DEVELOPMENT OF A PREVENTIVE MAINTENANCE SCHEDULE AND EVALUATION OF OVERALL EQUIPMENT EFFECTIVENESS IN A SELECTED GARMENT FACTORY: A CASE STUDY

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Development of a Preventive Maintenance Schedule and Evaluation of Overall Equipment Effectiveness in a Selected Garment Factory: A Case Study

by

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A thesis paper submitted to the Department of Industrial and Production Engineering (IPE), Bangladesh University of Engineering and Technology (BUET), Dhaka, in partial fulfillment of the requirement for the degree of Master of Engineering in Advance Engineering Management (AEM).

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CERTIFICATE OF APPROVAL

The thesis titled **"Development of a preventive maintenance schedule and evaluation of overall equipment effectiveness in a selected garment factory: a case study".** Submitted by Alok Kumer Sarker, Roll No: 0412082119 P, Session: April' 2012 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Master of Engineering in Advance Engineering Management on March 27, 2019.

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DECLARATION

It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

Alok Kumer Sarker

THIS THESIS IS DEDICATED

TO

MY FAMILY

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ABSTRACT

Manufacturing industries around the world spend a lot of money on buying new equipment to increase production but a little is done to get hundred percent outputs from the machine. However, because of increased competency levels and demand of quality products at lower costs, buying latest equipment is not a solution unless it is fully utilized. Therefore machine maintenance and in general implementing an appropriate maintenance strategy has become increasingly important for manufacturing companies to accomplish these requirements. Preventive maintenance schedule system has become one of the effective maintenance strategies to ensure high machine reliability since it is regarded as an integral part of total productive maintenance. Performance evaluation is the most important aspects in the field of continuous improving of the production process and overall equipment effectiveness (OEE) is one of the justified performance evaluation method that is popular in the manufacturing industries to assess the machine's effectiveness and performance. In this concern this research work has been conducted in a selected readymade garment factory to study and develop a preventive maintenance schedule system. From the comparative study of OEE analysis it has been found that downtimes are decreased and production increased in preventive maintenance schedule system. Based on the obtained result maintenance management have been suggested to maintain the preventive maintenance schedule system to maximize their productivity and minimize their overall maintenance cost.

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Chapter One
INTRODUCTION

1.1 Introduction

Maintenance has become more challenging in the current dynamic manufacturing environment. It is considered one of the important strategic decisions in operations management [1,6]. The manufacturing sector has been experiencing tremendous challenges in ensuring all products are delivered to customers on time. However, the current business environment and pressures from various parties such as customers, suppliers, governments and so forth have put manufacturing sectors under severe pressure. To operate efficiently and effectively, manufacturing sectors need to ensure no disruption due to equipment breakdown, stoppages and failure.

Manufacturing systems in particular often operate at less than full capacity, with low productivity, and the cost of producing products are high. Recent study shows that 25-30% of total production cost is attributed to maintenance activities in the factory [2]. The quality of maintenance significantly affects business profitability. The importance of maintenance functions has increased due to its role in keeping and improving the availability, product quantity, safety requirements, as maintenance costs constitute an important part of the operating budget of manufacturing organization [3].

In response to maintenance problems encountered in manufacturing environment, a maintenance system is developed called preventive maintenance. It is a maintenance system which is critical to effective asset management. From inspection tasks designed to detect impending failures to lubrication and wear part replacement, preventive maintenance system is the first line of defense against unplanned downtime and equipment failures. It describes a synergistic relationship among all organizational functions, but particularly between production and maintenance for continuous improvement of product quality, operational efficiency, capacity assurance and safety [4,5]. A preventive maintenance system is an integral part of a maintenance management solution and maximizes asset performance. An effective preventive

maintenance system also supports predictive maintenance by planning and scheduling their tasks as preventive maintenance work orders.

1.2 Background of the Study

The concept of preventive maintenance schedule system is completely different concept in readymade garment sector of Bangladesh. So there are lots of scopes for implementation of this concept in the Garments Industry. Garments Industry plays a vital role in country's economic growth not only for the organization but also for the country. The Garments Industry having good quality products and improved productivity can export goods to different Countries in the world in which their product is demanded and can earn foreign currency. To fulfill the demand of the customers and to stay in the competitive market, the existing situation of the industry should be improved, its productivity, efficiency must be at optimum level. That's why like other sections it is necessary to analyze problems arising in the maintenance section of the factory. Different downtime, failure, existing work efficiency, productivity and performance rate are need to analyze. Different studies are conducted based on identification and elimination of these problems.

At present the success of this readymade garment sector highly depends upon several factors such as production lead time, quality of product, production cost etc. To optimize all this factors it is necessary to introduce new concept of manufacturing management. In this context the readymade garment sector is selected for this thesis work .The selected garment factory consists of several sections such as cutting, sewing, finishing, packing, maintenance etc, among these departments the sewing sections are important because most of the activities (value added and non value added) for making garments are occur in this section with different types of sewing machine [5]. Sometime these machines occurs different types of problem like breakdown, failure, minor stoppage etc. And all types of machine's problem is maintain by maintenance department. That's why it is very important to manage this department to effective manufacturing.

This thesis work tries to extract the common scenario of readymade garment sector of Bangladesh by depicting the existing condition of sewing machine maintenance section. In this connection overall equipment effectiveness evaluation are used. This thesis work is mainly done to focus an effective machine maintenance system as well as performance is measured in terms of effectiveness, time, quality etc.

1.3 Significance of the Study

Preventive maintenance schedule is an aggressive strategy focuses on actually improving the function and design of the production equipment [7]. It's aims to increase the availability or effectiveness of existing equipment in a given situation, through the effort of minimizing input (improving and maintaining equipment at optimal level to reduce its life cycle cost) and the investment in human resources, which results in better hardware utilization [8].

Scheduled maintenance is planned component repair or replacement, often triggered by preventive maintenance inspections, pre trip and post trip inspections, regular oil changes and grease jobs etc, all of which are also scheduled maintenance activities. Preventive maintenance schedule has been envisioned as a comprehensive manufacturing strategy to improve overall equipment effectiveness (OEE).

1.4 Objectives

The specific objectives of the present research work are as follows:

- To Minimize equipment unplanned failure and accidents
- To Maximize equipment effectiveness
- To Establish a preventive maintenance schedule

From this research work a preventive maintenance schedule would be developed that will reduce future maintenance expenses.

1.5 Organization of the Thesis

This thesis consist five chapters and those are arranged as follows:

Chapter One introduces the problem addressed in this thesis and outlines the aims. **Chapter Two** represents literature review. It discusses the maintenance system and related terms. Finally overall equipment effectiveness is presented. **Chapter Three** introduces thesis methodology. This chapter contains the process of ongoing thesis. **Chapter Four** deals with data analysis and results. It contains the evaluation on existing problem in the context of downtime efficiency, production rate, production cost, production time and productivity. **Chapter Five** presents the conclusion and recommendations.

Chapter Two

LITERATURE REVIEW

2.1 Introduction

The technical meaning of maintenance involves functional checks, servicing, repairing or replacing of necessary devices, equipment, machinery, building infrastructure, and supporting utilities in industrial, business, governmental, and residential installations. Over time, this has come to often include both scheduled and preventive maintenance as cost-effective practices to keep equipment ready for operation at the utilization stage of a system lifecycle [11].

Maintenance is any activity such as tests, measurements, replacements, adjustments, and repairs intended to retain or restore a functional unit in or to a specified state in which the unit can perform its required functions. Maintenance is strictly connected to the utilization stage of the product or technical system, in which the concept of maintainability must be included. In this scenario, maintainability is considered as the ability of an item, under stated conditions of use, to be retained in or restored to a state in which it can perform its required functions, using prescribed procedures and resources.

2.2 Types of Maintenance

The basic types of maintenance in a manufacturing organization are as follows:

- **Breakdown Maintenance**

It is a type of maintenance used for equipment after equipment break down or malfunction. Breakdown maintenance is also called corrective maintenance. It is often most expensive – not only can worn equipment damage other parts and cause multiple damage, but consequential repair and replacement costs and loss of revenues due to down time during overhaul can be significant. Rebuilding and resurfacing of equipment and infrastructure damaged by erosion and corrosion as part of corrective

or preventive maintenance programs involves conventional processes such as welding and metal flame spraying, as well as engineered solutions with thermo set polymeric materials [12].

- **Predictive Maintenance**

This maintenance strategy uses sensors to monitor key parameters within a machine or system, and uses this data in conjunction with analyzed historical trends to continuously evaluate the system health and predict a breakdown before it happens. This strategy allows maintenance to be performed more efficiently, since more up-to-date data is obtained about how close the product is to failure. More recently, advances in sensing and computing technology have given rise to predictive maintenance [13].

- **Schedule Maintenance**

In this type of maintenance work, the total maintenance program is scheduled in consultation with the production department so that the particular equipment is made available for maintenance work. For this purpose, accurate failure data must be made available to establish machine failure patterns and therefore, maintenance interval. As the frequency o such maintenance work is predetermined, it is possible to utilize the idle time of the equipment to carry out maintenance work. This work also helps the maintenance department to make effective use of their available manpower [14].

- **Preventive Maintenance (PM)**

Preventive maintenance is time-based or run-based periodically inspecting, servicing cleaning, or replacing parts to prevent sudden failure system. It is maintenance performed with the intent of avoiding failures, safety violations, unnecessary production costs and losses, and to conserve original materials of fabrication [15]. The effectiveness of a preventive maintenance schedule depends on the overall equipment effectiveness (OEE) which it was based on, and the ground rules used for cost efficacy [14].

2.3 Benefits of Preventive Maintenance

The cost of breakdown maintenance is usually much greater than preventive maintenance [16]. Preventive maintenance has some benefit like…

- Keeps equipment in good condition to prevent large problems
- Extends the useful life of equipment
- Finds small problems before they become big ones
- Is an excellent training tool for technicians
- Helps eliminate rework/scrap and reduces process variability
- Keeps equipment safer and risk free
- Parts stocking levels can be optimized
- Greatly reduces unplanned downtime

2.4 Goal of Preventive Maintenance

The main goal behind PM is for the equipment to make it from one planned service to the next planned service without any failures caused by fatigue, neglect, or normal wear (preventable items). This may be by preventing the failure before it actually occurs which Planned Maintenance and Condition Based Maintenance help to achieve. It is designed to preserve and restore equipment reliability by replacing worn components before they actually fail.

Maintenance activities include partial or complete overhauls at specified periods, oil changes, lubrication, minor adjustments, and so on. In addition, workers can record equipment deterioration so they know to replace or repair worn parts before they cause system failure. The ideal machine maintenance program would prevent any unnecessary and costly repairs.

Machine maintenance for various equipment and facilities is quite nuanced. For instance, maintaining certain equipment may include a "preventive maintenance checklist" which includes small checks which can significantly extend service life. Furthermore, other considerations such as weather and equipment are taken into

account; for instance, in the case of HVAC systems, maintenance is often performed before the hottest time of the year.

Improving maintenance efficiency and effectiveness, this mean having a systematic approach to all maintenance activities. This involves the identification of the nature and level of preventive maintenance required for each piece of equipment, the creation of standards for condition-based maintenance, and the setting of respective responsibilities for operating and maintenance staff. The respective roles of "operating" and "maintenance" staff are seen as being distinct. Maintenance staff are seen as developing preventive actions and general breakdown services, whereas operating staff take on the "ownership" of the facilities and their general care. Maintenance staffs typically move for more facilitating and supporting role where they are responsible for the training of operators, problem diagnosis, and devising and assessing maintenance practice [17].

2.5 Planned Preventive Maintenance

Planned preventive maintenance (PPM), more commonly referred to as simply planned maintenance (PM) or scheduled maintenance, is any variety of scheduled maintenance to an object or item of equipment. Specifically, planned maintenance is a scheduled service visit carried out by a competent and suitable agent, to ensure that an item of equipment is operating correctly and to therefore avoid any unscheduled breakdown and downtime [18].

Along with condition-based maintenance, planned maintenance comprises preventive maintenance, in which the maintenance event is preplanned, and all future maintenance is preprogrammed. Planned maintenance is created for every item separately according to manufacturer’s recommendation or legislation. Plans can be date-based, based on equipment running hours, or on the distance travelled by the vehicle. A good example of a planned maintenance program is car maintenance, where time and distance determine fluid change requirements. A good example of condition-based maintenance is the oil pressure warning light that provides

notification that you should stop the vehicle because engine lubrication has stopped and failure will occur [19].

Planned maintenance has some advantages over condition-based maintenance (CBM), such as:

- Easier planning of maintenance and ordering spares
- Costs are distributed more evenly
- No initial costs for instruments used for supervision of equipment.

Disadvantages are:

- Less reliable than equipment with fault reporting associated with CBM
- More expensive due to more frequent parts change
- Requires training investment and ongoing labor costs

Parts that have scheduled maintenance at fixed intervals, usually due to wear out or a fixed shelf life are sometimes known as time-change interval or TCI items.

Scheduled component replacement is designed to replace the components before failure occurs at the end of the component's useful life. Failure patterns can help in selecting the correct procedure for component replacement [20]. Four types of component replacements are:

I. **Operate Until Failure**

This type of maintenance implies all repairs will be corrective. In this situation, work flow cannot be effectively, making it the least preferred strategy. However, it can be the most cost effective under two conditions - if the item is not mileage - dependent and cannot be monitored or if it is just as cost effective to replace the item after failure as it is before failure. Examples are fuses, light bulbs etc.

II. **Condition Based Maintenance**

Condition based maintenance can predict approaching failures when monitoring a component is possible. Brake shoe wear and oil consumption are examples of

condition based maintenance. The part or component is used until nearly the end of its life, but it is replaced before an in service failure causes significant additional maintenance costs. Unpredictable failures are also nearly eliminated. These are monitored through regularly scheduled preventive maintenance inspections and data analysis. An example of this type of maintenance is wear tolerance monitoring [21].

III. Fixed Mileage Maintenance

Fixed mileage maintenance can be carried out where there is a known relationship between miles traveled and failures. This type of maintenance has a degree of chance variation unlike condition based maintenance. For example, a specific transmission model has shown a history of failure at 150,000 miles. So, a manager initiates a campaign to overhaul the transmission before the vehicle reaches 150,000 miles. Some transmissions will be repaired long before they might otherwise fail. However, if the failure pattern is predictable, then this type of maintenance on select components is appropriate as it eliminates a disabled vehicle, an in service failure, and the costs incurred by performing an unscheduled repair. The maintenance manager can schedule work flow more efficiently and reduce road calls while increasing service reliability [20].

IV. Design Out Maintenance

Design out maintenance is the maintenance strategy that is used in cases where it is obvious that the existing design is not capable of withstanding or muddle through the expected reliability standards [22]. In addition it is a procedure that attempts to remove the maintenance problem. On occasion, manufacturing designs appear feasible but do not work in an actual operating environment. If maintenance costs are excessive the manufacturer may need to redesign the component or the transit agency may have to purchase an alternate component or system.

Maintenance managers must analyze each of these options and select the most efficient course of action to minimize total maintenance costs and vehicle downtime.

If it costs just as much to repair the item after it fails as it does before, then it should be replaced after it fails. If a failure disables the vehicle and results in a road call or if additional damage is caused by operating the component until failure, then all expenses related to the failure must be included in the estimate. Safety always overrides cost minimization when analyzing preventative and corrective maintenance.

It is important to remember that component replacement intervals are unique to each transit agency. For example, rough terrain and environmental conditions such as hot, humid climates may increase or decrease the mileage intervals at which a component may need to be replaced. It is important that maintenance managers develop a failure pattern for their own fleet in order to ensure accurate, scheduled replacement intervals.

Establishing campaigns, wear tolerance policies, and component replacement schedules allow the preventative maintenance process to become self sustaining. Even then, the policies should be continuously reviewed and analyzed for improvement opportunities. Actual vehicle performance must be monitored relative to the required and desired performance. This guarantees maintenance improvement and vehicle reliability.

Implementing a proactive maintenance program that focuses on scheduled maintenance will reduce costs by providing the maintenance manager a chance to plan for the purchase of necessary parts and arrange for vehicle downtime. An efficient preventative maintenance program will also ensure vehicle safety and longevity which are essential to guaranteeing that the maximum life of the vehicle is met [20].

2.6 Downtime

Equipment or machine downtime is an operational loss in any organization. The term downtime is used to refer to periods when a system is unavailable. Downtime or outage duration refers to a period of time that a system fails to provide or perform its primary function. This is usually a result of the system failing to function because of an unplanned event, or because of routine maintenance (a planned event) [23].

Downtime can be defined, period during which an equipment or machine is not functional or cannot function. It may be due to technical failure, machine adjustment, maintenance, or non availability of inputs such as materials, labor, and power. Average downtime is usually built into the price of goods produced, to recover its cost from the sales revenue. It is opposite of uptime and also called waiting time [24]. Percentage downtime of all downtime factors provide the critical factors to be consider for reducing this waste. Calculation of downtime includes the unavailability of machines due to planned maintenance, process and personnel problems.

2.7 Formulation of Overall Equipment Effectiveness (OEE)

OEE is the ratio of actual equipment output to its theoretical maximum output. The aims of preventive maintenance is to achieve the ideal performance and the Zero loss which means no production scrap or defect, no breakdown, no accident, no waste in the process running or changeover. The quantification of these accumulations of waste in time and its comparison to the total available time can give the production and the maintenance management a general view of the actual performance of the plant. It can help them to focus the improvement on the bigger loss. It is calculated using the following formula [25]:

OEE = Availability × Performance Rate × Quality Rate

Availability Ratio:

The availability is the ratio of actual run time and the scheduled time. Actual run time is the difference between scheduled run time and unplanned stoppage [26].

$$\text{Availability (\%)} = \frac{\text{Actual Running Time}}{\text{Scheduled Running Time}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$= \frac{\text{Scheduled Running Time} - \text{Unplanned stoppages}}{\text{Scheduled Running Time}} \times 100$$

Performance Ratio:

This factor indicates the ratio of the actual output and the targeted output. In other words, loss of production occurs due to underutilization of the machinery. Losses are incurred when the equipment is not run with full speed due to rough running of the equipment jams and equipment wear [27].

$$\text{Performance Rate (\%)} = \frac{\text{Actual Output}}{\text{Targeted Output}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (2)$$

Quality Ratio:

The amount of the production has to be discharged or scrapped which is calculated using the following formula [28]:

$$\text{Quality Rate (\%)} = \frac{\text{Total Output - Defects}}{\text{Total Output}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$= \frac{\text{Good Output}}{\text{Total Output}} \times 100$$

When analyzing OEE, many companies may be surprised to find that there is a significant room to increase the output certain pieces of equipment. Tracking OEE is helpful for identifying the sources of bottlenecks, for making capital spending decisions and for monitoring the effectiveness of programs to increase machine productivity. Lean manufacturing typically prioritizes the maximum utilization of people instead of the maximum utilization of machines. One reason for this is that factories that produce multiple products will not be able to use all machines at all times since the requirements may differ depending on the product being produced.

The practice of maximizing OEE involves taking a structured approach to minimizing the six major losses that impact upon these three elements [29,30]. These are shown in the table below:

Table 2.1: Overall equipment effectiveness (OEE), elements and losses

Elements of OEE	Sources of loss
1. Availability	Breakdown
	Set up and adjustment (including changeover)
2. Performance efficiency	Idling and minor stoppage
	Reduced speed
3. Quality rate	Quality defects and rework
	Start up

The first of these losses, breakdown, is the most obvious when it occurs. Immediate efforts will be applied to fix the problem but attention to solve the cause is also essential to prevent reoccurrence. A less obvious but equally likely cause of lost availability is set-up and adjustment losses. These occur during the period between making the last good piece of one batch to the first good piece of the next.

When the actual speed of a machine is lower than its designed speed can cause significant losses. Loss also occurs through the production of defective items. This may be due to sporadic incidents and also during the start-up of a process until it becomes stable [31].

OEE is different among different types of industry. The following table shows OEE values for different types of industries:

Table 2.2: OEE values for different types of industry

Types of Industry	OEE (Top Level)
Manufacturing	85%
Process	>90%
Metallurgy	75%
Paper	95%
Cement	>80%

Worldwide studies indicate that the average OEE rate in manufacturing industries is about 60%. From the above table a world class OEE is considered to be 85% or better. Clearly, there is room for improvement in most manufacturing plants [32].

2.8 Review of Literature

The literature has revealed that the manufacturing organizations worldwide are facing many challenges to achieve successful operation in today's competitive environment. Modern manufacturing requires that to be successful, organizations must be supported by both effective and efficient maintenance practices and procedures. Modern equipment management began with preventive maintenance and evolved into productive maintenance. These approaches both abbreviated as ''PM'' originated in the US with activities focused in the maintenance department. Preventive maintenance schedule, however, stands for total productive maintenance with a

specific time frame. Till 1950s organizations were carrying out breakdown maintenance. As and when machinery went out of order, maintenance crew was called to attend and put it back to normalcy for production.

Over the past two decades, manufacturing organizations have used different approaches to improve maintenance effectiveness [33]. One approach to improving the performance of maintenance activities is to implement and develop maintenance strategy. The preventive maintenance implementation methodology provides organizations with a guide to fundamentally transform their shop floor by a maintenance schedule system [34].

Modern equipment management began with preventive maintenance (PM) and evolved into productive maintenance. First developed in Japan, TPM is team based productive maintenance and involves every level and function in the organization, from top executives to the production floor operators. Japan adopted PM concept in 1951. PM can be thought of as a kind of physical check up and preventive medicine for equipment [10].

Lots of literatures are available from various resources in the field of maintenance management. Grag and Desmukh have presented various classifications of maintenance optimization models by analyzing 142 papers. A broad classification of these literatures can be divided into six areas. These areas are: maintenance optimization models, maintenance techniques, maintenance scheduling, maintenance performance measurement, maintenance information systems; and maintenance policies. In the process, articles published in the last three decades are identified, analyzed and classified [35]. This research traces the evolution of performance measures and measurement, in addition to the related maintenance organizational function, its resource utilization, activities and practices stated by Simo'es [36]. In another invited review, Ding and Kamarudin have undertaken a survey of maintenance policies [37].

In the area of maintenance management performance measurement an overview of various performance measurement systems (PMS), including indicators, reference

numbers and surveys, has been discussed in detail by Pintelon and Puyvelde [38]. Various approaches for measuring maintenance performance have also been reviewed by Tsang [39].

In another invited review, Wang has undertaken a survey of maintenance policies of deteriorating systems and has finally summarized, classified and compared various existing maintenance policies for both single- and multi-unit systems with emphasis on single unit systems [40].

Interval time and replacement cost components in the maintenance process has a tendency as follows; for parts that are replaced, when it fails then the time interval increases, cost tends to rise. For parts that are based on preventive maintenance, when it fails then by the time interval increases, costs tend to fall. The optimal value is obtained from the lowest total cost.

Rachaniotis & Pappis propose is a decision-making model for deteriorating reassembling different subsystems and components of a complex system from used and new parts [41]. The objective is to find the proper reassembly policies in a period of time so as to maximize the systems' overall performance values, under a limited budget, and reassembly and compatibility constraints. Environmental gains are incurred from these policies, since the used components' life cycle, at least in some cases, is extended instead of ending by entering the waste stream. A stochastic dynamic programming approach is proposed, and an example in the case of personal computers is presented. On the other hand, Zhanga proposed a model of imperfect maintenance that applies to sensor information system can be modeled by a stochastic process [42].

The imperfect maintenance proposed model is based on the intuition that the maintenance action will change the rate of damage to the system, and that each maintenance action should have a different degree of impact on the rate of deterioration. The quasi Monte Carlo method is utilized for fixed estimating the model parameters, and the filtering technique is utilized for dynamically estimating the impact from each maintenance action.

In different studies, Gilardoni and Mabrouk is equally focused on the timing of the PM but using a different method. Gilardoni using mathematical models [43] and numerical algorithms while Mabrouk using a Monte Carlo for simulation [44]. Similarly Nourelfath discusses the timing of PM associated with cost and quality [45]. This is determined through mathematical models with Markov method that has been determined.

For this research purpose, a detailed and exhaustive search of literature pertaining to preventive maintenance and related areas were conducted. The time period of this literature review mostly covers the period from 2006 till 2017, though, preventive maintenance related publications covers the period mostly from 2000 onwards. The literature review was conducted with an aim to search all possible related.

Chapter Three
METHODOLOGY

3.1 Introduction

The main goal of the methodology is to prepare and provide information needed for the selection of the maintenance strategy for individual system elements (machines), which effectively uses to the maintenance system and has maximum benefits for the whole system. The final decision about maintenance strategy makes maintenance manager. However, he can rely not only on his experience, but also on relevant information obtained through the proposed methodology and by using the overall equipment efficiency (OEE) evaluation [46].

This case study is conducted in a selected garment factory located in Dhaka. The study gives an idea about the existing scenario of the maintenance section of the garment factory. A garment factory has different sections like Merchandising, Supply chain, Cutting, Sewing, Finishing, Maintenance, Human resources, Commercial, Accounts & finance etc. All the sections are important for successfully run a factory but main focus of the project will be in maintenance section because of machines and mostly involvement of costs. The purpose of this project is to implement a preventive maintenance schedule, reduce downtime, failure rate and maximize productivity.

Operators and all maintenance employees should be actively involved in a maintenance program that enable to avoid any disruptions, breakdowns, stoppages, failures, and so forth in order to improve manufacturing performance [47]. To do so maintenance sections of the factory have been studied to identify and reduce equipment losses to maximize overall equipment efficiency (OEE) by using the techniques of preventive maintenance schedule [48]. Finally, the most significant losses were indicated and eliminated. The overall equipment efficiency (OEE) was also improved. This chapter represents the necessary steps required to perform the

case study. The overall steps involved in the study are presented below with the help of a flow diagram.

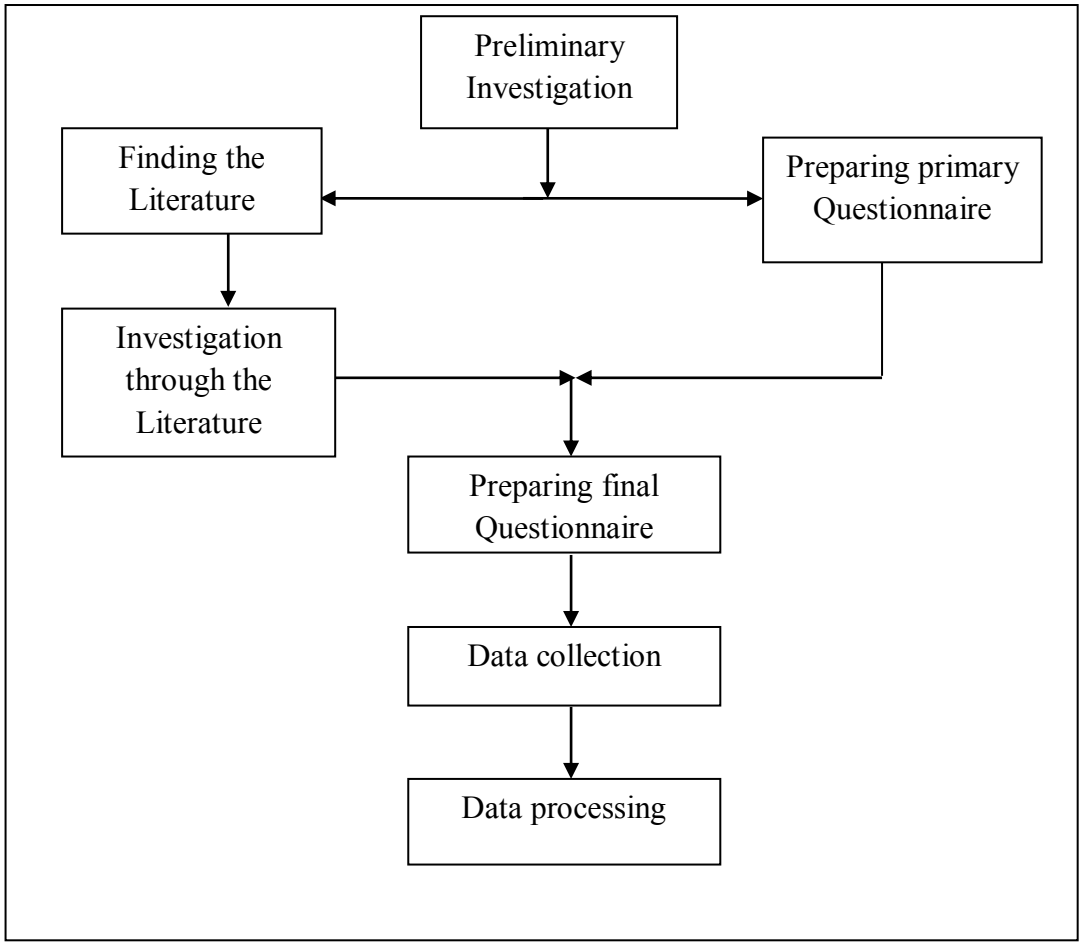

Fig. 3.1 Overall steps of the research study

3.2 Steps Involved in the Study

The proposed research methodology is outlined below:

3.2.1 Step-1: Primary investigation: At first a study of the existing maintenance system will be carried out to identify problems from maintenance section of a selected garment factory.

3.2.2 Step-2: Finding literature review: As there were not enough books available on the selected topics, very few books on preventive maintenance were found so an extensive search was carried out in the internet. Some papers related to preventive

maintenance schedule implementation in manufacturing industry was collected but topics relevant to successfully preventive maintenance schedule implementation in garments industry were not found, however.

3.2.3 Step-3: Investigation through the literature: After preparing the primary questionnaire, previous maintenance related data like downtime, failure rate, frequency and failure cost will be investigated from the maintenance department of the factory for analyzing and further study of preventive maintenance system. The entire maintenance section is finally evaluated on the basis of overall equipment effectiveness.

3.2.4 Step-4: Preparing the final questionnaire: After investigation of the entire maintenance section, the primary questionnaire is finalized and necessary modification was made considering specific study area through addition, deletion as well as reformation. Then this questionnaire is prepared and sorted in different groups. A sample of the final questionnaire is presented in Appendix.

3.2.5 Step-5: Data collection: After that the case study was conducted and data was collected through observation and questionnaire. Major quantitative data was collected through the observation of the maintenance section and some past record of the maintenance, production and quality control department of the selected garment factory. Other qualitative data was collected through interview with the maintenance in charge and quality in charge and finally by asking question to the maintenance worker, sewing operator, supervisor and quality checker.

3.2.6 Step-6: Data processing and analysis: After collected data need to analyze how the data is sufficient for the preventive maintenance schedule implementation. After that collected data was analyzed interpreting with overall equipment effectiveness (OEE). Then a technique will be found out to develop the system. As maintenance section was selected for detail analysis so all types of data was collected relevant to maintenance section. The steps involved for the detail analysis are represented by the flow diagram, which is given in fig.3.2.

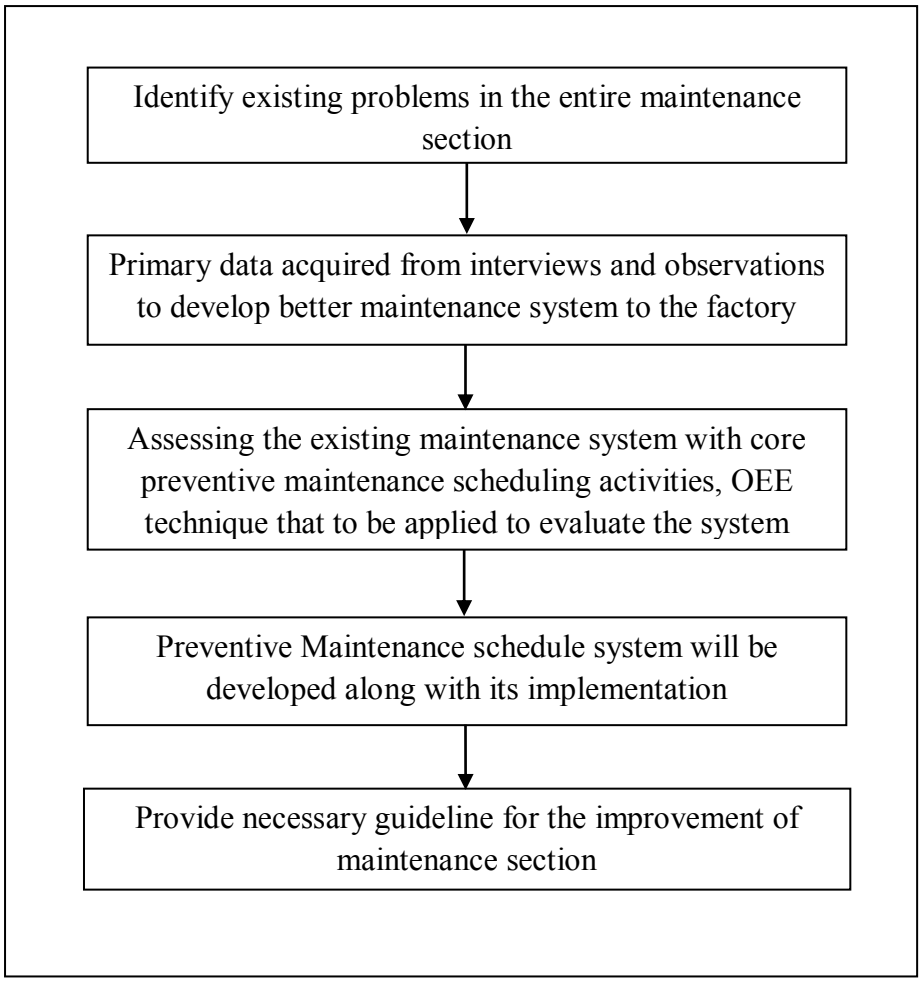

Fig. 3.2: Steps involved in the detail analysis

3.2.7 Step-7: Results & discussion: Finally results from the overall analysis are given and necessary guidelines are provided for improvement (failure rate, productivity, quality, unplanned downtime) of the maintenance section. A comparative study of existing system and the proposed model will be carried out. While the new technique is being implemented, failure related data should be collected on performance. Then evaluate overall equipment effectiveness (OEE) and financial analyze of the proposed maintenance system.

As per the steps described in the methodology section, case study on the selected garment factory has been conducted. The findings from this case study and their analysis on the basis of steps mentioned are presented in the following chapters.

Chapter Four
DATA ANALYSIS AND RESULT

4.1 Introduction

This chapter presents data collections, analysis and result for the case study. This case study has been conducted in a selected garment factory. This case study deals with various types downtime exists in sewing machine maintenance section more specifically in terms of cost. The information as well as data has been gathered through the questionnaire, observation and interview. The data and information was collected through the observation of the production floor and some past record from the production and maintenance departments of the selected factory. Finally all data has been analyzed by using OEE formula with various types of tables and graphs.

4.2 Data Analysis of Traditional Maintenance System

4.2.1 Summary of downtime data

The summary of 4 weeks downtime data and day wise average downtime for 10 teams in traditional maintenance system are as follows [Appendix A (Table 01 & 02)]:

Table 4.1: Downtime data (losses) for several machines

Downtime name	Machine name	Total Downtime (min)	Average (min)
Machine Breakdown	Over Lock, Flat Lock, Single Needle	9202	354
Idling & Minor Stoppages	Flat Lock, Over Lock, Single Needle	6734	259
Setup and Adjustment	Over Lock, Flat Lock, Single Needle	5745	221
Folder Error	Flat Lock, Single Needle	3667	141
Schedule Maintenance	Over Lock, Flat Lock, Single Needle	2342	90
	Total Downtime	**27690**	**1065**

4.2.2 OEE calculation

The calculations for Overall Equipment Efficiency (OEE) of the machines having losses are given bellow using by table 4.1 and Appendix C:

Table 4.2: Overall equipment effectiveness of traditional maintenance

A	Running time per day = 60 min*8 hrs = 480 min; [Working hours per day = 8]
B	Total working time = 480*11*10 min = 52800 min; [Manpower in a Team = 11]
C	Total down time per day =1065 min (Average)
D	Planed run time or total working time = 11*60*8*10 min = 52800 min
E	Actual operating time = Planed run time – Total down time [44] = (52800 - 1065) min = 51735 min
F	Output per day = 77 Pcs/hrs*8*10 = 6160 Pcs
G	Total rejection per day = About 282 Pcs
H	Average SMV of a product = 4.5 min
I	Actual Processing time = SMV*Actual Output = 4.5*6160 = 27720 min
J	**Availability** = E / D *100 = 51735 / 52800 * 100 = 97.98 %
K	**Performance rate** = I / D *100 = 27720 / 52800 *100 = 52.50 %
L	**Quality rate** = (F- G) / F *100 = (6160-282) / 6160 *100 = 95.42 %
Overall Equipment Effectiveness (OEE) = J* K*L *100 = 0.9798*0.5250*0.9542 *100 = 49.08 %	

4.3 Implementation of Preventive Maintenance Schedule

It is a 90 days periodic maintenance schedule for required machine maintenance. In this system about 5 machines would be maintenance at every day. About 448 sewing machines would be taken preventive maintenance. One machine which would be taken maintenance that machine would be periodically maintenance taken after every 90 days. Card system is taken for all machines preventive maintenance. Green card is for maintenance finished, Yellow card is for waiting for maintenance and Red card for repair the machines.

In this system three types of machine are servicing in every day according to the grater total rating factor of the observed machines which is obtain with some criteria. From the observation, which machines are having lower rating servicing will be done latter than the machines having greater rating. Some examples of observations of sewing machines with rating factor are as follows:

Table 4.4: Daily maintenance observation with highest rating number of a machine

Machine Wise Observation Data (4 weeks)

Model: SNL-56

SL.	Current Status Criteria	Rating	6/May/18	7/May/18	8/May/18	9/May/18	10/May/18	11/May/18	12/May/18	13/May/18	14/May/18	15/May/18	16/May/18	17/May/18	18/May/18	19/May/18	20/May/18	21/May/18	22/May/18	23/May/18	24/May/18	25/May/18	26/May/18	27/May/18	28/May/18	29/May/18	30/May/18	31/May/18	1/Jun/18	2/Jun/18	3/Jun/18	4/Jun/18	Total Rating	Remarks
1	Power button works or not?	10	√	√	×	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	×	√	√	√		×	√	√	30	
2	Needle position/ condition ok or not?	3	×	√	√	×	√		×	√	×	√	√	×		√	√	√	√	√	×		√	√	√	√	×	√		×	√	√	24	
3	How is Pressure foot condition?	5	×	×	√	√	×		√	√	√	√	√	√		×	×	×	×	×	√		√	×	√	√	×	×		√	×	×	60	
4	Thread Sequence/Stitching quality?	3	×	√	√	√	√		√	√	×	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	×	9	
5	Bobbin case thread tension ok or not?	2	√	√	×	×	×		√	√	√	×	×	√		×	×	√	√	√	×		×	×	×	×	√	√		√	×	×	28	
6	Motor speed sufficient or not?	4	×	√	√	√	×		√	×	√	√	×	×		√	×	×	√	√	√		×	√	√	×	×	×		×	√	√	48	
7	Pulley works smoothly or not?	6	√	×	√	√	√		√	×	×	√	√	√		√	√	√	×	√	√		√	√	×	√	×	√		√	√	√	36	
8	Motor sound condition normal or abnormal?	7	×	√	√	√	√		√	×	√	√	√	×		×	√	√	√	×	×		√	√	√	√	√	×		×	×	√	63	
9	Temperature of machine normal or not?	4	√	√	×	√	×		√	√	√	×	×	√		×	×	√	×	√	√		√	√	√	√	√	√		√	×	√	32	
10	What is Thread stand position(tight/straight)?	1	×	√	√	√	×		√	×	√	√	√	√		√	×	√	√	√	√		×	×	√	×	√	√		√	×	√	8	
11	Oil filter of the machine is cleaned or not?	5	√	√	×	×	√		√	√	×	√	√	√		√	√	√	√	√	×		×	√	√	√	√	√		√	√	√	25	
12	What is Oil Level or condition of the machine?	7	×	×	√	√	√		√	×	√	√	√	√		√	√	√	×	√	√		√	√	√	×	√	√		√	√	×	42	
13	Spring Operation of the machine is ok or not?	5	×	√	√	×	√		√	√	√	×	√	√		√	√	√	√	×	√		√	√	√	√	×	×		√	√	×	35	
14	How is Brake Position of the machine?	2	√	×	√	√	×		√	×	√	√	√	√		×	×	√	×	√	√		√	√	×	√	√	×		√	×	×	20	
15	What is the condition of Treadle(loseness or operation)?	7	×	√	√	√	√		√	√	√	×	×	√		√	√	√	√	√	×		√	√	×	×	√	√		√	√	√	42	
16	Oil Flow to Rotary Hook properly or not?	9	√	√	×	×	√		√	×	√	√	√	√		√	√	×	√	√	×		×	√	√	√	√	√		√	√	×	63	
17	What is the condition of belt?	6	√	√	×	√	√		×	×	√	√	×	√		√	√	×	×	√	√		×	√	√	√	×	×		√	√	√	54	
18	Belt Tension of the machne ok or not?	8	×	×	√	√	×		√	√	×	√	√	×		√	×	√	√	×	√		√	√	×	√	√	√		×	√	×	72	
19	Bobbin Winder Operation running or not?	2	√	√	√	√	√		×	×	√	√	√	√		√	√	×	×	√	√		√	√	√	×	√	√		√	√	√	10	
20	Cleaned machine thoroughly or not?	1	√	√	×	×	√		√	√	√	×	×	×		√	√	√	√	√	×		×	√	×	√	√	√		×	√	√	9	
21	What is the Condition of Rotary Hook?	8	×	×	√	√	√		√	√	√	×	√	×		√	√	√	√	√	×		√	√	√	√	×	√		×	√	√	56	
22	What is the condition of Feed Dog Height?	6	√	×	√	√	×		×	×	×	√	√	√		√	×	×	×	×	√		√	×	√	√	×	×		√	√	×	78	
23	Hook Timing is properly doing or not?	10	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	×	×	20	
24	Machine maintenance/servicing is occurred or not?	4	√	√	√	×	√		√	√	√	×	×	√		×	√	√	√	√	×		×	×	×	×	√	√		√	×	√	40	
25	Oil Change of the machine done or not?	3	×	×	×	×	×		×	×	×	×	×	×		×	×	×	×	×	×		×	×	×	×	×	×		×	√	×	75	
26	Presser Foot Sole Condition good or bad?	1	√	√	×	√	√		√	√	×	√	√	×		√	√	√	√	×	√		√	√	√	√	×	×		×	√	√	7	
																																	986	

Table 4.3: Daily maintenance observation with lowest rating number of a machine

Machine Wise Observation Data (4 weeks)

Model: SNL-101																																				
SL.	**Current Status Criteria**	**Rating**	**6/May/18**	**7/May/18**	**8/May/18**	**9/May/18**	**10/May/18**	**11/May/18**	**12/May/18**	**13/May/18**	**14/May/18**	**15/May/18**	**16/May/18**	**17/May/18**	**18/May/18**	**19/May/18**	**20/May/18**	**21/May/18**	**22/May/18**	**23/May/18**	**24/May/18**	**25/May/18**	**26/May/18**	**27/May/18**	**28/May/18**	**29/May/18**	**30/May/18**	**31/May/18**	**1/Jun/18**	**2/Jun/18**	**3/Jun/18**	**4/Jun/18**	**Total Rating**	**Remarks**
1	Power button works or not?	10	√	√	√	√	√		√	√	√	√	√	×		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	10	
2	Needle position/ condition ok or not?	3	√	√	√	×	√		√	√	√	×	√	√		×	√	√	√	√	×		√	√	×	√	√	√		×	√	×	21	
3	How is Pressure foot condition?	5	×	√	√	×	√		√	√	√	√	√	√		√	√	×	√	√	√		√	√	√	×	×	√		√	√	√	25	
4	Thread Sequence/Stitching quality?	3	√	×	√	×	×		√	×	×	√	√	√		×	×	√	×	√	√		√	√	×	√	×	√		√	×	√	33	
5	Bobbin case thread tension ok or not?	2	√	√	√	×	√		√	√	×	√	√	√		√	√	√	√	√	√		×	√	√	√	√	×		√	√	×	10	
6	Motor speed sufficient or not?	4	√	√	√	×	√		√	√	√	√	√	√		×	×	×	√	√	√		×	√	√	√	√	√		√	√	√	20	
7	Pulley works smoothly or not?	6	√	√	×	√	×		√	√	√	×	×	√		√	√	×	√	√	√		√	√	√	√	×	√		√	×	√	42	
8	Motor sound condition normal or abnormal?	7	√	√	×	√	√		√	√	√	√	√	√		√	×	√	√	√	×		√	√	√	√	×	×		×	√	√	42	
9	Temperature of machine normal or not?	4	×	√	√	√	√		×	√	×	×	√	√		√	√	√	√	√	√		×	√	√	√	√	×		√	×	√	28	
10	What is Thread stand position(tight/straight)?	1	×	√	√	√	√		×	×	√	√	×	×		√	√	√	√	×	×		√	√	×	√	√	√		√	√	√	8	
11	Oil filter of the machine is cleaned or not?	5	×	√	√	×	√		√	√	×	√	√	√		√	√	√	√	√	×		√	√	√	√	√	√		√	×	×	30	
12	What is Oil Level or condition of the machine?	7	√	√	√	×	√		√	√	√	√	√	√		×	×	√	×	×	√		√	√	√	×	×	√		√	√	√	49	
13	Spring Operation of the machine is ok or not?	5	√	√	×	√	×		√	√	√	×	×	√		√	√	×	√	√	×		√	√	×	√	√	√		√	√	×	40	
14	How is Brake Position of the machine?	2	√	×	×	√	√		√	√	√	√	×	×		√	×	√	×	√	√		√	√	×	√	√	√		√	×	√	16	
15	What is the condition of Treadle(loseness or operation)?	7	×	√	√	√	√		×	√	×	×	√	√		√	√	√	√	√	√		√	√	√	√	√	×		√	√	×	42	
16	Oil Flow to Rotary Hook properly or not?	9	×	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	9	
17	What is the condition of belt?	6	√	×	√	√	×		√	√	√	√	√	√		√	√	√	√	√	√		×	√	√	√	√	×		√	×	√	30	
18	Belt Tension of the machne ok or not?	8	×	√	×	√	√		√	√	√	√	√	√		√	√	×	√	√	√		√	√	√	√	√	×		×	√	√	40	
19	Bobbin Winder Operation running or not?	2	√	√	√	×	×		√	√	√	√	√	√		√	√	√	√	√	√		×	√	√	√	√	×		√	√	×	10	
20	Cleaned machine thoroughly or not?	1	×	×	√	√	√		√	×	×	×	√	√		×	√	√	√	×	√		√	×	√	√	×	×		×	×	√	12	
21	What is the Condition of Rotary Hook?	8	√	√	√	√	√		√	√	√	√	√	√		√	√	√	×	√	×		√	√	√	√	√	√		×	√	√	24	
22	What is the condition of Feed Dog Height?	6	√	√	√	√	√		√	√	√	√	×	×		×	√	√	√	√	√		×	√	√	√	×	√		√	√	√	30	
23	Hook Timing is properly doing or not?	10	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	0	
24	Machine maintenance/servicing is occurred or not?	4	×	×	√	√	√		√	×	×	×	√	√		×	√	√	×	×	×		√	√	√	×	×	√		√	√	√	44	
25	Oil Change of the machine done or not?	3	×	×	×	×	√		×	×	√	×	×	×		×	×	√	√	×	√		√	√	√	√	×	√		×	√	×	45	
26	Presser Foot Sole Condition good or bad?	1	√	√	√	√	×		√	√	√	√	√	√		√	×	√	√	√	√		√	√	√	√	√	√		√	√	×	3	
																																		663	

Similarly, above table 4.3 and 4.4 of daily maintenance observation of all sewing machines with rating factor are represented on Appendix B.

From the machine wise observation data of daily maintenance with rating factor, a maintenance schedule is prepared according to the higher to lower total rating number.

To improve performance of the machine maintenance (mechanics) department as well as the organization, the factory will maintain the preventive maintenance schedule instead of followed breakdown maintenance. The preventive maintenance schedule which is like bellow:

Maintenance Schedule

Day	Date	Machine ID				
1	6/5/2018	OL-67	OL-46	FL-22	SNL-24	SNL-56
2	6/6/2018	OL-23	OL-35	FL-32	SNL-29	SNL-70
3	6/7/2018	OL-44	OL-29	FL-07	SNL-33	SNL-25
4	6/8/2018					
5	6/9/2018	OL-54	OL-37	FL-11	SNL-31	SNL-12
6	6/10/2018	OL-39	OL-01	FL-08	SNL-22	SNL-02
7	6/11/2018	OL-57	OL-38	FL-14	SNL-67	SNL-13
8	6/12/2018	OL-65	OL-19	FL-10	SNL-62	SNL-34
9	6/13/2018	OL-07	OL-40	FL-18	SNL-14	SNL-15
10	6/14/2018	OL-49	OL-11	FL-03	SNL-51	SNL-61
11	6/15/2018					
12	6/16/2018	OL-41	OL-24	FL-13	SNL-40	SNL-17
13	6/17/2018	OL-02	OL-28	FL-33	SNL-11	SNL-55
14	6/18/2018	OL-18	OL-42	FL-28	SNL-16	SNL-10
15	6/19/2018	OL-05	OL-09	FL-15	SNL-39	SNL-19
16	6/20/2018	OL-15	OL-20	FL-12	SNL-44	SNL-46
17	6/21/2018	OL-31	OL-33	FL-19	SNL-93	SNL-96
18	6/22/2018					
19	6/23/2018	OL-34	OL-17	FL-05	SNL-8	SNL-37
20	6/24/2018	OL-03	OL-12	FL-35	SNL-53	SNL-85
21	6/25/2018	OL-77	OL-16	FL-49	SNL-80	SNL-59
22	6/26/2018	OL-79	OL-30	FL-37	SNL-89	SNL-55
23	6/27/2018	OL-82	OL-08	FL-43	SNL-42	SNL-45
24	6/28/2018	OL-48	OL-10	FL-01	SNL-19	SNL-58
25	6/29/2018					
26	6/30/2018	OL-50	OL-75	FL-47	SNL-79	SNL-72
27	7/1/2018	OL-73	OL-61	FL-24	SNL-43	SNL-09
28	7/2/2018	OL-81	OL-53	FL-26	SNL-88	SNL-38
29	7/3/2018	OL-23	OL-14	FL-17	SNL-57	SNL-50
30	7/4/2018	OL-04	OL-58	FL-21	SNL-81	SNL-76
31	7/5/2018	OL-76	OL-72	FL-41	SNL-75	SNL-112
32	7/6/2018					
33	7/7/2018	OL-22	OL-47	FL-27	SNL-91	SNL-69
34	7/8/2018	OL-51	OL-68	FL-30	SNL-104	SNL-77
35	7/9/2018	OL-62	OL-85	FL-36	SNL-101	SNL-107
36	7/10/2018					
37	7/11/2018					
38	7/12/2018					
39	7/13/2018					
40	7/14/2018					
41	7/15/2018					
42	7/16/2018					
43	7/17/2018					
44	7/18/2018					
45	7/19/2018					

Day	Date	Machine ID				
46	7/20/2018					
47	7/21/2018					
48	7/22/2018					
49	7/23/2018					
50	7/24/2018					
51	7/25/2018					
52	7/26/2018					
53	7/27/2018					
54	7/28/2018					
55	7/29/2018					
56	7/30/2018					
57	7/31/2018					
58	8/1/2018					
59	8/2/2018					
60	8/3/2018					
61	8/4/2018					
62	8/5/2018					
63	8/6/2018					
64	8/7/2018					
65	8/8/2018					
66	8/9/2018					
67	8/10/2018					
68	8/11/2018					
69	8/12/2018					
70	8/13/2018					
71	8/14/2018					
72	8/15/2018					
73	8/16/2018					
74	8/17/2018					
75	8/18/2018					
76	8/19/2018					
77	8/20/2018					
78	8/21/2018					
79	8/22/2018					
80	8/23/2018					
81	8/24/2018					
82	8/25/2018					
83	8/26/2018					
84	8/27/2018					
85	8/28/2018					
86	8/29/2018					
87	8/30/2018					
88	8/31/2018					
89	9/1/2018					
90	9/2/2018					

Fig 4.1: Preventive maintenance schedule board

Besides this, daily cleaning system by operator can minimize machine breakdown and some minor stoppages easily. Daily cleaning can easily do by an operator before going to lunch and before end of day's work. It's a continuous process doing by an operator and vastly contributes in machine maintenance system. To do this need to improving awareness and motivating maintenance team.

Accurate recording of the day to day maintenance work is essential for exercising effective control over the schedule maintenance program, planning, the replacement and procurement of store and spares. Initiate making record of machine breakdown time daily, type of machines that got breakdown, time required to repair or restart the machine. This record will help you to find top 20% machines that cause 80% of machine breakdown.

4.4 Data Analysis of Preventive Maintenance Schedule System

4.4.1 Summary of downtime data

The summary of 4 weeks downtime data and day wise average downtime for 10 teams in proposed preventive maintenance schedule system are as follows [Appendix A (Table 03 & 04)]:

Table 4.5: Downtime data (losses) for several machines in proposed system

Downtime name	Machine name	Total Downtime (min)	Average (min)
Machine Breakdown	Over Lock, Flat Lock, Single Needle	3128	120
Idling & Minor Stoppages	Flat Lock, Over Lock, Single Needle	2415	93
Setup and Adjustment	Over Lock, Flat Lock, Single Needle	3011	116
Folder Error	Flat Lock, Single Needle	1426	55
Schedule Maintenance	Over Lock, Flat Lock, Single Needle	4112	158
	Total Downtime	**14092**	**542**

4.4.2 OEE calculation

The calculations for Overall Equipment Efficiency (OEE) of the machines having losses are given bellow using by table 4.5 and Appendix C:

Table 4.6: Overall Equipment Effectiveness of Preventive Maintenance Schedule System

A	Running time per day = 60 min*8 hrs = 480 min; [Working hours per day = 8]
B	Total working time = 480*11*10 min = 52800 min; [Manpower in a Team = 11]
C	Total down time per day = 542 min (Average)
D	Planed run time or total working time = 11*60*8*10 min = 52800 min
E	Actual operating time = Planed run time – Total down time [44] = (52800- 542) min = 52258 min
F	Output per day = 92 Pcs/hrs*8*10 = 7360 Pcs
G	Total rejection per day = About 140 Pcs
H	Average SMV of a product = 4.5 min
I	Actual Processing time = SMV*Actual Output = 4.5*7360 = 33120 min
J	Availability = E / D *100 = 52258/52800 *100 = 98.97 %
K	Performance rate = I / D *100 = 33120 / 52800 *100 = 62.72 %
L	Quality rate = (F- G) / F *100 = (7360 - 140) / 7360 *100% = 98.09%
Overall Equipment Effectiveness (OEE) = J* K*L *100 = 0.9897*0.6272*0.9809 *100 = 60.89 %	

4.5 OEE Comparison

Comparisons between traditional and preventive maintenance schedule system are as follows:

Table 4.7: OEE Comparison of two different maintenance systems

Factor	Traditional Maintenance (%)	Preventive Maintenance Schedule System (%)
Availability	97.98 %	98.97 %
Performance rate	52.50 %	62.72 %
Quality rate	95.42%	98.09%
OEE	**49.08 %**	**60.89 %**

Difference between traditional maintenance system and preventive maintenance schedule system can be shown more clearly by the following graphical representation.

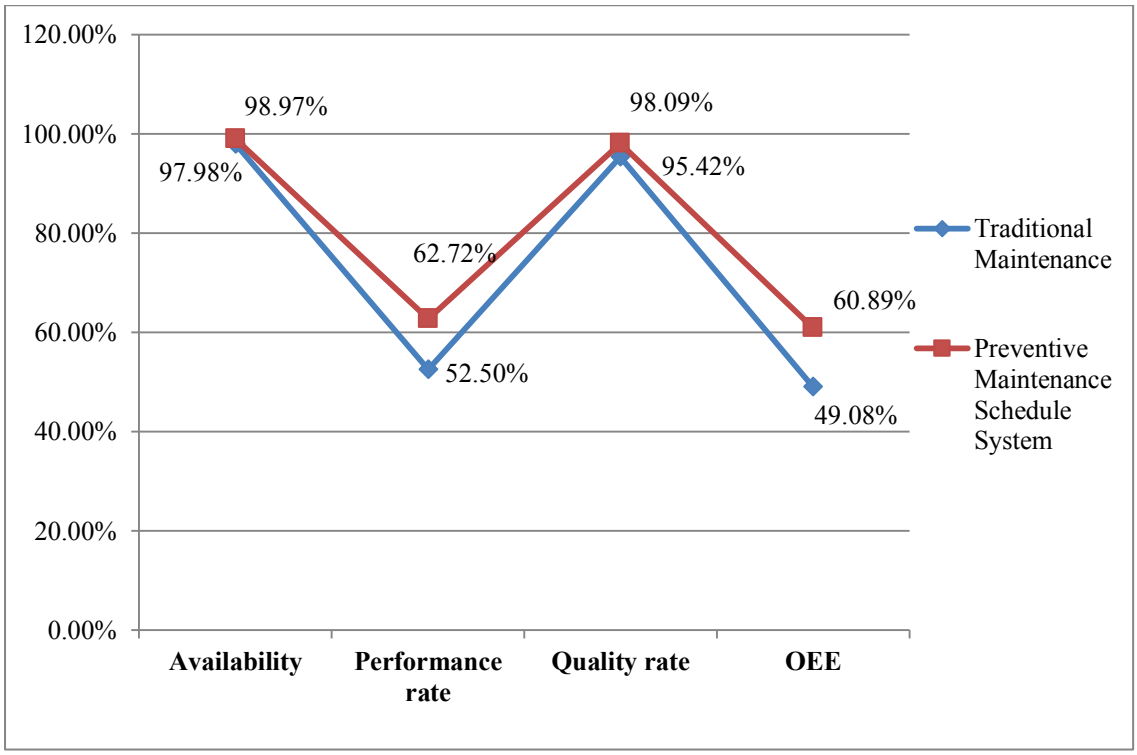

Fig 4.2: Graphical representation of two different maintenance systems

4.6 Financial Impact

4.6.1 Maintenance cost in traditional maintenance system

Maintenance cost analysis of traditional maintenance system by using table 4.1, 4.2 and Appendix C as follows:

Table 4.8: Monthly downtime cost in traditional maintenance system

A	Cost per minute (CPM) of the Factory = $0.06 = 4.8 Tk ; [1$=80 Tk]
B	Per day cost for a Team = A* Working min = 4.8*5280 min = 25344 Tk
C	Per day cost for 10 Team = B*10 = 25344*10 = 253440 Tk
D	Per day production for 10 team = 77*8*10 = 6160 Pcs;
E	Earned Money = 6160*1.70*80= 837760 Tk; [Average per product price=$1.70]
F	Loss for Downtime in a day = A* 1065 = 4.8 *1065 = 5112 Tk; Machine downtime = 1065 min per day for 10 team [Table 4.1]
G	Monthly downtime = 1065*26 = 27690 min; [monthly working days = 26]
So, monthly downtime cost = A* G = 4.8*27690 = 132912 Tk	

4.6.2 Maintenance cost in preventive maintenance schedule system

Maintenance cost analysis of proposed preventive maintenance schedule system by using table 4.5, 4.6 and Appendix C as follows:

Table 4.9: Monthly downtime cost in preventive maintenance schedule system

A	Cost per minute (CPM) of the Factory = $0.06 = 4.8 Tk ; [1$= 80 Tk]
B	Per day cost for a team = A* Working min = 4.8*5280 min = 25344 Tk
C	Per day cost for 10 team = B* 10 = 4.8*5280*10 = 253440 Tk
D	Per day production = 92 Pcs*8*10 = 7360 Pcs
E	Earned Money = D*1.70*80 = 1000960 Tk; [Average per product price=$1.70]

F	Loss for downtime in a day = A* Downtime = 4.8 * 542 = 2602 Tk Machine downtime = 542 min per day for 10 team
G	Monthly downtime = 542 *26 = 14092 min; [monthly working days = 26]
So, monthly downtime cost in preventive maintenance schedule system = A* G = 4.8*14092 = About 67642 Tk	

4.6.3 Financial comparison between two maintenance systems (monthly for 28 teams)

Comparison table of Traditional and Proposed Preventive Maintenance Scheduling System by using table 4.1, 4.5 and Appendix C are like below:

Table 4.10: Several financial factors comparison of two different maintenance systems

Factor	Traditional Maintenance	Preventive Maintenance Schedule System
Machine downtime	(1065*26*28)/10 = **77532 Min**	(542*26*28)/10 = **39458 Min**
Loss for downtime	77532*4.8 = **372153.60 Tk**	39458 *4.8 = **189398.40 Tk**
Production	77*28*8*26 = **448448 Pcs**	92*28*8*26 = **535808 Pcs**
Earned production Money	448448*$1.70 = **$ 762361.60 = 60988928 Tk**	535808*$1.70 = **$ 910873.60 = 72869888 Tk**

4.6.4 Maintenance cost evaluation

Different factors affecting maintenance cost of several machines of a team for a month is constructed as follows using by Appendix C:

Table 4.11: Maintenance cost evaluation of preventive maintenance schedule system

Maintenance Factor	Machine Name	No. of Machine	Maintenance Cost (Per unit)	Total Maintenance Cost Tk
Oil filter change	Flat Lock, Over Lock	4+6	50 Tk	10*50 = 500
Oil change	Flat Lock, Over Lock, Single Needle	4+6+6	240 Tk Per Litter	1/2* 4*240 = 480 1/2*6*240 = 720 1/4*6*240 = 360
Needle plate change, Thread Guide adjustment, Knife shine, Bush, Clamp holder adjustment, Belt change, Cleaning	Single Needle, Flat Lock, Over Lock	6+4+6	25000/28	892.85
Total Maintenance Cost				**2952.85 Tk**

[Source: Maintenance department of a selected readymade garment factory]

For preventive maintenance schedule system implementation need to employ extra maintenance worker and maintenance cost will be increased. There are 3 no. of extra maintenance employee employed for 28 teams and every maintenance employee's monthly salary (on average) about 12000 Taka [Appendix C].

Then extra maintenance worker wages cost for a team will be (12000*3/28) Taka = 1285.71 Taka per month

So grand total preventive maintenance cost will be for a team = (2952.85+1285.71) Tk = 4238.56 Tk

4.6.5 Overall impact

After analysis of proposed preventive maintenance schedule system some beneficial impact are shown at bellow table by using table no. 4.10 and 4.11 [For 28 teams]:

Table 4.12: Overall impact of preventive maintenance schedule system

Monthly downtime cost save	(372153.60 –189398.40) = 182755.20 Tk
Monthly grand total maintenance cost	4238.56 Tk *28 = 118679.68 Tk
Monthly general maintenance cost about 42000 Tk ; [Appendix C]	
Increases overall maintenance cost monthly	(118679.68 – 42000) = 76679.68 Tk
Monthly net cost saves after preventive maintenance scheduling system	**(182755.20 –76679.68) = 106075.52 Tk**
Similarly yearly cost saves	**106075.52 Tk*12 = 1272906.20 Tk**
Monthly production increases	**(535808 – 448448) Pcs = 87360 Pcs**
Similarly yearly production increases	**87360 Pcs *12 = 1048320 Pcs**

4.6.6 Overall financial impact

Yearly Cost Saves for Preventive Maintenance Schedule System (Net)	**About 1272906 Tk**

Proposed preventive maintenance scheduling system provides a useful maintenance system for regular maintenance of a manufacturing organization towards a competitive level. It also has a great financial impact on maintenance section as well as overall organization.

Chapter Five

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

This case study research has extracted an overall scenario of the sewing machine maintenance section of the selected garment factory in the context of productivity, quality, wastes as well as effectiveness, efficiency of every sewing line.

Today there is no quota system in readymade garment sector. Today competitiveness rather than quotas is determining the market share. So in order to gain the largest market share as well as to sustain in the present competitive market it is necessary to improve this sector. As maintenance section is one of the most important section among different sections of garment factory, so this thesis proceeds with a focus on improvement of the machine maintenance among different sections. In this connection preventive maintenance scheduling concept in maintenance system is applied as a diversified concept in the sewing machine maintenance section of the studied garment factory [48].

The improvement of any manufacturing organization depends on various issues such as waste minimization, productivity improvement, quality management as well as labor efficiency, resource utilization etc [49]. This research analysis has been oriented on the basis of lean tool overall equipment effectiveness (OEE) analysis. Before this analysis traditional maintenance system with huge cost of maintenance and production losses have been analyzed.

From OEE analysis, it has been found that the average OEE for the respective lines is very low from the standard before preventive maintenance schedule system. As OEE is calculated from three factors namely, availability, quality rate and performance rate; among these three factors performance rate & quality rate for every sewing line are lower than the availability. Performance rate and quality rate of every sewing line is reasonably low, that's why these factor lowers the OEE of the sewing line. Due to

this reason most of the time the sewing section are not being able to achieve the desired level of production. After implementation of preventive maintenance schedule system into the respective lines it is found that OEE value is better than the previous maintenance system. Performance rate and quality rate of every sewing line will be also better in this preventive maintenance schedule system.

From downtime analysis it has been found that on changeover day a significant amount of time is wasted due to machine setup problem. Time is also spent for bringing needle, trim, guide and other accessories as they are not available in the store moreover they are not properly arranged. So a significant time is spent to find out the right needle, trim, guide etc. That's why on changeover day (when new style enters in the line) the production rate is very low than the production rate in the next day (The day after change over). Due to excess changeover time, the lead-time for production is increased; consequently average defect per line is also increased [50].

There is an important relationship among OEE, machine breakdown, changeover and 5S housekeeping. If machine breakdown time, changeover time or setup time is more, then average OEE is low on the other hand if machine maintenance is not properly maintained then it is very difficult to reduce breakdown time and setup time[51].

This case study research has depicted the existing scenario of the sewing machine maintenance section using OEE analysis it has been identified that there is a significant impact on production rate because of excess down time or breakdown and quality rate etc.

5.2 Recommendations for the Future Study

Based on the current thesis work, further study can be done on the garments industry in different dimensions. Some of them are presented below:

♦ As this thesis work is concentrated only the sewing machine maintenance of the selected garment factory, so further study can be done in other section of the selected industry such as spinning, knitting, dying section etc.

♦ This thesis work is done in a knit garment factory; so further study can be done in woven and other types of apparel industry.

♦ This thesis work or analysis is mainly maintenance system development & OEE analysis but further study can be performed by using other lean tools such as value stream mapping, kanban, JIT system etc.

♦ The OEE analysis is done only to show the overall impact of machine maintenance on manufacturing cost, efficiency and production but further study can be performed in sewing section by using SMED method to reduce changeover time.

♦ Various types of downtime (wastage) are identified according to lean theory but in future this waste can be represented in terms of money, which can help the organization to know about the loss of money and lead them to think about how to overcome this loss.

5.3 Limitations of the Thesis Work

This research work is conducted on machine maintenance and the basis of lean tool OEE analysis but for time limitation other lean tools are not analyzed. In this research work only maintenance section is analyzed based on this lean tool, for time limitation other section of the selected factory such as knitting, dying, cutting, finishing and packing section are not consider. The studied garment factory has various types of machine, but for shortage of time only few types of machine are analyzed and data is collected by observation of few lines. Few data sheets related to line-wise non-productive time and line-wise daily rejections are collected due to time limitation. If other sections of the organization could be analyzed better improvement result may occur. Machine breakdown time analysis and OEE analysis are also analyzed by observing few lines and few styles. Excess material handling wastes related to layout problem is not identified. In this research work various types of wastes as well as various reasons behind failure of production in sewing section is identified but no solution is provided to overcome this wastes and problems.

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APPENDICES
APPENDIX - A

Table 01: Downtime for several machines in traditional maintenance system

Day	Observation Date	Downtime name	Team 1		Team 2		Team 3		Team 4		Team 5	
			Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)
1	1/6/2018	Machine Breakdown	Flat Lock	22+26	Flat Lock,OverLock	15+20	OverLock	24+22	Single needle	12+15	Flat Lock	20
		Idling & Minor stoppages	OverLock	12	Flat Lock	14	Flat Lock	10	OverLock	10+18	OverLock	20+30
		Setup and adjustment	Flat Lock,OverLock	15,20	Single needle	20	Single needle	25	Over Lock,Flat Lock	12,25	Flat Lock,OverLock	12+8
		Folder error	Flat Lock	14	Flat Lock	20+30	Flat lock	20+10			Flat Lock	21+16
		Schedule maintenance	Single needle	16			Over Lock	20			Single needle	19
2	1/7/2018	Machine Breakdown	Flat Lock,Single needle	30,21	OverLock	21+16	OverLock	21+16	Flat Lock	10,17	Single needle	15+17
		Idling & Minor stoppages	OverLock	17+11	Flat Lock,OverLock	12	Flat Lock,OverLock	15,12	Overlock	19+16	Flat Lock	28
		Setup and adjustment	Flat Lock	24	Flat Lock	15	Flat Lock	15	OverLock	16	Single needle	6+10
		Folder error	Single needle	10	Single needle	18	Single needle	18	Flat Lock	10	Flat Lock	10
		Schedule maintenance	OverLock	25					Single needle	38	Flat Lock	25
3	1/8/2018	Machine Breakdown	Over Lock,Flat Lock	20,30	Single needle	12+18	Single needle	15,20	OverLock	17+21	OverLock	20,30
		Idling & Minor stoppages	OverLock	12+10	Flat Lock	21+16	OverLock	16	Over Lock,Flat Lock	20	Flat Lock,OverLock	12+18
		Setup and adjustment	Flat Lock,OverLock	15+20	Flat Lock	22	Over Lock,Flat Lock	20	OverLock	24	OverLock	21+16
		Folder error	Flat Lock	14	OverLock	15			Flat Lock	10		
		Schedule maintenance	Single needle	20	Flat Lock	28	Flat Lock	24	Flat Lock	25		
4	1/9/2018	Machine Breakdown	Flat Lock	20+30	Flat Lock	16+18	Flat Lock	15	Single needle	20+30	OverLock	28
		Idling & Minor stoppages	OverLock	12+13	Flat Lock	15,20	Overlock	25	Flat Lock	12+15	Flat Lock	16+18
		Setup and adjustment	Flat Lock	21+16	Single needle	16	Flat Lock,OverLock	20,30	Flat Lock	15+18	Single needle	15,20
		Folder error					Flat Lock	12+10			Single needle	16
		Schedule maintenance	Single needle	15							Flat Lock	20
5	1/10/2018	Machine Breakdown	Flat Lock	28	Flat Lock	18,16	Flat Lock	20	Flat Lock	10+16	OverLock	24,32
		Idling & Minor stoppages	OverLock	16+18	Single needle	12+8	Flat Lock	15	Single needle	10	Flat Lock,OverLock	18,16
		Setup and adjustment	Flat Lock,OverLock	15,20	OverLock	21	OverLock	28	Single needle	18	Flat Lock	11+16
		Folder error	Flat Lock	16	Flat Lock	15	Flat Lock	16	Single needle	16	Single needle	14
		Schedule maintenance			OverLock	14			0ver lock	10	Flat Lock	15
6	1/11/2018	Machine Breakdown	Flat Lock,single needle	24,32	Flat Lock,OverLock	20	Single needle	16	Flatlock	38	Single needle	28
		Idling & Minor stoppages	Flat Lock,Over Lock	18,16	Flat Lock	20+30	Single needle	20	OverLock	17+16	Flat Lock	16+18
		Setup and adjustment	OverLock	18	Single needle	12+8	Flat Lock	24	Flat Lock	20	Flat Lock	15,20
		Folder error	Flat Lock	12	Flat Lock	21+16	Single needle	14	Single needle	20		
		Schedule maintenance	Single needle	25	Single needle	12						
7	1/12/2018											
8	1/13/2018	Machine Breakdown	Flat Lock	35	Flat Lock	28	Single needle	24	Flat Lock,OverLock	21,16	Single needle	18
		Idling & Minor stoppages	OverLock	12	Single needle	12+14	Flat Lock	24	Flat Lock	15	Single needle	15
		Setup and adjustment	Flat Lock,OverLock	20,18	Flat Lock	22	OverLock	15	Single needle	15	Flat Lock	28
		Folder error	Single needle	12	Flat Lock	20	Flat Lock	15	Flat Lock	28	Flat Lock	15
		Schedule maintenance	Flat lock	20			Flat Lock	30			Over Lock	20

Day	Observation Date	Downtime name	Team 1		Team 2		Team 3		Team 4		Team 5	
			Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)
9	1/14/2018	Machine Breakdown	Over lock	18+22	FlatLock,OverLock	30,24	Single needle	15	OverLock	20	Flat Lock,OverLock	21+16
		Idling & Minor stoppages	OverLock, Flat lock	10,17	OverLock	25	Flat Lock	10	Flat Lock,OverLock	15+20	Single needle	8+10
		Setup and adjustment	Flat Lock,OverLock	19,16	Single needle, Flatlock	8,20	Single needle	12+8	Flat Lock	14	OverLock	15
		Folder error	Flat Lock	16			Flat Lock	21+16	Single needle	20	Flat Lock	28
		Schedule maintenance	Single needle	10	OverLock	25						
10	1/15/2018	Machine Breakdown	Flat Lock	38	Flat Lock	30	Flat Lock	25	OverLock	22,18	Flat Lock,OverLock	15,20
		Idling & Minor stoppages	OverLock	7+6	Single needle	16	Single needle	28	Over Lock,Flat Lock	21+16	Flat Lock	16
		Setup and adjustment	OverLock	20	OverLock	18	Flat Lock	16+18	OverLock	12	Single needle	18
		Folder error			Flat Lock	12			Flat Lock	15	Flat Lock	15
		Schedule maintenance	Flat lock	30			OverLock	16	Flat Lock	28		
11	1/16/2018	Machine Breakdown	Single needle	15+19	Flat Lock,OverLock	17,20	Flat Lock,OverLock	20,15	OverLock	20	Single needle	14
		Idling & Minor stoppages	OverLock,Flat lock	7,18	Flat Lock	20	Flat Lock	24	Flat Lock,OverLock	12,8	Flat Lock	19
		Setup and adjustment	OverLock	18	Single needle	8+12	Single needle	8+6	Flat Lock	20+17	Flat Lock	22
		Folder error	Flat Lock	10	Flat Lock	10+7			Single needle	9+16		
		Schedule maintenance			OverLock	16	Flat Lock	32	Single needle	12	Flat Lock	18
12	1/17/2018	Machine Breakdown	Over lock	34	Flat Lock	16	OverLock	19	OverLock	15,18	Flat Lock	25
		Idling & Minor stoppages	OverLock	8+11	Single needle	10	Flat Lock,OverLock	10,13	Over Lock,Flat Lock	12,15	Single needle	20
		Setup and adjustment	Flat Lock	18	Flat Lock	38	Flat Lock	12	OverLock	20	Single needle	16
		Folder error			Flat Lock	7+6	Single needle	20	Flat Lock	20	Flat lock	23
		Schedule maintenance	Over Lock	22								
13	1/18/2018	Machine Breakdown	Flat Lock	38	Flat Lock,OverLock	20,15	Single needle	10,17	Single needle	12+15	OverLock	26
		Idling & Minor stoppages	OverLock	12	Single needle	25	Flat Lock	19,16	OverLock	10+8	Single needle	10+12
		Setup and adjustment	Flat Lock,OverLock	15,20	OverLock	20+30	Single needle	16	Over Lock,Flat Lock	12,22	OverLock	14
		Folder error	Single needle	14	Single needle	15	Over Lock	10			Single needle	10
		Schedule maintenance	Flat lock	20	OverLock	14						
14	1/19/2018											
15	1/20/2018	Machine Breakdown	Single needle	15+18	Flat Lock	20	OverLock	20	Flat Lock,OverLock	19,16	Single needle	12+15
		Idling & Minor stoppages	OverLock	12	Over Lock,Flat Lock	12,18	Flat Lock	21+16	Flat Lock	16	OverLock	24
		Setup and adjustment	Flat Lock	15+12	OverLock	21+16	Single needle	17	Single needle	10	Over Lock,Flat Lock	10
		Folder error	Single needle	14	Flat Lock	12	Flat Lock	15	Flat Lock	18		
		Schedule maintenance	Single needle	20	Single needle	15					Single needle	20
16	1/21/2018	Machine Breakdown	Flat Lock	30	OverLock	28	OverLock	16+18	OverLock	20	OverLock	20
		Idling & Minor stoppages	Single needle	12+8	Over Lock,Flat Lock	12	Flat Lock,OverLock	15,20	OverLock	34	Over Lock,Flat Lock	20+30
		Setup and adjustment	OverLock	21+16	OverLock	10+18	Flat Lock	16	Flat Lock	22	OverLock	12+8
		Folder error	Flat Lock	15	Over Lock	12	Single needle	12	Single needle	14	Flat Lock	16
		Schedule maintenance							Flat Lock	12		
17	1/22/2018	Machine Breakdown	Flat Lock,OverLock	28	Single needle	15+12	Flat Lock	22	Single needle	10+18	Flat Lock	35
		Idling & Minor stoppages	Flat Lock	6+8	Flat Lock	25	Single needle	20	Flat Lock	12+15	Single needle	28
		Setup and adjustment	Single needle	14	Flat Lock	20	Flat Lock	15	Flat Lock	20	Flat Lock	16+18
		Folder error	Flat Lock	20	Single needle	12	Flat Lock	10+7			Flat Lock	15
		Schedule maintenance			Flat Lock	18	OverLock	19	Flat Lock	17	OverLock	14
18	1/23/2018	Machine Breakdown	Single needle	12+18	Flat Lock	22	Flat Lock,OverLock	16,18	OverLock,Single needle	19,16	Flat Lock,OverLock	20
		Idling & Minor stoppages	Flat Lock	14	OverLock	20	Flat Lock	10	Single needle	16	Flat Lock	30
		Setup and adjustment	OverLock	20	Flat Lock,OverLock	21,16	Single needle	38	Flat Lock	10	Single needle	12
		Folder error	Flat Lock	17			Flat Lock	7+6	Single needle	18	Flat Lock	21+16
		Schedule maintenance					Single needle	20			Single needle	12
19	1/24/2018	Machine Breakdown	Flat Lock	21+16	Single needle	28	Flat Lock	25	Flat Lock	20	Flat Lock	15+34
		Idling & Minor stoppages	Flat Lock,OverLock	15,10	Flat Lock	6+8	Single needle	12	OverLock	10,7	OverLock	28
		Setup and adjustment	Flat Lock	15	Flat Lock	15+20	Flat Lock	12+8	Flat Lock,OverLock	19,16	Flat Lock	15
		Folder error	Single needle	18	OverLock	16			Flat Lock	16	Single needle	18
		Schedule maintenance	Flat Lock	14	Flat Lock	20			Single needle	10		

Day	Observation Date	Downtime name	Team 1		Team 2		Team 3		Team 4		Team 5	
			Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)
20	1/25/2018	Machine Breakdown	OverLock	15+20	Single needle	24	Flat Lock	27+24	Flat Lock	38	Flat Lock	22+28
		Idling & Minor stoppages	Flat Lock,OverLock	16,18	Flat Lock	18+16	Single needle	28	OverLock	10+16	Single needle	21+16
		Setup and adjustment	Single needle	20	Flat Lock		Over Lock,Flat Lock	6+8	Flat Lock	20	Flat Lock	32
		Folder error	Single needle	24			Flatlock	15	Single needle	12	Single needle	15
		Schedule maintenance	Flat Lock	20					Flat Lock	34		
21	1/26/2018											
22	1/27/2018	Machine Breakdown	Flat Lock	25	Flat Lock	22	OverLock	24	Flat Lock	32	Single needle	15,20
		Idling & Minor stoppages	Over Lock	14	Single needle	10+8	Flat Lock	18+16	OverLock	10+16	OverLock	16
		Setup and adjustment	Flat Lock	20	Flat Lock	12	Single needle	6+14	Flat Lock,OverLock		Over Lock,Flat Lock	12+8
		Folder error			Single needle	20	Flat Lock	15	Flat Lock	24		
		Schedule maintenance	OverLock	20								
23	1/28/2018	Machine Breakdown	Single needle	21+16	OverLock	15+20	Flat Lock	26+18	Flat Lock,OverLock	25	Flat Lock	15+29
		Idling & Minor stoppages	Over Lock	12	Flat Lock	16	Single needle	15,20	Flat Lock	20+30	Flat Lock	28
		Setup and adjustment	Flat Lock	15	Single needle	20	Flat Lock	16	Single needle	12+8	Flat Lock	
		Folder error	Single needle	15			Flat Lock	20	Flat Lock	21+16	Single needle	12+8
		Schedule maintenance					OverLock	32			Flat Lock	16
24	1/29/2018	Machine Breakdown	Single needle	15+20	OverLock	25	Flat Lock,OverLock	18,26	OverLock	15+27	Single needle	25
		Idling & Minor stoppages	Flat lock	16	Flat Lock,OverLock	20,30	Flat Lock	20	Flat Lock,OverLock	28	OverLock	15
		Setup and adjustment	Over Lock,Flat Lock	20	Flat Lock	12+8	Single needle	16	Flat Lock	6+8	Over Lock,Flat Lock	28
		Folder error	Flat Lock	20	Single needle	16			Single needle	15+20		
		Schedule maintenance					Flat Lock	38	Flat Lock	16		
25	1/30/2018	Machine Breakdown	Flat Lock	20	Over Lock,Flat Lock	25,30	Single needle	24	Single needle	20+16	Flat Lock	26
		Idling & Minor stoppages	Single needle	20+26	OverLock	28	OverLock	10	Flat Lock	24,32	Flat Lock	20+30
		Setup and adjustment	Flat Lock	12+8	Flat Lock,OverLock	6+8	Over Lock,Flat Lock	25	OverLock	8,6	Single needle	12,8
		Folder error			Flat Lock	15	Single needle	10			Flat Lock	21+16
		Schedule maintenance	Flat Lock	22	Flat Lock	16						
26	1/31/2018	Machine Breakdown	Flat Lock	15	OverLock	20+24	Flat Lock	21+26	OverLock	10+18	OverLock	15+18
		Idling & Minor stoppages	Single needle	28	Flat Lock,OverLock	24,32	Single needle	12	OverLock	12	Flat Lock,OverLock	28,19
		Setup and adjustment	Flat Lock	6+8	Flat Lock	8,6	Flat Lock	15	Flat Lock	20	Flat Lock	15+20
		Folder error	Single needle	15+20	Single needle	16					Single needle	16
		Schedule maintenance	OverLock	16	Over Lock	27						
27	2/1/2018	Machine Breakdown	Flat Lock	20+22	OverLock	32	OverLock	15+20	Flat Lock	19+16	Single needle	24+32
		Idling & Minor stoppages	OverLock	24+32	Flat Lock,OverLock	15,12+8	Flat Lock,OverLock	16	Single needle	16	Flat Lock	20+30
		Setup and adjustment	Flat Lock,OverLock	20+30	Flat Lock	18	Flat Lock	20	Flat Lock	10	Single needle	12+8
		Folder error	Flat Lock	12+8			Flat Lock	24+12	Single needle	18	Flat Lock	15+20
		Schedule maintenance	Single needle	15			Single needle	14			Single needle	22
28	2/2/2018											
29	2/3/2018	Machine Breakdown	Over Lock	20	Flat Lock	26	Over Lock,Single needle	15,20	Flat Lock,OverLock	22,18	Flat Lock	33
		Idling & Minor stoppages	Flat Lock	15	OverLock	15+20	OverLock	14	Flat Lock	21+16	OverLock	16
		Setup and adjustment	OverLock	28	Flat Lock,OverLock	16	Flat Lock,OverLock	20	Single needle		Flat Lock,OverLock	15+20
		Folder error	Flat Lock	10+8	Flat Lock	20	Flat Lock	20	Flat Lock	15	Flat Lock	14
		Schedule maintenance			Single needle	16			Flat Lock	28		
30	2/4/2018	Machine Breakdown	Flat lock	24+28	Over Lock,Single needle	20,30	Flat Lock	21+26	OverLock	26+28	Flat Lock	20
		Idling & Minor stoppages	Single needle	20	OverLock	12+8	Single needle	12	Flat Lock,OverLock	15,20	Single needle	12+8
		Setup and adjustment	Flat lock	24,32	Flat Lock,OverLock	15+20	Over Lock,Single needle	15	Flat Lock	16	Flat Lock	21+16
		Folder error	Flat Lock	15	Flat Lock	23			Single needle	20	Single needle	12
		Schedule maintenance			OverLock	28	Flatlock	36			Single needle	15

Table 02: Downtime for several machines in traditional maintenance system

Day	Observation Date	Downtime name	Team 6		Team 7		Team 8		Team 9		Team 10	
			Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)
1	1/6/2018	Machine Breakdown	Flat Lock	28+30	Flat Lock,OverLock	25+20	OverLock	24	Single needle	22	Flat Lock	20
		Idling & Minor stoppages	OverLock	12	Flat Lock	10,8	Flat Lock	10	OverLock	10,8	OverLock	20+30
		Setup and adjustment	Flat Lock,OverLock	15,20	Single needle	12	Single needle	25	Over Lock,Flat Lock	12	Flat Lock,OverLock	12+8
		Folder error	Flat Lock	14	Flat Lock	20					Flat Lock	21+16
		Schedule maintenance	Single needle	16							Single needle	22
2	1/7/2018	Machine Breakdown	FlatLock,Singleneedle	28,16	OverLock	10+27	OverLock	21+16	Flat Lock	20+30	Single needle	15
		Idling & Minor stoppages	OverLock	16+13	Flat Lock,OverLock	19,16	Flat Lock,OverLock	10,8	Single needle	18	Flat Lock	28
		Setup and adjustment	Flat Lock	10	Flat Lock	15	Flat Lock	15	OverLock	10+7	Single needle	12+14
		Folder error	Single needle	15	Single needle	28	Single needle	17	Flat Lock	19+16	Flat Lock	22
		Schedule maintenance			Flat Lock	22					Flat Lock	20
3	1/8/2018	Machine Breakdown	Over Lock,Flat Lock	22+28	Single needle	22+18	Single needle	15+20	OverLock	25	OverLock	24+22
		Idling & Minor stoppages	OverLock	21+16	Flat Lock	21+16	OverLock	16	Over Lock,Flat Lock	20,30	Flat Lock,OverLock	10
		Setup and adjustment	Flat Lock,OverLock	10,18	Flat Lock	22	OverLock,Flat Lock	20	OverLock	12	OverLock	25
		Folder error	Flat Lock	15	OverLock	15	Single needle	24	Flat Lock,OverLock	15,20		
		Schedule maintenance	Single needle	28			Flat Lock	24				
4	1/9/2018	Machine Breakdown	Flat Lock	26	Flat Lock	26+23	Flat Lock	30	Single needle	20+30	OverLock	25+18
		Idling & Minor stoppages	OverLock	15,20	Flat Lock	15,20	Flat Lock	25	Flat Lock	12	Flat Lock	30
		Setup and adjustment	Flat Lock	16	Single needle	16	Flat Lock,OverLock	20,30	Flat Lock	10,8	Single needle	16
		Folder error					Flat Lock	12+8			Single needle	14
		Schedule maintenance	Single needle	12			Single needle	16				
5	1/10/2018	Machine Breakdown	Flat Lock	33	Flat Lock	28	Flat Lock	25	Flat Lock	20+35	OverLock	28+22
		Idling & Minor stoppages	OverLock	11+8	Single needle	12	Flat Lock	15	Single needle	10,7	Flat Lock,OverLock	12,16
		Setup and adjustment	Flat Lock,OverLock	15,20	OverLock	20	OverLock	28	Single needle	19+16	Flat Lock	20
		Folder error	Flat Lock	16	Flat Lock	17	Flat Lock	10+8	Single needle	16	Single needle	17
		Schedule maintenance									Flat Lock	15
6	1/11/2018	Machine Breakdown	Flat Lock	32+28	Flat Lock,OverLock	29,16	Single needle	16+22	Flatlock	38	Single needle	28
		Idling & Minor stoppages	Flat Lock,Over Lock	11,16	Flat Lock	20+30	Single needle	20	OverLock	14	Flat Lock	12+18
		Setup and adjustment	OverLock	18	Single needle	12+8	Flat Lock	32	Flat Lock	20	Flat Lock	15,20
		Folder error	flat lock	12	Flat Lock	21+16	Single needle	8+6	Single needle	20		
		Schedule maintenance	Single needle	25							Flat Lock	20
7	1/12/2018											
8	1/13/2018	Machine Breakdown	Flat Lock	35+30	Flat Lock	33	Flat Lock	25	Flat Lock,OverLock	21+26	Single needle	29
		Idling & Minor stoppages	OverLock	12	Single needle	12	Flat Lock	24	Flat Lock	16	Single needle	15
		Setup and adjustment	Flat Lock,OverLock	10,18	Flat Lock	20	OverLock	10	Single needle	15	Flat Lock	28
		Folder error	Single needle	12	Flat Lock,Single needle	12,8	Flat Lock,OverLock	15,10	Flat Lock	28	Flat Lock	15
		Schedule maintenance					Flat Lock	20	Single needle	14		
9	1/14/2018	Machine Breakdown	Over lock	25	Flat Lock,OverLock	29,26	Single needle	15+23	OverLock	25+20	Flat Lock,OverLock	21,16
		Idling & Minor stoppages	OverLock, flat lock	10,17	Single needle	17	Flat Lock	18	Flat Lock,OverLock	15,20	Single needle	14
		Setup and adjustment	Flat Lock,OverLock	19,16	Single needle,Flatlock	12,14	Single needle	12+8	Flat Lock	14	OverLock	15
		Folder error	Flat Lock	16			Flat Lock	21+16	Single needle	20	Flat Lock	18
		Schedule maintenance			Over Lock	17					OverLock	19

Day	Observation Date	Downtime name	Team 6		Team 7		Team 8		Team 9		Team 10	
			Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)
10	1/15/2018	Machine Breakdown	Flat Lock	38	Flat Lock	20	Flat Lock	15+25	OverLock	22+23	Flat Lock,OverLock	15,20
		Idling & Minor stoppages	OverLock	17+11	Single needle	11+9	Single needle	28	Over Lock,Flat Lock	21+16	Flat Lock	16
		Setup and adjustment	OverLock	20	OverLock	10,7	Flat Lock	6+8	OverLock	12	Single needle	18
		Folder error			Flat Lock	16	Flat Lock	20	Flat Lock	15	Flat Lock	15
		Schedule maintenance	Flat lock	30			OverLock	16				
11	1/16/2018	Machine Breakdown	Single needle	15+18	Flat Lock,OverLock	24,20	Flat Lock,OverLock	20	OverLock	20+25	Single needle	14+18
		Idling & Minor stoppages	OverLock,Flat lock	17,18	Flat Lock	16	Flat Lock	32	Overlock, Single needle	18,12	Flat Lock	19
		Setup and adjustment	OverLock	18	Single needle	18	Single needle	8,6	Flat Lock	10,7	Flat Lock	22
		Folder error	Flat Lock	10					Single needle	19,16		
		Schedule maintenance			OverLock	16			Single needle	12		
12	1/17/2018	Machine Breakdown	Over lock	34	Flat Lock	16+29	OverLock	12+26	OverLock	15+18	Flat Lock	25
		Idling & Minor stoppages	OverLock	8+11	Single needle	10	Flat Lock,OverLock	10,18	Over Lock,Flat Lock	10+18	Single needle	20
		Setup and adjustment	Flat Lock	18	Flat Lock	38	Flat Lock	12	OverLock	10+8	Single needle	16
		Folder error			Flat Lock	7+6	Single needle	8	Flat Lock	10+8	Flatlock	23
		Schedule maintenance	Over Lock	22							Over Lock	18
13	1/18/2018	Machine Breakdown	Flat Lock	38	Flat Lock,OverLock	30,25	Single needle	10,17	Single needle	20	OverLock	26
		Idling & Minor stoppages	OverLock	12	Single needle	25	Flat Lock	19,16	OverLock	10,17	Single needle	10+12
		Setup and adjustment	Flat Lock,OverLock	15,20	OverLock	20+30	Single needle	16	Over Lock,Flat Lock	19,16	OverLock	14
		Folder error	Single needle	14	Single needle,Flat Lock	15+20			Over Lock	20		
		Schedule maintenance			OverLock	14					Single needle	26
14	1/19/2018											
15	1/20/2018	Machine Breakdown	Single needle	15+20	Flat Lock	20	OverLock	20	Flat Lock,OverLock	19,16	Single needle	27
		Idling & Minor stoppages	OverLock	12	Flat Lock,OverLock	12,8	Flat Lock	21+16	Flat Lock	16	OverLock	24
		Setup and adjustment	Flat Lock	15+12	OverLock	21+16	Single needle	17	Single needle	10	Over Lock,Flat Lock	10
		Folder error	Single needle	14	Flat Lock	12	Flat Lock	15	Flat Lock	18		
		Schedule maintenance	Single needle	20					Flat Lock	13		
16	1/21/2018	Machine Breakdown	Flat Lock	28	OverLock	28	OverLock	26+18	OverLock	22	OverLock	20+22
		Idling & Minor stoppages	Single needle	12+8	Over Lock,Flat Lock	12	Flat Lock,OverLock	15,20	OverLock	34	Over Lock,Flat Lock	20,30
		Setup and adjustment	OverLock	21+16	OverLock	10+8	Flat Lock	16	Flat Lock	22	OverLock	12+8
		Folder error	Flat Lock	14	Flat Lock	12	Single needle	12	Single needle	14	Flat Lock	16
		Schedule maintenance	Over Lock	15								
17	1/22/2018	Machine Breakdown	Flat Lock,OverLock	28,26	Single needle	12+15	Flat Lock	32	Single needle	20,23	Flat Lock	32
		Idling & Minor stoppages	Flat Lock	16+18	Flat Lock	20	Single needle	20	Flat Lock	15	Single needle	28
		Setup and adjustment	Single needle	14	Single needle	12+8	Flat Lock	11+9	Single needle	20	Flat Lock	16+18
		Folder error	Flat Lock	20	Single needle	10+7	Flat Lock	10			Flat Lock	15+10
		Schedule maintenance					Over Lock	19			Over Lock	14
18	1/23/2018	Machine Breakdown	Single needle	12+23	Flat Lock	27	Flat Lock,OverLock	30+26	OverLock	19,26	Flat Lock,OverLock	35,20
		Idling & Minor stoppages	Flat Lock	14	OverLock	20	Flat Lock	10	Flat Lock,OverLock	16	Flat Lock	20+30
		Setup and adjustment	OverLock	20	Flat Lock,OverLock	21+16	Single needle	38	Flat Lock	10	Single needle	20
		Folder error	Single needle	14			Flat Lock	7+6	Single needle	8	Flat Lock	16
		Schedule maintenance	Over Lock	20	Flat Lock	15	Single needle	20				
19	1/24/2018	Machine Breakdown	Flat Lock	21+31	Single needle	28	Flat Lock	25	Flat Lock	20+28	Flat Lock	30
		Idling & Minor stoppages	Flat Lock,OverLock	15,10	Single needle	12	Single needle	8	OverLock	10,7	OverLock	28
		Setup and adjustment	Flat Lock	15	Flat Lock	15+20	Flat Lock	12+8	Flat Lock,OverLock	19,16	Flat Lock	15
		Folder error	Single needle	8	Flat Lock	17			Flat Lock	16	Single needle	18
		Schedule maintenance			Flat Lock	20			Single needle	18		

Day	Observation Date	Downtime name	Team 6		Team 7		Team 8		Team 9		Team 10	
			Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)
20	1/25/2018	Machine Breakdown	OverLock	20	Single needle	24+32	Flat Lock	25	Flat Lock	32	Flat Lock	32+28
		Idling & Minor stoppages	Flat Lock,OverLock	16,18	Flat Lock	18+16	Single needle	28	OverLock	20	Single needle	21+16
		Setup and adjustment	Single needle	20	Flat Lock	10+12	Over Lock,Flat Lock	6+8	Flat Lock	8+12	Flat Lock	32
		Folder error	Single needle	12			Flatlock	15	Single needle	10+7	Single needle	15
		Schedule maintenance	Flat Lock	20			Flat Lock	16	Flat Lock	19		
21	1/26/2018											
22	1/27/2018	Machine Breakdown	Single needle	15+20	Flat Lock	32	OverLock	32	Flat Lock	24+28	Single needle	15+20
		Idling & Minor stoppages	Over Lock	14+12	Single needle	10,8	Flat Lock	14+16	OverLock	10+16	OverLock	16
		Setup and adjustment	Flat Lock	20	Flat Lock	12	Single needle	6+14	Flat Lock,OverLock	15,10	Over Lock,Flat Lock	12+8
		Folder error	Single needle	13	Single needle	10	Flat Lock	15	Flat Lock	24		
		Schedule maintenance			Flat Lock	14					OverLock	26
23	1/28/2018	Machine Breakdown	Single needle	21+16	OverLock	15+20	Flat Lock	36+28	Flat Lock,OverLock	25,20	Flat Lock	35
		Idling & Minor stoppages	Over Lock	12+16	Flat Lock	16+18	Single needle	15+20	Flat Lock	20,30	Overlock	28
		Setup and adjustment	Flat Lock	15	Single needle	20	Flat Lock	16	Single needle	12+8	Flat Lock	18
		Folder error	Flatlock	18			Flat Lock	20	Flat Lock	11+16	Single needle	12+8
		Schedule maintenance			Over Lock	10					Flat Lock	21
24	1/29/2018	Machine Breakdown	Single needle	15+20	OverLock	25	Flat Lock,OverLock	38,26	OverLock	35	Single needle	25
		Idling & Minor stoppages	Flat lock	16+20	Flat Lock,OverLock	20,30	Flat Lock	20	Flat Lock,OverLock	28	OverLock	15
		Setup and adjustment	Over Lock,Flat Lock	20	Flat Lock	12+8	Single needle	16	Flat Lock	6+8	Over Lock,Flat Lock	28
		Folder error	Flat lock	15	Single needle	17	Single needle	12	Single needle	15		
		Schedule maintenance	OverLock	26					Flat Lock	16		
25	1/30/2018	Machine Breakdown	Flat Lock	24,32	Over Lock,Flat Lock	15,35	Single needle	24	Single needle	20	Flat Lock	28+26
		Idling & Minor stoppages	Single needle	24	OverLock	28	OverLock	10+12	Flat Lock	24,32	Flat Lock	20+30
		Setup and adjustment	Flat Lock	10	Flat Lock,OverLock	16+8	Over Lock,Flat Lock	10,15	OverLock	8,6	Single needle	12,8
		Folder error			Flat Lock	15					Flat Lock	17
		Schedule maintenance			Flat Lock	16					Flat Lock	12
26	1/31/2018	Machine Breakdown	Flat Lock	32+28	OverLock	22+20	Flat Lock	21+26	Overlock, Single needle	20,28	OverLock	17
		Idling & Minor stoppages	Single needle	21+16	Flat Lock,OverLock	24,32	Single needle	14+12	Overlock	12+10	Flat Lock,OverLock	28,20
		Setup and adjustment	Flat Lock	12+8	Flat Lock	15	Flat Lock	15	Flat Lock	20	Flat Lock	15+20
		Folder error	Single needle	15	Single needle	16	Flatlock	18			Single needle	16
		Schedule maintenance	OverLock	28			Flat Lock	14	Single needle	17		
27	2/1/2018	Machine Breakdown	Flat Lock	20	OverLock	32	OverLock	15,20	Flat Lock	19+16	Single needle	24,32
		Idling & Minor stoppages	OverLock	24+32	Flat Lock,OverLock	15,12+18	Flat Lock,OverLock	16	Single needle	16	Flat Lock	20+30
		Setup and adjustment	Flat Lock,OverLock	15,10	Flat Lock	18	Flat Lock	20	Flat Lock	10	Single needle	12+8
		Folder error	Flat Lock	12+8	Singleneedle	14	Flat Lock	14+12	Single needle	8	Flat Lock	15
		Schedule maintenance			OverLock	28					Single needle	22
28	2/2/2018											
29	2/3/2018	Machine Breakdown	Over Lock	24+32	Flat Lock	38	Over Lock,Single needle	25+20	Flat Lock,OverLock	27+18	Flat Lock	34
		Idling & Minor stoppages	Flat Lock	24	OverLock	15+20	OverLock	14+12	Flat Lock	21+16	OverLock	22
		Setup and adjustment	Over Lock	10	Flat Lock,OverLock	16	Flat Lock,OverLock	20	Single needle	26	Flat Lock,OverLock	15+20
		Folder error	Flat Lock	15	Flat Lock	20	Flat Lock	20	Flat Lock	15	Flat Lock	14
		Schedule maintenance	Single needle	20			Single needle	20	Flat Lock	28		
30	2/4/2018	Machine Breakdown	Flat lock	27+28	Over Lock,Single needle	20,30	Flat Lock	21+36	OverLock	26+23	Flat Lock	24+16
		Idling & Minor stoppages	Single needle,Over Lock	16,21	Over Lock	12+18	Single needle	12+18	Flat Lock,OverLock	15,20	Single needle	12+8
		Setup and adjustment	Flat lock	28	Flat Lock,Over Lock	15,20	Over Lock,Single needle	15	Flat Lock	16	Flat Lock	21+16
		Folder error	Flat Lock	15	Flat Lock	23			Single needle	10	Single needle	12
		Schedule maintenance			OverLock	28					Single needle	15

Table 03: Downtime for several machines in preventive maintenance scheduling system

Day	Observation Date	Downtime name	Team 1		Team 2		Team 3		Team 4		Team 5	
			Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)
1	5/2/2018	Machine Breakdown	Flat Lock	14	Over lock	12	Flat Lock	10	Single needle	8	Overlock	12
		Idling & Minor stoppages	Over Lock	6+7	Flat Lock	9	Single needle,Overlock	5,7	Flat Lock	6	Single needle	9
		Setup and adjustment	Flat Lock	12	Flat Lock	16	Flat Lock	11	Over lock	14	Flat Lock, Over lock	8,6
		Folder error	Single needle	9			Single needle	10			Single needle	7
		Schedule maintenance	Flat lock	16	Flat lock	14	Flat lock	17	Over Lock	18	Flat lock	14
2	5/3/2018	Machine Breakdown	Flat Lock	15	Over lock	14	Flat Lock	13	Single needle	9	Flat Lock	12
		Idling & Minor stoppages	Over Lock,Flatlock	8,6	Single needle	9	Single needle	14			Over Lock	6
		Setup and adjustment	Flat Lock	10	OverLock,Flat lock	6,8	Flat Lock	16	Flat Lock	8	Flat Lock	12
		Folder error							Single needle	11		
		Schedule maintenance	Over Lock	15	Single needle	10	OverLock	18	OverLock	15	Over lock	22
3	5/4/2018											
4	5/5/2018	Machine Breakdown	Flat Lock,Over Lock	12,9	Single needle	7	Flat Lock	14	Over lock	11	Flat Lock	16
		Idling & Minor stoppages	Over Lock	6	Single needle	13	Over Lock	12	Flat Lock	15	Over Lock	14
		Setup and adjustment	Flat Lock,	7	Over Lock	13	Flat Lock	7+8	Over Lock	7+6	Over lock	7
		Folder error	Single needle	12			Single needle	8				
		Schedule maintenance	Flat lock	18	Overlock	8	Flat lock	12	Single needle	10	Single needle	11
5	5/6/2018	Machine Breakdown	Over lock	10	Flat Lock	12	Over Lock, Single needle	10,6	Flat lock	15	Over Lock	10
		Idling & Minor stoppages	Single needle	7	Over Lock	9	Over Lock	5	Flat Lock	7	Flat Lock	12
		Setup and adjustment	Over Lock	8	Flat Lock	16	Over lock	13	Over Lock	14		
		Folder error			Single needle	7			Flat Lock	11	Single needle	9
		Schedule maintenance	Over lock	12	Flat lock	9	Flat Lock	11	Single needle	8	Flat Lock	16
6	5/7/2018	Machine Breakdown	Flat Lock	9	Flat Lock	14	Over Lock	8	Flat Lock	11	Single needle	13
		Idling & Minor stoppages	Flat Lock	10	Over Lock	6			Flat Lock	7	Over Lock	10
		Setup and adjustment	Over Lock,Flatlock	12,8	Flat Lock	4	Over lock	6	Over Lock, Flat lock	5,15	single needle	8
		Folder error			Single needle	8	Single needle	10				
		Schedule maintenance	Single needle	8	Over lock	11	Flatlock	12	Over lock	10	Flatlock	12
7	5/8/2018	Machine Breakdown	Over Lock	11	Single needle	7	Flat Lock	9+12	Single needle	6+8	Single needle	8
		Idling & Minor stoppages	Over Lock,Flatlock	5,6	OverLock	12	Single needle	8	Over Lock	6	Over Lock	5
		Setup and adjustment	Flat Lock	14	Flat Lock	6	Single needle	6	Flat Lock	8	Flat Lock	14
		Folder error	Flat Lock	11							Single needle	6
		Schedule maintenance	Single needle	8	Overlock	12	Single needle	11	Overlock	14	Single needle	10
8	5/9/2018	Machine Breakdown	Flat Lock	11	Flat Lock	10	Single needle	12	Over lock	13	Flat Lock	11
		Idling & Minor stoppages	Single needle	4	Single needle	5			Single needle	8	Single needle	8
		Setup and adjustment	Overlock	6	Overlock	8	Flat Lock	15			Overlock	12
		Folder error			Single needle	6			Single needle	9		
		Schedule maintenance	Flat lock	14	Flat lock	20	Overlock	16	Flat lock	14	OverLock	18

Day	Observation Date	Downtime name	Team 1		Team 2		Team 3		Team 4		Team 5	
			Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)
9	5/10/2018	Machine Breakdown	Over lock	8			Single needle	6	Over lock	7	Flat Lock	16
		Idling & Minor stoppages	Flat lock	4	Over Lock,flat lock	9,7			Over Lock	6	Over lock	5
		Setup and adjustment	OverLock	13	OverLock	11	OverLock	13	Over Lock	17	Single needle	7
		Folder error	Single needle	5					Single needle	7		
		Schedule maintenance	Flat Lock	10	Flat Lock	15	Over Lock	13	Flat Lock	11	Over Lock	13
10	5/11/2018											
11	5/12/2018	Machine Breakdown	Flat Lock	11	Flat Lock	9	Flat Lock	10	Single needle	6	Flat Lock	10
		Idling & Minor stoppages	Over Lock,Flatlock	7,8			Over lock	8	Flat lock	8	Single needle	6
		Setup and adjustment	Over lock	16	Flat Lock	15	Single needle	6	Over lock	7	OverLock	9
		Folder error	Flat Lock	10					Flat Lock	8		
		Schedule maintenance	Flat Lock	15	Flat Lock	12	Over Lock	12	Flat Lock	8	Over Lock	10
12	5/13/2018	Machine Breakdown	Over lock	10	Over lock	11+15	Flat Lock	18	Over lock	10	Over lock,Single needle	9,6
		Idling & Minor stoppages	Single needle	6	Overlock	7	Over Lock	11				
		Setup and adjustment	Flat Lock	12			Single needle	8	Flat Lock	10	Flat Lock	8
		Folder error			Single needle	10			Single needle	7		
		Schedule maintenance	Over Lock	12	Over Lock	11	Single needle	10	Over Lock	8	Flat Lock	13
13	5/14/2018	Machine Breakdown	Flat Lock	8	Flat Lock	16	Over Lock	6	Flat Lock	10		
		Idling & Minor stoppages	OverLock	5	Over Lock	15	Flat Lock	7	Over lock	6	OverLock	5
		Setup and adjustment	Flat lock,Over Lock	7,5	Flat Lock	12		12	OverLock, Flat lock	7,8		
		Folder error	Single needle	8	Single needle	5					Single needle	6
		Schedule maintenance	Flat lock	18	Flat lock	20	Flat Lock	22	Flat lock	16	Single needle	14
14	5/15/2018	Machine Breakdown	Flat Lock	9	Single needle	8	Over lock,Single needle	11,8	Flat Lock	17	Over Lock	10
		Idling & Minor stoppages			Over Lock	9	Single needle	8	OverLock	5	Flat Lock	6
		Setup and adjustment	Single needle	7	Over Lock	6	OverLock	9	Single needle	11		
		Folder error	Flat Lock	11					Flat Lock	7		
		Schedule maintenance	Over lock	14	Over lock	11	Over lock	16	Over lock	12	Flat Lock	15
15	5/16/2018	Machine Breakdown	Single needle	10	Over lock,Single needle	10,6	Over lock	9	Over lock	8	Single needle	6
		Idling & Minor stoppages	OverLock	7	Flat lock	10	Flat lock	15			Flat Lock	10
		Setup and adjustment	Flat Lock	12	Flat Lock	7	Flat Lock	8	Flat Lock	6	Single needle	5
		Folder error			Single needle	6	Single needle	10				
		Schedule maintenance	Over Lock	14	Over Lock	12	Over Lock	12	Single needle	11	Single needle	10
16	5/17/2018	Machine Breakdown	Flat Lock	12	Flat Lock	12	Flat Lock	10	Flat Lock	12	Flat Lock	12
		Idling & Minor stoppages	Single needle	7	Over lock	14	Single needle	6	Single needle	6	Single needle	13
		Setup and adjustment	OverLock	11	Flat Lock	9	OverLock	12	Flat Lock	7	OverLock	6
		Folder error	Single needle	6	Flat lock	9			Single needle	8		
		Schedule maintenance	Flat lock	12	Single needle	12	Overlock	18	Flatlock	20	Single needle	12
17	5/18/2018											
18	5/19/2018	Machine Breakdown	Over lock	8	Flatlock	11	Singleneedle	8	Single needle	11	Over lock	9
		Idling & Minor stoppages	Flat lock,Over Lock	6,8	Over Lock, Single needle	8,7	OverLock, Single needle	4,6	OverLock, Flat lock	9,7	OverLock, Single needle	6,8
		Setup and adjustment	OverLock	7	Flat Lock	7+6	Flat Lock,Single needle	7,5	Flat Lock	11	OverLock	7
		Folder error	Flat Lock	7			Flat Lock	8			Flat Lock	11
		Schedule maintenance	Over lock	13	Over lock	10	Single needle	16	Over lock	12	Single needle	10
19	5/20/2018	Machine Breakdown	Flat Lock	11	Single needle	5+8	Flat Lock	15+9	Flat Lock	12	Single needle	8
		Idling & Minor stoppages	Flat Lock	9+8	Flat Lock	11	Flat Lock	15	Flat Lock	13	Flat Lock	9
		Setup and adjustment	Over Lock,Flat lock	8,5	Over Lock	9	Over Lock	8	Single needle	7	OverLock	7
		Folder error			Single needle	11					Single needle	5
		Schedule maintenance	Over lock	12	Over lock	14	Single needle	17	Single needle	9	Over lock	13

Day	Observation Date	Downtime name	Team 1		Team 2		Team 3		Team 4		Team 5	
			Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)
20	5/21/2018	Machine Breakdown	Single needle	7	Single needle	6	Flatlock	9			Single needle	5
		Idling & Minor stoppages	Over Lock	5			Over Lock	8	Over Lock	6+8	Over Lock	6
		Setup and adjustment	Flat Lock,	10	Single needle	8	Flat Lock	10	Single needle	7	Flat Lock	7
		Folder error										
		Schedule maintenance	Single needle	10	OverLock	13	Flat lock	18	Over Lock	10	Single needle	8
21	5/22/2018	Machine Breakdown	Over lock	11	Flat Lock	12	Flat Lock	10	Over lock	7	Flat Lock	16
		Idling & Minor stoppages	Single needle	6	Single needle	6			Single needle	8	Single needle	13
		Setup and adjustment	Over Lock	17	Flat Lock	8	Flat Lock	12	OverLock	7	Flat Lock	12
		Folder error										
		Schedule maintenance	Flat lock	17	Flat lock	11	Flat Lock	18	Flat lock	20	Flat lock	11
22	5/23/2018	Machine Breakdown	Over lock	15	Over lock	10					Over lock	15
		Idling & Minor stoppages	Flat lock	6	Flat lock	7	Over lock	9	Flat lock	11	Single needle	5
		Setup and adjustment	OverLock	8	Over Lock	12	Single needle	6	OverLock	8	Over lock	8
		Folder error			Single needle	6						
		Schedule maintenance	Over Lock	14	Over Lock	16	Flat Lock	12	Over Lock	14	Over Lock	12
23	5/24/2018	Machine Breakdown	Flat Lock	12	Single needle	9	Over lock	8	Flat Lock	12	Flat Lock	10
		Idling & Minor stoppages			Flat lock	7	Single needle	6	Over Lock	7+8	Over Lock,Flat lock	7,12
		Setup and adjustment	OverLock	18	Single needle	11	Flat Lock	5	Over Lock	18		
		Folder error	Single needle	5	Flatlock	10	Single needle	7	Single needle	6	Single needle	5
		Schedule maintenance	Single needle	16	Flat Lock	18	Single needle	12	Flat lock	10	Flat Lock	18
24	5/25/2018											
25	5/26/2018	Machine Breakdown	Flatlock,Overlock	10,7	Over lock	7			Flat Lock	14	Over lock	12
		Idling & Minor stoppages	Over Lock	8	Single needle	6	overLock	9			Single needle	9
		Setup and adjustment	Flat Lock	10	Flat Lock	12	Flat Lock	9+7	Flat Lock	24	Flat Lock	10
		Folder error			Flat Lock	10			Flat Lock	10		
		Schedule maintenance	Over Lock	14	Over Lock	17	Over Lock	14	Over Lock	15	Over Lock	14
26	5/27/2018	Machine Breakdown	Flat Lock	11	Flat Lock	11	Single needle	8	Flat Lock	12		
		Idling & Minor stoppages	Over Lock	12	Over Lock	7	Over Lock	7	Single needle	3		
		Setup and adjustment	Flat Lock	8	Over lock	11			Flat Lock	5	Flat Lock	7
		Folder error	Single needle	10			Single needle	6	Single needle	8		
		Schedule maintenance	Flat lock	18	Flat Lock	10	Flat lock	18	Flat lock	10	Flat lock	18
27	5/28/2018	Machine Breakdown	Flat Lock	10	OverLock	13	Flat Lock	10	Flat Lock,Over lock	10,8	Over lock	10
		Idling & Minor stoppages	Single needle	5			Flat lock	11	Over Lock	6	Flat Lock	8
		Setup and adjustment	Over Lock	14	Over lock	14	OverLock	14	OverLock	4	Flat Lock	14
		Folder error			Single needle	8	Single needle	6				
		Schedule maintenance	Single needle	10	OverLock	17	Single needle	8	Single needle	15	Flatlock	12
28	5/29/2018	Machine Breakdown	Flat Lock	11	Flat Lock	12	Over lock	8	Flat Lock	11	Over lock	7
		Idling & Minor stoppages	Over Lock	6	Single needle	10			Over Lock	6	Single needle	8
		Setup and adjustment	Flat Lock	6			Flat Lock	14			Over Lock	10
		Folder error			Flat Lock	13			Single needle	10	Flat Lock	12
		Schedule maintenance	Flat lock	12	Single needle	11	Flat lock	14	Flat lock	12	Overlock	14
29	5/30/2018	Machine Breakdown	Flat Lock	9+7	Over Lock	8	Flat Lock	12	Flat Lock	9	Single needle	5
		Idling & Minor stoppages	Over Lock,Flat lock	11	Single needle	5	Over Lock,Flat lock	10	Over Lock,Flat lock	12	Flat Lock	5+7
		Setup and adjustment	Single needle	12	Over Lock	7+6	OverLock	7,5	Over Lock	7,8	Overlock	8
		Folder error	Flat Lock	10			Single needle	14	Flat Lock	8		
		Schedule maintenance	Over Lock	14	Flat Lock	18	Flat Lock	12	Single needle	8	Single needle	10
30	5/31/2018	Machine Breakdown	Flat Lock	15	Over Lock	10	Flat Lock	11	Flat Lock	14	Single needle	12
		Idling & Minor stoppages	Single needle	7	Overlock	7	Single needle	7	Single needle	3	Over Lock	7
		Setup and adjustment	Singleneedle	12	FlatLock,Over Lock	7,8	OverLock	15	Flat Lock	12	Over Lock	6
		Folder error			Flat Lock	12	Single needle	7			Flat Lock	11
		Schedule maintenance	Flatlock	15	Single needle	16	Overlock	20	Single needle	19	Overlock	14

Table 04: Downtime for several machines in preventive maintenance scheduling system

Day	Observation Date	Downtime name	Team 6		Team 7		Team 8		Team 9		Team 10	
			Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)
1	5/2/2018	Machine Breakdown	Flat Lock,Over Lock	10,8	Over lock	10	Flat Lock	11	Single needle	14	Flat Lock	17
		Idling & Minor stoppages	Flat Lock	12	Over Lock	6+5			Flat Lock,Over Lock	8,5	Over Lock	9
		Setup and adjustment	Single needle	7	Flat Lock	14	Over lock	8	Flat Lock	12	Flat Lock	12
		Folder error	Flat Lock	11	Single needle	12					Single needle	14
		Schedule maintenance	Flat Lock	10	Flat lock	17	Flat lock	16	Flat Lock	13	Flat lock	10
2	5/3/2018	Machine Breakdown	Over Lock	11	Flat Lock	15	Flat Lock,Over Lock	10,8	Flat Lock	15	Flat Lock	16+13
		Idling & Minor stoppages	Flat Lock	16	Flat lock,Over Lock	7,6	Flat Lock	12	OverLock	7+6		
		Setup and adjustment	Flat Lock	10	Flat Lock	24	Single needle	20	Flat Lock	14	Flat Lock	11
		Folder error			Single needle	10	Flat Lock	16	Flat Lock	10	Single needle	12
		Schedule maintenance	Single needle	13	Over Lock	15	Flat Lock	14	Single needle	11	Flat Lock	15
3	5/4/2018											
4	5/5/2018	Machine Breakdown	Flat Lock	12	Flat Lock	16	Flat Lock,Over Lock	17,8	OverLock	16	Over Lock	12
		Idling & Minor stoppages	Over Lock	10	Over Lock	8	Flat Lock	7	Over Lock,Flat Lock	6,8	Flat Lock,Over Lock	8,10
		Setup and adjustment	Flat Lock	14	Flat Lock,Over Lock	7,4	Single needle	12	Over Lock	14	Flat Lock	12
		Folder error	Single needle	11					Flat Lock	12		
		Schedule maintenance	Flat lock	12	Single needle	20	Over Lock	30	Flat Lock	32	Single needle	9+7
5	5/6/2018	Machine Breakdown	Over lock	10	Flatlock	25	Over Lock,Flat Lock	10,13	OverLock	10	Over Lock	11
		Idling & Minor stoppages	Single needle	6	Flat Lock	6	Over Lock	9+7	Over Lock	6		
		Setup and adjustment	Flat Lock,Over Lock	12,8	Single needle	9+7	Flat Lock,Over Lock	11	Overlock	9+7	OverLock	10
		Folder error	Flat Lock	8	Flat Lock	11	Flat Lock	12	Single needle	11	Flat Lock	10
		Schedule maintenance	Over lock	10	Flat Lock	22	OverLock	15	Flat Lock	12	Single needle	9
6	5/7/2018	Machine Breakdown	Flat Lock	9	Over Lock	12					Flat Lock	12
		Idling & Minor stoppages	Flat Lock	7	Flat Lock,Over Lock	5,6	Flat Lock	12	Flat Lock,Over Lock	8,8	Single needle	12
		Setup and adjustment	Over Lock, Flat lock	8,7	OverLock	5+7	Single needle	20	Flat Lock	6+7	Flat Lock	20
		Folder error			Flatlock	12					Flat Lock	13
		Schedule maintenance	Over lock	20	Flat Lock,Over Lock	22,18	Flat Lock	34	Flat Lock,Over Lock	20,16	OverLock	23
7	5/8/2018	Machine Breakdown	Single needle	8	Over Lock	14	Single needle	11	Flat Lock	14		
		Idling & Minor stoppages	Over Lock	8			Over Lock	10	Single needle	3+5	Flat Lock	10
		Setup and adjustment	Flat Lock,Single needle	12,4	Single needle	10	Over Lock,Flat Lock	8+12	Flat Lock	12	Single needle	10
		Folder error					Single needle	8	Flat Lock	13	Flat Lock	14
		Schedule maintenance	Single needle	18	Over Lock,Flat Lock	18,20	Flat Lock,OverLock	12,14	OverLock	18	Single needle	10
8	5/9/2018	Machine Breakdown	Flat Lock	13	Over Lock	15	Flat Lock,Over lock	16,13	Flat Lock,Over Lock	15,10	Flat Lock	14
		Idling & Minor stoppages	Single needle	6	Flat Lock,Over Lock	5,8	Single needle	7	Flat Lock	11	Over Lock	12
		Setup and adjustment	Flat Lock,Over Lock	10,8	Flat Lock	12	Flat Lock	12	Single needle	6	Flat Lock	15
		Folder error	Single needle	14	Single needle	8			Overlock	12		
		Schedule maintenance	Flat lock	24	Flat Lock	24	Over Lock,Flat Lock	12,14	Flatlock	20	Flat Lock,Over Lock	16,14
9	5/10/2018	Machine Breakdown	Over lock	12	Single needle	7	Over Lock	9	Flat Lock	12	Flat Lock	9+10
		Idling & Minor stoppages	Over Lock, Flat lock	6,9	Flat Lock	16	Flat Lock,Over Lock	9+7	Over Lock	10+7	Single needle	6+7
		Setup and adjustment	OverLock	14	Flat Lock	13	Flat Lock	11	Single needle	19+16	Over Lock,Flat Lock	13,5
		Folder error	Single needle	11			Flat Lock	10			Flatlock	10
		Schedule maintenance	Over Lock	20	Flat Lock	22	Single needle	14	Single needle	10	Flat Lock,Over Lock	25,20
10	5/11/2018											

Day	Observation Date	Downtime name	Team 6		Team 7		Team 8		Team 9		Team 10	
			Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)
11	5/12/2018	Machine Breakdown	Over Lock	12	Single needle	6+5	Over Lock	15	Flat Lock	14	OverLock	9
		Idling & Minor stoppages	Flat Lock	7	Single needle	7+8	Flat Lock	12			Flat Lock	8
		Setup and adjustment	Single needle	18	Flat Lock	14	Single needle	20	Over Lock	24	Single needle	12
		Folder error			Flat Lock	10	Flat Lock	14	Single needle	10	Flat Lock	10
		Schedule maintenance	Over Lock,Flat Lock	14,16	Over Lock	14	Flat Lock	12	Flat Lock	15	Flat Lock,Over Lock	14,22
12	5/13/2018	Machine Breakdown	Over Lock	15	Flat Lock,Over Lock	14,12	Over Lock	9+10	Over lock	20	Flat Lock	14
		Idling & Minor stoppages	Flat Lock,Over Lock	8,10	Flatlock	8	Flat Lock,Over Lock	8,11	Single needle,Over Lock	4,8	Single needle	8
		Setup and adjustment	Flat Lock	10	Single needle	12	Flat Lock	11	Overlock	10+8	Flat Lock	14
		Folder error	Single needle	15	Flat Lock	13	Single needle	14	Single needle	12	Flat Lock	13
		Schedule maintenance	Flat Lock	24	OverLock	22	Flat Lock	18	Over Lock	20	OverLock	16
13	5/14/2018	Machine Breakdown	Single needle	10	Flat Lock	12	Single needle	10	Flat Lock	12	Over Lock	12
		Idling & Minor stoppages	Over Lock	6	Single needle	5+4	Flat Lock	5+5	OverLock	10	Flat Lock	12
		Setup and adjustment	Over Lock,Flat Lock	12,9	Single needle	8+7	Flat Lock	12	Flat Lock	16	Single needle	6
		Folder error	Single needle	10	Single needle	8					Flatlock	12
		Schedule maintenance	Flat Lock	20	Single needle	14	Flat Lock,Over Lock	10+8	Flat lock	18	Flat Lock	16
14	5/15/2018	Machine Breakdown	Flat Lock	10	Single needle	6	Flat Lock	12	Flat Lock	14	Single needle	8
		Idling & Minor stoppages	Single needle	4+6	Flat Lock	9	Flat Lock	6	Overlock	3+6	OverLock	7+5
		Setup and adjustment	Flat Lock,Over Lock	7,8	Flat Lock	9			Over Lock	10	Over Lock,Flat Lock	7,9
		Folder error					Single needle	7	Flat Lock	11	Single needle	8
		Schedule maintenance	Single needle	11	Flat Lock,Over Lock	7,8	Over Lock	16	Over lock	15	Flat Lock,Over Lock	19,18
15	5/16/2018	Machine Breakdown	Flat Lock	18	Flat Lock	12	Flat Lock	16	Over lock	8	Flat Lock	20
		Idling & Minor stoppages	Flat Lock	12	Single needle	8	Single needle	10	Flat lock	10	Single needle	10
		Setup and adjustment	Over Lock	22	Single needle	16	Over Lock	15	Flat Lock	20	Flat Lock	24
		Folder error	Flat Lock	14	Single needle	8	Flat Lock	6				
		Schedule maintenance	Flat Lock	22	Over Lock,Flat Lock	18,22	Over Lock	20	Flatlock	24	Over Lock,Flat Lock	18,20
16	5/17/2018	Machine Breakdown	Single needle	9	Over Lock	12	Flat Lock,Over Lock	14,11	Flat Lock	12	Over Lock	10
		Idling & Minor stoppages	Single needle	5			Flat Lock	11	Single needle	8	Flat Lock,Over Lock	8,6
		Setup and adjustment	Flat Lock	10	Over Lock	12	Single needle	5	Flat Lock	12	Flat Lock	8
		Folder error	Single needle	15					Single needle	14	Flat Lock	12
		Schedule maintenance	Overlock	12	Single needle	8	Single needle	9	Single needle	12	Single needle	10
17	5/18/2018											
18	5/19/2018	Machine Breakdown	Flat lock	16	Over lock	7	Overlock	12	Flat lock	17	Over Lock	12
		Idling & Minor stoppages	Flat Lock	11	Singleneedle	6	Over Lock, Single needle	7,9	Over Lock, Flat lock	6+8		
		Setup and adjustment	Over Lock	16	Flat Lock,Over Lock	10,9	Flat Lock,Over Lock	6,8	Flat Lock,Over Lock	7,8	Single needle	8
		Folder error			Flat Lock	10			Flat Lock	12		
		Schedule maintenance	Flat Lock	18	Over lock	14	Over lock	16	Over lock	20	Flat Lock	30
19	5/20/2018	Machine Breakdown	Single needle	7	Flat Lock	9	Flat Lock	13	Flat Lock	12	Over Lock	14
		Idling & Minor stoppages	Flat Lock	15	Flat Lock	11	Flat Lock	16	Flat Lock	6+13	Flat Lock,Over Lock	9
		Setup and adjustment	Single needle	6+3	OverLock, Flat lock	12,10	Single needle	10	Over Lock, Flat lock	9,7	Flat Lock	11
		Folder error	Flat Lock	9+7	Single needle	32	Single needle	8	Single needle	11	Single needle	12
		Schedule maintenance	Flat Lock,Over Lock	21,10	Over lock	15	Over lock	17+16	Over lock	20	Flat Lock	22
20	5/21/2018	Machine Breakdown	Flat Lock	11	Single needle	17	Flat Lock	11	Single needle	8	Single needle	6
		Idling & Minor stoppages	Single needle	14	Over Lock	16			Over Lock	13+5	Over Lock	7
		Setup and adjustment	Flat Lock	8	Flat Lock	20	Flat Lock	10	Flat Lock	17	Over Lock,Flat Lock	8,18
		Folder error	Flat Lock	7			Flat Lock	13			Single needle	10
		Schedule maintenance	Over Lock	12	Single needle	8	Single needle	20	Single needle	20	Flat Lock,Over Lock	16,14

Day	Observation Date	Downtime name	Team 6		Team 7		Team 8		Team 9		Team 10	
			Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)	Machine name	Downtime (min)
21	5/22/2018	Machine Breakdown	Flat Lock	10	Flat Lock	15	Flat Lock	12	Flat Lock	14	Flat Lock	15
		Idling & Minor stoppages	Flat Lock	3+5	Single needle	8	Single needle	10,8	Single needle	3+5	Overlock	12
		Setup and adjustment	Single needle	12	Over Lock	10	Flat Lock	12			Flat Lock,Over Lock	11,10
		Folder error					Single needle	15				
		Schedule maintenance	Flat Lock	18			Flat lock	16	Flat lock	18	Single needle	15
22	5/23/2018	Machine Breakdown	Over Lock	15	Over lock	10+8	Over lock	11	Over lock	15	Flat Lock	8
		Idling & Minor stoppages	Flat Lock	7+8	Flat lock	14			Over Lock, Flat lock	5,6	Flat Lock	10+8
		Setup and adjustment	Flat Lock	8	Over Lock	11	Single needle	8	Over Lock	10	Over Lock	14
		Folder error	Single needle	14	Single needle	12					Flat Lock	13
		Schedule maintenance	Flat Lock	16	Over Lock	13	Over Lock	14	Over Lock	12	Flat Lock	15
23	5/24/2018	Machine Breakdown	Single needle	8	Flat Lock	13	Flat Lock	9	Flat Lock	14	Single needle	14
		Idling & Minor stoppages	Over lock	7+10			Over Lock, Flat lock	6,8	Over Lock, Flat lock	7,9	Single needle	8
		Setup and adjustment	Single needle	6	Over Lock	16	Over Lock	11	Over Lock	7	Flat Lock	15
		Folder error			Single needle	11	Single needle	8	Single needle	10	Single needle	7
		Schedule maintenance	Over Lock	24	Single needle	10	Flat Lock	16	Flat Lock	14	Over Lock	18
24	5/25/2018											
25	5/26/2018	Machine Breakdown	Over Lock	15	Flat Lock,Over Lock	18,16	Over lock,Single needle	10,7	Flat Lock	12	Single needle	6
		Idling & Minor stoppages	Flat Lock	12	Flat Lock	11	Single needle	8	Over Lock	6	Flat Lock	14
		Setup and adjustment	Single needle	10	Single needle	12	Flat Lock	13	Flat Lock,Over Lock	10,6	Over Lock	8
		Folder error	Flat Lock	11			Flat Lock	14			Single needle	12
		Schedule maintenance	Flat Lock	12	Flat Lock	22	Over Lock	14	Single needle	8	Flat Lock	13
26	5/27/2018	Machine Breakdown	Over Lock	11	Over Lock	12	Flat Lock	18	Single needle	11	Single needle	8
		Idling & Minor stoppages	Flat Lock,Over Lock	12,8	Flat Lock,Over Lock	13,5	Over Lock	12	Flat Lock	8	Flat Lock	10
		Setup and adjustment	Flat Lock	12	Flat Lock	22	Flat Lock	6	Single needle	5	Single needle	13
		Folder error	Single needle	10	Single needle	14			Flat Lock	10		
		Schedule maintenance	Flat Lock	18	Over lock	15	Flat lock	18	Single needle	14	Flat Lock	18
27	5/28/2018	Machine Breakdown	Flat Lock	13	Single needle	12	Flat Lock	10	Over Lock	12+10	Flat Lock	14
		Idling & Minor stoppages	Single needle	7+5	Flat Lock	8	Over Lock, Flat lock	9,6	Flat Lock,Over Lock	4,5	Single needle	4
		Setup and adjustment	Flat Lock	8	Flat Lock	7	Over Lock	4	OverLock	9	Flat Lock	8
		Folder error	Flat Lock	12			Single needle	10	Single needle	12	Flat Lock	7
		Schedule maintenance	Over Lock	20	Flat Lock	19	Single needle	15	Over Lock	12	Over Lock	14
28	5/29/2018	Machine Breakdown	Flat Lock,Over Lock	12,8	Flat Lock	11	Flat Lock	13	Over Lock	16	Flat Lock	9
		Idling & Minor stoppages	Flat Lock	10	Flat Lock	11	Over Lock	14	Flat Lock	8	Flat Lock	7
		Setup and adjustment	Single needle	9+8	Single needle	7+8	Flat Lock,	19	Single needle	10	Single needle	11
		Folder error	Flat Lock	11								
		Schedule maintenance	Single needle	13	Over Lock	15	Flat lock	14	Flat Lock	14	Single needle	16
29	5/30/2018	Machine Breakdown	Flat Lock	11	Flat Lock	16	Flat Lock	18	Over Lock	11	Single needle	8+6
		Idling & Minor stoppages	Overlock	12	Single needle	10	Over Lock,Flat lock	12,14	Flat Lock,Over Lock	7,5	Flat Lock,Over Lock	14,6
		Setup and adjustment	Flat Lock	8	Over Lock	13	Over Lock	7+8	Flat Lock	16	Flat Lock	7
		Folder error			Flat Lock	7	Flat Lock	14	Single needle	6	Single needle	11
		Schedule maintenance	Over Lock	16	Over Lock	12	Flat Lock	12	Single needle	12	Flat Lock	15
30	5/31/2018	Machine Breakdown	Flat Lock	12	Flat Lock	14	Over Lock	8	Single needle	7	Single needle	10
		Idling & Minor stoppages	Single needle	8+7	Flat Lock	10	Single needle	6	Flat Lock	8	Flat Lock	8+9
		Setup and adjustment	Over Lock	14	Single needle	15	Flat Lock	8	Flat Lock	6	Single needle	17
		Folder error	Flatlock	12			Single needle	8			Single needle	10
		Schedule maintenance	Flat Lock	16	Single needle	12	Single needle	13	Over Lock	15	Flat Lock	14

APPENDIX - B

Machine Wise Observation Data (4 weeks)

Model: SNL-24

SL.	Current Status Criteria	Rating	6/May/18	7/May/18	8/May/18	9/May/18	10/May/18	11/May/18	12/May/18	13/May/18	14/May/18	15/May/18	16/May/18	17/May/18	18/May/18	19/May/18	20/May/18	21/May/18	22/May/18	23/May/18	24/May/18	25/May/18	26/May/18	27/May/18	28/May/18	29/May/18	30/May/18	31/May/18	1/Jun/18	2/Jun/18	3/Jun/18	4/Jun/18	Total Rating	Remarks
1	Power button works or not?	10	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		×	√	√	10	
2	Needle position/ condition ok or not?	3	×	√	×	√	√		√	×	√	√	√	×		√	√	√	√	√	√		×	×	×	√	√	√		×	√	×	27	
3	How is Pressure foot condition?	5	√	√	√	√	√		√	√	×	×	√	√		×	×	√	√	√	√		√	√	√	×	×	√		√	√	√	30	
4	Thread Sequence/Stitching quality?	3	√	√	×	×	×		√	×	√	√	√	√		√	√	×	×	×	×		√	√	√	√	√	√		√	×	×	30	
5	Bobbin case thread tension ok or not?	2	×	√	√	×	√		√	√	×	×	√	√		√	√	×	√	√	×		×	√	√	√	√	×		√	√	√	16	
6	Motor speed sufficient or not?	4	√	√	√	×	√		×	√	√	√	√	√		×	×	√	√	√	√		√	√	√	√	×	√		×	√	√	24	
7	Pulley works smoothly or not?	6	√	√	×	√	×		√	√	√	×	×	√		√	√	×	×	×	√		√	×	√	×	×	√		√	√	√	60	
8	Motor sound condition normal or abnormal?	7	√	×	×	√	√		√	√	√	√	×	×		√	×	√	√	×	√		√	√	×	√	×	√		√	√	√	56	
9	Temperature of machine normal or not?	4	×	√	√	√	√		×	√	×	×	√	√		√	√	×	√	√	×		×	√	×	√	√	×		√	×	×	44	
10	What is Thread stand position(tight/straight)?	1	×	√	√	√	√		×	×	√	√	×	×		√	√	√	×	√	√		×	×	√	×	√	√		×	√	×	11	
11	Oil filter of the machine is cleaned or not?	5	√	×	√	√	×		√	√	√	√	√	√		×	×	×	×	×	√		√	√	√	√	×	√		√	√	√	40	
12	What is Oil Level or condition of the machine?	7	×	√	×	√	√		×	√	√	√	√	√		√	√	√	√	√	√		√	×	×	×	√	√		√	×	×	56	
13	Spring Operation of the machine is ok or not?	5	√	√	√	×	×		√	√	√	√	√	√		√	√	√	√	√	×		×	×	√	√	×	√		√	×	√	35	
14	How is Brake Position of the machine?	2	×	×	√	√	√		√	×	×	×	√	√		×	√	√	×	√	√		√	×	×	√	×	√		√	√	√	20	
15	What is the condition of Treadle(loseness or operation)?	7	√	×	×	×	×		√	√	√	√	√	√		√	√	√	√	×	√		√	√	√	×	×	×		√	√	√	56	
16	Oil Flow to Rotary Hook properly or not?	9	√	√	√	√	√		√	√	√	√	×	×		×	√	√	×	√	√		√	√	√	√	×	√		√	×	√	54	
17	What is the condition of belt?	6	√	√	√	√	√		√	√	×	×	√	√		√	√	×	×	√	√		√	√	√	√	×	×		×	√	√	42	
18	Belt Tension of the machne ok or not?	8	×	×	√	√	√		√	×	×	×	√	√		×	√	√	√	×	×		√	√	√	√	√	×		√	√	×	80	
19	Bobbin Winder Operation running or not?	2	√	√	√	√	√		√	√	√	√	×	×		√	√	√	×	√	√		√	×	×	×	√	√		√	√	√	12	
20	Cleaned machine thoroughly or not?	1	√	√	×	×	×		√	×	×	√	√	√		√	×	√	√	√	×		×	√	√	×	×	×		×	√	√	12	
21	What is the Condition of Rotary Hook?	8	√	√	√	×	√		√	√	×	√	√	×		√	√	×	√	√	√		√	√	×	×	√	√		√	×	√	56	
22	What is the condition of Feed Dog Height?	6	×	×	×	√	√		×	√	√	×	×	√		√	×	√	√	×	×		×	×	√	√	√	√		√	√	√	66	
23	Hook Timing is properly doing or not?	10	√	√	√	√	√		√	√	√	√	√	√		×	√	×	×	√	√		√	√	√	√	√	√		√	√	√	12	
24	Machine maintenance/servicing is occurred or not?	4	√	√	√	×	×		×	×	×	√	√	√		×	√	√	√	√	×		×	√	×	√	×	×		√	√	×	48	
25	Oil Change of the machine done or not?	3	×	×	×	×	×		×	×	×	×	×	×		×	×	×	×	×	×		×	×	√	×	×	×		×	×	×	75	
26	Presser Foot Sole Condition good or bad?	1	√	√	×	√	√		√	√	√	×	√	×		√	√	×	×	×	√		√	√	√	√	√	√		√	×	√	7	
																																	979	

Machine Wise Observation Data (4 weeks)

Model: SNL-70																																				
SL.	**Current Status Criteria**	**Rating**	**6/May/18**	**7/May/18**	**8/May/18**	**9/May/18**	**10/May/18**	**11/May/18**	**12/May/18**	**13/May/18**	**14/May/18**	**15/May/18**	**16/May/18**	**17/May/18**	**18/May/18**	**19/May/18**	**20/May/18**	**21/May/18**	**22/May/18**	**23/May/18**	**24/May/18**	**25/May/18**	**26/May/18**	**27/May/18**	**28/May/18**	**29/May/18**	**30/May/18**	**31/May/18**	**1/Jun/18**	**2/Jun/18**	**3/Jun/18**	**4/Jun/18**	**Total Rating**	**Remarks**
1	Power button works or not?	10	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	0	
2	Needle position/ condition ok or not?	3	×	×	×	√	√		×	×	×	√	√	√		√	√	√	×	√	√		√	×	×	×	×	×		√	√	√	36	
3	How is Pressure foot condition?	5	×	√	√	√	√		×	√	√	√	×	√		×	√	√	√	√	×		√	√	√	×	×	×		×	√	√	45	
4	Thread Sequence/Stitching quality?	3	√	√	×	×	×		√	√	×	√	√	√		×	×	√	×	√	√		×	√	√	√	√	√		√	×	×	30	
5	Bobbin case thread tension ok or not?	2	√	√	√	√	√		√	√	√	√	×	×		√	√	×	√	×	√		√	√	×	√	√	×		√	√	√	12	
6	Motor speed sufficient or not?	4	√	×	√	√	√		√	×	√	×	√	√		√	√	√	√	√	×		×	√	×	×	×	√		×	√	√	36	
7	Pulley works smoothly or not?	6	×	√	×	×	×		√	√	×	×	√	√		√	√	√	√	√	×		√	×	√	√	×	√		√	×	×	66	
8	Motor sound condition normal or abnormal?	7	√	×	√	√	√		√	√	√	×	√	√		√	√	×	×	×	√		√	√	√	√	√	√		√	×	√	42	
9	Temperature of machine normal or not?	4	√	√	√	×	√		√	√	√	√	×	×		√	√	√	×	√	√		√	√	×	×	√	×		√	√	×	32	
10	What is Thread stand position(tight/straight)?	1	×	√	×	√	×		×	√	×	√	√	×		√	×	√	√	√	√		√	×	√	√	√	√		×	√	√	9	
11	Oil filter of the machine is cleaned or not?	5	√	√	√	√	√		×	×	×	×	√	√		√	√	√	√	×	×		√	×	×	√	×	√		√	×	×	55	
12	What is Oil Level or condition of the machine?	7	√	×	×	×	√		√	×	×	√	√	√		×	√	√	√	√	×		×	√	√	√	√	×		×	√	√	63	
13	Spring Operation of the machine is ok or not?	5	×	√	√	×	×		×	√	√	√	×	×		×	×	√	×	×	√		√	×	√	√	√	×		√	√	√	60	
14	How is Brake Position of the machine?	2	×	×	×	√	√		√	√	√	√	√	√		√	×	×	×	√	√		√	×	×	×	×	√		√	√	√	20	
15	What is the condition of Treadle(loseness or operation)?	7	√	√	√	√	√		√	√	√	×	√	√		√	×	√	√	×	√		√	√	√	√	√	√		√	√	√	21	
16	Oil Flow to Rotary Hook properly or not?	9	√	√	×	×	×		√	√	√	√	√	√		×	×	√	×	×	√		√	√	√	√	√	√		√	×	√	72	
17	What is the condition of belt?	6	√	×	×	√	√		√	×	×	√	√	×		√	√	×	×	√	√		×	√	√	√	×	×		√	×	×	72	
18	Belt Tension of the machne ok or not?	8	√	√	√	√	×		√	√	√	×	√	√		√	×	√	√	×	√		√	√	√	√	√	×		×	√	×	56	
19	Bobbin Winder Operation running or not?	2	×	×	×	√	√		×	×	×	√	√	√		√	√	×	×	√	√		√	×	√	×	×	√		√	√	√	22	
20	Cleaned machine thoroughly or not?	1	×	√	√	√	√		×	√	√	√	×	×		√	√	√	√	√	×		×	×	×	√	√	×		×	√	√	10	
21	What is the Condition of Rotary Hook?	8	√	√	√	×	×		√	√	√	√	√	√		×	×	√	√	√	√		√	√	√	√	√	√		√	√	×	40	
22	What is the condition of Feed Dog Height?	6	×	√	√	√	√		×	√	√	×	×	×		×	√	√	√	×	×		×	×	√	√	√	√		√	√	√	60	
23	Hook Timing is properly doing or not?	10	√	√	√	√	√		√	√	√	√	√	√		√	√	×	√	√	√		√	√	√	×	×	√		√	√	√	30	
24	Machine maintenance/servicing is occurred or not?	4	√	√	√	√	√		√	√	√	√	√	√		√	√	√	×	√	√		√	√	×	×	×	√		√	×	√	20	
25	Oil Change of the machine done or not?	3	×	×	×	×	×		×	×	×	×	×	×		√	√	√	√	√	×		×	×	×	×	×	×		×	×	×	63	
26	Presser Foot Sole Condition good or bad?	1	√	√	√	√	√		√	√	√	√	√	√		√	√	×	×	×	×		×	√	√	√	√	√		√	√	√	5	
																																		977	

Machine Wise Observation Data (4 weeks)

Model: SNL-29																																			
SL.	**Current Status Criteria**	**Rating**	**6/May/18**	**7/May/18**	**8/May/18**	**9/May/18**	**10/May/18**	**11/May/18**	**12/May/18**	**13/May/18**	**14/May/18**	**15/May/18**	**16/May/18**	**17/May/18**	**18/May/18**	**19/May/18**	**20/May/18**	**21/May/18**	**22/May/18**	**23/May/18**	**24/May/18**	**25/May/18**	**26/May/18**	**27/May/18**	**28/May/18**	**29/May/18**	**30/May/18**	**31/May/18**	**1/Jun/18**	**2/Jun/18**	**3/Jun/18**	**4/Jun/18**	**Total Rating**	**Remarks**
1	Power button works or not?	10	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	×	×		√	√	√	√	√	√		√	√	√	20	
2	Needle position/ condition ok or not?	3	×	√	×	×	√		√	×	√	√	√	×		√	√	×	√	√	×		√	×	√	×	√	√		×	√	√	30	
3	How is Pressure foot condition?	5	√	×	√	√	√		√	√	×	×	√	√		×	×	×	×	√	√		×	√	√	√	√	√		√	×	×	40	
4	Thread Sequence/Stitching quality?	3	×	×	×	×	√		√	√	√	√	√	√		√	√	×	√	√	√		√	√	√	×	√	√		√	√	√	18	
5	Bobbin case thread tension ok or not?	2	√	√	×	√	√		×	√	√	√	×	√		×	×	√	√	×	×		×	√	√	√	×	×		√	×	×	24	
6	Motor speed sufficient or not?	4	√	×	√	×	√		√	√	√	√	√	√		√	√	×	√	√	√		×	√	×	√	√	×		×	√	×	32	
7	Pulley works smoothly or not?	6	×	√	×	√	√		×	×	√	×	×	×		√	×	√	×	√	√		√	√	×	×	√	√		√	√	√	66	
8	Motor sound condition normal or abnormal?	7	√	√	√	√	×		×	×	×	√	√	×		×	√	×	√	√	√		√	√	×	√	√	√		×	×	√	70	
9	Temperature of machine normal or not?	4	√	√	√	√	×		√	√	√	√	√	√		×	×	√	√	×	√		×	√	√	√	×	×		√	×	×	36	
10	What is Thread stand position(tight/straight)?	1	√	×	×	×	√		√	×	√	√	√	×		√	×	×	√	√	√		×	√	×	√	√	√		√	√	×	10	
11	Oil filter of the machine is cleaned or not?	5	×	√	√	√	√		×	√	√	√	×	√		√	√	√	√	×	×		√	√	√	×	√	√		√	√	√	30	
12	What is Oil Level or condition of the machine?	7	√	√	√	√	×		√	√	√	√	√	×		√	√	×	×	√	√		√	√	×	√	√	√		√	√	√	35	
13	Spring Operation of the machine is ok or not?	5	√	×	×	×	×		√	×	×	√	√	×		√	√	×	√	√	×		√	√	√	√	×	√		√	√	√	50	
14	How is Brake Position of the machine?	2	√	×	√	×	√		√	√	√	√	√	√		√	√	√	×	√	√		×	√	×	√	√	√		√	×	×	14	
15	What is the condition of Treadle(loseness or operation)?	7	√	√	√	×	×		√	√	√	√	×	√		√	√	×	√	√	√		√	√	√	√	×	×		√	√	√	42	
16	Oil Flow to Rotary Hook properly or not?	9	×	×	√	√	√		√	√	√	×	√	√		×	√	√	√	×	×		√	√	×	√	√	√		√	√	√	54	
17	What is the condition of belt?	6	√	×	√	√	×		√	√	√	×	√	√		×	×	√	√	×	√		√	×	×	√	√	×		√	√	√	54	
18	Belt Tension of the machne ok or not?	8	×	√	×	√	√		√	√	√	√	√	×		√	√	×	×	√	√		×	√	√	×	√	√		×	√	×	64	
19	Bobbin Winder Operation running or not?	2	√	×	√	√	√		×	√	×	√	√	√		×	√	√	√	√	√		√	×	×	√	√	√		√	√	√	12	
20	Cleaned machine thoroughly or not?	1	√	√	√	×	×		×	×	√	√	×	×		√	√	√	√	×	×		√	√	√	√	×	×		×	√	√	11	
21	What is the Condition of Rotary Hook?	8	√	√	√	×	√		√	√	×	√	√	√		√	√	×	×	√	√		√	√	√	√	×	√		×	√	√	48	
22	What is the condition of Feed Dog Height?	6	×	×	×	√	√		×	√	√	×	×	√		×	×	√	×	√	√		×	×	×	×	√	√		√	√	×	84	
23	Hook Timing is properly doing or not?	10	√	√	√	√	√		√	√	√	√	√	√		×	√	√	√	√	√		√	√	√	√	√	√		√	√	√	10	
24	Machine maintenance/servicing is occurred or not?	4	√	√	√	×	×		×	×	×	√	×	√		×	√	√	√	√	×		√	√	√	√	×	×		√	×	√	44	
25	Oil Change of the machine done or not?	3	×	√	×	×	×		√	√	√	√	√	×		×	×	×	×	×	×		×	×	×	×	×	×		×	×	×	60	
26	Presser Foot Sole Condition good or bad?	1	×	√	×	√	√		√	√	√	×	√	×		√	√	√	√	×	√		√	√	√	×	√	√		×	√	√	7	
																																		965	

Machine Wise Observation Data (4 weeks)

Model: SNL-107																																			
SL.	**Current Status Criteria**	**Rating**	**6/May/18**	**7/May/18**	**8/May/18**	**9/May/18**	**10/May/18**	**11/May/18**	**12/May/18**	**13/May/18**	**14/May/18**	**15/May/18**	**16/May/18**	**17/May/18**	**18/May/18**	**19/May/18**	**20/May/18**	**21/May/18**	**22/May/18**	**23/May/18**	**24/May/18**	**25/May/18**	**26/May/18**	**27/May/18**	**28/May/18**	**29/May/18**	**30/May/18**	**31/May/18**	**1/Jun/18**	**2/Jun/18**	**3/Jun/18**	**4/Jun/18**	**Total Rating**	**Remarks**
1	Power button works or not?	10	√	√	√	√	√		×	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	10	
2	Needle position/ condition ok or not?	3	√	×	√	√	√		×	×	√	√	√	√		×	×	×	√	×	√		√	√	×	√	√	√		×	√	√	27	
3	How is Pressure foot condition?	5	√	√	√	×	√		√	√	√	√	√	√		×	√	√	√	√	√		√	√	×	×	×	×		√	×	×	40	
4	Thread Sequence/Stitching quality?	3	×	×	√	√	√		√	√	×	×	√	√		×	×	√	√	×	√		√	√	×	√	√	√		√	√	√	24	
5	Bobbin case thread tension ok or not?	2	√	√	√	×	×		×	×	√	√	×	√		√	√	√	√	√	×		×	√	√	√	√	×		√	×	√	18	
6	Motor speed sufficient or not?	4	√	√	×	√	√		√	√	√	×	√	×		√	√	√	×	√	√		×	√	√	×	√	√		×	√	√	28	
7	Pulley works smoothly or not?	6	√	√	√	√	√		×	√	×	×	√	√		×	×	√	×	√	√		√	√	×	√	×	√		√	√	√	48	
8	Motor sound condition normal or abnormal?	7	×	×	×	√	√		√	×	√	√	√	√		√	√	√	×	×	√		√	√	√	√	√	√		×	×	√	56	
9	Temperature of machine normal or not?	4	√	√	√	×	×		√	×	√	√	×	√		√	√	√	√	√	√		×	√	√	√	√	×		√	×	×	32	
10	What is Thread stand position(tight/straight)?	1	√	×	√	√	×		×	√	×	√	√	×		×	×	√	×	√	√		√	√	×	×	×	√		√	√	×	12	
11	Oil filter of the machine is cleaned or not?	5	√	√	×	√	√		√	×	√	×	√	√		√	×	√	√	×	√		√	√	√	√	√	√		√	√	√	25	
12	What is Oil Level or condition of the machine?	7	√	×	√	√	√		√	√	√	√	×	×		√	√	√	×	√	√		√	√	×	√	√	√		√	√	√	35	
13	Spring Operation of the machine is ok or not?	5	√	√	√	×	×		×	√	√	√	×	√		×	√	√	√	√	√		√	√	√	√	√	√		√	√	√	25	
14	How is Brake Position of the machine?	2	×	×	√	√	√		×	×	√	√	√	√		√	√	√	×	×	√		√	√	×	√	√	√		√	√	√	14	
15	What is the condition of Treadle(loseness or operation)?	7	√	√	×	×	√		√	√	×	√	√	√		√	√	√	√	√	√		×	√	√	√	×	√		√	×	√	42	
16	Oil Flow to Rotary Hook properly or not?	9	√	×	×	√	√		√	√	√	√	√	√		×	√	√	×	√	√		√	√	√	√	√	√		√	√	√	36	
17	What is the condition of belt?	6	√	×	√	√	×		√	√	√	×	×	√		√	√	×	√	√	√		×	√	√	√	√	√		√	√	√	36	
18	Belt Tension of the machne ok or not?	8	√	√	×	×	√		√	√	√	√	×	×		√	×	√	√	√	√		√	√	√	√	√	×		×	√	×	64	
19	Bobbin Winder Operation running or not?	2	×	×	√	√	√		×	√	×	×	√	√		√	√	×	×	√	√		√	×	√	×	×	√		√	√	√	20	
20	Cleaned machine thoroughly or not?	1	×	√	√	×	×		×	×	×	√	×	×		√	√	√	√	√	×		×	×	×	√	√	√		√	×	√	13	
21	What is the Condition of Rotary Hook?	8	√	√	√	√	√		√	√	√	√	√	√		√	√	×	√	√	×		√	√	√	×	√	×		√	√	√	32	
22	What is the condition of Feed Dog Height?	6	√	√	×	×	√		×	×	√	√	√	√		√	√	√	√	×	√		√	×	√	√	√	√		√	√	√	36	
23	Hook Timing is properly doing or not?	10	√	√	√	√	√		√	√	√	×	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	×	√	20	
24	Machine maintenance/servicing is occurred or not?	4	×	×	√	√	√		√	×	×	√	√	√		×	√	×	√	×	√		×	×	×	×	√	√		√	√	√	44	
25	Oil Change of the machine done or not?	3	√	×	×	×	×		×	×	√	×	×	×		×	×	√	√	√	×		×	×	×	√	√	√		×	√	√	48	
26	Presser Foot Sole Condition good or bad?	1	√	√	√	√	√		√	√	√	√	×	×		√	√	√	√	√	√		√	√	√	√	√	×		×	√	√	4	
																																		789	

Machine Wise Observation Data (4 weeks)

Model: FL-22																																				
SL.	**Current Status Criteria**	**Rating**	**6/May/18**	**7/May/18**	**8/May/18**	**9/May/18**	**10/May/18**	**11/May/18**	**12/May/18**	**13/May/18**	**14/May/18**	**15/May/18**	**16/May/18**	**17/May/18**	**18/May/18**	**19/May/18**	**20/May/18**	**21/May/18**	**22/May/18**	**23/May/18**	**24/May/18**	**25/May/18**	**26/May/18**	**27/May/18**	**28/May/18**	**29/May/18**	**30/May/18**	**31/May/18**	**1/Jun/18**	**2/Jun/18**	**3/Jun/18**	**4/Jun/18**	**Total Rating**	**Remarks**
1	Power button works or not?	10	√	√	√	√	√		√	√	×	√	√	√		√	×	√	√	√	√		√	√	√	√	√	√		√	√	√	20	
2	Needle position/ condition ok or not?	3	×	√	√	×	×		×	√	√	√	×	×		√	×	√	√	√	×		×	×	√	√	√	×		√	×	×	39	
3	How is Pressure foot condition?	5	×	√	×	×	√		√	√	√	×	×	√		√	√	×	×	√	√		√	×	×	×	×	√		√	√	√	45	
4	Thread Sequence/Stitching quality?	3	√	×	√	√	√		×	×	×	√	√	×		×	×	√	√	×	√		√	√	√	×	√	√		√	√	√	27	
5	Bobbin case thread tension ok or not?	2	×	√	√	×	×		×	√	√	√	×	√		√	√	√	×	×	√		√	√	√	√	√	√		√	×	×	18	
6	Motor speed sufficient or not?	4	√	×	×	√	√		×	√	√	×	√	√		√	√	×	×	√	√		×	√	√	√	×	×		√	√	√	36	
7	Pulley works smoothly or not?	6	√	×	√	√	√		√	√	×	×	√	×		×	√	√	√	×	√		√	√	√	√	√	×		×	√	×	48	
8	Motor sound condition normal or abnormal?	7	√	√	√	√	√		√	×	√	×	√	√		√	×	×	×	√	√		√	×	√	×	×	√		√	√	√	56	
9	Temperature of machine normal or not?	4	×	√	√	×	×		√	×	√	√	×	√		×	√	√	√	√	×		×	×	×	√	√	×		×	√	√	48	
10	What is Thread stand position(tight/straight)?	1	√	×	×	√	×		√	√	×	√	√	×		√	√	√	√	√	√		√	√	√	√	√	√		√	×	×	7	
11	Oil filter of the machine is cleaned or not?	5	×	√	√	√	√		×	×	√	×	√	×		√	×	√	√	×	×		×	×	√	√	√	√		√	√	√	50	
12	What is Oil Level or condition of the machine?	7	√	×	√	√	√		×	√	√	√	√	√		×	×	√	√	√	√		√	√	√	×	×	√		√	√	√	42	
13	Spring Operation of the machine is ok or not?	5	√	√	√	×	×		√	√	√	√	√	×		×	√	×	×	√	√		√	√	×	×	×	√		√	×	√	50	
14	How is Brake Position of the machine?	2	√	×	×	√	√		√	×	×	×	√	×		√	√	×	×	√	√		√	×	×	×	×	√		√	√	√	24	
15	What is the condition of Treadle(loseness or operation)?	7	√	√	×	√	√		×	√	×	√	√	√		√	√	√	√	×	√		√	√	√	×	√	√		√	√	√	35	
16	Oil Flow to Rotary Hook properly or not?	9	√	×	√	√	√		√	√	√	√	√	√		√	×	×	×	√	√		√	×	√	×	×	√		√	√	√	63	
17	What is the condition of belt?	6	×	×	×	×	×		√	√	√	×	×	√		√	√	√	√	√	×		×	×	×	√	√	×		×	√	√	78	
18	Belt Tension of the machne ok or not?	8	×	√	√	√	√		√	√	√	√	×	√		√	√	√	√	√	√		√	√	√	√	√	√		√	×	×	32	
19	Bobbin Winder Operation running or not?	2	√	×	×	√	√		×	×	×	√	√	×		√	×	√	√	×	×		×	×	√	√	√	√		√	√	√	22	
20	Cleaned machine thoroughly or not?	1	×	√	√	×	×		√	√	√	√	×	√		×	×	√	√	√	√		√	√	√	×	×	√		×	×	√	10	
21	What is the Condition of Rotary Hook?	8	√	√	√	√	√		√	√	√	√	√	√		×	×	×	×	√	√		√	√	×	×	×	√		√	√	√	56	
22	What is the condition of Feed Dog Height?	6	√	√	×	×	×		√	√	√	√	√	×		√	√	×	×	√	√		√	×	×	×	×	√		√	√	√	60	
23	Hook Timing is properly doing or not?	10	×	√	×	√	√		√	√	√	√	√	√		√	√	√	√	×	√		√	√	√	√	√	√		√	√	√	30	
24	Machine maintenance/servicing is occurred or not?	4	×	×	×	√	√		×	×	×	×	×	√		√	×	√	×	×	√		√	√	√	√	√	√		√	×	×	52	
25	Oil Change of the machine done or not?	3	×	×	√	√	×		×	×	×	×	×	×		×	×	×	×	√	√		×	√	√	√	×	×		×	√	√	48	
26	Presser Foot Sole Condition good or bad?	1	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	0	
																																		996	

Machine Wise Observation Data (4 weeks)

Model: FL-32																																				
SL.	**Current Status Criteria**	**Rating**	**6/May/18**	**7/May/18**	**8/May/18**	**9/May/18**	**10/May/18**	**11/May/18**	**12/May/18**	**13/May/18**	**14/May/18**	**15/May/18**	**16/May/18**	**17/May/18**	**18/May/18**	**19/May/18**	**20/May/18**	**21/May/18**	**22/May/18**	**23/May/18**	**24/May/18**	**25/May/18**	**26/May/18**	**27/May/18**	**28/May/18**	**29/May/18**	**30/May/18**	**31/May/18**	**1/Jun/18**	**2/Jun/18**	**3/Jun/18**	**4/Jun/18**	**Total Rating**	**Remarks**
1	Power button works or not?	10	√	√	√	√	√		√	√	×	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	10	
2	Needle position/ condition ok or not?	3	×	√	√	×	×		×	√	√	√	×	×		√	×	√	×	√	√		√	×	×	√	√	√		√	×	√	30	
3	How is Pressure foot condition?	5	√	√	×	×	√		√	√	√	×	×	√		√	√	√	√	√	√		√	×	√	√	√	√		√	×	√	30	
4	Thread Sequence/Stitching quality?	3	×	×	√	√	√		×	×	×	√	√	√		×	×	×	×	√	√		√	×	×	×	√	√		√	×	√	39	
5	Bobbin case thread tension ok or not?	2	√	√	√	×	×		√	√	√	√	×	√		√	√	√	√	√	×		×	√	√	√	√	×		√	√	√	12	
6	Motor speed sufficient or not?	4	×	×	×	√	√		√	√	√	×	√	×		√	√	√	√	×	√		√	√	×	√	√	√		×	√	√	32	
7	Pulley works smoothly or not?	6	√	×	×	√	√		×	√	×	×	√	√		×	×	×	×	×	√		√	×	√	×	×	√		√	√	×	84	
8	Motor sound condition normal or abnormal?	7	√	√	×	√	√		√	×	√	×	√	√		√	√	√	√	×	√		√	√	×	√	√	√		√	√	√	35	
9	Temperature of machine normal or not?	4	×	√	√	×	×		√	×	√	√	×	√		×	×	√	√	√	×		×	√	√	√	√	×		√	×	√	44	
10	What is Thread stand position(tight/straight)?	1	√	×	√	√	×		×	√	×	√	√	×		√	×	√	×	√	√		×	×	√	×	√	√		×	√	√	11	
11	Oil filter of the machine is cleaned or not?	5	√	√	√	√	√		×	×	√	×	√	√		√	√	√	×	×	√		√	×	√	√	×	√		√	√	√	35	
12	What is Oil Level or condition of the machine?	7	×	×	√	√	√		√	√	√	√	√	√		×	×	√	×	√	√		√	√	×	√	√	×		×	×	√	63	
13	Spring Operation of the machine is ok or not?	5	√	√	√	×	×		×	√	√	√	√	√		×	×	√	√	√	×		×	×	√	√	√	×		√	√	×	50	
14	How is Brake Position of the machine?	2	×	×	√	√	√		×	×	×	×	√	√		√	√	×	×	√	√		√	√	×	×	×	√		√	√	√	22	
15	What is the condition of Treadle(loseness or operation)	7	√	√	×	√	√		√	√	×	√	√	√		√	√	×	√	×	√		√	√	√	×	√	√		√	√	√	35	
16	Oil Flow to Rotary Hook properly or not?	9	√	×	×	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	×	×	36	
17	What is the condition of belt?	6	×	×	√	×	×		√	√	√	×	×	×		√	√	√	√	√	√		×	×	×	√	×	×		√	√	√	72	
18	Belt Tension of the machne ok or not?	8	√	√	×	√	√		√	√	√	√	×	√		√	×	√	√	×	√		√	√	√	√	√	×		×	√	√	48	
19	Bobbin Winder Operation running or not?	2	×	×	√	√	√		×	×	×	√	√	√		√	√	×	×	√	√		√	×	×	×	×	√		√	√	√	22	
20	Cleaned machine thoroughly or not?	1	√	√	√	×	×		√	√	√	√	×	×		√	√	√	√	√	×		×	×	√	√	√	×		×	√	√	9	
21	What is the Condition of Rotary Hook?	8	×	√	√	√	√		√	√	√	√	√	√		×	×	√	√	√	√		√	√	√	√	√	√		√	×	×	40	
22	What is the condition of Feed Dog Height?	6	√	√	×	×	×		×	√	√	√	√	√		√	√	√	√	×	×		×	×	√	√	√	√		√	√	√	48	
23	Hook Timing is properly doing or not?	10	√	√	√	√	√		√	√	×	×	×	√		√	√	×	√	√	√		√	√	√	×	×	√		√	√	√	60	
24	Machine maintenance/servicing is occurred or not?	4	×	×	√	√	√		√	×	×	×	×	×		√	×	×	×	√	√		√	√	×	×	×	√		√	√	√	52	
25	Oil Change of the machine done or not?	3	×	×	√	×	×		×	×	×	×	×	×		×	×	×	×	×	×		×	√	×	√	×	×		×	×	×	69	
26	Presser Foot Sole Condition good or bad?	1	√	×	×	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	×		×	√	√	4	
																																		992	

Machine Wise Observation Data (4 weeks)

Model: OL-46

SL.	Current Status Criteria	Rating	6/May/18	7/May/18	8/May/18	9/May/18	10/May/18	11/May/18	12/May/18	13/May/18	14/May/18	15/May/18	16/May/18	17/May/18	18/May/18	19/May/18	20/May/18	21/May/18	22/May/18	23/May/18	24/May/18	25/May/18	26/May/18	27/May/18	28/May/18	29/May/18	30/May/18	31/May/18	1/Jun/18	2/Jun/18	3/Jun/18	4/Jun/18	Total Rating	Remarks
1	Power button works or not?	10	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	×	√	√		√	√	√	10	
2	Needle position/ condition ok or not?	3	×	√	√	√	√		×	√	√	√	×	√		√	√	×	√	√	×		×	×	√	√	√	×		×	√	×	27	
3	How is Pressure foot condition?	5	√	√	√	×	√		√	×	√	√	√	√		√	×	√	√	×	×		√	√	√	√	×	×		√	√	√	35	
4	Thread Sequence/Stitching quality?	3	√	×	√	√	√		√	×	×	√	√	√		×	√	×	×	√	√		√	×	×	×	√	√		√	×	×	33	
5	Bobbin case thread tension ok or not?	2	×	√	√	√	×		×	√	√	×	×	√		√	√	√	√	√	×		×	√	√	√	√	×		√	√	√	14	
6	Motor speed sufficient or not?	4	√	√	√	×	√		×	×	√	√	√	√		√	√	×	×	×	√		√	√	√	√	×	√		×	√	√	32	
7	Pulley works smoothly or not?	6	√	×	√	√	√		√	×	×	√	√	√		×	×	√	×	×	√		√	×	√	×	×	√		√	×	×	72	
8	Motor sound condition normal or abnormal?	7	√	√	√	×	×		√	√	√	√	×	√		√	√	√	√	×	√		√	√	×	√	×	√		√	√	√	42	
9	Temperature of machine normal or not?	4	×	√	×	√	√		√	√	√	×	√	×		√	√	×	√	√	×		×	√	×	√	√	×		√	×	×	44	
10	What is Thread stand position(tight/straight)?	1	√	×	×	√	√		×	√	×	×	√	√		×	×	√	×	√	√		×	×	√	×	√	√		×	√	×	13	
11	Oil filter of the machine is cleaned or not?	5	×	√	×	√	√		√	×	√	√	√	√		√	√	√	√	√	√		√	×	×	√	×	√		√	√	√	30	
12	What is Oil Level or condition of the machine?	7	√	√	√	×	×		√	×	√	√	×	√		×	√	×	×	√	√		√	√	√	√	√	√		√	×	×	63	
13	Spring Operation of the machine is ok or not?	5	√	×	√	√	×		×	√	×	√	√	×		√	×	√	√	√	×		×	×	√	√	√	√		√	×	×	55	
14	How is Brake Position of the machine?	2	√	×	×	√	√		×	×	√	×	√	√		√	√	×	×	√	√		√	×	×	×	×	√		√	√	√	22	
15	What is the condition of Treadle(loseness or operation)?	7	×	×	√	√	√		√	√	√	√	√	√		×	√	√	√	×	√		√	√	√	×	√	√		√	√	√	35	
16	Oil Flow to Rotary Hook properly or not?	9	√	√	×	×	√		√	√	√	×	√	√		√	√	√	×	×	√		√	√	√	√	√	√		√	√	√	45	
17	What is the condition of belt?	6	√	×	√	√	√		√	√	×	√	×	√		√	√	×	×	√	×		×	√	√	√	×	×		×	√	√	60	
18	Belt Tension of the machne ok or not?	8	×	×	√	√	√		√	×	×	√	√	√		√	×	√	√	×	√		√	√	√	√	√	×		√	√	×	64	
19	Bobbin Winder Operation running or not?	2	√	×	√	√	√		×	√	√	√	√	√		√	√	×	×	√	√		√	×	×	×	√	√		√	√	√	14	
20	Cleaned machine thoroughly or not?	1	√	√	×	×	×		×	√	√	×	×	×		√	√	√	√	×	×		×	√	×	×	×	×		×	√	√	15	
21	What is the Condition of Rotary Hook?	8	×	√	√	×	√		√	×	√	√	√	√		×	×	×	√	√	√		√	√	√	√	√	√		√	×	×	64	
22	What is the condition of Feed Dog Height?	6	×	×	√	√	√		×	√	×	√	√	√		√	√	√	√	×	×		×	×	√	√	√	√		√	√	√	48	
23	Hook Timing is properly doing or not?	10	√	√	√	√	×		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	×	×		√	√	√	30	
24	Machine maintenance/servicing is occurred or not?	4	√	√	×	×	√		√	√	√	×	√	√		×	√	×	×	√	√		√	√	×	×	×	×		×	√	×	48	
25	Oil Change of the machine done or not?	3	×	√	√	√	×		×	×	×	√	×	×		×	×	×	×	√	×		×	×	×	×	×	×		×	×	×	63	
26	Presser Foot Sole Condition good or bad?	1	√	×	√	√	×		√	×	√	√	×	×		×	×	√	×	×	√		√	√	√	√	√	√		√	×	√	10	
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Machine Wise Observation Data (4 weeks)

Model: OL-67

SL.	Current Status Criteria	Rating	6/May/18	7/May/18	8/May/18	9/May/18	10/May/18	11/May/18	12/May/18	13/May/18	14/May/18	15/May/18	16/May/18	17/May/18	18/May/18	19/May/18	20/May/18	21/May/18	22/May/18	23/May/18	24/May/18	25/May/18	26/May/18	27/May/18	28/May/18	29/May/18	30/May/18	31/May/18	1/Jun/18	2/Jun/18	3/Jun/18	4/Jun/18	Total Rating	Remarks
1	Power button works or not?	10	×	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	10	
2	Needle position/ condition ok or not?	3	√	√	√	×	√		√	√	√	√	√	×		√	√	√	√	√	×		×	×	√	√	√	×		×	√	×	24	
3	How is Pressure foot condition?	5	√	×	√	√	×		×	√	√	√	√	√		×	√	√	√	√	×		√	√	√	√	√	√		√	√	×	30	
4	Thread Sequence/Stitching quality?	3	√	√	×	√	√		√	√	√	×	√	√		√	×	√	√	√	√		√	×	×	×	√	√		√	×	×	24	
5	Bobbin case thread tension ok or not?	2	×	√	√	×	×		√	×	√	√	×	√		×	√	√	√	√	×		×	√	√	√	√	×		×	√	√	20	
6	Motor speed sufficient or not?	4	√	√	√	×	√		×	√	×	√	√	×		√	√	√	√	√	√		√	√	√	×	×	×		×	×	×	40	
7	Pulley works smoothly or not?	6	√	×	×	√	√		×	√	√	×	×	√		√	×	×	×	×	√		√	×	√	√	√	√		√	×	×	72	
8	Motor sound condition normal or abnormal?	7	√	×	√	√	√		√	√	√	×	√	×		×	√	√	√	×	√		√	√	×	√	×	√		√	√	√	49	
9	Temperature of machine normal or not?	4	√	√	√	×	×		×	×	×	√	√	√		×	√	√	√	√	×		×	√	×	√	√	×		√	√	×	44	
10	What is Thread stand position(tight/straight)?	1	√	×	√	√	√		×	×	√	√	√	√		√	×	√	×	√	√		×	×	×	×	√	√		×	√	×	11	
11	Oil filter of the machine is cleaned or not?	5	√	√	×	√	√		√	√	√	×	×	√		√	√	√	√	√	√		√	×	×	√	×	√		√	×	×	40	
12	What is Oil Level or condition of the machine?	7	√	×	×	√	√		√	×	√	√	√	√		×	√	×	×	√	√		√	√	√	√	√	√		√	×	×	56	
13	Spring Operation of the machine is ok or not?	5	×	×	√	√	×		√	√	×	√	√	√		√	×	√	√	√	×		×	×	×	√	√	√		×	×	×	60	
14	How is Brake Position of the machine?	2	√	√	×	√	√		√	×	×	√	√	×		√	√	√	×	√	√		√	√	√	√	√	√		×	√	√	12	
15	What is the condition of Treadle(loseness or operation)?	7	×	×	√	√	√		×	×	√	√	×	√		√	√	√	√	×	√		√	√	√	×	√	√		√	×	×	63	
16	Oil Flow to Rotary Hook properly or not?	9	√	×	×	√	√		√	√	√	√	√	√		×	√	√	×	×	√		√	√	√	√	√	×		√	√	√	54	
17	What is the condition of belt?	6	×	×	√	√	×		√	√	√	×	√	√		√	√	√	×	√	√		√	√	√	√	×	×		×	√	√	48	
18	Belt Tension of the machne ok or not?	8	√	√	×	√	√		√	√	√	√	×	×		√	×	×	×	√	√		√	√	√	√	√	√		√	√	√	48	
19	Bobbin Winder Operation running or not?	2	√	×	×	√	√		×	√	×	×	√	√		×	×	×	×	√	√		√	×	×	×	√	√		√	×	√	26	
20	Cleaned machine thoroughly or not?	1	×	√	×	√	√		√	×	√	√	√	√		√	√	√	√	√	×		×	√	√	√	√	×		×	×	×	9	
21	What is the Condition of Rotary Hook?	8	√	√	√	√	√		√	×	√	√	×	√		×	√	√	√	√	√		√	×	×	√	√	√		√	×	×	56	
22	What is the condition of Feed Dog Height?	6	√	×	√	√	×		×	√	×	√	√	×		√	×	√	√	×	×		×	×	√	√	√	√		√	√	√	54	
23	Hook Timing is properly doing or not?	10	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	×	√	√		√	√	√	10	
24	Machine maintenance/servicing is occurred or not?	4	×	×	√	√	√		√	√	√	√	×	×		×	√	√	√	√	√		√	√	×	×	×	×		×	×	×	48	
25	Oil Change of the machine done or not?	3	√	√	×	×	√		×	×	×	×	×	×		×	×	×	×	√	×		×	×	×	×	×	×		×	×	×	66	
26	Presser Foot Sole Condition good or bad?	1	√	√	×	×	√		√	√	√	√	√	√		√	√	√	×	×	√		×	×	×	√	√	√		√	√	√	7	
																																	981	

Machine Wise Observation Data (4 weeks)

Model: OL-35

SL.	Current Status Criteria	Rating	6/May/18	7/May/18	8/May/18	9/May/18	10/May/18	11/May/18	12/May/18	13/May/18	14/May/18	15/May/18	16/May/18	17/May/18	18/May/18	19/May/18	20/May/18	21/May/18	22/May/18	23/May/18	24/May/18	25/May/18	26/May/18	27/May/18	28/May/18	29/May/18	30/May/18	31/May/18	1/Jun/18	2/Jun/18	3/Jun/18	4/Jun/18	Total Rating	Remarks
1	Power button works or not?	10	√	√	√	×	√		√	×	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	×	30	
2	Needle position/ condition ok or not?	3	√	√	√	×	√		√	√	√	×	√	×		√	√	√	√	√	×		×	×	√	×	×	√		×	√	×	30	
3	How is Pressure foot condition?	5	×	×	×	√	√		×	√	√	×	×	√		×	×	√	√	×	√		√	√	×	×	√	√		√	√	√	55	
4	Thread Sequence/Stitching quality?	3	√	√	√	√	√		√	√	√	√	√	√		√	×	√	√	√	√		×	×	√	√	√	√		√	×	×	15	
5	Bobbin case thread tension ok or not?	2	√	√	√	×	×		×	×	×	√	√	√		×	×	√	√	√	×		√	√	√	×	×	×		√	√	√	22	
6	Motor speed sufficient or not?	4	×	×	×	×	×		×	√	×	×	×	×		√	√	×	×	×	√		√	×	×	√	√	√		×	√	√	64	
7	Pulley works smoothly or not?	6	√	×	√	√	√		√	×	√	×	√	√		√	√	×	√	×	√		√	×	√	√	√	√		√	×	×	48	
8	Motor sound condition normal or abnormal?	7	√	√	×	×	√		√	√	√	√	×	×		×	√	×	√	√	√		√	√	×	√	√	√		√	√	√	49	
9	Temperature of machine normal or not?	4	√	×	√	√	√		√	√	√	√	√	√		×	√	√	√	√	×		×	√	×	×	√	√		√	×	×	32	
10	What is Thread stand position(tight/straight)?	1	√	√	√	√	×		×	√	×	√	√	√		×	√	√	×	√	√		×	×	√	√	√	√		×	√	×	9	
11	Oil filter of the machine is cleaned or not?	5	√	√	√	×	×		√	√	√	√	√	√		√	√	×	√	√	√		√	×	×	√	×	√		√	√	√	30	
12	What is Oil Level or condition of the machine?	7	√	×	√	√	√		√	√	×	√	√	√		√	×	√	×	√	√		√	√	√	×	×	√		√	×	×	56	
13	Spring Operation of the machine is ok or not?	5	√	√	×	√	√		√	√	√	×	×	√		√	×	√	√	√	×		×	×	√	√	√	√		√	×	√	40	
14	How is Brake Position of the machine?	2	√	×	√	√	√		√	×	√	√	×	√		×	×	×	×	√	√		√	×	×	×	×	×		√	√	√	24	
15	What is the condition of Treadle(loseness or operation)?	7	√	√	√	×	√		√	×	×	√	√	√		√	√	√	√	×	√		√	√	√	√	√	√		√	√	√	28	
16	Oil Flow to Rotary Hook properly or not?	9	×	√	√	×	×		√	×	√	√	√	√		√	×	√	√	√	√		√	√	√	√	√	×		√	√	√	54	
17	What is the condition of belt?	6	×	×	√	√	×		√	√	√	×	×	√		√	√	×	×	√	√		×	√	√	√	√	×		×	√	√	60	
18	Belt Tension of the machne ok or not?	8	√	√	×	√	√		√	×	√	√	√	×		√	×	√	√	√	√		√	√	√	√	√	√		√	√	×	40	
19	Bobbin Winder Operation running or not?	2	×	×	√	√	√		√	√	×	√	√	√		√	√	√	×	√	×		√	×	×	×	√	×		√	√	√	18	
20	Cleaned machine thoroughly or not?	1	√	√	√	×	×		√	×	√	√	√	×		√	√	√	√	√	×		√	√	×	√	√	√		×	√	√	7	
21	What is the Condition of Rotary Hook?	8	√	√	√	×	√		√	√	√	×	√	×		√	√	√	√	√	×		√	√	×	√	√	√		√	×	×	56	
22	What is the condition of Feed Dog Height?	6	×	×	×	√	√		×	√	√	×	×	√		√	×	√	√	×	×		×	×	×	×	×	√		√	√	√	84	
23	Hook Timing is properly doing or not?	10	√	√	√	√	√		√	√	√	√	√	√		×	×	√	√	√	√		√	√	√	√	√	√		√	√	√	20	
24	Machine maintenance/servicing is occurred or not?	4	√	√	√	×	×		×	×	×	√	√	√		×	√	×	×	×	√		√	√	×	√	√	×		√	√	×	48	
25	Oil Change of the machine done or not?	3	×	×	×	×	×		×	×	×	×	×	×		√	×	√	√	√	√		√	×	×	×	×	√		√	×	×	54	
26	Presser Foot Sole Condition good or bad?	1	√	√	×	√	√		√	√	√	×	×	×		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	4	
																																	977	

Machine Wise Observation Data (4 weeks)

Model: OL-23																																				
SL.	**Current Status Criteria**	**Rating**	**6/May/18**	**7/May/18**	**8/May/18**	**9/May/18**	**10/May/18**	**11/May/18**	**12/May/18**	**13/May/18**	**14/May/18**	**15/May/18**	**16/May/18**	**17/May/18**	**18/May/18**	**19/May/18**	**20/May/18**	**21/May/18**	**22/May/18**	**23/May/18**	**24/May/18**	**25/May/18**	**26/May/18**	**27/May/18**	**28/May/18**	**29/May/18**	**30/May/18**	**31/May/18**	**1/Jun/18**	**2/Jun/18**	**3/Jun/18**	**4/Jun/18**	**Total Rating**	**Remarks**
1	Power button works or not?	10	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	√	√	0	
2	Needle position/ condition ok or not?	3	√	√	√	√	√		√	×	√	√	×	×		√	√	√	×	×	√		×	√	×	×	√	√		×	×	×	33	
3	How is Pressure foot condition?	5	√	√	×	√	√		√	×	×	×	√	√		√	√	×	×	√	√		√	×	×	√	×	√		√	×	√	50	
4	Thread Sequence/Stitching quality?	3	×	×	√	√	√		√	√	×	√	√	√		√	×	√	√	√	×		×	√	√	×	√	×		√	√	√	24	
5	Bobbin case thread tension ok or not?	2	√	√	√	×	×		√	√	√	√	×	√		√	√	√	×	√	√		√	√	×	√	√	√		√	×	√	12	
6	Motor speed sufficient or not?	4	×	√	×	√	√		×	√	√	×	√	×		√	√	×	√	×	√		√	×	√	×	×	×		×	√	×	52	
7	Pulley works smoothly or not?	6	√	√	√	√	√		×	√	×	×	√	√		×	×	×	√	√	×		×	×	√	√	×	×		√	√	√	66	
8	Motor sound condition normal or abnormal?	7	√	√	×	√	√		√	×	√	√	√	√		√	×	×	√	√	√		√	×	√	√	×	√		√	√	√	42	
9	Temperature of machine normal or not?	4	√	√	√	×	√		√	×	√	√	×	√		×	√	√	×	√	×		×	√	×	×	√	√		√	×	√	40	
10	What is Thread stand position(tight/straight)?	1	√	√	√	√	×		×	√	×	√	√	×		√	×	√	√	×	√		×	√	√	√	√	×		×	√	×	10	
11	Oil filter of the machine is cleaned or not?	5	×	×	×	√	√		×	×	√	×	√	√		√	√	×	√	√	√		√	√	√	√	×	√		√	√	√	40	
12	What is Oil Level or condition of the machine?	7	×	×	√	√	√		√	√	√	√	×	×		×	√	√	√	√	×		×	√	√	×	√	×		√	√	√	63	
13	Spring Operation of the machine is ok or not?	5	√	√	√	×	×		×	√	√	×	√	√		√	×	√	√	√	×		×	√	×	√	√	√		√	√	√	40	
14	How is Brake Position of the machine?	2	√	×	√	√	√		×	×	×	×	√	√		√	√	×	√	√	√		√	√	√	×	×	×		√	√	√	18	
15	What is the condition of Treadle(loseness or operation)?	7	√	√	×	√	√		√	√	√	√	√	√		×	√	√	√	√	√		√	×	√	√	√	√		√	√	√	21	
16	Oil Flow to Rotary Hook properly or not?	9	√	×	√	√	√		√	×	√	√	×	√		√	×	√	√	√	√		√	×	√	√	√	×		√	√	√	54	
17	What is the condition of belt?	6	√	×	√	√	×		√	√	√	×	×	√		√	√	×	×	×	√		√	√	√	√	×	×		×	×	×	72	
18	Belt Tension of the machne ok or not?	8	√	√	×	√	√		√	√	×	√	√	×		√	×	√	×	√	√		×	×	√	√	√	√		√	×	√	64	
19	Bobbin Winder Operation running or not?	2	×	×	√	√	√		×	√	×	×	√	√		√	√	√	√	√	√		√	√	√	×	√	×		√	√	√	14	
20	Cleaned machine thoroughly or not?	1	√	×	√	×	√		×	×	√	√	×	×		×	√	√	×	×	√		√	√	×	√	√	√		×	×	×	13	
21	What is the Condition of Rotary Hook?	8	√	√	√	√	×		√	√	√	√	√	√		×	√	√	√	√	×		×	√	√	×	√	√		√	√	√	40	
22	What is the condition of Feed Dog Height?	6	√	√	×	√	√		×	√	√	√	√	√		√	√	√	√	√	√		√	×	×	√	√	√		√	√	√	24	
23	Hook Timing is properly doing or not?	10	√	√	√	√	√		√	√	√	√	×	√		√	√	×	×	√	√		√	√	√	√	×	√		√	×	√	50	
24	Machine maintenance/servicing is occurred or not?	4	√	×	√	√	√		√	×	×	√	√	√		×	√	×	×	√	×		×	×	×	×	×	√		√	×	×	56	
25	Oil Change of the machine done or not?	3	×	×	×	×	×		×	×	×	×	×	×		×	×	×	×	×	×		×	√	×	×	×	×		×	×	×	75	
26	Presser Foot Sole Condition good or bad?	1	√	√	√	√	√		√	√	√	√	√	√		√	√	√	√	√	√		√	×	√	√	√	×		√	√	√	2	
																																		975	

APPENDIX C

Questionnaire for Collecting Data

1. What is your machine maintenance system?

   Ans: ……

2. Which machine's failure rate is high?

   Ans: ……

3. Which machine's failure rate is low?

   Ans: ……

4. Which machine is needed more maintenance time?

   Ans: ……

5. Which machine is needed less maintenance time?

   Ans: ……

6. Which machine has more idling & minor stoppages?

   Ans: ……

7. Folder error mostly occurred in which machine?

   Ans: ……

8. What is machine failure time in a day?

   Ans: ……

9. What is your set up & adjustment rate?

   Ans: ……...

10. Have you any training system for maintenance personnel?

    Ans: ……

11. Have you schedule maintenance system?

    Ans: ……

12. What is your maintenance personnel average salary?

    Ans: ……

13. What is your working hour per day?

    Ans: ……

14. How many operators in a team?

    Ans: ……

15. What type of products you produce?

Ans: ……

16. What is your product's average SMV?

Ans: ……

17. How much product produces per team per hour?

Ans: ……

18. How much reject body produces per day?

Ans: ……

19. What is CPM rate of your factory?

Ans: ……

20. What is your product price rate?

Ans: ……

21. How many teams in your factory?

Ans: ……

22. How much maintenance cost in your factory (monthly)?

Ans: ……

23. How many employees in maintenance department?

Ans: ……

24. How much time need to service a machine?

Ans: ……

25. What parts need to change in schedule maintenance?

Ans: ……

26. What are the main factors for machine breakdown or failure?

Ans: ……

27. How can you prioritize these factors?

Ans: ……

28. How much rating factor you can give to power button out of 10?

Ans: ……

29. Which others factor you can give most rating?

Ans: ……

30. Which factors you can give rating 9?

Ans: ……

31. Which factors you can give rating 8 out of 10?

    Ans: ……

32. Which factors you can give rating 7 out of 10?

    Ans: ……

33. Belt condition and feed dog height can be given which rating?

    Ans: ……

34. Which factors you can give rating 5 out of 10?

    Ans: ……

35. Motor speed and temperature need to give which rating?

    Ans: ……

36. Machine servicing need to give how much rating?

    Ans: ……

37. Which factors you can give rating 3 out of 10?

    Ans: ……

38. Which factors you can give rating 2 out of 10?

    Ans: ……

39. Which others factor you can give less rating out of 10?

    Ans: ……

40. How much product produces each team per hour after implementation of preventive maintenance schedule system?

    Ans: ……

41. How many reject pieces produce every 10 team in a day after implementation of preventive maintenance schedule system?

    Ans: ……

Source: A well reputed readymade garment factory.