006	2979
2007	2850
2008	2416

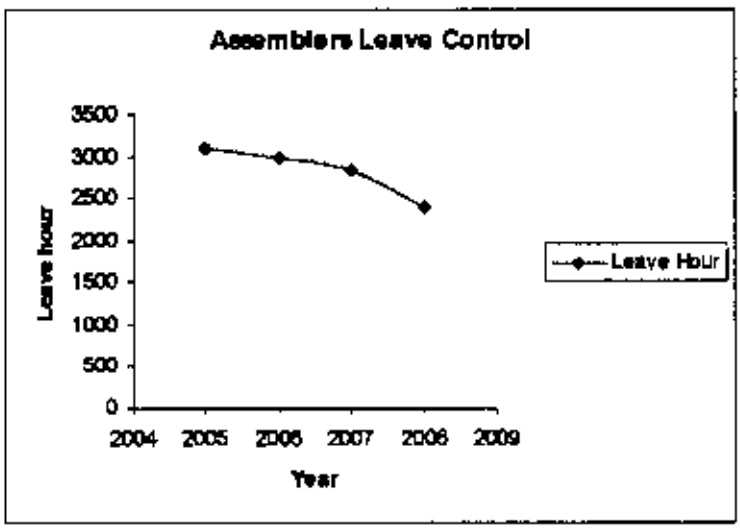


Figure 4.5.b: Assemblers leave status

4.6 In House Training

PROBLEM

Very few assemblers (5-6 persons) have no past experience about motor cycle assembling. For better performance proper training is necessary.

Figure 4.6: In-house training

SOLUTION

The following action took for in-house training:

a) Assign new comers for a specific job location.

b) Supervisor & experience assembler help them time to time.

c) They will stay at their stages for a long time period (3-4 months).

d) After then they will inter change their job location and teach them each other.

REMARKS

Very quickly new assemblers learn their jobs in multi stages.

4.7 Service/ Customer Complain Analysis

PROBLEM

Quality means customer satisfaction. So we analysis the customer complain in monthly and try to solve it.

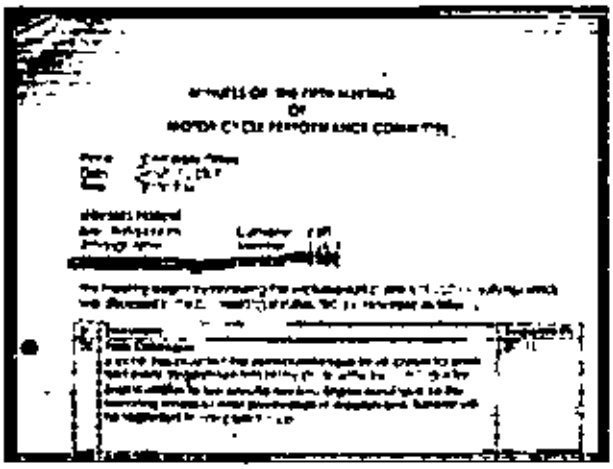


Figure 4.7.a: Customer/service complain analysis

SOLUTION

Proposal to make a "Motor cycle performance committee". First week of every month there will conduct a meeting. The following activities done by the committee:

a) Analysis service complains in production point of view.

b) Make a quality improvement report and send it to supplier.

REMARKS

Quality improved. Reduce repairing work so productivity high.

Table 4.5: Service compliant status

Year	Service compliant (%)
2005	15
2006	13.33
2007	7.28
2008	5.82

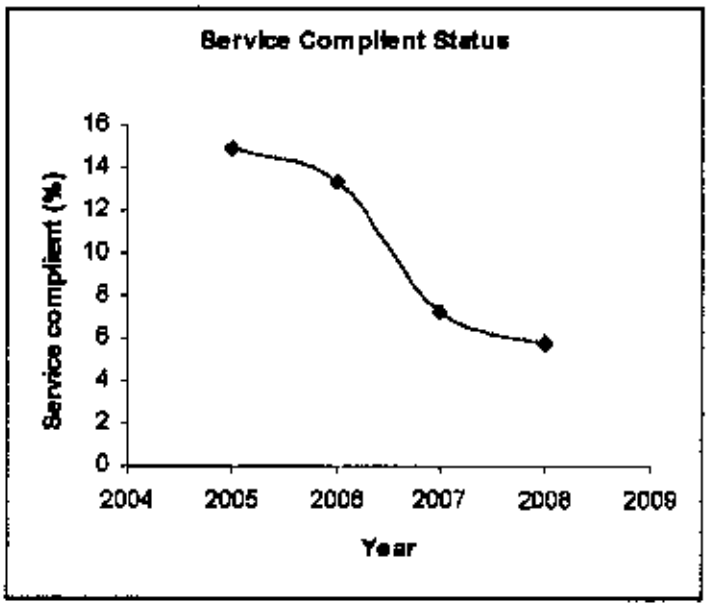


Figure 4.7.b: Service Compliant Analysis

4.8 Control Total Preventive Maintenance (TPM)

PROBLEM

In motor cycle production floor there are few technical accessories which are directly utilize/assist in production. If these machineries items are not work in time then production will delay. Such as:

a) Motor cycle assembly belt
b) Quality control tester with computer
c) Exhaust gas analyses
d) Drill machine (hand & bench)
e) Grinding machine (hand & bench)
f) Air impact wrench/ pneumatic gun
g) Welding machine
h) Air compressor (for assembly line, 1.5 hp,)
i) Air compressor (for paint booth, 0.5 hp, 10 kg/sq.cm)

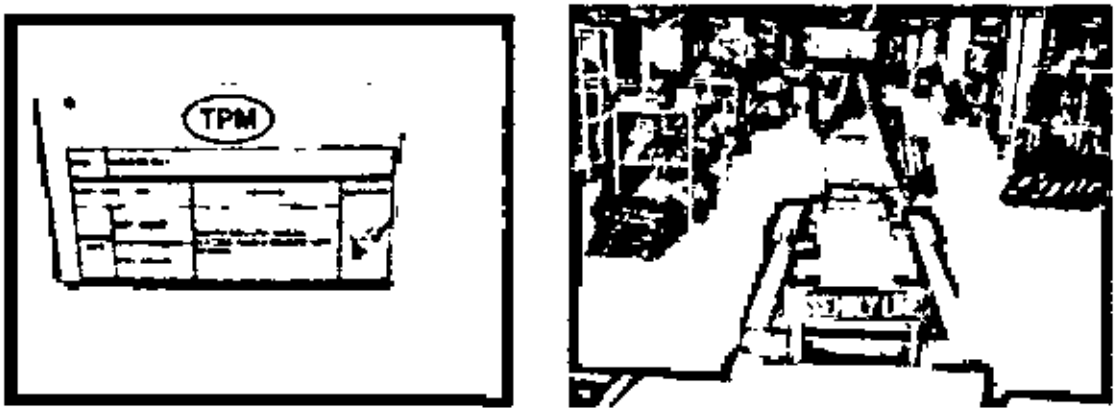


Figure 4.8: Total preventive maintenance

SOLUTION

Maintain Total Preventive Maintenance (TPM) schedule. The maintenance work done after working hour or holiday.

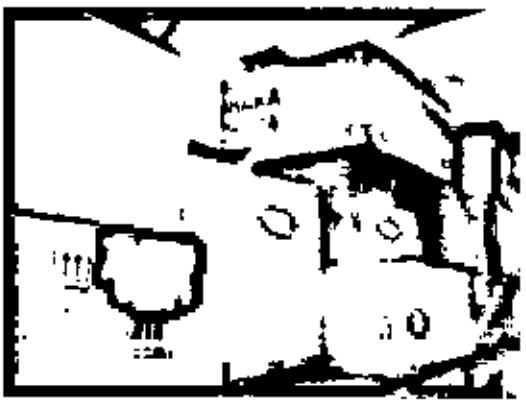
REMARKS

Due to machineries fault, no production loss happens.

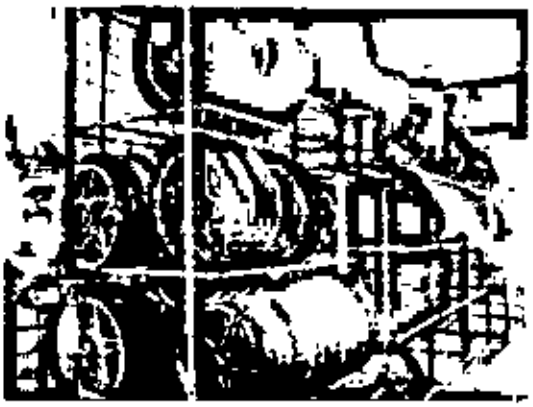
4.9 Proper Storing of Complete Knocked Down (CKD) Parts

PROBLEM

If the CKD parts are not in proper storing then increase the amount of damage items. As a result more repairing work will needed, so productivity will slow.



Before implementation



Implemented (Wheel rack)

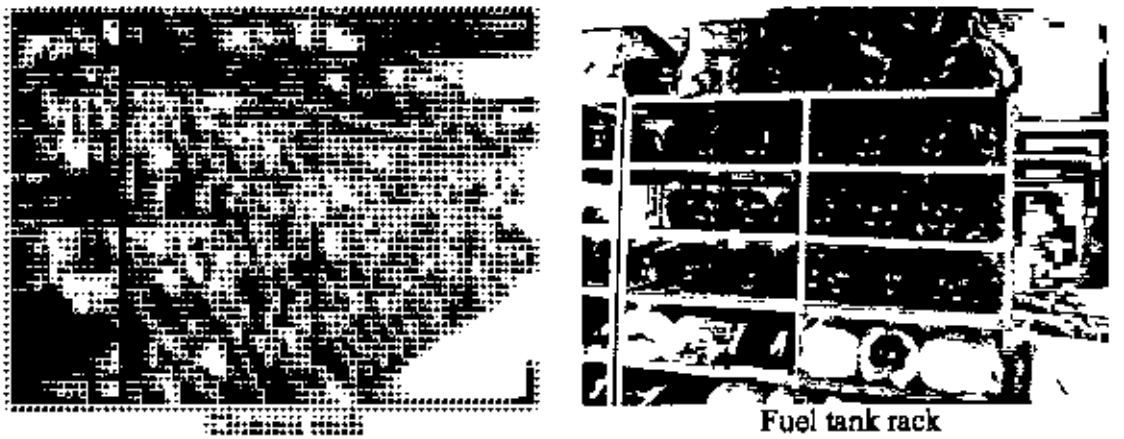


Figure 4.9.a: Raw materials store

SOLUTION

Making racks for storing knock down parts. Each rack is assign for specific parts. This will help to find out easy & proper storing.

REMARKS

Reduce damage parts, reduce repairing time. So productivity high.

Table 4.8: Status of Unbalance Motorcycle

Year	Unbalance Motorcycle
2005	77
2006	56
2007	19
2008	9

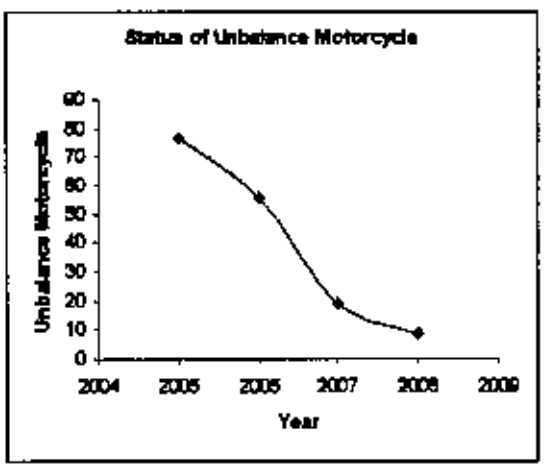


Figure 4.9.b: Status of Unbalance Motorcycle

4.10 Improper Placement of Air Impact Wrench

PROBLEM

The position of air impact wrench was not suitable for using an assembler. It was placed in his back. Again and again he turned his body back & collected the gun. So he felt tired in his job. As a result, fatigue came in his work.

Before implementation

Implemented

Figure 4.10: Suitable position of air impact wrench

SOLUTION

Air impact wrench hang on his front. So it is easy to collect & easy to use.

REMARKS

Fatigue does not come on his job.

4.11 Reduced Tool Setting Time

PROBLEM

In each operational stage there were huge nuts & bolts to fix. Several sockets were used to tight them in both sides. If these sockets were changes in regular order then time was killed.

Figure 4.11: Time economy working process

SOLUTION

Use an extra assembler in opposite side of main assembler. Try to work parallel in two motor cycles. At the same time two assembles work two sides.

REMARKS

Time is saving due to exchange sockets.

4.12 Engine Carry Easier

PROBLEM

In earlier 35-40 kgs engine was carried & lifting manually. To apply extra effort assemblers felt tired to work in this section so everyone try to avoid in this stage.

Before implementation Implemented

Figure 4.12.a: Easier engine carrier

SOLUTION
Now use height adjuster tally to carry & lift.

REMARKS
Less effort, less time needed. So assembler works willingly to work in this section.

Table 4.7: Engine carrier implemented

Implementation	Engine ass'y /hr
Before	4
after	5

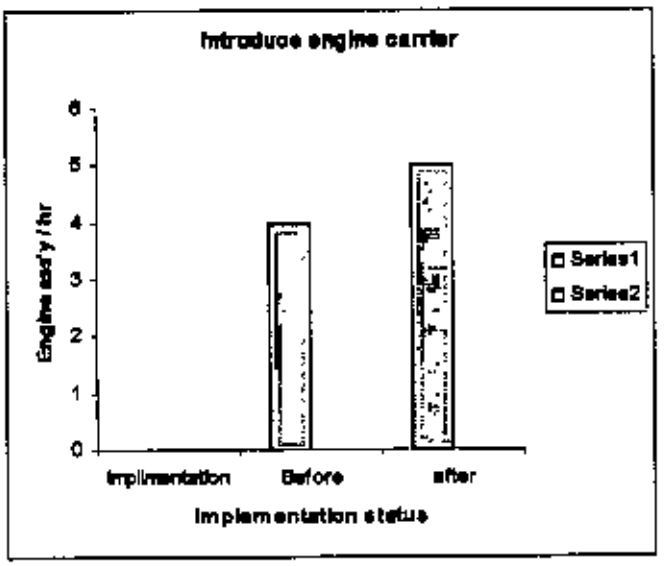
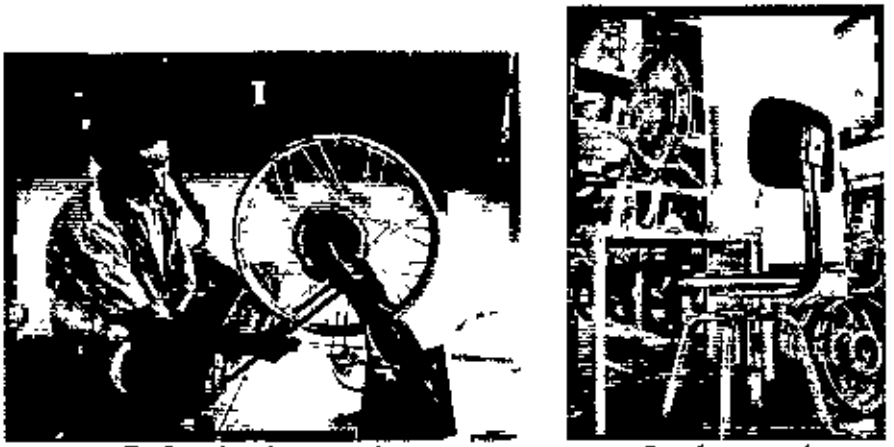


Figure 4.12.b: Engine carrier status

4.13 Wheel Balancing Setup Adjusted

PROBLEM
Wheel balancing (dynamic) setup was not comfortable use for an assembler. He felt pain in his backbone after worked long time. That's why every body tried to avoid in this stage.



Before implementation Implemented

Figure 4.13.a: Wheel balancing setup.

SOLUTION

Introduced height adjustable evolving chair

REMARKS

Fatigue does not come on his job.

Table 4.8: Wheel balancing setup

Implementation	Wheel aligned / hr
Before	3.75
After	5

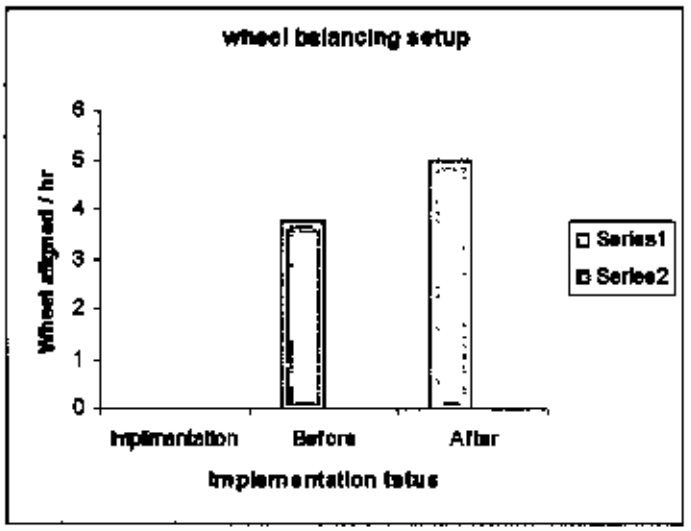


Figure 4.13.b: Wheel balancing setup

4.14 Introduced Paint Booth

PROBLEM

Some times we found scratch on fuel tank, side cover, front & rear fender. This looks indecent in a new bike. Earlier then these types of problem solved by local workshop. Because of their serial maintain, time was killed in production floor & expensed was high also.

Figure 4.14.a: Paint booth

SOLUTION

Introduced a paint booth in a corner of production floor. And appointment a repair technician who has knowledge about welding, painting & general repairing.

REMARKS

Cost economic & time is saving for repairing time.

Table 4.9: Utilization of Paint booth

Paint Booth	Time Required (day)
Outside	4
In-house	2.5

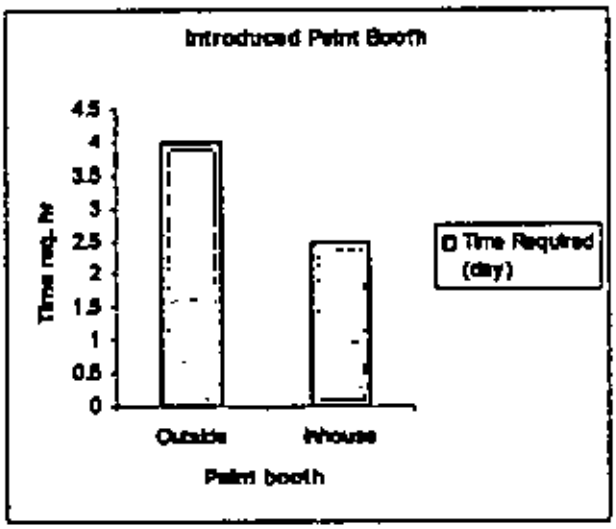


Figure 4.14.b: Paint booth status

4.15 Production Time (man hour) Analysis in Monthly Basis

PROBLEM

In earlier there was no record keeping in time sheet or production man hour. It was difficult to analysis the man hour per motor cycle in monthly basic. So team performance was not evaluated.

Figure 4.15: Man hour calculation sheet

SOLUTION

Introducing monthly statement sheet. The analysis parameters are: a) actual working time (exclude leave & material waiting), b) actual declare production, c) raw materials status (model wise), d) finish goods status (model wise), e) direct & indirect man hour, f) summary of whole month & year to date.

REMARKS

It is easy to know about the assembler's performance in monthly basic (model wise). Say in year 2005 the actual man hour was 8.2. And in year 2006 the actual man hour 6.7. So team speed increase that means production will higher.

4.16 Create Special Service Tool for Specific Job

PROBLEM

There was no special tool for special job. It was difficult for an assembler to done a critical job in a usual tool in a limited amount of time.

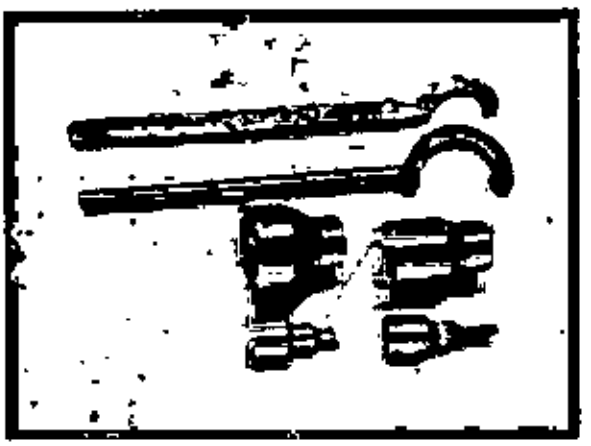


Figure 4.16.a: Special service tools

SOLUTION

To make special service tools for specific job.

REMARKS

Now it is easy to do the job in precise manner in limited amount of time.

Table 4.10: Activities of special service tools

Year	Time Saved (hr/day)
2005	1
2006	1.25
2007	1.3
2008	2

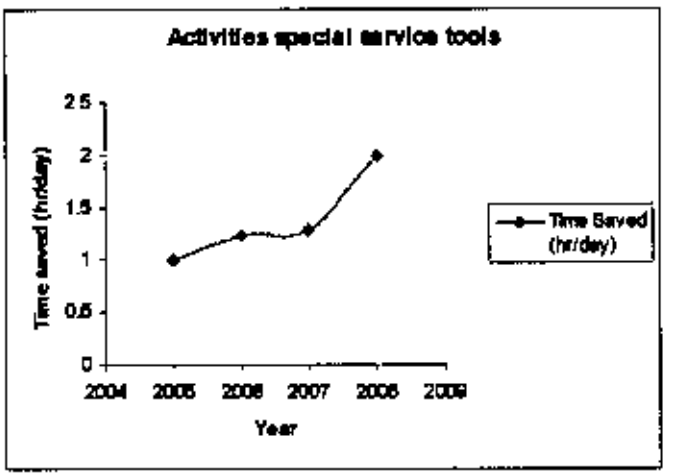


Figure 4.16.b: Special service tools activities

4.17 In House Calibration of Machineries

PROBLEM

All machineries in motor cycle production floor there was no calibration facilities. So very difficult to realize the measurable data. So at least three times check in each data for an acceptable result.

Figure 4.17: In-house calibration

SOLUTION

Very expensive to calibrate the measurable all parts. But it needs to be calibrated. So take initiative the common parameters of the three different plants (Motor cycle, Cable & Audio video).

REMARKS

Correct torque used in respective places.

4.18 Work Accountability of Assemblers

PROBLEM

There were no work accountabilities in assemblers. Each assembler worked their own experience. Have no responsibilities, traces & accountabilities. So very difficult to find anybody for his specific fault.

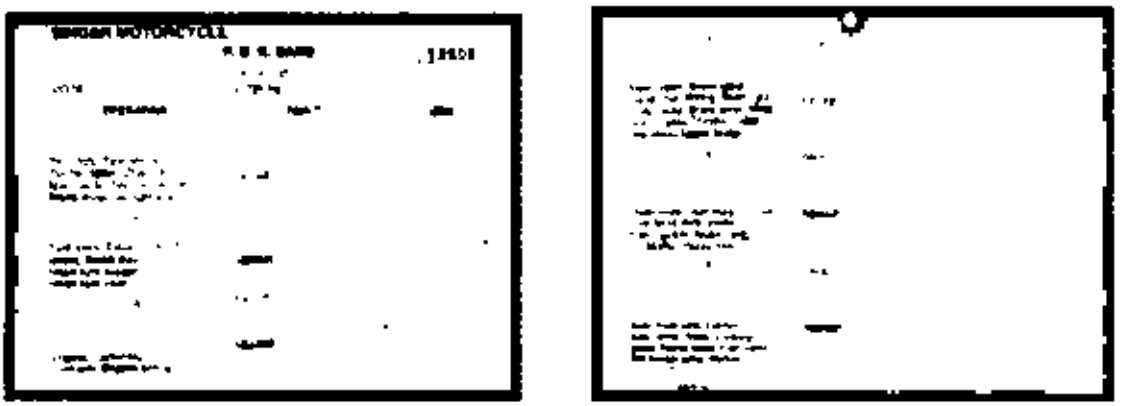


Figure 4.18: Pre-quality control card

SOLUTION

Introduce new PQC (Pre Quality Control) card in every stages. After completed his jobs each assembler sign the card in its respective place and pass through the next stage. When he sign for specific motor cycle (engine & chassis number registered with date) he has responsibility to done the work in perfect. Other wise he can trace easily and will be punished.

REMARKS

To reduce the mistake in production. As a result, needed minimum time for quality control & repairing section. So delivery will be smooth.

4.19 Assembler's Leave Control

PROBLEM

If one assembler takes leave (unnecessary casual) then other 15 assemblers need around extra 30 mins to makeup his duty. So productivity loses Due to smooth operation assembler's leave must be controlled.

SOLUTION

Assemblers casual leave are strongly discourage. Motivate them to present at plant regularly by month ending assessment & annual increment. Disobedient assemblers face in official show cause.

REMARKS

Tendency of casual leave reduce gradually. We get maximum present, maximum working time. So productivity will improve.

Table 4.11: Assemblers leave control

Year	Leave Hour
2005	3104
2006	2979
2007	2850
2008	2416

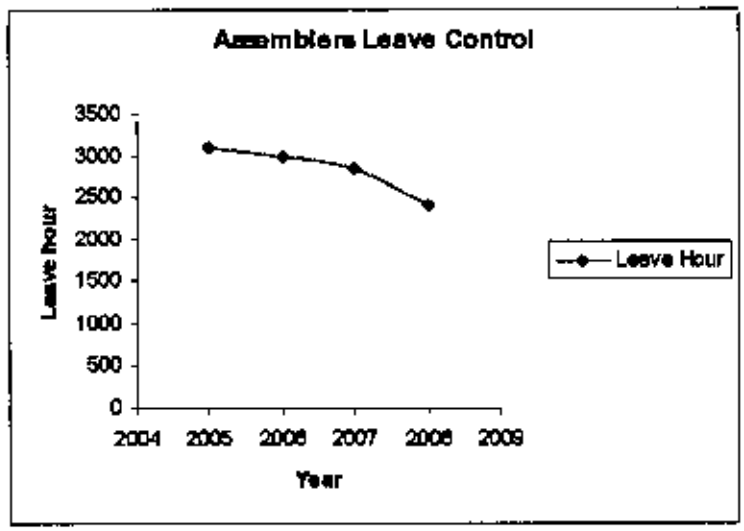


Figure 4.19: Assemblers leave status

4.20 Create Assemblers Setup in Specific Models

PROBLEM

Assemblers worked their as usual order in all models. But the special luxury items vary model to model. It was difficult for assemblers to learn all the items in all models.

SOLUTION

To specialize different items in different assemblers. Rearrange assembler's setup in different models. So they can handle their jobs comfort.

REMARKS

Reduce operational time in different models. Productivity improved.

Figure 4.20: Model wise assembler's set-up

4.21 Smooth Supply Chain (External)

PROBLEMS

Supply chain of External (overseas) is very essential. If we don't forecast our raw materials transfer to finish goods then either the production floor wait for raw materials or huge amount of raw materials compact in store. Both the case is harmful for a production floor. First case productivity loss and the second case raw materials damage.

SOLUTION

First identified the sales target in model wise then L/C opened for CKD (complete knocked down) parts in regular ordered from factory.

REMARKS

Reduce raw materials damaged and improved productivity.

Table 4.12: Supply chain analysis, external

Year	Material Waiting (Day)
2005	48
2006	21
2007	17
2008	12

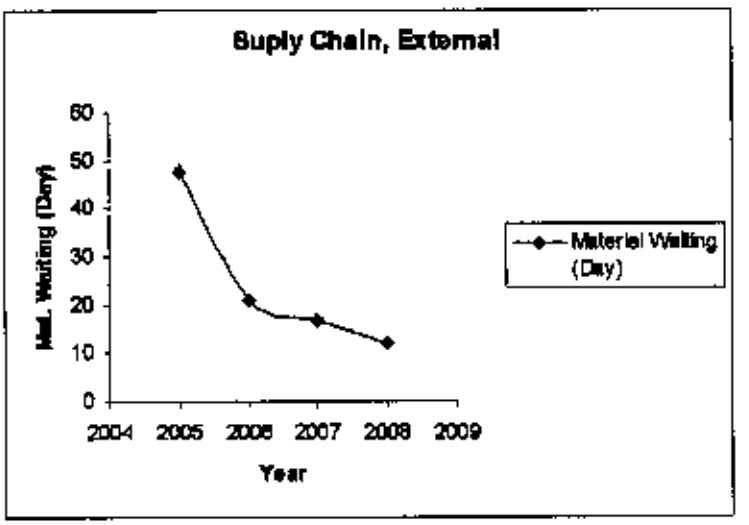


Figure 4.21: Supply chain, external

4.22 Smooth Supply Chain (Internal)

PROBLEMS

Supply chain of internal (raw materials store to production) assurance a smooth production especially in model change. In every model change there is production lose. Proper supply chain technique can protect the production lose.

SOLUTION

Issue raw materials from store in a systematic ways. Calculation leading factor, issue time factor.

REMARKS

Smooth supply chain insures high productivity, reduce damage of CKD parts.

Table 4.13: Supply chain analysis, internal

Year	Time Save (Hour/Day)
2005	1.5
2006	3
2007	3.5
2008	4.5

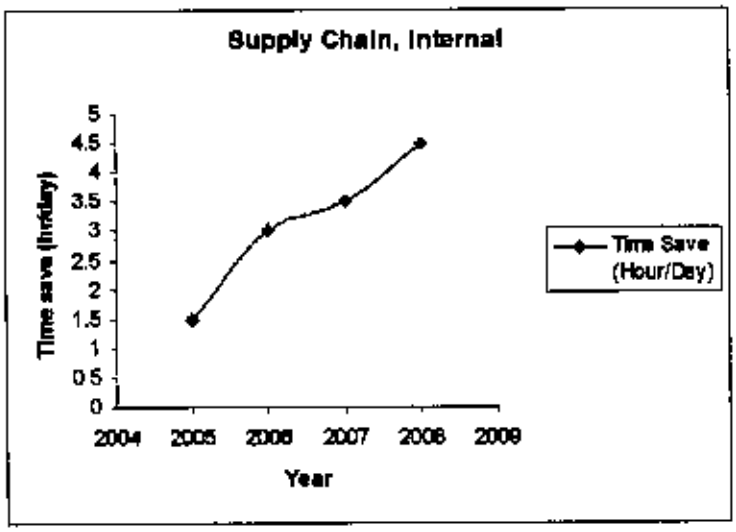


Figure 4.22: Supply chain, internal

CHAPTER 5

RESULTS AND DISCUSSION

5.1 Productivity Analysis

People are engaged in various fields of economic activities like farms, non-farms, mills, factories, hospitals, banks, schools, offices etc. to earn a living by producing good and services which is required by the community. The inter-relationship of all these economic activities is called an economic system which caters comfort and well-being of individuals. In order to produce goods and services resources in the form of man. machine, materials and money are required. And the more efficient use of the resources is ensured the more goods and services will be produced. By this process of efficient use and effective utilization of resources the economic system can attain self-sustain growth. And in fact this efficient use and effective utilization of resources is truly productivity which is an essential element and successful strategy for the well-being of the individuals.

Productivity Calculation

a) Time study analysis
b) Line balancing study
c) Auto production belt
d) Smooth supply chain.
e) Proper in-house training

Productivity = Output/Input. This is a general definition of productivity. Depending on type of output and type of input Before classified last few years production shown:

Table 5.1: Data for yearly production

Year	Total Production
2005	1993
2006	4461
2007	2819
2008	3584

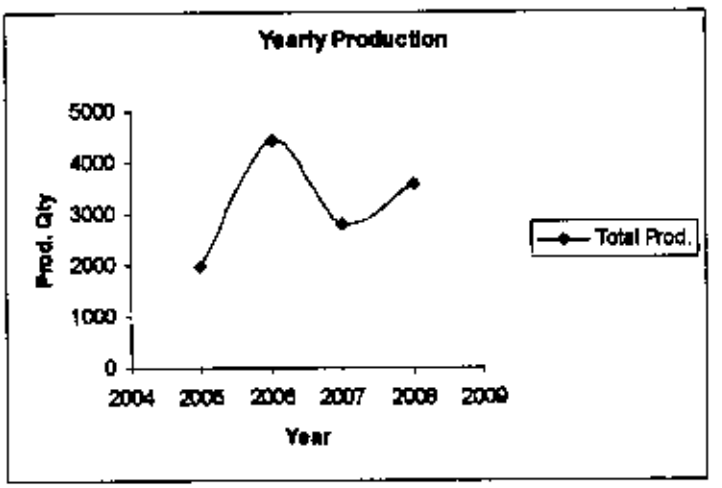


Figure 5.1: Yearly production.

Productivity may be classified as

a) Factor productivity
b) Partial productivity
c) Total factor productivity
d) Total productivity

An example (say, one pc of motor cycle) of all these kinds of productivity are furnished here for Singer Motor Cycle Plant with the following data for a given period.

Data	Cost (Tk)	Data	Cost (Tk)
Output	75000	Capital	42000
Labor	312	Energy	50
Materials	28000	Other expenses	100

$$\text{a) Labor productivity} = \frac{\text{Output}}{\text{Input}} = \frac{75000}{312} = 240.38$$

Table 5.2: Labor productivity improvement

Year	Improvement (%)
2005-2006	15.61
2006-2007	12.48
2007-2008	9.79

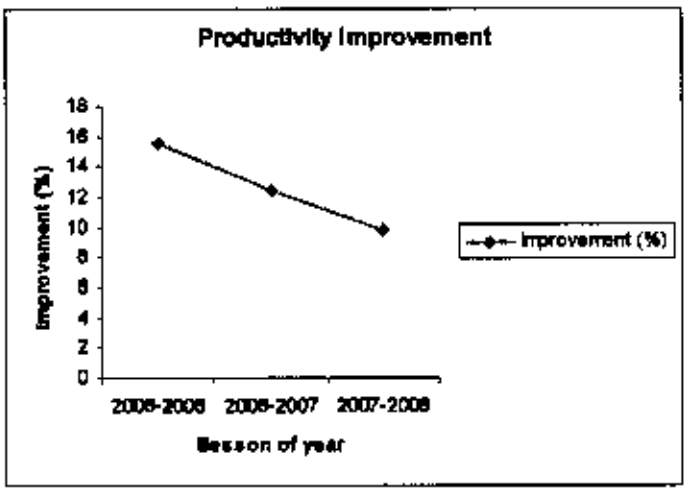


Figure 5.2: Labor productivity

$$\text{b) Martial productivity} = \frac{\text{Output}}{\text{Input}} = \frac{75000}{28000} = 2.69$$

$$\text{c) Capital productivity} = \frac{\text{Output}}{\text{Input}} = \frac{75000}{42000} = 1.79$$

Table 5.3: Over time analysis

Year	Over time (hour)
2005	248
2006	207
2007	140
2008	0

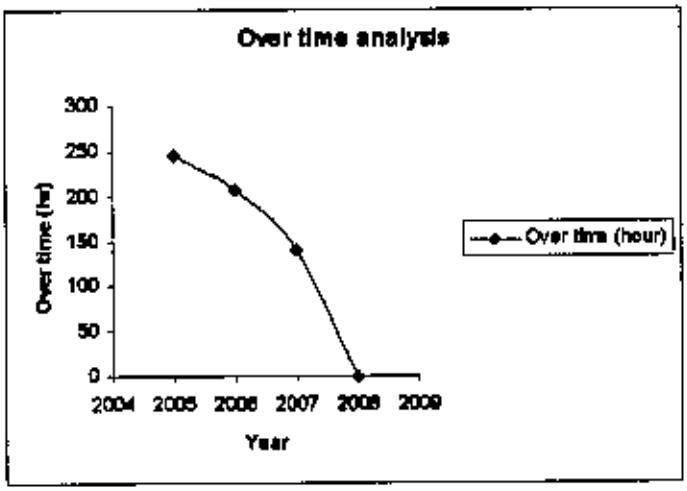


Figure 5.3: Over time analysis

$$\text{d) Energy productivity} = \frac{\text{Output}}{\text{Input}} = \frac{75000}{50} = 1500$$

$$\text{e) Others productivity} = \frac{\text{Output}}{\text{Input}} = \frac{75000}{100} = 750$$

Table 5.4: Other indirect activities

Year	Indirect Activities (hr)
2005	0
2006	2751
2007	7851
2008	9135

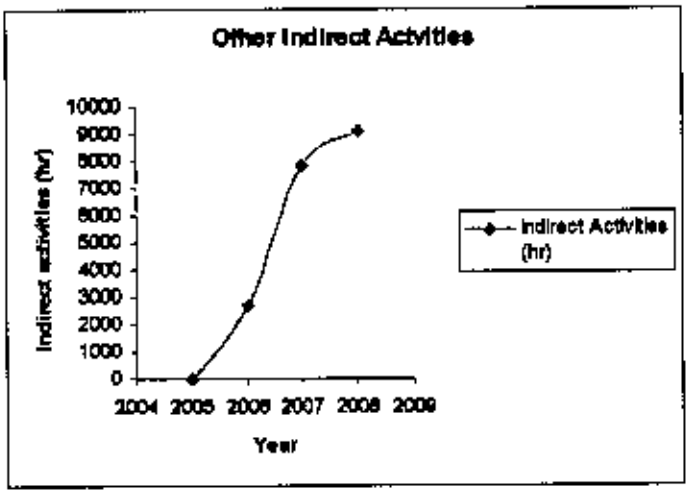


Figure 5.4: Other indirect productivity

$$\text{f) Total productivity} = \frac{\text{Total output}}{\text{Labor} + \text{Materials} + \text{Capital} + \text{Energy} + \text{Others}}$$

$$= \frac{75000}{312 + 28000 + 42000 + 50 + 100}$$

$$= 1.065$$

Table 5.5: Data for yearly productivity

Year	Man-hour/ Motor cycle
2005	7.88
2006	6.65
2007	5.82
2008	5.25

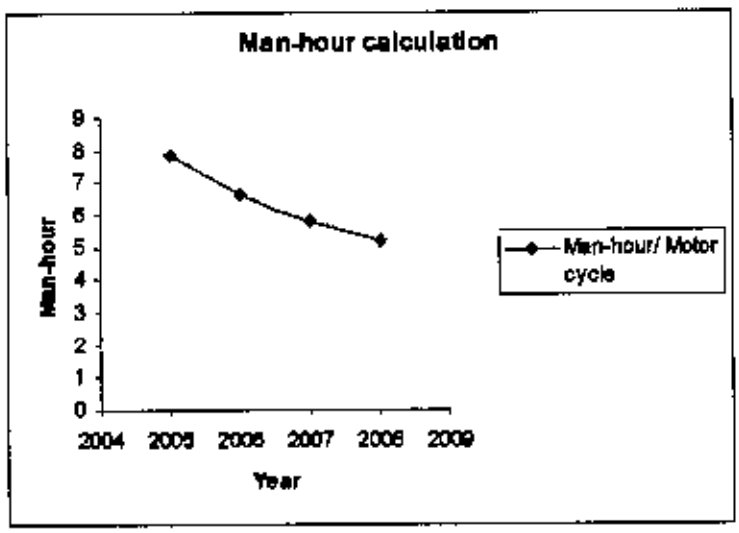


Figure 5.5: Man-hour calculation

5.2 Method of Improvement of Productivity

a) Total preventive maintenance
b) Raw materials store
c) Suitable position of air impact wrench
d) Time economic working process
e) Easier engine carrier process
f) Wheel balancing set-up
g) Paint booth
h) Special service tools

Productivity = Output/Input. By using this model of Output/Input it appears that there are five possible ways in which productivity can be improved;

a) **Reduce Cost:**
This is possible where output remains constant by input is reduce.

Example:

Year	2005	2006	% of change
Output (motor cycle)	1993	1993	--
Input (month)	12	5.30	(-) 55 83
Productivity	166.08	376.04	126.42

b) **Manage Growth:**
This can occur when there is slight increase in input but at the same time a larger increase in output is achieved

Example:

Year	2005	2006	% of change
Output (motor cycle)	1993	4461	123.83
Input (assemblers)	13	16	23.08
Productivity	152 31	278.81	83.05

c) Work Smarter:
This is a situation where input remains constant but there is an increase in output

Example:

Year	2005	2006	% of change
Output (motor cycle)	1993	4461	123.83
Input (month)	12	12	--
Productivity	166.08	371.75	123.83

d) Work Efficiency:
This is a case where there is a reduction in input yet at the same time there is an increase in output

Example.

Year	2005	2006	% of change
Output (motor cycle)	1993	3656	83.44
Input (month)	12	10	(-) 16.67
Productivity	166.83	365 60	119.15

e) **Pare Down:**
A large reduction in input can result in increasing productivity as there is a only slight reduction in output

Example:

Year	2005	2006	% of change
Output (motor cycle)	1993	1811	(-) 9.13
Input (month)	12	5	(-) 58.33
Productivity	166 83	362.20	117.12

CHAPTER 6

CONCLUSIONS

In this thesis work, productivity of Singer Motor Cycle Plant and its quality tried to improve. Actually it's a continuous process. Still it has enough opportunity to grow up. Here focus on following three session's data (Like 2005-2006, 2006-2007, 2007-2008) Utilization of proper production management and proper quality assurance can developed a production floor day by day Achievements of the thesis work are shown in case by case basis:

First come quality. Quality means customer satisfaction. A customer satisfaction comes when the process of the product is quality. So process implementation is the key objective of this thesis. Proper line balancing, time study and effective in-house training can give a quality process. And a quality process can gives quality product. After studying the each operation time the production line should be balanced. The assemblers must aware of these For this reason they should trained properly.

The price of the product must be reasonable for customer. So production cost should be optimized. Reduce wastage of raw materials and curtailing overtime can easily save the production cost. Proper handling of raw materials during the production period then minimum brake down can achieved. And to avoid overtime, perfect time management is very essential.

In a line production each assembler works in a particular one job. After complete the job it passes in next stage. Everybody has a specific job And they are very expert on these. If some one has disconnected or leave for few days then very difficult for others to continues the job in same expertise So multi hand expertise is essential for the vacant or absent post. Most of the assemblers are trained and pickup them in multi purpose used

Every year has few unbalanced motor cycles which create for short or damage of the parts. This unbalanced motor cycles increase the over head of the production floor due to

loss of inventory So unbalanced motor cycles should be balanced by local fabricated parts or bought from overseas.

In an assembling plant no improvement can possible without manufacturers So service feedback is helpful for further improvement or modification. Collected customer complaint from service center and analyzed their justification and then informed to manufacturers to modify. To achieve this target a motor cycle performance committee also formed

Supply chain of External (overseas) is very essential. If we don't forecast our raw materials transfer to finish goods then either the production floor wait for raw materials or huge amount of raw materials compact in store. So identified the sales target in model wise then L/C opened for CKD (complete knocked down) parts in regular ordered Supply chain of internal (raw materials store to production) assurance a smooth production especially in model change. Smooth supply chain insures high productivity, reduce damage of CKD parts.

Finally the main objective of this thesis work to improve the productivity of Singer Motor Cycle Plant. It is the sum of all above activities. If follows the quality production processes, reduced production cost, produce quality product, minimize the holding of unbalance motor cycles, save the wastage time and ensure the smooth supply chain then productivity improved automatically The result is productivity improved from 7.88 hr/motor cycle (in 2005) to 5.25 hr/motor cycle (in 2008). It is possible to do better in next. It's a continuous improvement process.

CHAPTER 7

REFERENCES

[1] Graves S.C & Willems S.P, Optimizing Strategic Safety Stock Placement in Supply Chains, Journal of Manufacturing and Operational Management, Vol: 2, No: 1, pp 68-83. Winter 2000.

[2] Richard B.Chase & Nicholas J Aquilano & Robert Jacobs, Production and Operational Management, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 8th Edition.

[3] Sushil Kumar Srivasava, Maintenance Engineering and Management, S. Chand and Company Ltd, New Delhi, 5th Edition.

[4] P K Talapatra and P. K. Ray, Implementation of a TQM Program in Research and Development of a Manufacturing Unit, International Conference on Manufacturing, ICM 2002, Vol 1, pp: 223

[5] S. S. Dutta and Dr S Mitra, Appliation of ISO 9001 2000 Standard of Quality Management in Service Sectors, International Conference on Manufacturing, ICM 2002, Vol: 1, pp: 239

[6] M. Kundu and R Bhattacharya, Modeling of Material delivery System for Supply Chain with Discrete Event Simulation, International Conference on Manufacturing, ICM 2002, Vol: 1, pp: 579-582.

[7] K Krishnaiah and K. Ravikumar, Ergonomic Study on Eye Strain and Lifting, International Conference on Manufacturing, ICM 2002, Vol: 1, pp: 639, 648.