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REDUCING MACHINE BREAKDOWN TIME USING DMAIC APPROACH IN A GARMENT INDUSTRY

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Abstract— **In the garment industry, reducing machine breakdowns is essential because it has a direct impact on production hours, customer orders, and financial losses. In order to reduce downtime and increase operational effectiveness in the garment industry, the DMAIC (Define, Measure, Analysis, Improvement, and Control) approach is the main topic of this research paper. The study starts with a thorough review of the literature, examining various downtime minimization strategies applied in various industrial industries. The importance of downtime reduction in increasing output, reducing costs, and improving overall corporate performance is emphasized. The study emphasizes the value of scheduled, corrective, and preventive maintenance to find and fix any problems before they cause breakdowns. The article offers insights into effective tactics like preventative maintenance, condition-based monitoring, and efficient scheduling, and data-driven approaches using machine learning algorithms and real-time monitoring. The research paper also includes a case study of how the DMAIC methodology was used in the real-world textile industry to drastically minimize downtime. The DMAIC strategy consists of five phases: defining the issue and project goal, assessing the existing situation, investigating the underlying reasons, putting improvement strategies into practise, and setting up controls to maintain the gains. The study prioritises the primary causes of machine failure time, identifies the causes, and suggests remedies such worker training, providing workers with the ability to change needles, putting preventive maintenance in place, and applying standard operating procedures.**

Keywords— **Machine Breakdown Time, DMAIC, Preventive Maintenance, Six Sigma**

I. INTRODUCTION

Machine Breakdown Time is the time which the machine is out of order and cannot add value to a process or product. Minimizing breakdown time is important because it saves us valuable production hours. When your machines break down often, it means you're unable to meet customer's orders on time. If it requires a lot of time get it back up and running, the problem gets worse because every minute spent fixing a broken machine means a minute of lost production. If you have calculated your cost per minute (CPM) then you might know how much you are suffering from these down times. Ultimately, this leads to significant financial losses, potentially costing hundreds or even thousands of dollars to fix the broken equipment. If these down times are not considered as risk and not addressed on time. Then the machine can never be restored to its best condition unless a huge amount of money is spent on it. [1] [2]

There are many Non Productive time (NPT) which contains Planned and unplanned down times. A planned down time refers to scheduled time when machines and equipments are taken offline for the purpose to improve machine health and reduce sudden breakdowns. This downtime is planned carefully in order to minimize the disruption in production so that the process can be done efficiently. Unplanned Breakdown Time refers to the down time which occurs unexpected and unscheduled. When a machine or equipment unexpectedly fails and experience issue that requires sudden addressing. [3]

Both planned and unplanned breakdown time can have significant impacts on productivity, effectiveness and efficiency. Minimizing both types of downtime is crucial to maximize operational uptime and reduce the negative effects on production and overall business performance. [4]

To avoid these breakdown times implementing preventive, corrective and Scheduled based maintenance. It is must to inspect and maintain machines to identify potential issues before they turn into breakdowns. For that purpose organizations have maintenance departments whose job description is to develop maintenance schedule and then following it carefully. [5]

Machine Breakdown Time not only affects our production and quality but it also affects us financially. Most of the time to get the machine up and running it is must to either repair the part or replace it with a new part which costs us too. [6]

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II. LITERATURE REVIEW:

"An Investigation on Downtime Minimization Techniques: explores the many methods used to reduce downtime in the cigarette production sector. The study explores the value of minimizing downtime in manufacturing operations and examines the difficulties and roadblocks unique to the cigarette manufacturing sector. It emphasizes the significance of downtime reduction for raising output, cutting expenses, and raising operational effectiveness as a whole. The study offers insights into the important downtime minimization tactics, such as preventive maintenance, condition-based monitoring, and efficient scheduling strategies by reviewing the body of literature and completing case studies. The research's findings add to the body of knowledge on downtime reduction in the context of the cigarette manufacturing business and are a useful resource for those working in the field of production management and industrial engineering. [7]

Minimizing machine downtime is crucial in the plastic manufacturing industry to achieve maximum production effectiveness and total profitability. There has been a lot of study and exploration into how to minimize machine downtime. Different strategies and procedures were investigated in the study by S.C. Nwanya, J.I. Udofia, and O.O. Ajayi to successfully reduce machine downtime in the plastic manufacturing sector. Preventive maintenance, predictive maintenance, and sophisticated monitoring systems were all included in these tactics to find and fix any problems before they result in unscheduled downtime. In order to improve the predictive capacities of downtime management systems, the researchers also explored the use of data-driven strategies like machine learning algorithms and real-time monitoring. The study's findings offer helpful perceptions and suggestions for practitioners. and researchers seeking to optimize machine downtime in plastic manufacturing, thereby improving productivity and competitiveness in the industry. [8]

In the field of industrial production, minimizing downtime and analyzing its associated costs are crucial for enhancing operational efficiency and profitability. Mohamad Tabikh's work titled "Downtime Cost and Reduction Analysis: Survey Results" provides a thorough examination of the expenses associated with downtime and methods for lowering them in the context of creative production. In order to better understand the numerous variables causing downtime and their financial ramifications, the study collects survey data from diverse businesses. To provide a thorough overview of the downtime environment, Tabikh dives into the reasons of downtime, including equipment failures, maintenance tasks, changeovers, and unscheduled events. The survey's findings provide important information about the costs associated with downtime, including direct costs, missed opportunities for production, and potential consumer displeasure. The thesis also looks into numerous strategies and industry-accepted best practices for reducing downtime, including preventive maintenance, better scheduling, training initiatives, and cutting-edge monitoring systems. The findings of this study serve as a valuable resource for practitioners and researchers seeking to understand the financial impact of downtime and develop effective strategies to mitigate it in innovative production settings. [9]

In the field of production management, reducing downtime is a critical objective to improve operational efficiency and meet customer demands. The research conducted by A. H. Christer and W. M. Waller concentrates on using delay-time analysis to cut down on production downtime. Their research examines the factors that lead to downtime, such as equipment malfunctions, system upgrades, and maintenance procedures, and it examines the ensuing delay times. The researchers want to find potential bottlenecks and inefficiencies in the production process by looking at the delay times. The research's conclusions shed light on the particular factors that cause downtime and present potential for focused efforts to reduce delays. The study also looks at how downtime can be effectively decreased by implementing tactics like better scheduling, preventive maintenance, and quicker changeover procedures. The findings demonstrate the potential advantages of using delay-time analysis as a tool for streamlining manufacturing processes and reducing disruptions. [10]

In the field of paint manufacturing, evaluating machine downtime and failure analysis of components plays a crucial role in maintaining efficient operations and optimizing productivity. This paper focuses on the evaluation of machine downtime and failure analysis in a paint manufacturing unit. The study aims to elucidate the reasons behind downtime and analyse component failures during the production process. The authors examine many aspects of machine downtime, such as equipment failures, maintenance processes, and process inefficiencies, by evaluating existing literature and research. To determine the fundamental causes of component failures and create prevention and mitigation measures, they also delve into failure analysis methodologies including root cause analysis and fault diagnosis. By offering a thorough grasp of machine downtime and failure analysis, the review paper's findings add to the body of knowledge in paint manufacturing. The learning from this evaluation can help practitioners and researchers create practical plans to decrease downtime, increase equipment reliability, and enhance performance in paint manufacturing facilities. [11]

The Case Study focuses on The DMAIC (Define, Measure, Analysis, Improvement, and Control) approach was used to improve processes, particularly with regard to reducing downtime. The goal of the study was to look into how the DMAIC methodology may be used in a real-world case study to significantly decrease downtime and improve process performance. The researchers used DMAIC, which consists of five phases: defining the problem and project goal; measuring the process' current status; identifying underlying causes; developing improvement techniques; and building control measures to maintain the gains. The results of this analysis of

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the literature offer important new perspectives on the practical application and efficiency of the DMAIC approach in lowering downtime and increasing process effectiveness in industrial settings. [12]

The study's objectives were to comprehend how DMAIC is used in service-oriented organizations and to list the benefits and challenges that arise when it is put into practice. The researchers used an exploratory methodology to examine case studies and collect empirical data to determine how DMAIC affected customer satisfaction, operational effectiveness, service quality, and overall business success. The results highlighted how employing DMAIC can improve service delivery, process standardization, and continuous improvement. The survey also emphasized the difficulties faced by service businesses, such as reluctance to change, a lack of data, and the requirement for specialized knowledge and training. [13]

III. METHODOLOGY

The method used for this is DMAIC which is Acronym for Define, Measure, Analysis, Improvement and Control**.**

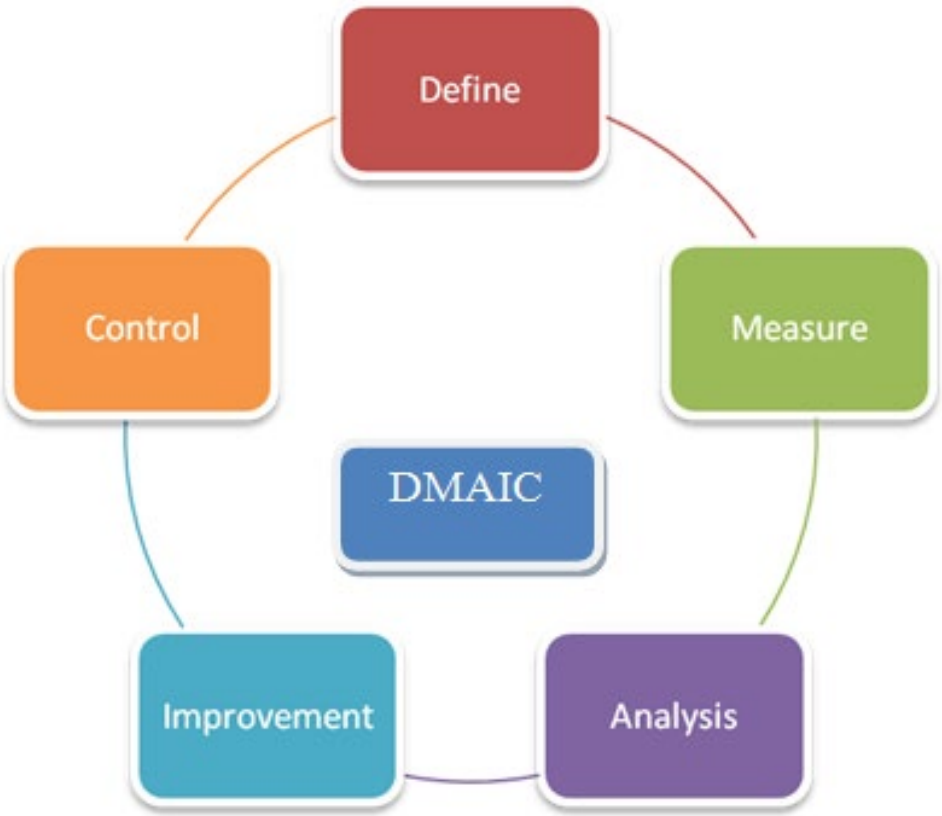

Figure 1 Methodology

DEFINE

In define phase we will define our problem and project goal that we are going to do. Our goal of this paper is to reduce down time by using the Six Sigma tool. The monthly Machine Breakdown Time can be seen in the below table which is in an industry with more than 1000 single needle sewing machines .

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Table 1 Monthly Machine Breakdown Time

Machine Breakdown Issues	(MBT) minutes	% time
Shuttle	756	54.35%
Presser Foot	345	24.80%
Bobbin Case	88	6.33%
Feed dog	73	5.25%
Cam Cutter	45	3.24%
Needle Throat Plate	44	3.16%
Needle	40	2.88%
	1391	

If we calculate our daily Machine Breakdown Time (MBT) from the monthly data we can get the below chart.

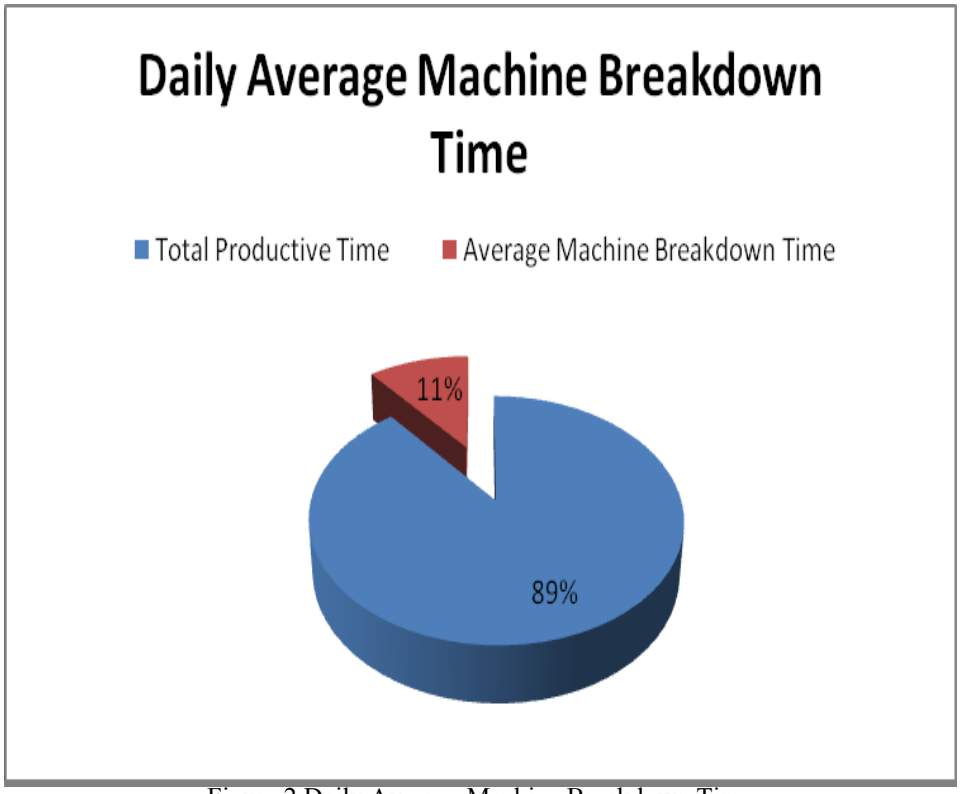

Figure 2 Daily Average Machine Breakdown Time

We can see that due to MBT we lost 11% of our total working time.

MEASURE

The second phase focuses on gathering data and measuring the current state of the process. Key process metrics are identified, and data is collected to understand the performance of the process. This phase helps establish a baseline and provides a clear understanding of the magnitude and impact of the problem.

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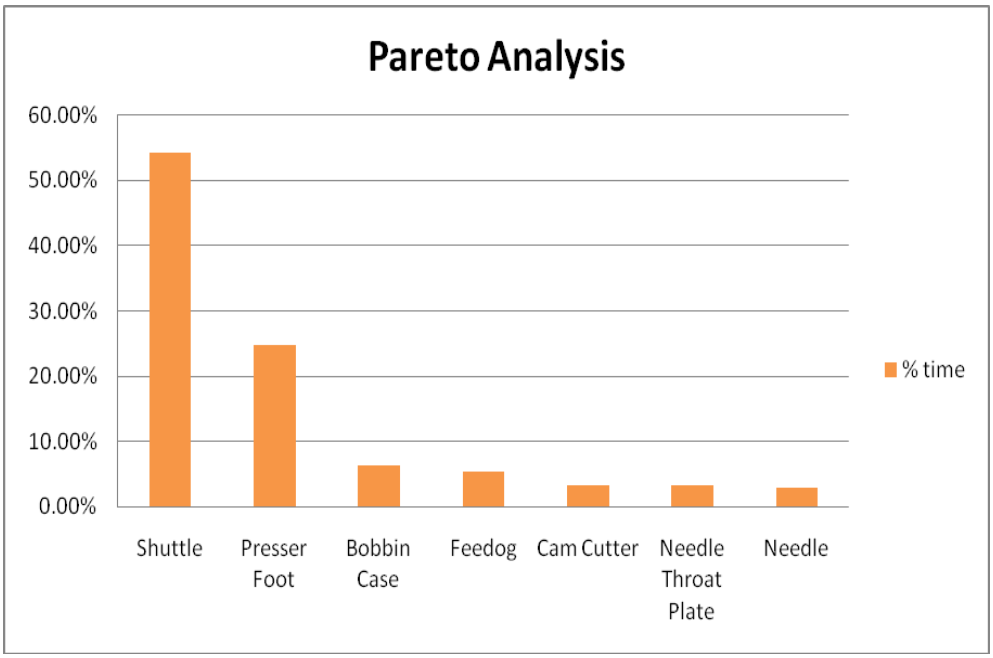

Graph 1 Pareto Analysis of MBT

After the collection of data for a month, we will do Pareto Analysis where we see that almost 60% of the Machine Breakdown Time is because of the Shuttle. We will prioritize the most important factors or issues contributing to a problem or outcome.

ANALYSIS

In the Analysis phase the root cause of the most important factor or issue which contributes to a problem is done. Various statistical and analytical tools are used to determine the factors that contribute to the factors. The goal is to find the most vital factors that have significant impact on the problem or outcome

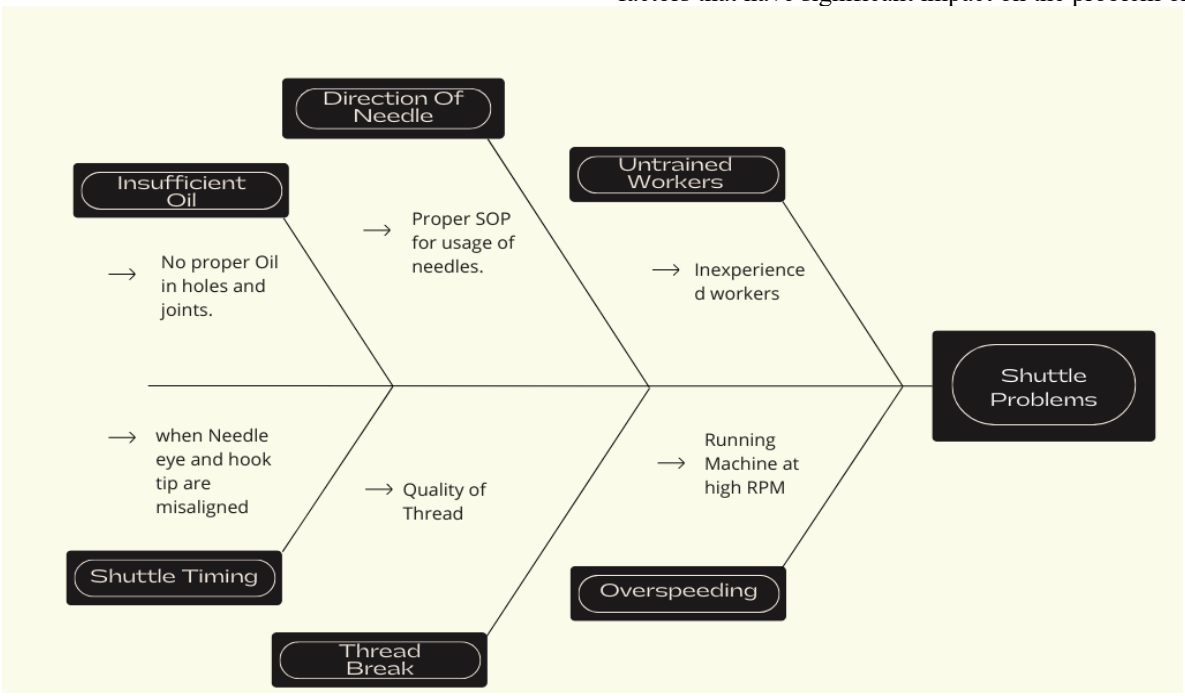

Figure 3 Root Cause Analysis of Shuttle Problem

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If we can focus on causes on the shuttle problems we can easily reduce the machine down time with ease. First, we have to train workers on sewing machine before they are placed in production lines. While training they should also be taught on how to change needle themselves. If the worker knows that their needle is deformed they should change it before it causes an unexpected failure which will affect our production. If we can only focus on these causes which affect our outcome we can the 60% of the Breakdown time easily.

IMPROVE

After determining the main issues, the improvement phase is concerned with coming up with and putting into action solutions to deal with those issues. Utilizing simulations or experiments, potential solutions are created, assessed, and tested. The ideal solution is chosen and put into practice. We can go for kaizen to keep our machine breakdown time more. There should be proper training.

In order to avoid failures, breakdowns, or performance concerns, preventive maintenance is a proactive method to maintaining equipment, machinery, or systems. It entails scheduling routine inspections, modifications, cleaning, and maintenance on assets to make sure they are in top operational shape. Preventive maintenance is to avoid unplanned downtime, increase equipment longevity, lower repair costs, and ensure reliable performance.

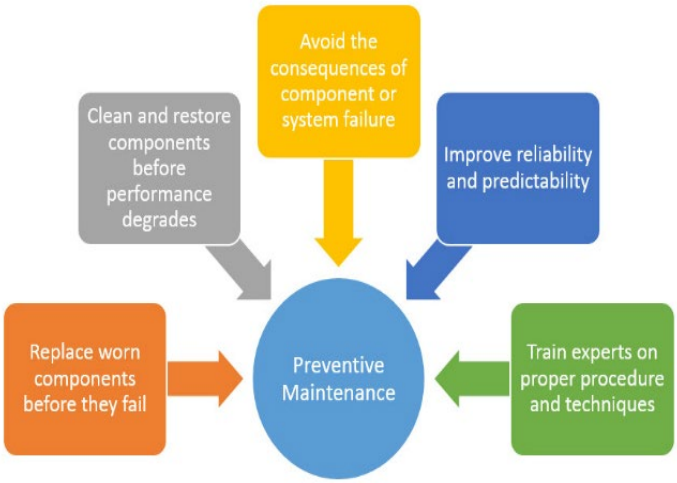

Figure 4 Preventive Maintenance Components

Designing Standard of procedure for the mechanics in the industry will help a lot in reducing machine breakdown time.

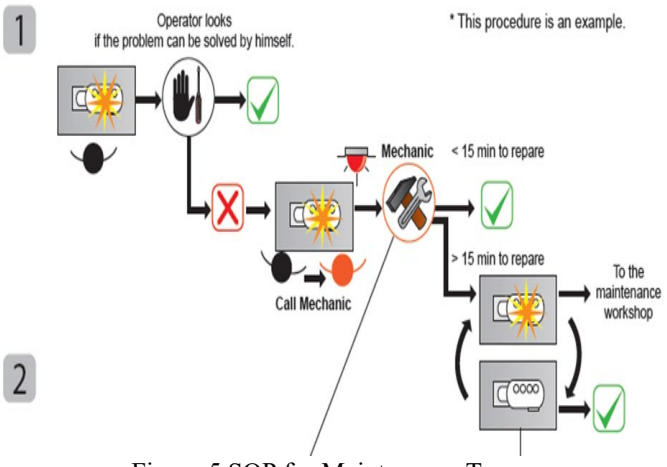

Figure 5 SOP for Maintenance Team

CONTROL

Making sure the advancements are maintained over time is the main goal of the DMAIC's last phase. To keep track of the process and guarantee that the improvements made during the improvement phase are sustained, control measures are put in place. To keep the process from returning to the initial

condition, statistical process control (SPC) methods are frequently employed to monitor and regulate it.

In order to improve, it is better to have a daily and weekly meeting with Maintenance team. So everyone can give their daily work that how much work they have done and what should be improved. If we continue our routine we will have a huge impact on reducing our down time.

IV. RESULT

The study's main objective was to decrease machine breakdown time in the apparel sector. The amount of time that machines are out of work, resulting in lost production time and probable financial losses, is referred to as machine breakdown time. The study emphasized the need of minimizing breakdown time to fulfill client orders on time and save money.

The study determined the primary causes of machine malfunctions by using the DMAIC (Define, Measure, Analysis, Improvement, and Control) methodology. A Pareto analysis showed that shuttle problems were responsible for a sizable chunk of the breakdown time. The need for worker training and giving them the ability to change needles on their own was emphasized by root cause analysis, which went deeper into the variables causing shuttle issues.

Preventive maintenance was emphasized in order to deal with these problems and enhance equipment reliability. The study suggested that the maintenance team create standard operating procedures (SOPs) to ensure that machinery are regularly inspected, adjusted, and cleaned. To track development and maintain gains, it was also advised to put in place a control mechanism, such as daily and weekly meetings with the maintenance team.

The results of this study emphasize the value of worker training, preventative maintenance procedures, and ongoing improvement initiatives in lowering machine breakdown times in the apparel business. The industry can increase productivity, promptly satisfy client requests, and reduce monetary losses brought on by downtime by putting these techniques into practice

V. DISCUSSION

Machine breakdowns are a major problem for the garment industry because they reduce efficiency, throw off production schedules, and cost money. Meeting customer needs, maximizing operational uptime, and enhancing overall business performance all depend on minimizing equipment breakdown time. The DMAIC approach (Define, Measure, Analysis, Improvement, and Control) has shown to be a successful tool in dealing with this problem.

The shuttle problem was the main factor in this study's identification of the primary causes of machine failure time in a garment company using the DMAIC technique. It was discovered through root cause analysis that worker empowerment and training can greatly cut down on shuttle-related downtime. It was advised to do preventive maintenance, which includes routine checks and adjustments, to increase the reliability of the equipment.

To maintain the gains made, it was proposed that the maintenance staff adopt standard operating procedures (SOPs) and control mechanisms, such as daily and weekly meetings. These steps guarantee continued observation, constant development, and the avoidance of relapse into the predicament. The garment industry may significantly reduce machine breakdown time by adopting the DMAIC approach and putting the suggested techniques into practice. As a result, production rises, orders are fulfilled promptly, and financial losses are reduced.

In conclusion, lowering machine breakdown times is essential for success in the clothing sector. Industries can successfully address the underlying causes of machine malfunctions by prioritizing training, adopting preventative maintenance, and developing control systems. The DMAIC methodology's adoption promotes ongoing improvement and guarantees long-term success. The garment business may improve operational effectiveness, satisfy customer expectations, and make money by implementing these tactics.

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