Measurement & Analysis of Productivity and Finding Solutions to Improve Productivity in a Garment Factory in Bangladesh

Muhammad Abdus Samad, Chowdhury Luthfur Rahman, Md. Toufiqur Rahman, Md. Shafiqul Islam, Prodip Sarkar

Abstract: ***RMG is the biggest manufacturing sector in Bangladesh, which contributes biggest part in the growth rate of GDP. Though, this sector has some obstacles to overcome for greater outcomes. To ensure sustainable economic growth and compete in the global market, the garment industries should utilize their resources properly. Higher productivity ensures higher utilization of available resources i.e. man power, raw materials etc. In this paper we have studied and analyzed the productivity in sewing section of a garment factory. The focus of the study was labor productivity and defects in the production floor. Labor productivity was measured and analyzed using Kurosawa's structural approach. It was found that the labor productivity is not up to the standard level. The reasons that reduce labor productivity and the factors for improving labor productivity were identified using questionnaires and observations. Occurrence of defects was analyzed using Pareto analysis which helped to identify the vital defects. Using root cause analysis, cause and effect diagram was generated and the reasons of the defects were identified. Based on that, the solutions for reducing those defects were recommended. Some of the techniques that the garment manufacturing factory can implement are six sigma, automation and nominal group technique.***

Keywords: ***Kurosawa Approach, Pareto Analysis, Labor Productivity, Root Cause Analysis, Cause and Effect Diagram.***

I. INTRODUCTION

Productivity can be defined simply as the ratio of output to input. If we elaborate it little further, productivity is the relation between the defect free outputs generated by a manufacturing or service system and the resources that were provided to create the output. The resources used include labor, capital, land, materials, energy and information. Improving productivity means achieving more output using the same input or achieving same output using less input. Two important factors for productivity growth are technical advancement and efficient technical planning. However, the improvement of production is not an easy task due to obstructions from different part of the organization or system.

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The major obstruction faced by an organization or system is the fear of change. The inefficient utilization of manpower and improper utilization of raw materials are the problems that were identified to study in this thesis. There are multiple methods that can be applied together or one by one to improve the productivity. Bangladesh's economy is one of the fastest growing economies of the world. In the year of 2016 the growth rate of Gross Domestic Product (GDP) was 7.11%. Contribution of industry was 28.1% where RMG sector donate the biggest part [1]. In the fiscal year of 2014-15 Bangladesh earned 25491.40 million USD only by exporting RMG. It became 28094.16 million USD in 2015-16 fiscal year and 28149.84 million USD in 2016-17 fiscal year [2]. In RMG sector Bangladesh's main competitors are now China, India, Vietnam, Cambodia, Sri Lanka and Pakistan. In the year of 2015 the exports of garments of Bangladesh decreased by 6.8%. After that in the year of 2016 the market became stable [3]. New method and technology introduced in the last several years provided with a lot of scope to improve productivity and quality. So to stay in the business, the existing situation n of garments industries should be improved. Garments industry, by improving quality and productivity, can also extend their business in the global market.

II. THEORETICAL STUDY AND LITERATURE REVIEW

There are many models and approaches for measuring productivity. In this study we used Kurosawa's structural approach of productivity measurement for measuring the labor productivity [4]. This approach was developed by Dr. Kazukiyo Kurosawa. In this approach, Dr. Kurosawa developed a structure of work hours. From the structure, he developed methods to calculate the productivity of the labors.

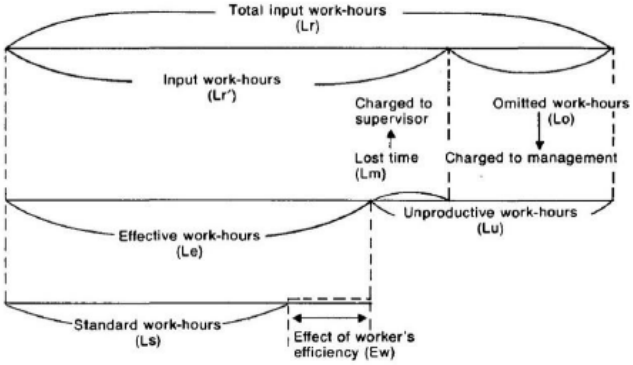

Fig 2.1 Structure of Work Hours in the Kurosawa Approach [1].

From figure 2.1,

L_r = Total input work hours, $L_{r'}$ = Input work hours, L_e = Effective work hours, L_s = Standard work hours, L_o = Omitted work hours (Includes: work breaks, mealtime, cleaning and maintenance etc.). L_m = Lost time (Includes: breakdown, shortage of materials etc.), E_w = Worker's efficiency.

From the structure of work hours following equations were developed [4]:

Worker's efficiency E_w:

$$E_w = \frac{L_s}{L_e} \quad (1)$$

Process efficiency τ'':

$$\tau'' = \frac{L_s}{L_{r'}} \quad (2)$$

Overall efficiency of labor τ'_R:

$$\tau'_R = \frac{L_s}{L_r} \quad (3)$$

K8Standard productivity τ_F:

$$\tau_F = \frac{Q}{L_s} \quad (4)$$

Overall labor productivity τ_R:

$$\tau_R = \frac{Q}{L_r} \quad (5)$$

Q is the output.

A research paper titled "Productivity improvement by work and time study technique for earth energy-glass manufacturing company" was published by Cetindere et. al. The authors analyzed a firm that produces tea glass in terms of work/time during the process of model production. Time survey was developed and used to calculate the standardized time. The study helped to increase efficiency by 53% and it also increased the capacity of the model production [5].

A research paper titled "Assessment of Work Stress Influence on Work Productivity in Romanian Companies" presented by Iordache, R. et. al. used scientific, theoretical and methodological base to include as many aspects of stress as possible and their correlation to the indicators of work productivity. The research presented the base of the stress that influenced the work productivity in the companies of the Romanian economic environment [6].

Loera et. al. conducted study on labors of an industrial group in Mexico. The authors used work sampling tools to identify the main factors that affected labor productivity. It was proposed to apply lean thinking to improve the labor productivity [7].

The theoretical studies and past research works helped us to identify the methods that can be used to successfully complete the study.

III. METHODOLOGY

Steps followed in Methodology

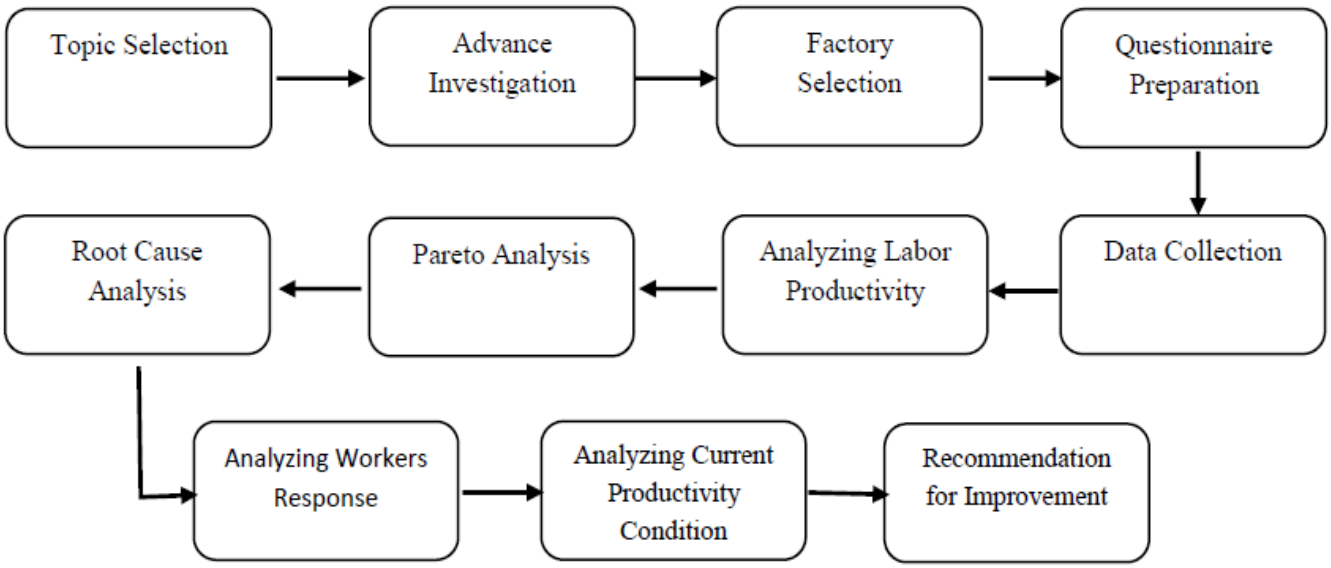

Fig 3.1Steps of Study

IV. DATA COLLECTION AND ANALYSIS

4.1. Labor Productivity

The workers were interviewed in the sewing section of the factory. There were 334 workers working in 10 lines. Each line produces a certain type of product. The labor productivity related data were taken from everyone separately. The data collection procedure is briefly discussed below:

First, the demographical data were obtained. The regular work hours and overtime work hours for each employee were recorded. The input work hours were calculated using the regular time and the overtime. The overtime hours were an average of the month of July 2017 for each worker. The output of the workers in the regular time and overtime were average of the past data. Lost time and omitted work hours were also obtained from management as average of past data. Lost time and omitted work hours during overtime period were negligible.

No worker makes the whole product themselves. They perform a specific task assigned to them. So, in this case, the average output for the employees are not output as a whole product. Rather, it is the output of the tasks they have performed to complete a whole product. The output was calculated by multiplying the effective time with regular time output per hour and adding the multiplication of overtime and overtime output per hour. The overall productivity was calculated for each individual using equation (4). The calculation of output and productivity of the employees is shown below:

Line-A, Sl. No.-1

Regular Time 8 hours and Overtime 2 hours. So, total input work hour L_r = 10 hours.

Omitted work hour L_o=1 hour and lost time L_m= 0.5 hour.

So, effective work hour for regular 8 hour shift $L_e = 8 - (L_o + L_m) = 8 - 1.5 = 6.5$ hr

Output (Q) $= (L_e \times Regular\ Time\ Output) + (Overtime \times Over$

$= (6.5 \times 30) + (2 \times 35)$

$= 265$

Productivity $= Q \div L_r$

$= 265 \div 10$

$= 26.5$ units/hour

The output and productivity calculation for all the 334 employees and all the 10 lines in the sewing department were done by the above method.

Graphical representation of Output and Productivity for Line-A is given for better understanding.

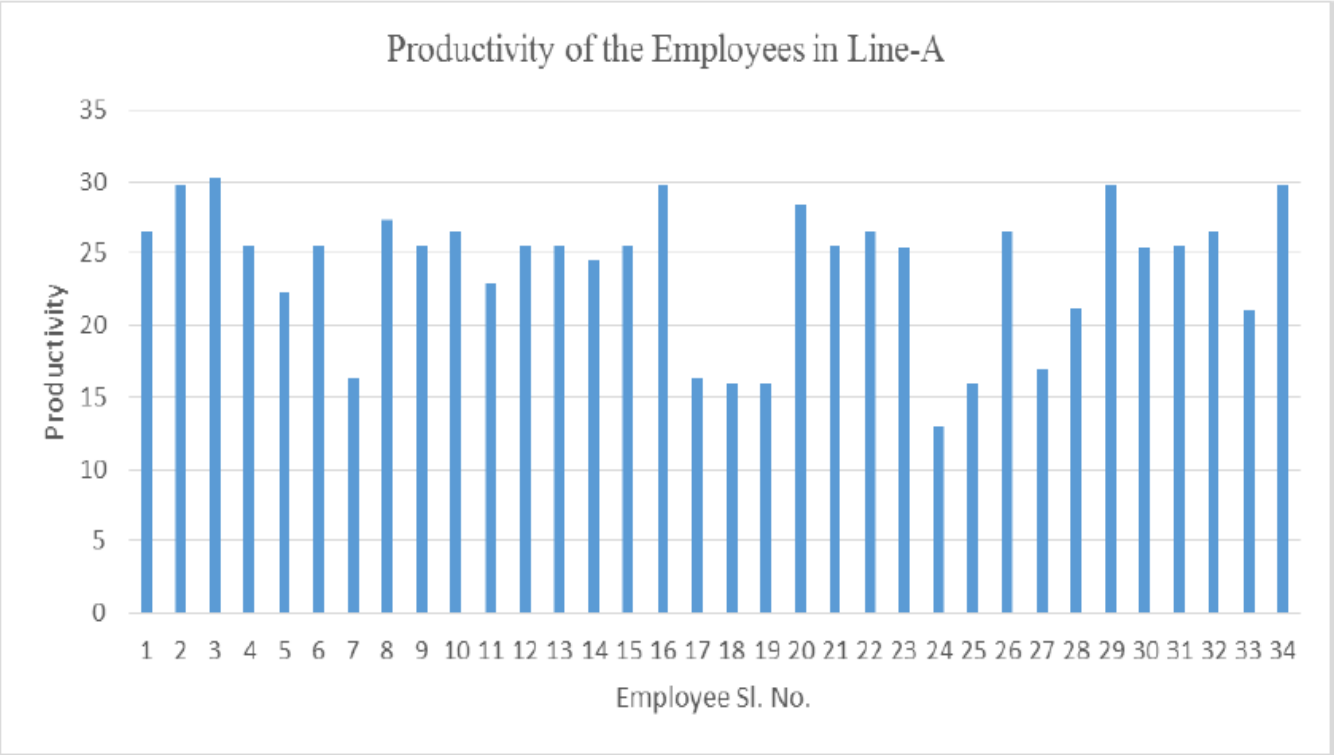

Fig 4.1Graphical Representation of Output and Productivity for Line-A

The standard labor productivity set by the management is 50. It is clear from the tables that no employee was able to achieve the standard productivity.

The reasons for not achieving standard labor productivity are:

- Unproductive work hours.
- Bottlenecks.
- Material Shortages.
- Machine Breakdown.
- Rework for defective items.
- Lack of experience.
- Training.

Comparison of Productivity Target and Productivity Achieved in the Last 12 Months.

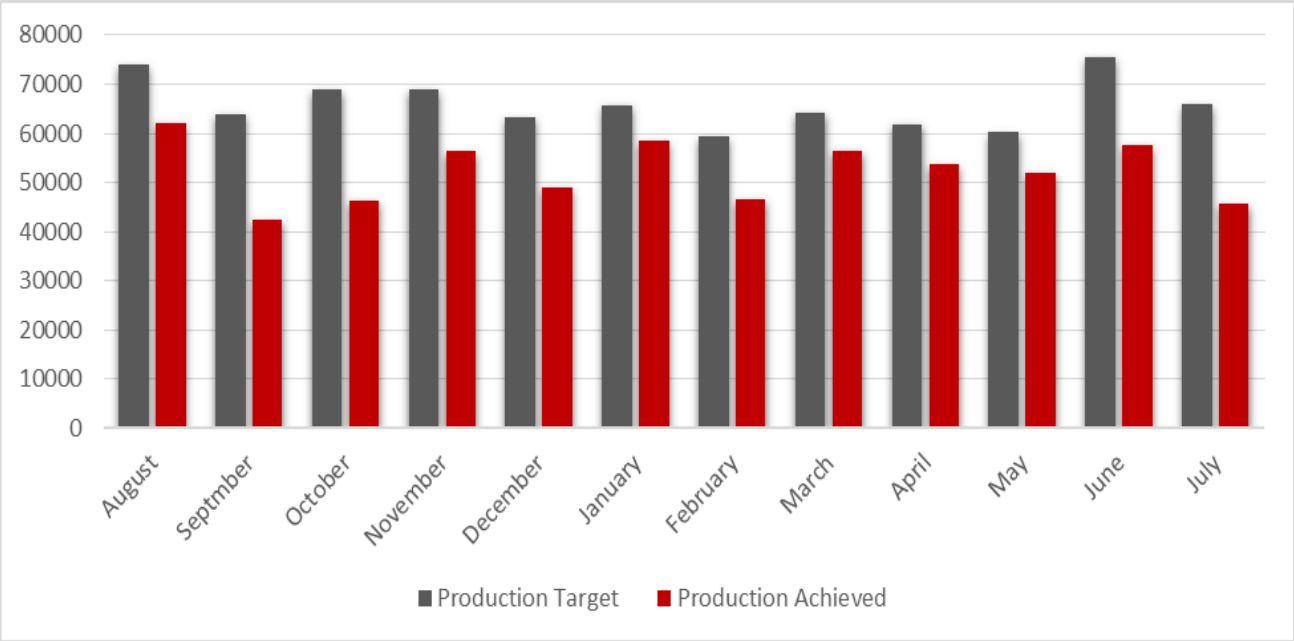

Fig 4.2 Comparison of Productivity Target and Productivity Achieved in the Last 12 Months.

The productivity achieved in the last 12 months here is always lower than the target. The employee of the sewing department was unable to meet the set target implies that the manpower and other resources are not used efficiently and effectively. Since the sewing department is unable to achieve the targets, it means some proportion of the resources are being wasted. Some reasons that we have identified for low productivity are:

- Machine Breakdown
- Absenteeism
- Manual operation
- Defective products and Rework

4.2. Defects and Quality Control

The percentages of the occurrences of different defects in the sewing department of the past 12 months were collected. The collected data is from August 2016 to July 2017. Based on this data, Pareto analysis was performed. The reason for using Pareto analysis was to identify the vital few defects that take up around 80% of the total defect that occurred.

Table 4.2 Frequency and Percentage of Different Defects in the Sewing Department for a year

Defects Name	No. of Occurrences	Percentage of Occurrence (%)
Needle Cut	933	0.95%
Needle Mark	658	0.67%
Broken Stitch	4684	4.77%
Blind Stitch	2091	2.13%
Skip Stitch	16093	16.39%
Top Stitch	5577	5.68%
Run off Stitch	2592	2.64%
Uneven Stitch	4094	4.17%
Dirty Spot	14443	14.71%
Oil Spot	2641	2.69%
Print Defect	1247	1.27%
Embroidery Defect	874	0.89%
Fabric Defect	1051	1.07%
Label Missing	442	0.45%
Label Mistake	275	0.28%

Defects Name	No. of Occurrences	Percentage of Occurrences (%)
Scissor Cut	628	0.64%
Uncut Thread	12421	12.65%
Button Hole	462	0.47%
Fabric Hole	275	0.28%
Distorted Shape	187	0.19%
Twisting	245	0.25%
Puckering	157	0.16%
Raw Edge Out	7266	7.40%
Open Seam	7158	7.29%
Shading	746	0.76%
Point Up Down	314	0.32%
Pleat	6922	7.05%
High/Low	1905	1.94%
Wavy	776	0.79%
Improper Button Attachment	962	0.98%
Others	69	.07%

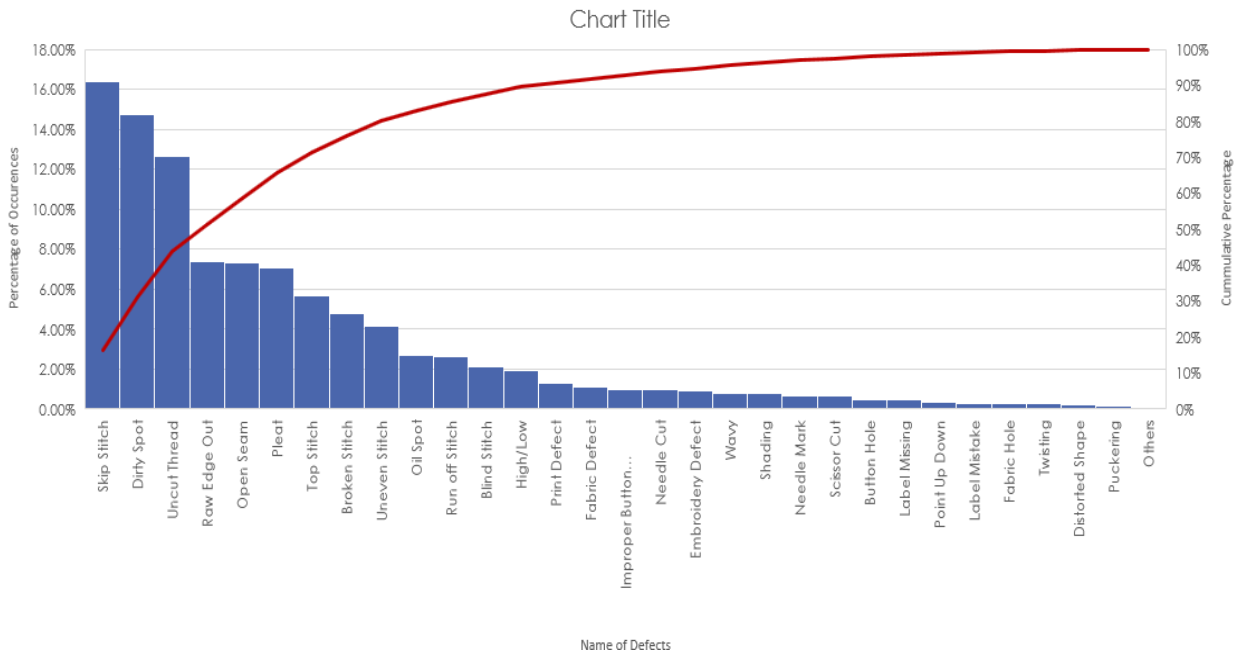

Fig 4.3 Pareto Analysis for the Defects in the Sewing Department.

From the pareto analysis, the vital defects identified are:

- Skip Stitch (16.39%)
- Dirty Spot (14.71%)
- Uncut Thread (12.65%)
- Raw Edge Out (7.4%)
- Open Seam (7.29%)
- Pleat (7.05%)
- Top Stitch (5.68%)
- Broken Stitch (4.77%)

These occurrences of these 8 defects are more than 75% of the total defects. The root cause analysis and solution to reduce these defects is discussed next.

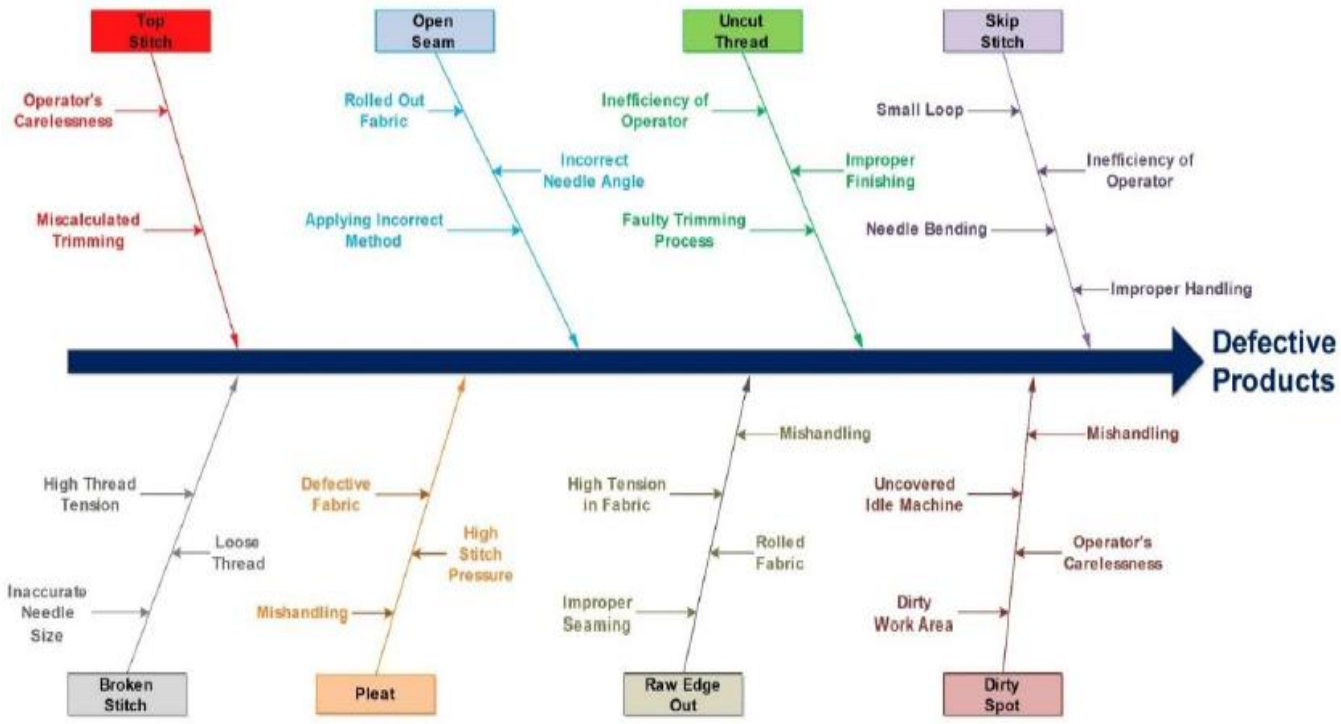

Fig 4.4 Root Cause Analysis of the Defects in the Sewing Department

Based on the cause and effect diagram, the root causes were identified for the vital defects of the sewing section. The root causes and their possible solutions are discussed in the below table:

Table 4.4 Root Cause Analysis of the Major Defects and Solution of the Problems in the Sewing Department.

Name of the Defect	Root Cause	Solution of the Problem
Skip Stitch	1. Small loop 2. Inefficiency of operator 3. Needle bending 4. Improper handling	1. Use proper size needle to facilitate the loop formation. 2. Train operators. 3. Adjust and mount the needle in the right position. 4. Proper focus and attention of the operator is needed.
Dirty Spot	1. Dirty work area 2. Uncovered idle machine 3. Mishandling. 4. Operator's carelessness	1. The work should be kept neat and clean. 5s method can be beneficial if implemented properly. 2. Idle machines should be always covered. 3. Operators should wash their hand properly before starting the job. 4. Operators need to be more careful about not placing the product in any dirty spot i.e. dirty tables, contact with dirty machines etc.
Uncut Thread	1. Faulty trimming process. 2. Improper finishing. 3. Inefficiency of operator.	1. The trimming process should be monitored to ensure perfect trimming. 2. The function of the trimming machine should be inspected regularly. 3. Provide the operator adequate training on the process.
Raw Edge Out	1. High tension in fabric. 2. Rolled fabric. 3. Mishandling. 4. Improper seaming.	1. Adjusting the tension to proper level before processing. 2. Unroll the fabric manually before processing. 3. Provide adequate training to the operator about the process. 4. Inspecting the previous processes.
Open Seam	1. Rolled out fabric 2. Incorrect needle angle. 3. Applying incorrect method.	1. Unroll the fabric manually before processing. 2. Check the adjustment of the needle angle before operation. 3. The method should be improved.
Pleat	1. Defective fabric. 2. Mishandling. 3. High stitch pressure.	1. Inspect the fabric before supplying to the sewing department. 2. Skill of the operator should be increased by training. 3. Stitch pressure should be medium.
Top Stitch	1. Operator's carelessness. 2. Miscalculated trimming.	1. Provide adequate training to the operator about the process. 2. The trimming calculation should be according to the requirement.
Broken Stitch	1. Inaccurate needle size. 2. Loose thread 3. High thread tension.	1. Needle size should be adjusted with the thread size. 2. The material of the thread should be standard. 3. Adjust the thread tension properly.

4.3. Analysis of the Overall Productivity

Based on the data collected from the selected garments manufacturing factory, it can be concluded that the productivity of the factory is not up to the mark. The problems that were identified from the analysis are:

i. The overall labor productivity is lower than the standard labor productivity for most of the months.

ii. The target production cannot be achieved most of the time

The root causes of the low productivity in the garments manufacturing are shown in the cause and effect diagram:

Raw Materials:

The low quality of the raw materials causes defects in the product. Low quality fabrics causes rolled out problems, distortion, improper thread tension, high stitch pressure etc. These are the causes of some of the vital defects that were identified based on the Pareto analysis. Some machine parts like needles are also an important raw material. Low quality needle can bend, break, and make incorrect stitches.

Machine

From the response of the workers and the management personnel it was identified that the machine downtime and accidents due to machine failure are some of the problems that this department faces. Vibration of the machines can cause damage to the body parts of the workers over time. Most of the sewing machines are manually operated.

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This manual operation increases the frequency of accidents. Proper lubrication is not administrated and as a result the machine breakdown occurs which causes accidents

Management

The management does not provide proper incentives in this department. As a result, the employees get demotivated and responded that their wages are not enough. Introducing a proper incentive plan for all the employees in the department will increase motivation among the employees which will help to improve the productivity.

Fig: 4.5 Cause and Effect Diagram for Low Productivity in the Garments Factory.

Maintenance

The reactive maintenance of the department causes many unexpected breakdown and failure of the machine. Sometimes multiple breakdown causes delay as the manpower is not enough to tackle too much breakdowns at the same time. Regular inspection of the machines and taking preventive maintenance measures will help to solve the breakdown related problems.

Workers

Around 1/3rd of the workers are younger and most of them have zero to very little amount of experience. As a result, they need supervision to function properly. The extra time needed with supervision increases unproductive work hours. The newer employees have not received enough training yet. As a result, their understanding about the functionality of the process is still low. Train the employee to increase their capability and improve their technical knowledge can reduce defects and labor unproductive time.

Defective Products

The percentage of defects is 14.61%. The defective product item goes back for rework and further inspection. As a result, time is lost due to rework. So, the employees become unable to achieve the production quota and their productivity falls down further from the standard labor productivity set by the management. The major defects that occur are Skip Stitch (16.39%), Dirty Spot (14.71%), Uncut Thread (12.65%), Raw Edge Out (7.4%), Open Seam (7.29%), Pleat (7.05%), Top Stitch (5.68%) etc.

Working Condition

The work environment and working condition influence the output and the productivity. The overall work environment is good. However, some problems were identified that should be solved. The lighting condition in some part of the sewing department is not ideal.

V. RESULTS

The summary that we can draw from the findings at the garments factory is:

- Most of the work here are manual. As a result, labor productivity has a huge impact on the overall productivity.
- Hand operated machines are used. So, machine breakdowns and downtime increase unproductive labor time.
- The standard labor productivity calculated by the management was based on study conducted considering the highest capability of a skilled worker.
- The defects in the production floor are the main obstacle on achieving production quota.
- Defective products are sent back for rework which incurs extra time and effort of the workers.
- During the study period, the sewing department was unable to achieve the set production quota.
- The work environment is relatively better than the lamp manufacturing factory.
- There is no suitable incentive program in the factory.
- Supervisor's behavior towards newer and unexperienced workers is hostile and is not suitable for a workplace.
- Training received by the employees is inadequate.
- Lack of technical knowledge and inexperience of the employees are associated with most of the vital defects identified by using Pareto analysis.
- A huge number of employees are unable to work in multiple sections. This becomes a concerning problems when absenteeism occurs in large number.

Especially after Religious festival vacations.

- Lighting condition in some part of the factory is not ideal hence the workers face problem and it creates defects as some of the processing needs to be precise.
- Most of the employees sustained injuries while working here.
- Management has plans to improve the productivity of the factory gradually.
- The productivity improvement techniques currently used by the management are: work study, work simplification, Pareto analysis, lean tools, organizational development and brainstorming. However, management faces difficulties and obstacles while implementing those tools and techniques. As a result, they are unable to get the full benefit from these methods.

VI. PROPOSED SUGGESTIONS FOR PRODUCTIVITY IMPROVEMENT

Steps that should be taken by the management of the sewing section of the garments manufacturing factory are:

- Automation can boost up the production speed in the factory. As most of the machines are manually hand operated, it slows down the speed of production. Also, automation can help to produce less defective products.
- The defects in the production floor are the main obstacles in achieving the production quota. Solutions for reducing the defects have been briefly discussed in the previous chapter. Management should try and implement those solutions.
- There is no proper incentive program for the employees. Introducing a proper incentive program will motivate the employees to achieve the production quota.
- All the employees should be equipped with personal protective tools.
- The supervisors should show more compassion towards new and inexperienced employees.
- Management is unable to properly implement the productivity improvement tools that they currently use. They can either find a way to implement them properly and undertake following newer techniques.
  - **A. Six sigma:** Six sigma process capability enhance the quality of the products. Implementing this technique will produce more defect free products in the sewing section which will reduce rework of defective products. Implementing six sigma offers better customer loyalty, better time management, reduced time cycle and motivated management employee.
  - **B. Nominal work group:** Nominal group technique (NGT) will help to generate better ideas for improving the productivity by solving the problems in the production floor. As this tool ensures equal importance to the ideas of every employee, this technique is best to create effective ways to tackle problems.
  - **C. Automation:** Automation will increase the capability of the sewing department. As most of the machines here are manually human operated, the fatigue of human slows down the production process. Also, introducing automation will produce less defective products.

VII. DISCUSSION

The selected garments factory is unable to meet the production target, which means productivity isn't optimal. The main reasons of low productivity lie within management, machine breakdown, defective products, and incentives. Working condition of the garments factory is relatively better but there is no suitable incentive program. Planning department set target production based on market demand, past data, employees' capability etc. As the garment factory don't fulfill target production quota, it means resources aren't fully utilized. We provide our recommendations for better productivity based on employees' interview, consultancy with management and as a potential industrial engineer.

VIII. CONCLUSION

Mainly labor productivity & defects of a selected garment factory was presented in this paper. The result indicated that labor productivity is lower than the standard level. The occurrences of defects are also high. That means resources aren't fully utilized. As RMG is the main manufacturing sector of Bangladesh, other countries (China, India, Viet Nam, Cambodia, Sri Lanka and Pakistan.) shows good performance in global market. To remain competitive in global market, resources need to be fully utilized and defects need to be minimized. . This study has some future scope to continue further. Implementation of the solutions for the defects can be monitored in the selected factory. Analysis of other factories in other industries can be done and then compared with the factory that was discussed in this study. The study has some limitations. Only sewing section of the garment manufacturing factory was considered for our study.

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