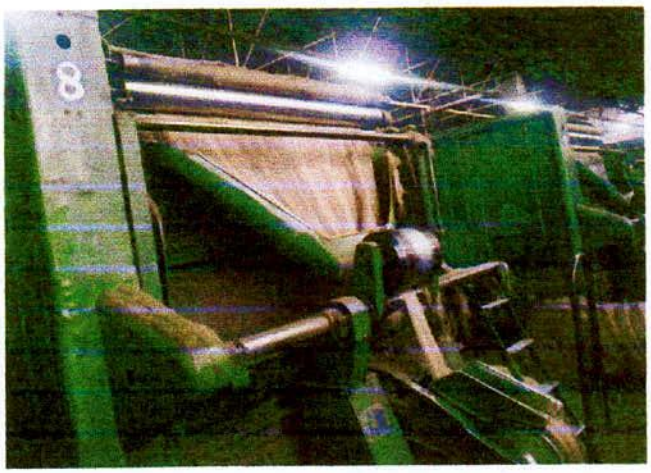
Development of Maintenance Plan of a jute mill.

(Case study : Eastern Jute mills Ltd, Khulna.)

By

Suvendra kumar Ghosh



A project report submitted in partial fulfillment of the requirements for the award of the degree of Master of Science in Industrial Engineering and Management .

Khulna University of Engineering & Technology

Khulna 9203, Bangladesh.
June -2012

Declaration

This is to certify that the project work entitled 'Development of maintenance plan of a jute mill' has been carried out by Suvendra Kumar Ghosh, Department of Industrial Engineering and Management, Khulna University of Engineering & Technology, Khulna, Bangladesh. The above research or any part of the work has not been submitted any where for the award of any degree or diploma.

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Approval

This is to certify that the project work submitted by Suvendra Kumar Ghosh entitled 'Development of maintenance plan in a jute mill' has been approved by the Board of Examiners for the partial fulfillment of the requirements for the degree of Master of Science in Engineering in the Department of Industrial Engineering & Management, Khulna University of Engineering & Technology, Khulna, Bangladesh in June 2012 .

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24th June, 2012 The Author

ABSTRACT

Maintenance acts like the heart of the machine. Due to running, every machine undergoes wear and tear due to friction. Maintenance of a machine consists of all the various activities required to keep machine in standard working condition, so that, production operations will not be interrupted by machine failure.

In Eastern Jute mill, there are various types of maintenance such as break-down, preventive and overhauling maintenance. Breakdown maintenance may be minor or major. Preventive maintenances are routine and periodic. Routine maintenance means day to day cleaning and greasing. In the factory, periodic maintenance is done strictly in every week. As a result, all machines run smoothly for the rest six days.

There are different types of machines. The breaker and finisher card machine play an important role in the production system of the jute mill. The breaker and finisher card machines consist of 7 and 13 repining rollers respectively. Among these, the cylinder roller is the biggest.

At present, at every 3 months interval, the cylinder roller is repined by dismantling its 150 staves. At that time, the breaker card machine is stopped completely. The rest of rollers are repined when they are broken. For this reason, the machine has to be stopped frequently. The finisher card machine is stopped every 5 months; the cylinder roller is repined by dismantling its 189 staves. As a result, the machine becomes idle and the production system is hampered severely. About four and half lac taka is lost, if production is hampered for a single day. So, it is found that the jute mill has been facing a huge amount of loss, if machines are stopped for repair frequently.

The objective of the present study is to investigate the possibility of repining all the rollers at a time. For this purpose, the break-down data of the above mentioned machines were collected from the log book from 2005 to 2010. Breakdown interval is obtained by deducting the two consecutive break-down. Frequency chart of 3-12 months were made for 1 month interval as shown in tables 3, 5, 7, 9, 12, 14, 16.

Total maintenance cost was calculated for different time intervals. Total cost curve is shown in figures 1, 2, 3, 4, 5, 6, 7 which are U-shaped graphs. The lowest point of U-shaped graph gives breakdown interval at which the total maintenance cost is minimum. It is found that production loss can be minimized by repining all the rollers including the cylinder at an interval of 6 months for breaker card and for finisher card machine, the same is 7 months. So, the develop model tells us that, if the maintenance of the breaker card and finisher card is done at an interval of 6 and 7 months respectively, the no. of sudden breakdown of machines will be reduced and at the same time production loss will also be minimum.

Contents

DESCRIPTION

List of Abbreviations

BJMC	:	Bangladesh Jute mills Corporation
EJM	:	Eastern Jute Mills Ltd.
M/C	:	Machine
%	:	Percent
BJRI	:	Bangladesh Jute Research Institute
BADC	:	Bangladesh Agriculture Development Corporation
MT	:	Metric Ton
CBC	:	Carpet Backing Clothes
BM	:	Break-down Maintenance cost
TC	:	Total Cost
XEN	:	Executive Engineer
SDE	:	Sub Divisional Engineer
GM	:	Group Maintenance cost

CHAPTER 01
INTRODUCTION

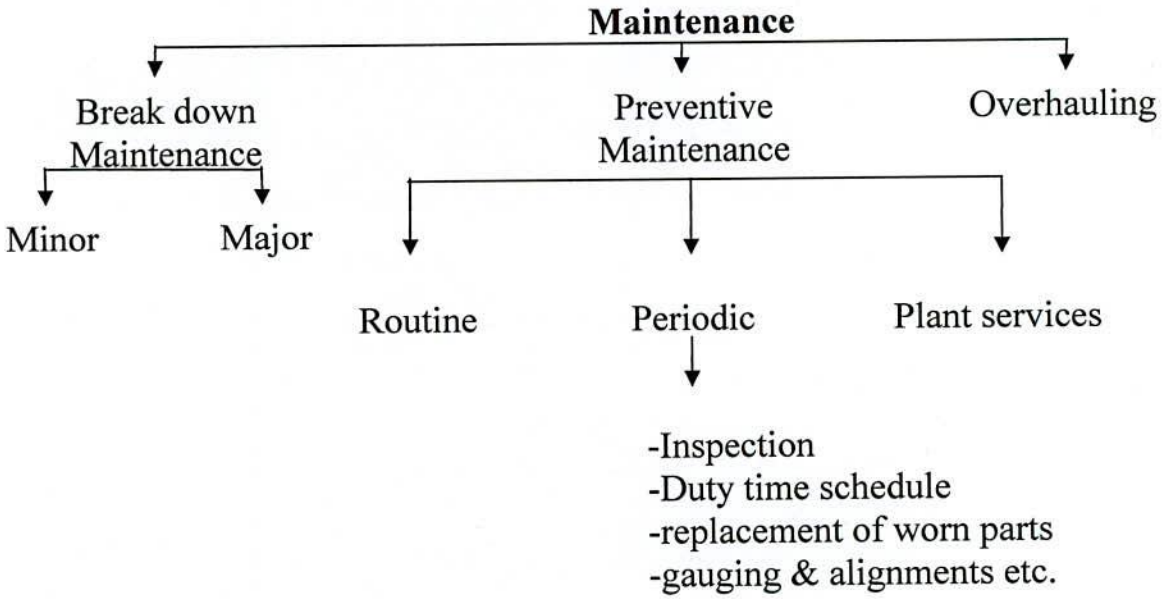
1.1 General

Maintenance acts like the heart of a machine. Due to running, every machine undergoes wear and tear due to friction. Maintenance of a machine consists of all the various activities required to keep machine in standard working condition and serviceable for the purpose for which it is designed for so that production operations will not be interrupted by machine failure.

A machine when it is used, it will be subjected to wear and tear hence proper attention should be given to protect the machine and its components from wear and tear and thus protect them from failures. A proper attention means lubrication, cleaning, timely inspection and systematic maintenance. Maintenance of a machine means efforts directed towards up-keeping and repair of that machine.

1.2 Classification of Maintenance

The following figure shows the different types of maintenance.



1.2.1Breakdown Maintenance

Breakdown of a machine can occur due to the following two reasons

1. Due to unpredictable failures of components which cannot be prevented.
2. Due to gradual wear and tear of the parts, which can be eliminated to a large extent by regular inspections, known as preventive maintenance. From proper maintenance planning it can be decided, when a part should be replaced, so that, breakdown can be avoided.

In breakdown maintenance, defects are rectified only when the machine cannot perform its function any longer and the production department is compelled to call on the maintenance engineers. After repairing the defect, the maintenance engineers do not attend the machine again until another failure occurs.

In this type of maintenance repair shall have to be done after failure, thus it may disrupt the whole production process. This method is much expensive due to increase of maintenance cost, payment to idle operators, overtime to the maintenance staff for the emergency repairs and production loss cost.

1.2.2 Preventive Maintenance

Preventive maintenance is sometimes termed as 'planned maintenance' or 'scheduled maintenance' or 'systematic plant maintenance' etc. It is an extremely important function for the reduction of maintenance cost and to keep the good operational condition of equipment and hence increases the reliability. It aims to locate the sources of trouble and to remove them before breakdown occurs. Thus it is based on the ideas 'Prevention is better than cure'. Best safeguard against costly breakdowns is to inspect, lubricate and check up the equipment as frequently as possible. To take full use of equipment, to maintain it in reliable condition, necessary measures should be taken to prevent overloading, dampness, negligence. Frequency of inspection should be decided on the basis of the importance of the machine, wear and tear of the machine, its delicacy and

total maintenance cost. This periodic inspection or checking helps to find out the reasons leading to breakdown and to rectify them, when they are in minor stages. Thus the repair can be done when one wants to do it, i.e. when it has least effect on the production schedule. Further this repair requires lesser time as compared to that of breakdown repair and thus down time is reduced by doing preventive maintenance.

1.3 Individuals versus Group-Replacement policy for low-valued items

A Production system may use a large number of identical low-valued components whose probability of break-down increases with age. Failure of these items may not result in major disruptions, but they still require replacement if the system is to perform satisfactorily. Examples of such items include telephone poles, street lights, park sprinklers, etc. Even though the unit replacement cost for such items is low, it requires sending a maintenance crew to do the necessary work. With only a limited extra effort we can replace a whole group instead of 1 unit of similar components. This is a situation with a high setup cost and a low variable cost per unit. The main issue in this case is to decide whether there is an economic advantage in replacing a whole group of similar components regardless of age at predetermined intervals rather than replacing units individually as they fail. If accurate data on the breakdown frequency distribution for such components and estimates of cost for individual and group replacement are available, it can be analyzed the breakdown data for evaluating repair versus preventive maintenance polices.

1.4 Advantage of maintenance

Following are the some of important advantages of efficiently planned and well executed maintenance programmed.

1. Reduction in production down time.
2. Lesser overtime pay for maintenance personnel.

3. Lesser number of standby equipments is needed.
4. Less expenditure on repairs.
5. Due to planned spare parts replacement, lesser spare parts are needed to remain in store at all time.
6. Greater safety to employees because of reduced breakdowns.

1.4.1 Requirement for Good Maintenance

For achieving maintenance of high order, following are some of the essential requirements:

1. Good supervision and administration of maintenance department.
2. Proper control of work i.e. Priority be fixed with care and after consultation with production and engineering department.
3. Correct clear and detailed instruction is given to the maintenance crew and to the operators.
4. Operations should be well trained.
5. A good lubrication programmed should be chalked out.
6. Proper maintenance record should be maintained.
7. Adequate stock of spares should always be kept.
8. Surroundings should be dust free and clean with proper ventilation and illumination
9. Manufacturers of the machine tools should be consulted as and when required.
10. Maintenance Department should remain in contact with planning and purchasing department in deciding the type of machine tools is purchased. A machine tool to be purchased should be of best design, adequately safe with good lubrication arrangements, minimum of moving parts and easy availability of spares etc.

1.5 Objectives of the Study

Jute is a natural fiber and it has no side effect. Huge quantity of machineries, raw jute, workers and public are involved in jute industry. Breaker and finisher card are the two types of important machines in the jute mills. These machines are mainly responsible for most of the production losses. For keeping these machines in good working condition, maintenance plays an important role. So, it is necessary to find out an effective maintenance plan for these machines. The specific objective of this research is as follows:

1. To study the whole maintenance systems of the Eastern Jute Mill.
2. To find out the defects of breaker and finisher card machines.
3. To develop maintenance plan for the breaker and finisher card machines.

1.6 Scope of the Study

Data has been collected from Eastern Jute Mills under BJMC, while carrying out the research work, Finisher and Breaker Card Machines of the Eastern jute Mills Ltd. located at Atra Industrial area, Khulna

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CHAPTER- 02

LITERATURE REVIEW

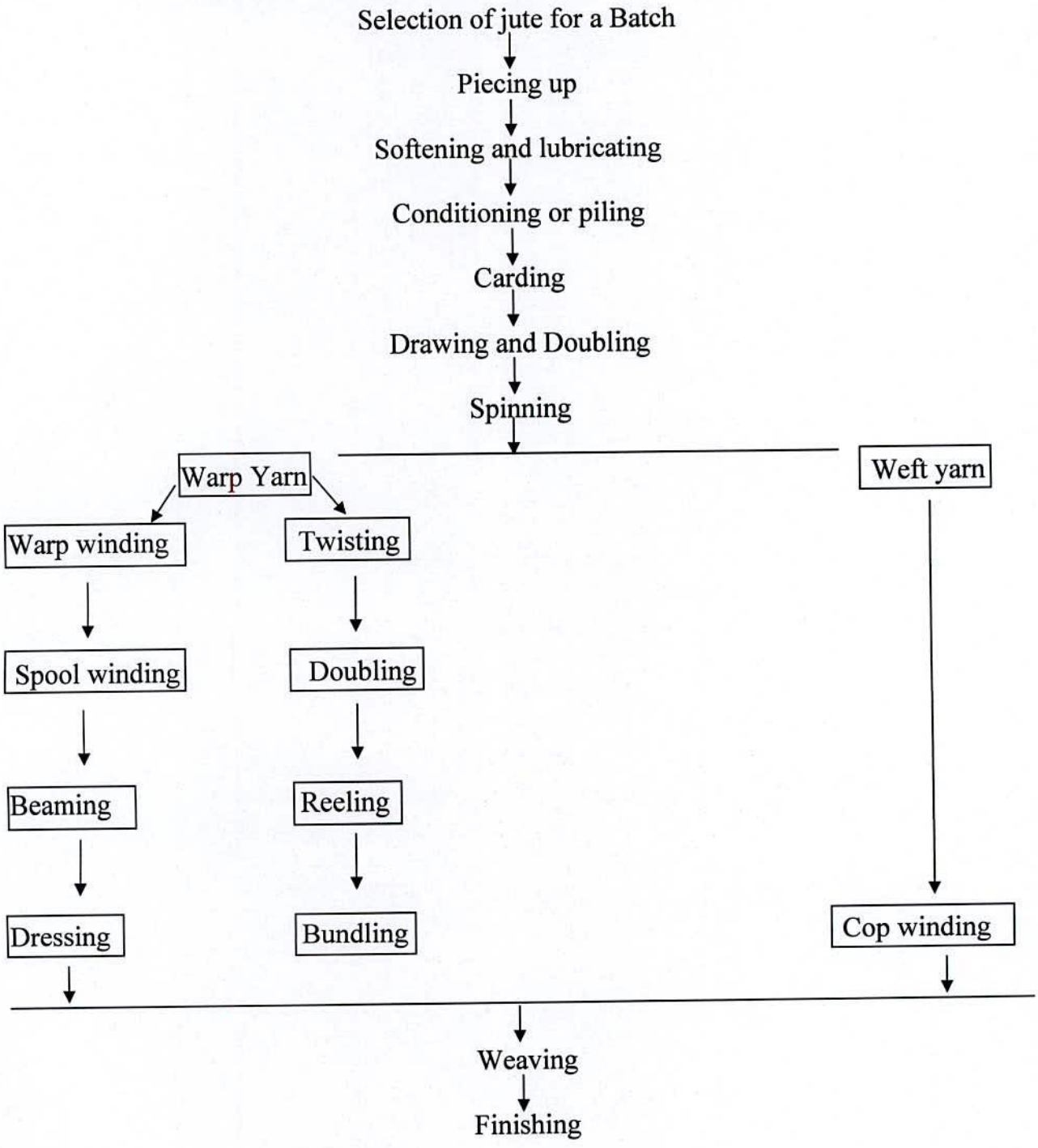
2.1 General

Jute is one of the mainstays of Bangladesh economy. It accounts for about 6 percent of the foreign currency earnings from export. Among the jute growing countries of the world, Bangladesh ranks second in respect of production. Jute fiber produced from 0.461 million hectares of land which covered 2.86 percent of total cropped area amounted to 0.912 million tons of fiber (BBS, 2007). The crop is a versatile and environmental friendly biodegradable natural fiber widely grown in Asia, particularly in Bangladesh, India and china. It is a rapid growing renewable biomass and photo reactive crop with only 120 days harvesting period. It is an important cash crop in Bangladesh and India. It is mainly grown for fiber rather than the seed. Its fiber is primarily used for making hessian, sack and carpet backing clothes. It has versatile uses for making mats, blankets, furnishing fabrics and packaging materials in the jute mills. Besides the use of jute fiber jute sticks and root stamps are traditionally used as fuel in the rural areas [9].

Predominantly jute is grown for fiber and little attention is given to its seed production. Conventionally, farmers of Bangladesh grow jute seed along with the fiber crop. Jute crop requires few months more for producing seeds and farmers keep some plants for this purpose at the corner of the field during harvesting of the crop for fiber. Sometimes, farmers cannot grow good crop for using poor quality seeds obtained from markets. To over come the problem the scientists of BJRI evolved improved technique for quality seed production of jute crop.

Jute covers about 2.45% of total cropped area and accounts for about 5% of total foreign exchange through export of raw jute and jute products. To cultivate usually the said area, the farmers require about 3500 to 4000 tons of seed. Many jute farmers use to produce jute crops by their own seeds to meet their requirements but such seeds are of poor in quality. One of the most important problems for jute production in Bangladesh is the non availability of quality seeds at proper time of sowing. The jute grown in Bangladesh generally does not grow a separate jute crop for seed production. The farmers usually keep a small portion of crop at one corner or any suitable place of the field to produce seeds and rest of the crop is harvested for fiber. Principally two species of jute are cultivated in Bangladesh viz corchorus capsularis L. and corchorus olitorius L. Due to recurrent flood production of jute seed adopting conventional method has become very disappointing. Bangladesh jute Research Institute (BJRI) has developed numbers of high yielding varieties of C oilitorius L. At present Bangladesh Agriculture Development Corporation BADC is the only public sector producing certified jute seeds in their own firm as well as through contract growers. BADC cannot meet up more than 10% of the total requirement. Seed is the basic input for crop production. Quality seed of a variety is the key to better crop establishment and better yield. In Bangladesh, jute is grown in about 0.48 million hectares of land by about 4 million out of 10 million farm families. Bangladesh annually requires about four thousands metric tons of jute seeds to grow in about 0.48 millions hectares of land. About 10-12% of jute seeds are produced under the supervision of the Bangladesh Agricultural Development Corporation (BADC) and the rest of the seeds are produced and managed by the farmers themselves. Bangladesh jute Research Institution (BJRI) in recent years is advocating for switching over of planting time of jute seed crop from March-April to August-September.

2.2 Flow graph of jute manufacturing processes



Activities needed to develop maintenance plan towards maintenance are the responsibility of industrial organizations. But it is found that the maintenance departments are not generally conscious about their responsibility. Most of the industry takes necessary activities to increase development of maintenance plan. Even activities necessary to make the maintenance teams are also not taken by the organization. The Management does not provide necessary support to the employees to work safely.

2.3 Jute yarn numbering table

- 90 inches or 2/2 yards = 1 Thread.
- 120 thread or 300 yards = 1 Cut.
- 2 Cuts or 600 yards = 1 Heer.
- 12 Cuts or 3600 yards = 1 Hank.
- 48 cuts or 14400 yards = 1 spindle.

The weight in lbs of 1 spindle or 14400 yards of jute yarn is the count of that yarn. For example, if 14400 yards weights 8 Lbs, it is 8 Lbs. jute yarn and if 10 lbs. then it is 10 lbs. jute yarn.

2.4 Ply or folded yarn:

When 2 or more strand of single yarn are twisted together to make a strong and coarse thread, the resultant thread is called a ply or Folded Yarn or twine. The count of a ply yarn can be found out by multiplying the single yarn count with the number of strands twisted together.

2.5 Brief Description of E.J.M:

EJM is situated within City Corporation at 15 kms distance from Khulna Town. It was established 29.07.1967 on 40.87 acres of land. This export oriented industry was nationalized on 26.03.1970. At present, it is under BJMC and has various types of departments such as administration, accounts and finance, wages, export,

Purchase, labor and welfare, production, maintenance, Jute and above well medical center. Installed looms are for sacking 118, Hessian 122 and CBC 35 i.e. total installed capacity was 275. At present, budgeted looms were for sacking 110, Hessian 103 and CBC 28 i.e. total budgeted loom is 241. Setup Man power were officer's 72, Staffs 153 and workers 1285 hands. But actual man power is officers 39, Staffs 120 and worker 1381 hands. Here residents of officers, staffs and workers are located in separate places. Budget production in fiscal year 2009-10 are sacking 4109 metric ton, Hessians 1405 metric ton and CBC 703 metric ton, that is, total Budget production was 6217 metric ton. But actual Production in fiscal year 2009-10 were sacking 4782 metric ton, Hessian 53 metric ton, and CBC 669 metric ton, that is, total production achieved was 5982 metric ton. Among these productions, 511 metric ton of Hessian, 3407metric ton of sacking and CBC 505 metric ton have been exported. Foreign currency is earned from Hessian tk.382.20 lacs, sacking tk.1883.38 lacs and CBC tk.297.40 lacs, that is, total tk.2563 lacs. Domestic sales Amounts to Hessian 16 metric ton, sacking 1285metric ton and cbc 243 metric ton, that is, total domestic consumption was 1493 metric ton whose market price was tk. 1162.87 lacs.

Maintenance department is the combination of mechanical and Electrical department. When a machine runs, moving parts undergoes in wear and tear. An Engineer or a technician understands the position of the machines. Then that machine is taken into preventive maintenance or overhauling. Various parts of these machines are checked thoroughly. Warned out and damaged parts are fully replaced. Costly rollers and items are repaired by workshop. After repairing the costly parts and collecting other low valued items of that machine assembly is done. After 4 to 5 days, the machine is run by preventive maintenance. Considering all the parameters of production loss due to failure, I would like to establish an effective maintenance planning of Breaker and Finisher card machines.

CHAPTER 03

Methodology

3.1 General:

'This chapter deals with the presentation of all the methods implemented to gather data and how the actual research work has been conducted. The methodology used in this research covers the collection of information. The collection of enlist & reliable information and analyzing them we can reach at correct decision. It consists of the following 6(six) steps.

3.2 Data collection

Breaker card and finisher card are the two types of important machine in the jute mills. These machines are mainly responsible for most of the production losses. So, data was collected from batching department in the Eastern jute Mills Ltd. Attra, Khulna. Break-down dates of breaker Card and finisher Card machines were collected from the log-book. To make the data more reliable and authentic different categories of workers (charge-hand, fitter, journey man, helper, boodle, Causal etc.) managers and engineers were interviewed based on the level of technical knowledge, experience and intimacy with the breakdown and also considering the education level during the study.

3.3 Presentation of data

Collected data is presented in frequency chart according to the following rules.

1. The break-down duration of machinery had been taken for the last five years from 13.05.05 to 12.10.10.
2. Break-down interval is calculated by subtracting two consecutive break-down dates.
3. Frequency charts are drawn taking break-down interval.

3.4 Determination of production loss cost

Production loss cost = production per hour × production price/kg × efficiency × working hour.

3.5 Determination of breakdown maintenance cost

Breakdown maintenance cost has the following components

Material cost + machining cost + fitting cost + production loss cost.

1. Material cost consists of material cost of pinion, machining cost and fitting cost of pinion, roller arbor, ball / roller bearing.
2. Production loss cost is calculated with the following formulae.

   Production loss cost = production per hour ×production price/kg × efficiency × working hour.

3.6 Determination of group-maintenance cost

Group-maintenance cost is the Combination of material cost for group maintenance and production loss cost. The material cost consists of the repining cost of cylinder roller, feed roller, worker rollers, stripper and doffer rollers.

3.7 Determination of total cost

To find out total cost the following formulae is used.

Total cost = Group maintenance cost × frequency of group maintenance / year + breakdown maintenance cost × expected frequency of breakdown during two consecutive group maintenance.

CHAPTER-4
Data Analysis and Results

4.1 Introduction:

In this section, methodology developed in the previous chapter is applied for Breaker Card and Finisher Card machines of Eastern Jute Mills LTD. under Bangladesh Jute Mills Corporation (BJMC). The findings are presented and illustrated with figures and tables in the subsequent sections.

4.2 Determination of repining cost of Breaker Card machine

There are seven rollers in a breaker card machine. The cost of repining of each roller is shown in table-1.

Table-1:

Repining cost of Breaker Card machine

Name of Roller	No. of line	No. of pin per line	Total No. of bottoms	Total pin	Pin size	Cost/ Thousand pin Tk.	Pin cost Tk.	Labor cost Tk.	Total Cost Tk.
1. Cylinder Roller	5	42	150	31,500	$13(.94)\times1''$	273.00	8736.00	5625	14,361
2. Feed Roller	7	54	57	21,546	$12.(.103)\times1\frac{1}{4}''$	352.00	7744.00	2700	10,444
3. Stripper Roller no.1	5	54	45	12,150	$13(.94)\times1\frac{3}{16}''$	248.00	3000.00	2700	5,700
4. Stripper Roller no.2	5	54	45	12,150	$13(.94)\times1\frac{3}{16}''$	248.00	3000.00	2700	5,700
5.Worker Roller no.1	6	54	51	16,524	$12(.105)\times1\frac{1}{2}''$	457.00	7769.00	2700	10,469
6.Worker Roller no.2	6	54	51	16,524	$12(.105)\times1\frac{1}{2}''$	457.00	7769.00	2700	10,469
7. Doffer Roller	7	66	69	31,878	$14(.83)\times1\frac{3}{4}''$	345.00	7840.00	3000	10,856
									67,993
									68,000

4.3 Determination of material Cost of break down maintenance

When an accident is occurred, various parts such as rollers, bearings, pinions and studs are damaged.

Cost of damaged staves of rollers	=	Tk. 12,500.00
Cost of Bearings	=	Tk. 2,400.00
Cost of Pinions	=	Tk. 2,800.00
Cost of Studs	=	Tk. 800.00
Worker engagement Cost 4 hands / 8 hours	=	Tk. 1000.00
Overhead Cost = 1000×60%	=	Tk. 600.00

S0, material Cost of break-down maintenance = 12,500 +2400+ 2800 +800 + 1000 + 600

= Tk. 20, 100

= Tk. 20,000

4.4 Determination of Production loss cost

Production Loss cost = Production / hour × price of production / kg× efficiency × 23.5 hours.

Here, price of production / kg = tk.95.00

Working hour = 23.5 hour/day

Efficiency = 70%

4.5 Determination of production / hour

When a breaker-card m/c is running, production / hour is taken randomly.

6am	-7am	=	290kg
7am	-8am	=	280kg
9am	-10am	=	300kg
10am	-11am	=	310kg
01pm	-02pm	=	295kg
2pm	-3pm	=	325kg

$\therefore$ Average production / hour = $\frac{290+280+300+310+295+325}{6} = 300kg$

4.6 Break-down Data collection

Breakdown data from 22.08.2005 to 07.08.2010 collected from log book of Breaker Card machine no.-1 and tabulated in table-2.

Table- 2:

Break-down data of Breaker card machine no.-1 from 2005 to 2010

Name of Rollers	Break down Dates	Break down Intervals (Months)	Material Cost,Tk.	Break-down Maintenance Cost,Tk.	Production Loss Cost	Total Cost
01. Cylinder Roller.	28.08.2006		14361.00	20000.00	468825.00	503186.00
	26.06.2007	10	14361.00	20000.00	468825.00	503186.00
	09.04.2008	10	14361.00	20000.00	468825.00	503186.00
	23.06.2009	12	14361.00	20000.00	468825.00	503186.00
	14.02.2010	08	14361.00	20000.00	468825.00	503186.00
	20.08.2010	06	14361.00	20000.00	468825.00	503186.00
02. Worker Roller No-1.	22.08.2005		10469.00	20000.00	156275.00	186744.00
	20.08.2006	12	10469.00	20000.00	156275.00	186744.00
	17.06.2007	10	10469.00	20000.00	156275.00	186744.00
	25.01.2008	07	10469.00	20000.00	156275.00	186744.00
	31.08.2009	07	10469.00	20000.00	156275.00	186744.00
03. Worker Roller No-2.	29.11.2005		10469.00	20000.00	156275.00	186744.00
	26..09.2006	10	10469.00	20000.00	156275.00	186744.00
	24.09.2007	12	10469.00	20000.00	156275.00	186744.00
	31.08.2009	23	10469.00	20000.00	156275.00	186744.00
04. Doffer Roller.	29.11.2005		10856.00	20000.00	156275.00	187131.00
	27.04.2007	17	10856.00	20000.00	156275.00	187131.00
	31.08.2009	28	10856.00	20000.00	156275.00	187131.00
	19.03.2010	07	10856.00	20000.00	156275.00	187131.00
05. Stripper Roller No-1.	29.11.2005		5700.00	20000.00	156275.00	181975.00
	27.04.2007	17	5700.00	20000.00	156275.00	181975.00
	31.08.2009	28	5700.00	20000.00	156275.00	181975.00
06. Stripper Roller No-2.	29.11.2005		5700.00	20000.00	156275.00	181975.00
	26.09.2006	10	5700.00	20000.00	156275.00	181975.00
	31.08.2009	35	5700.00	20000.00	156275.00	181975.00
	07.08.2010	11	5700.00	20000.00	156275.00	181975.00
07. Feed Roller.	29-11-2005		10444.00	20000.00	156275.00	186719.00
Total Cost						= 6908880.00

Net total cost = 6908880.00 / 5 Years
= 1381776.00 / 1 Year

Table- 3:
Break-down Frequency chart

Intervals (Months)	Frequency
06	1
07	3
08	1
09	×
10	5
11	1
12	3
12>	5

4.7 Determination of Group Maintenance, Break-down Maintenance and Total Cost.

Group Maintenance cost (GM) = Material Cost + Production loss Cost during group maintenance.

Break-down Maintenance Cost (BM) = Material Cost + Production loss Cost during break-down maintenance.

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected frequency of break-down.

G.M Cost = Material Cost + Production loss Cost

$$= 68000.00 + 300 \text{ kg} \times 95 \times \frac{70}{100} \times 23.5$$

$$= 68000.00 + 468825.00$$

$$= 536825.00$$

Break-down Maintenance Cost $= 20{,}000.00 + \frac{468825}{3}$ [Production loss is only 8 hours due to breakdown, so $\frac{468825}{3}$]

$$= 20000.00 + 156275.00$$

$$= 1{,}76{,}275.00$$

For the frequency 6 months

BM Cost = 0

Total Cost $= \text{GM Cost} \times \frac{12}{6} + 0$

$$= 536825.00 \times 2 + 0$$

$$= 10{,}73{,}650.00$$

For the frequency 7 months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$$= 536825.00 \times \frac{12}{7} + 1{,}76{,}275.00 \times 1$$

= 9,20,271.00 + 1,76,275.00

= 10,96,546.00

For the frequency 8 months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$$= 536825.00 \times \frac{12}{8} + 1,76,275.00 \times 4$$

= 8,05,237.00+7,05,100.00

= 15,10,337.00

For the frequency 9 months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$$= 536825.00 \times \frac{12}{9} + 1,76,275.00 \times 5$$

= 7,15,766.00 + 8,81,375.00

= 15,97,141.00

For the frequency 10 months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$$= 536825.00 \times \frac{12}{10} + 1,76,275.00 \times 5$$

= 6,44,190.00 + 8,81,375.00

= 15,25,265.00

For the frequency 11 months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected frequency of break down.

= 5,85,627.00 + 17,62,750.00

= 23,48,377.00

For the frequency 12 months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$$= 536825.00 \times \frac{12}{12} + 1,76,275.00 \times 11$$

= 5,36,825.00 + 19,39,025.00

= 24,75,850.00

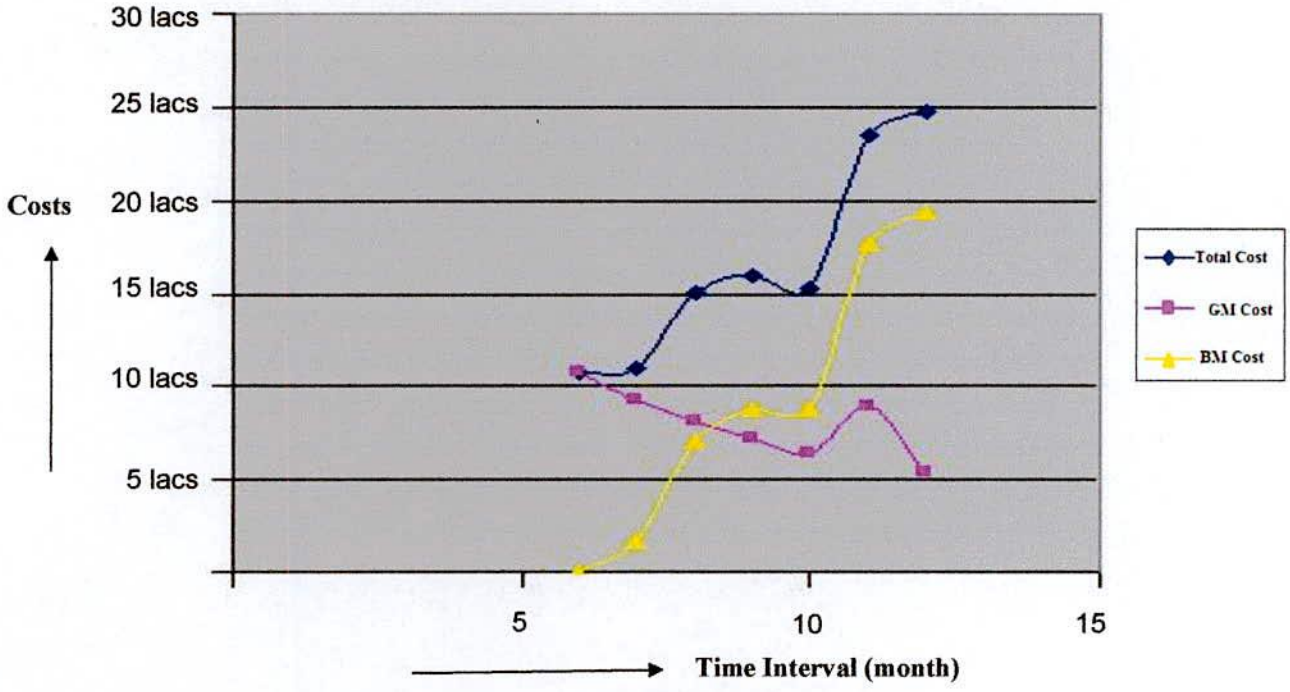


Figure- 1

Graph Breaker card machine no. - 1 cost (Tk) versus interval (month)

From the figure-1, it is seen that the total maintenance cost is minimum when the group maintenance interval is 6 month with a total cost of Tk.10,73,650.00. After that the total maintenance cost increases with the increase of group maintenance interval. This is because of increasing breakdown maintenance with the increase of group maintenance interval.

4.8 Break-down Data collection

Breakdown data from 22.08.2005 to 07.08.2010 collected from log book of Breaker Card machine no.-2 and tabulated in table-4

Table- 4:

Break-down data of Breaker Card machine No.-2 from 2005 to 2010

Name of Rollers	Break down Dates	Break down Intervals (Months)	Material Cost	Break-down Maintenance Cost	Production Loss Cost	Total Cost
01. Cylinder Roller.	14.02.2005		14361.00	20000.00	468825.00	503186.00
	21.08.2005	06	14361.00	20000.00	468825.00	503186.00
	14.01.2009	30	14361.00	20000.00	468825.00	503186.00
	03.04.2009	03	14361.00	20000.00	468825.00	503186.00
	12.09.2009	05	14361.00	20000.00	468825.00	503186.00
	09.12.2009	03	14361.00	20000.00	468825.00	503186.00
02. Worker Roller No-1.	29.09.2005		10469.00	20000.00	156275.00	186744.00
	21.07.2006	10	10469.00	20000.00	156275.00	186744.00
03. Worker Roller No-2.	29.09.2005		10469.00	20000.00	156275.00	186744.00
	27.08.2008	35	10469.00	20000.00	156275.00	186744.00
	12.04.2009	07	10469.00	20000.00	156275.00	186744.00
04. Feed Roller.	14.02.2005		10444.00	20000.00	156275.00	186719.00
	29.04.2008	38	10444.00	20000.00	156275.00	186719.00
	25.12.2008	08	10444.00	20000.00	156275.00	186719.00
05. Doffer Roller.	10.03.2005		10856.00	20000.00	156275.00	187131.00
	20.07.2007	28	10856.00	20000.00	156275.00	187131.00
	30.10.2007	39	10856.00	20000.00	156275.00	187131.00
06. Stripper Roller No-1.	19.09.2005		5700.00	20000.00	156275.00	181975.00
	20.06.2006	09	5700.00	20000.00	156275.00	181975.00
	17.04.2010	36	5700.00	20000.00	156275.00	181975.00
07. Stripper Roller No-2.	19.09.2005		5700.00	20000.00	156275.00	181975.00
	12.09.2009	48	5700.00	20000.00	156275.00	181975.00
Total Cost						5984261.00

Net total cost = 5984261.00 / 5 Years
= 1196852.00 / 1 Year

Table- 5:
Break-down Frequency chart

Intervals (months)	Frequency
03	2
04	×
05	1
06	1
07	1
08	1
09	1
10	1
11	×
12	1
12>	6

4.9 Determination of Total Cost

Group Maintenance cost = Material Cost + Production loss Cost.

Break-down Maintenance Cost = Material Cost + Production loss Cost.

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

G.M Cost = Material Cost + Production loss Cost

$$= 68000.00 + 300 \text{ kg} \times 95 \times \frac{70}{100} \times 23.5$$

$$= 68000.00 + 468825.00$$

$$= 536825.00$$

$$\text{Break-down Maintenance Cost} = 20{,}000.00 + \frac{468825}{3}$$

$$= 20000.00 + 156275.00$$

$$= 1{,}76{,}275.00$$

For the frequency 3 Months

BM Cost = 0

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$$= 5{,}36{,}825.00 \times \frac{12}{3} + 0$$

$$= 6{,}36{,}825.00 \times 4 + 0$$

$$= 21{,}47{,}300.00$$

For the frequency 4 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{4} + 1,76,275.00 \times 2$

$= 5,36,825.00 \times 3 + 3,52,550.00$

$= 19,63,025.00$

For the frequency 5 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{5} + 1,76,275.00 \times 2$

$= 5,36,825.00 \times 2.4 + 3,52,550.00$

$= 16, 40,930.00$

For the frequency 6 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{6} + 1,76,275.00 \times 3$

$= 5,36,825.00 \times 2 + 5,28,825.00$

$= 16,02,475.00$

For the frequency 7 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{7} + 1,76,275.00 \times 4$

$= 9,20,271.00 + 7,05,100.00$

$= 16,25,371.00$

For the frequency 8 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{8} + 1,76,275.00 \times 5$

$= 8,05,237.00 + 8,81,375.00$

$= 16,86,612.00$

For the frequency 9 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$$= 5,36,825.00 \times \frac{12}{9} + 1,76,275.00 \times 6$$

$$= 7,15,767.00 + 10,57,650.00$$

$$= 17,73,417.00$$

For the frequency 10 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$$= 5,36,825.00 \times \frac{12}{10} + 1,76,275.00 \times 7$$

$$= 6,44,190.00 + 12,33,925.00$$

$$= 18,78,115.00$$

For the frequency 11 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$$= 5,36,825.00 \times \frac{12}{11} + 1,76,275.00 \times 8$$

$$= 5,85,627.00 + 14,10,200.00$$

$$= 19,95,827.00$$

For the frequency 12 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$$= 5,36,825.00 \times \frac{12}{12} + 1,76,275.00 \times 8$$

$$= 5,36,825.00 + 14,10,200.00$$

$$= 19,47,025.00$$

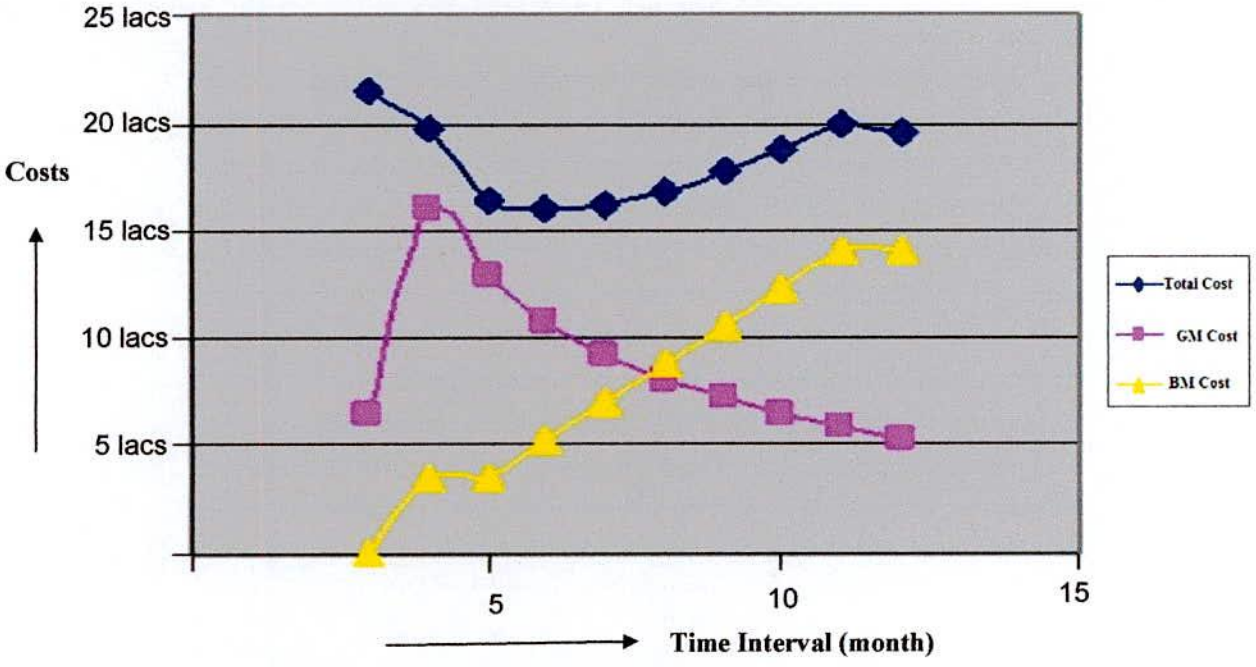


Figure 2

Graph Breaker card machine no. - 2 cost (Tk) versus interval (month)

From the figure 2, it is seen that the total maintenance cost is minimum when the group maintenance interval is 6 month with a total cost of Tk.16,02,475.00. After that the total maintenance cost increases with the increase of group maintenance interval. This is because of increasing breakdown maintenance with the increase of group maintenance interval.

4.10 Break-down Data collection

Breakdown data from 22.08.2005 to 07.08.2010 collected from log book of Breaker Card machine no.-3 and tabulated in table-6.

Table- 6:

Break-down data of Breaker card machine no.-3 from 2005 to 2010.

Name of Rollers	Break down Dates	Break down Intervals (Months)	Material Cost	Break-down Maintenance Cost	Production Loss Cost	Total Cost
01. Cylinder Roller.	13.05.2006		14361.00	20000.00	468825.00	503186.00
	26.02.2007	09	14361.00	20000.00	468825.00	503186.00
	22.09.2007	07	14361.00	20000.00	468825.00	503186.00
	09.09.2008	12	14361.00	20000.00	468825.00	503186.00
	13.08.2009	11	14361.00	20000.00	468825.00	503186.00
	04.02.2010	06	14361.00	20000.00	468825.00	503186.00
	12.06.2010	03	14361.00	20000.00	468825.00	503186.00
02. Worker Roller No-1.	28.01.2006		10469.00	20000.00	156275.00	186744.00
	22.09.2007	20	10469.00	20000.00	156275.00	186744.00
	12.06.2010	33	10469.00	20000.00	156275.00	186744.00
	06.09.2010	03	10469.00	20000.00	156275.00	186744.00
03. Worker Roller No-2.	28.01.2006		10469.00	20000.00	156275.00	186744.00
	08.08.2006	05	10469.00	20000.00	156275.00	186744.00
	12.06.2010	46	10469.00	20000.00	156275.00	186744.00
04. Feed Roller.	13.05.2005		10444.00	20000.00	156275.00	186719.00
	22.09.2007	28	10444.00	20000.00	156275.00	186719.00
05. Doffer Roller.	28.01.2006		10856.00	20000.00	156275.00	187131.00
	08.08.2006	06	10856.00	20000.00	156275.00	187131.00
	13.08.2009	36	10856.00	20000.00	156275.00	187131.00
06. Stripper Roller No-1.	13.05.2005		5700.00	20000.00	156275.00	181975.00
	08.08.2006	15	5700.00	20000.00	156275.00	181975.00
	28.07.2007	12	5700.00	20000.00	156275.00	181975.00
	13.08.2009	24	5700.00	20000.00	156275.00	181975.00
	14.07.2010	11	5700.00	20000.00	156275.00	181975.00
07. Stripper Roller No-2.	28.01.2006		5700.00	20000.00	156275.00	181975.00
	26.02.2007	13	5700.00	20000.00	156275.00	181975.00
	22.09.2007	07	5700.00	20000.00	156275.00	181975.00
	12.06.2009	21	5700.00	20000.00	156275.00	181975.00
Total Cost						7402116.00

Net total cost = 7402116.00 / 5 Years
= 1480423.00 / 1 Year

Table- 7:
Break-down Frequency chart

Intervals (months)	Frequency
03	2
04	×
05	1
06	2
07	2
08	×
09	1
10	×
11	2
12	2
12>	9

4.11 Determination of Total Cost

Group Maintenance cost = Material Cost + Production loss Cost.

Break-down Maintenance Cost = Material Cost + Production loss Cost.

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected frequency of break down.

G.M Cost = Material Cost + Production loss Cost

$$= 68000.00 + 300 \text{ kg} \times 95 \times \frac{70}{100} \times 23.5$$

$$= 68000.00 + 468825.00$$

$$= 536825.00$$

$$\text{Break-down Maintenance Cost} = 20{,}000.00 + \frac{468825}{3}$$

$$= 20000.00 + 156275.00$$

$$= 1{,}76{,}275.00$$

For the frequency 3 Months

BM Cost = 0

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$$= 5{,}36{,}825.00 \times \frac{12}{3} + 0$$

$$= 5{,}36{,}825.00 \times 4 + 0$$

$$= 21{,}47{,}300.00$$

For the frequency 4 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{4} + 1,76,275.00 \times 2$

$= 5,36,825.00 \times 3 + 3,52,550.00$

$= 19,63,025.00$

For the frequency 5 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{5} + 1,76,275.00 \times 2$

$= 5,36,825.00 \times 2.4 + 3,52,550.00$

$= 12,88,380.00 + 3,52,550.00$

$= 16,40,530.00$

For the frequency 6 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{6} + 1,76,275.00 \times 3$

$= 5,36,825.00 \times 2 + 5,28,825.00$

$= 10,73,650.00 + 5,28,825.00$

$= 16,02,475.00$

For the frequency 7 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{7} + 1,76,275.00 \times 5$

$= 9,20,271.00 + 8,81,375.00$

$= 18,01,446.00$

For the frequency 8 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{8} + 1,76,275.00 \times 7$

$= 8,05,237.00 + 12,33,925.00$

$= 20,39,162.00$

For the frequency 9 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{9} + 1,76,275.00 \times 7$

$= 7,15,767.00 + 12,33,925.00$

$= 19,49,492.00$

For the frequency 10 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{10} + 1,76,275.00 \times 8$

$= 6,44,190.00 + 14,10,200.00$

$= 20,54,390.00$

For the frequency 11 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{11} + 1,76,275.00 \times 8$

$= 5,85,627.00 + 14,10,200.00$

$= 19,95,827.00$

For the frequency 12 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{12} + 1,76,275.00 \times 10$

$= 5,36,825.00 + 17,62,750.00$

$= 22,99,575.00$

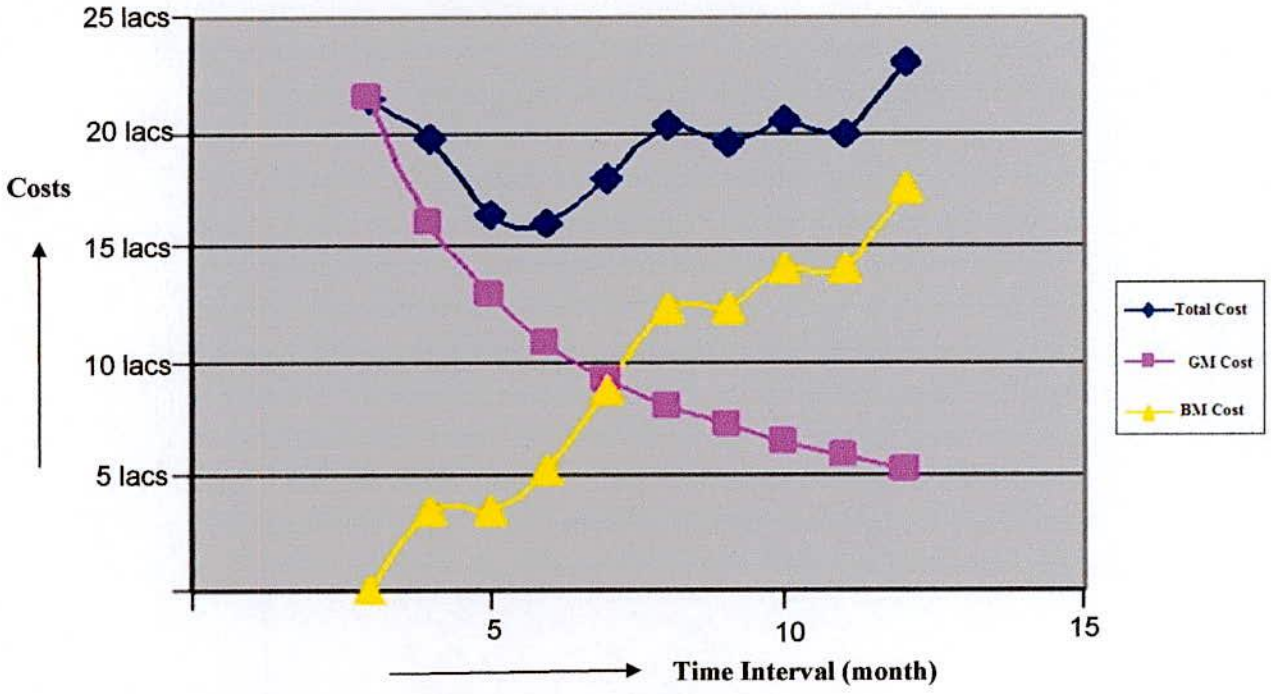


Figure 3

Graph Breaker card machine no. - 3 cost (Tk) versus interval (month)

From the figure 3, it is seen that the total maintenance cost is minimum when the group maintenance interval is 6 month with a total cost of Tk. 16,02,475.00. After that the total maintenance cost increases with the increase of group maintenance interval. This is because of increasing breakdown maintenance with the increase of group maintenance interval.

4.12 Break-down Data collection

Breakdown data from 22.08.2005 to 07.08.2010 collected from log book of Breaker Card machine no.-3 and tabulated in table-8.

Table- 8:

Break-down data of Breaker card machine no.-4 from 2006 to 2010

Name of Rollers	Break down Dates	Break down Intervals (Months)	Material Cost	Break-down Maintenance Cost	Production Loss Cost	Total Cost
01. Cylinder Roller.	22.05.2006		14361.00	20000.00	468825.00	503186.00
	19.11.2006	06	14361.00	20000.00	468825.00	503186.00
	18.07.2007	08	14361.00	20000.00	468825.00	503186.00
	12.11.2007	04	14361.00	20000.00	468825.00	503186.00
	10.02.2008	03	14361.00	20000.00	468825.00	503186.00
	20.03.2009	13	14361.00	20000.00	468825.00	503186.00
	01.07.2009	03	14361.00	20000.00	468825.00	503186.00
	01.05.2010	10	14361.00	20000.00	468825.00	503186.00
	12.08.2010	03	14361.00	20000.00	468825.00	503186.00
02. Worker Roller No-1.	12.05.2006		10469.00	20000.00	156275.00	186744.00
	18.07.2007	14	10469.00	20000.00	156275.00	186744.00
	01.07.2009	23	10469.00	20000.00	156275.00	186744.00
	30.03.2010	09	10469.00	20000.00	156275.00	186744.00
	16.07.2010	03	10469.00	20000.00	156275.00	186744.00
03. Worker Roller No-2.	12.05.2006		10469.00	20000.00	156275.00	186744.00
	20.08.2007	15	10469.00	20000.00	156275.00	186744.00
	30.03.2010	31	10469.00	20000.00	156275.00	186744.00
04. Feed Roller.	22.05.2006		10444.00	20000.00	156275.00	186719.00
	20.08.2007	15	10444.00	20000.00	156275.00	186719.00
05. Doffer Roller.	22.05.2006		10856.00	20000.00	156275.00	187131.00
	18.07.2007	14	10856.00	20000.00	156275.00	187131.00
	10.06.2006	35	10856.00	20000.00	156275.00	187131.00
06. Stripper Roller No-1.	22.05.2006		5700.00	20000.00	156275.00	181975.00
	18.07.2007	14	5700.00	20000.00	156275.00	181975.00
	20.11.2007	04	5700.00	20000.00	156275.00	181975.00
	01.07.2009	08	5700.00	20000.00	156275.00	181975.00
	26.08.2010	13	5700.00	20000.00	156275.00	181975.00
07. Stripper Roller No-2.	14.10.2005		5700.00	20000.00	156275.00	181975.00
	18.07.2007	21	5700.00	20000.00	156275.00	181975.00
	07.10.2008	15	5700.00	20000.00	156275.00	181975.00
	26.11.2009	14	5700.00	20000.00	156275.00	181975.00
	01.05.2010	05	5700.00	20000.00	156275.00	181975.00
Total Cost						8777207.00

Net total cost = 8777207.00 / 5 Years

= 1755441.00 / 1 Year

Table- 9:
Break-down Frequency chart

Intervals (months)	Frequency
03	4
04	2
05	1
06	1
07	1
08	1
09	1
10	1
11	×
12	×
12>	14

4.13 Determination of total cost

Group Maintenance cost = Material Cost + Production loss Cost.

Break-down Maintenance Cost = Material Cost + Production loss Cost.

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected frequency of break down.

G.M Cost = Material Cost + Production loss Cost

$$= 68000.00 + 300 \text{ kg} \times 95 \times \frac{70}{100} \times 23.5$$

$$= 68000.00 + 468825.00$$

$$= 536825.00$$

$$\text{Break-down Maintenance Cost} = 20{,}000.00 + \frac{468825}{3}$$

$$= 20000.00 + 156275.00$$

$$= 1{,}76{,}275.00$$

For the frequency 3 Months

BM Cost = 0

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$$= 5{,}36{,}825.00 \times \frac{12}{3} + 0$$

$= \quad 5{,}36{,}825.00 \times 4 + 0$

$= \quad 21{,}47{,}300.00$

For the frequency 4 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= \quad 5{,}36{,}825.00 \times \frac{12}{4} + 1{,}76{,}275.00 \times 4$

$= \quad 5{,}36{,}825.00 \times 3 + 7{,}05{,}100.00$

$= \quad 23{,}15{,}575.00$

For the frequency 5 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= \quad 5{,}36{,}825.00 \times \frac{12}{5} + 1{,}76{,}275.00 \times 6$

$= \quad 5{,}36{,}825.00 \times 2.4 + 3{,}52{,}550.00$

$= \quad 12{,}88{,}380.00 + 10{,}57{,}650.00$

$= \quad 23.46.038.00$

For the frequency 6 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= \quad 5{,}36{,}825.00 \times \frac{12}{6} + 1{,}76{,}275.00 \times 7$

$= \quad 5{,}36{,}825.00 \times 2 + 12{,}33{,}925.00$

$= \quad 10{,}73{,}650.00 + 12{,}33{,}925.00$

$= \quad 23{,}07{,}575.00$

For the frequency 7 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= \quad 5{,}36{,}825.00 \times \frac{12}{7} + 1{,}76{,}275.00 \times 8$

$= \quad 9{,}20{,}271.00 + 14{,}10{,}200.00$

$= \quad 23{,}30{,}471.00$

For the frequency 8 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{8} + 1,76,275.00 \times 9$

$= 8,05,237.00 + 15,86,475.00$

$= 23,91,712.00$

For the frequency 9 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{9} + 1,76,275.00 \times 10$

$= 7,15,767.00 + 17,62,750.00$

$= 24,78,517.00$

For the frequency 10 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{10} + 1,76,275.00 \times 11$

$= 6,44,190.00 + 19,39,025.00$

$= 25,83,215.00$

For the frequency 11 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{11} + 1,76,275.00 \times 12$

$= 5,85,627.00 + 21,15,300.00$

$= 27,00,927.00$

For the frequency 12 Months

Total Cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of break down.

$= 5,36,825.00 \times \frac{12}{12} + 1,76,275.00 \times 12$

$= 5,36,825.00 + 21,15,300.00$

$= 26,52,125.00$

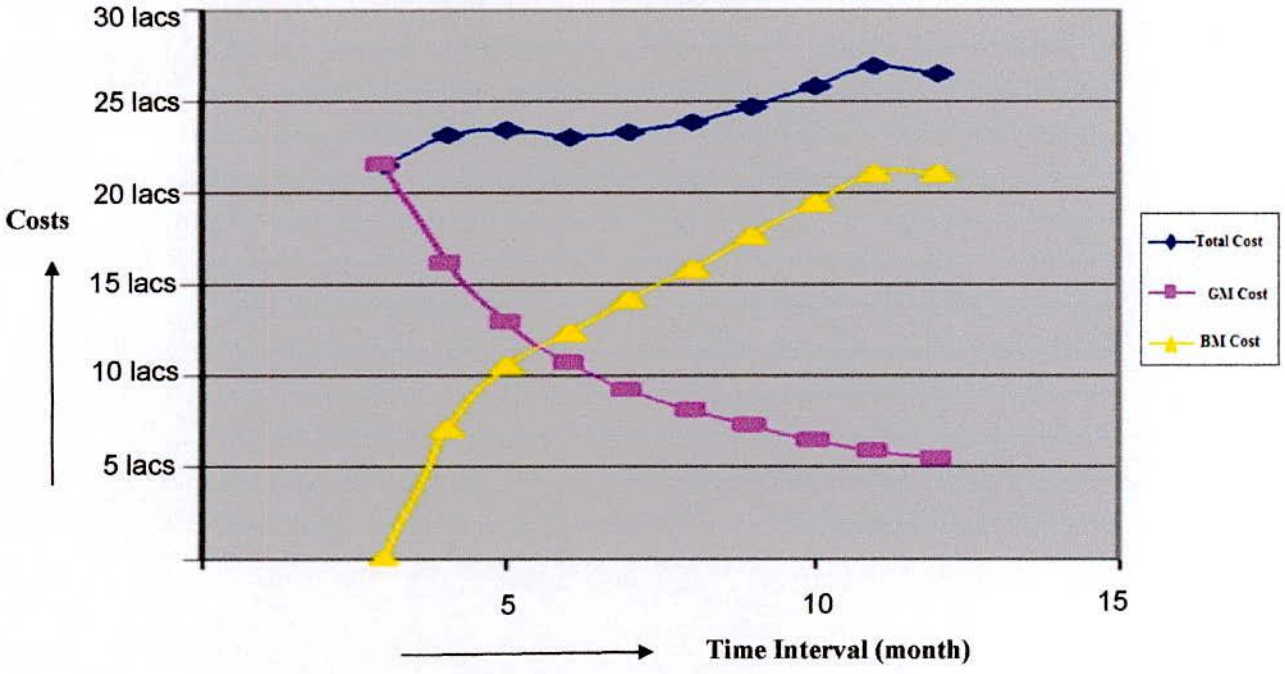


Figure 4

Graph Breaker card machine no. - 4 cost (Tk) versus interval (month)

From the graph 4, it is seen that the total maintenance cost is minimum when the group maintenance interval is 6 month with a total cost of Tk. 23,07,575.00. After that the total maintenance cost increases with the increase of group maintenance interval. This is because of increasing breakdown maintenance with the increase of group maintenance interval.

4.14 Determination of repining cost of Finisher Card machine

There are thirteen rollers in a Finisher Card machine. The cost of repining of each roller is shown in table-10.

Table-10:

Determination of material cost of finisher Card machine

Name of Roller	No. of line	No. of pin per line	Total No. of bottoms	Total pin	Pin size	Cost/ Thousand	Material cost Tk.	Labor cost Tk.	Total Cost Tk.
1.Cylinder	10	72	189	1,36,080	$17(.68)\times 11/16''$	78.00	10,615.00	11,340	21,955.00
2.Feed Roller	7	66	27	12,474	$13.(.92)\times 15/16''$	256.00	3,328.00	1,620	4,948.00
3.stripper Roller no.1	9	90	39	31,590	$15(.72)\times 11/16''$	186.00	5,952.00	2,340	8,292.00
4.stripper Roller no.2	9	90	39	31,590	$15(.72)\times 11/16''$	186.00	5,952.00	2,340	8,292.00
5.stripper Roller No.3	9	90	39	31,590	$16(.64)\times 7/8''$	125.00	4,000.00	2,340	6,340.00
6.stripper Roller No.4	10	94	39	36,660	$16(.64)\times 7/8''$	125.00	4,625.00	2,340	6,965.00
7.Worker Roller No.1	8	71	45	25,560	$16(.64)\times 1\,1/16''$	145.00	37,70.00	2,700	6,470.00
8.Worker Roller no.2	8	71	45	25,560	$16(.64)\times 1\,1/16''$	145.00	37,70.00	2,700	6,470.00
9.Worker Roller No.3	9	96	39	37,440	$17(.56)\times 1\,1/16''$	116.00	4,408.00	2,340	6748.00
10.Worker Roller no.4	10	96	39	37,440	$17(.56)\times 1\,1/16''$	116.00	4,408.00	2,340	6748.00
11.Doffer Roller no.1	12	107	57	73,188	$17(.56)\times 1''$	110.00	81,40.00	3,420	11560
12.Doffer Roller no.2	12	107	57	73,188	$17(.56)\times 1''$	110.00	8,140.00	3,420	11560.00
13.Feed stripper roller	7	61	39	16,653	$15(.72)\times \frac{11''}{16}$	149.00	2,533.00	2,340	4,873.00
									1,11,221.00
									1,11,000.00

4.15 Determination of material cost of break-down maintenance

When an accident has been occurred, various parts such as rollers, bearings, pinions and studs are damaged.

Cost of damaged staves of rollers	=	14, 300.00
Cost of Bearings	=	3,200.00
Cost of Pinions	=	3,500.00
Cost of Studs	=	1,800.00
Worker engagement Cost 6 hands/8 hours	=	1,500.00
Over head cost $= 1500 \times 60\%$	=	900.00
So, material cost of break-down maintenance	=	14,300 + 3200 + 3500 + 1800 + 1500 + 900
	=	25,200.00
	=	25,000.00

4.16 Determination of production loss cost

Production Loss cost = Production/ hour × Production price / hour × efficiency × 23.5 hours

4.17 Determination of production /hour

When a finisher card machine is running, production /hour is taken randomly.

6am - 7am	=	190 kg
7am - 8am	=	180 "
9am - 10am	=	200 "
10am – 11am	=	210 "
01pm - 02pm	=	195 "
02pm – 03pm	=	225 "

$\therefore$ Average production / hour $= \frac{190+180+200+210+195+225}{6} = 200kg$

4.18 Break-down Data collection

Breakdown data from 06.02.2006 to 06.07.2010 collected from log book of Finisher Card machine no.-1 and tabulated in table11.

Table- 11:

Break-down data of Finisher card machine no. -1 from 2006 to 2010

Name of Rollers	Break down dates	Break down intervals (months)	Material Cost	Break-down Maintenance Cost	Production Loss Cost	Total Cost
01. Cylinder Roller.	06.02.2006		21955.00	25000.00	312550.00	359505.00
	13.07.2009	41	21955.00	25000.00	312550.00	359505.00
	03.11.2009	04	21955.00	25000.00	312550.00	359505.00
	06.07.2010	08	21955.00	25000.00	312550.00	359505.00
02. Feed Roller.	06.02.2006		4948.00	25000.00	104183.00	134131.00
	13.07.2009	41	4948.00	25000.00	104183.00	134131.00
	03.11.2009	04	4948.00	25000.00	104183.00	134131.00
	06.07.2010	08	4948.00	25000.00	104183.00	134131.00
03. Stripper Roller No-1.	06.02.2006		8292.00	25000.00	104183.00	137475.00
	18.05.2008	27	8292.00	25000.00	104183.00	137475.00
	03.11.2009	18	8292.00	25000.00	104183.00	137475.00
	22.05.2010	07	8292.00	25000.00	104183.00	137475.00
04. Stripper Roller No-2.	06.02.2006		8292.00	25000.00	104183.00	137475.00
	05.12.2006	09	8292.00	25000.00	104183.00	137475.00
	03.11.2009	35	8292.00	25000.00	104183.00	137475.00
05. Stripper Roller No-3.	06.02.2006		6340.00	25000.00	104183.00	135523.00
	28.09.2009	44	6340.00	25000.00	104183.00	135523.00
	28.01.2010	04	6340.00	25000.00	104183.00	135523.00
06. Stripper Roller No-4.	06.02.2006		6965.00	25000.00	104183.00	136148.00
	03.11.2009	44	6965.00	25000.00	104183.00	136148.00
07. Worker Roller No-1.	06.02.2006		6470.00	25000.00	104183.00	135653.00
	18.05.2008	27	6470.00	25000.00	104183.00	135653.00
	13.07.2009	14	6470.00	25000.00	104183.00	135653.00
08. Worker Roller No-2.	06.02.2006		6470.00	25000.00	104183.00	135653.00
	18.05.2008	27	6470.00	25000.00	104183.00	135653.00
	13.07.2009	14	6470.00	25000.00	104183.00	135653.00
09. Worker Roller No-3.	06.02.2006		6748.00	25000.00	104183.00	135931.00
	22.12.2008	35	6748.00	25000.00	104183.00	135931.00
	13.11.2009	10	6748.00	25000.00	104183.00	135931.00
10. Worker Roller No-4.	06.02.2006		6748.00	25000.00	104183.00	135931.00
	03.11.2009	44	6748.00	25000.00	104183.00	135931.00
11. Doffer Roller No-1.	06.02.2006		11560.00	25000.00	104183.00	140743.00
	13.07.2009	41	11560.00	25000.00	104183.00	140743.00
	06.07.2010	12	11560.00	25000.00	104183.00	140743.00
12. Doffer Roller No-2.	06.02.2006		11560.00	25000.00	104183.00	140743.00
	03.11.2009	44	11560.00	25000.00	104183.00	140743.00
	06.07.2010	08	11560.00	25000.00	104183.00	140743.00
13. Feed Stripper Roller.	06.02.2006		4873.00	25000.00	104183.00	134056.00
	03.11.2009	44	4873.00	25000.00	104183.00	134056.00
Total Cost						6221877.00

Net total cost = 6221877.00 / 5 Years
= 1244375.00 / 1 Year

Table 12
Break-down of frequency chart

Intervals (Months)	Frequency
04	3
05	×
06	×
07	1
08	3
09	1
10	1
11	×
12	1
12>	16

4.19 Determination of Group Maintenance, Break down maintenance and Total Cost

Group Maintenance cost = Material cost + Production loss cost

Break-down Maintenance cost = Material cost + Production loss cost

Total cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of Break down

GM cost = Material cost + Production loss cost

$= 1, 11,000.00. + 200 \text{ kg} \times 95 \times \frac{70}{100} \times 23.5$

$= 1, 11,000.00 + 3,12,550.00$

$= 4,23,550.00$

Break-down Maintenance cost $= 25000.00 + \frac{3,12,550.00}{3}$ [Production loss is 8 hours due to break-down. so $\frac{3,12,550.00}{3}$]

$= 25,000.00 + 1,04,183.00$

$= 1,29,183.00$

For the frequency 4 Months

BM Cost = ×

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= 4,23,550.00 \times \frac{12}{4} + 0$

= 4,23,550 × 3

= 12,70,650.00

For the frequency 5 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

= $4,23,550.00 \times \frac{12}{5} + 1,29,183.00 \times 3$

= 10,16,520.00 + 3,87,549.00

= 14,04,069.00

For the frequency 6 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

= $4,23,550.00 \times \frac{12}{6} + 1,29,183.00 \times 3$

= 8,47,100.00 + 3,87,549.00

= 12,34,649.00

For the frequency 7 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

= $4,23,550.00 \times \frac{12}{7} + 1,29,183.00 \times 3$

= 7,26,085.00 + 3,87,549.00

= 11,13,634.00

For the frequency 8 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

= $4,23,550.00 \times \frac{12}{8} + 1,29,183.00 \times 4$

= 6,35,325.00 + 5,16,732.00

= 11,52,057.00

For the frequency 9 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

= $4,23,550.00 \times \frac{12}{9} + 1,29,183.00 \times 7$

= 5,64,733.00 + 9,04,281.00

= 14,69,014.00

For the frequency 10 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

= $4,23,550.00 \times \frac{12}{10} + 1,29,183.00 \times 8$

= 5,08,260.00 + 10,33,464.00

= 15,41,724.00

For the frequency 11 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

= $4,23,550.00 \times \frac{12}{11} + 1,29,183.00 \times 9$

= 4,62,054.00 + 11,62,647.00

= 16,24,701.00

For the frequency 12 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

= $4,23,550.00 \times \frac{12}{12} + 1,29,183.00 \times 9$

= 4,23,550.00 + 11,62,647.00

= 15,86,197.00

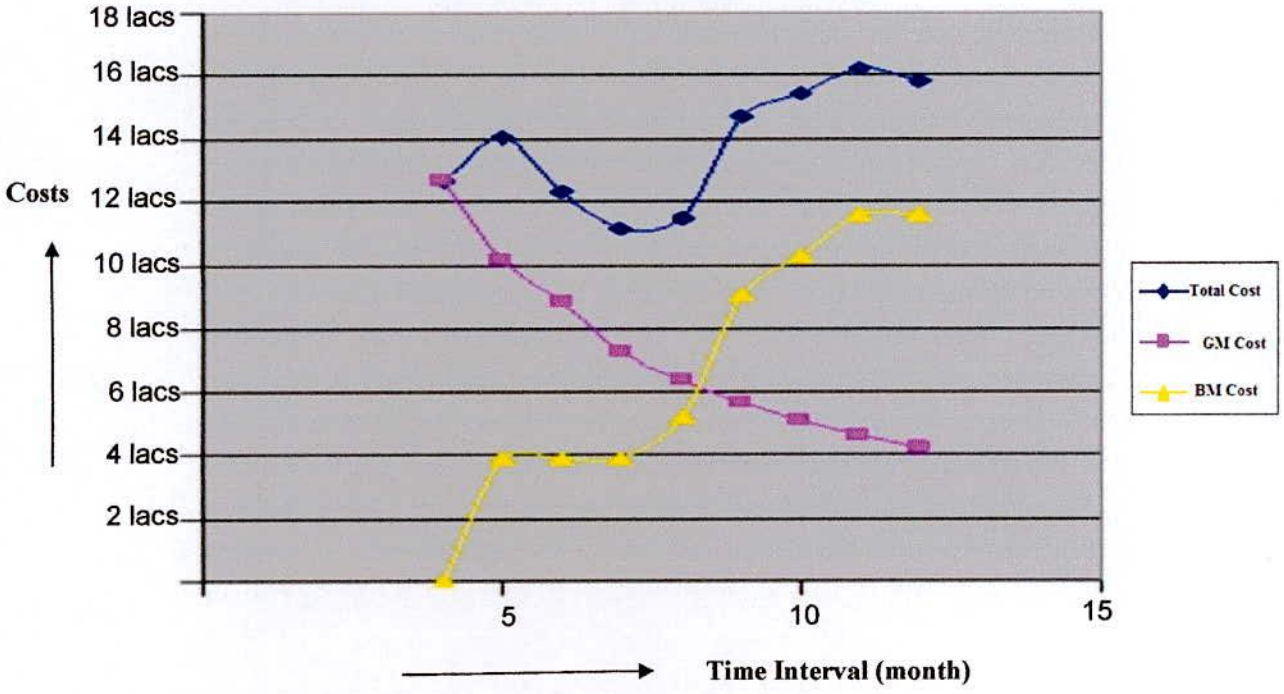


Figure 5

Graph Finisher card machine no. - 1 cost (Tk.) versus interval (month)

From the figure-5, it is seen that the total maintenance cost is minimum when the group maintenance interval is 7 month with a total cost of Tk.11,13,634.00. After that the total maintenance cost increases with the increase of group maintenance interval. This is because of increasing breakdown maintenance with the increase of group maintenance interval

4. 20 Break-down Data collection

Breakdown data from 06.02.2006 to 06.07.2010 collected from log book of Finisher Card machine no.-2 and tabulated in table13.

Table- 13:

Break-down data of Finisher card machine no.-2 from 2006 to 2010.

Name of Rollers	Break down dates	Break down intervals (months)	Material Cost	Break-down Maintenance Cost	Production Loss Cost	Total Cost
01. Cylinder Roller.	02.01.2006		21955.00	25000.00	312550.00	359505.00
	03.05.2006	04	21955.00	25000.00	312550.00	359505.00
	06.05.2007	12	21955.00	25000.00	312550.00	359505.00
	02.01.2008	08	21955.00	25000.00	312550.00	359505.00
	23.09.2009	21	21955.00	25000.00	312550.00	359505.00
	25.02.2010	05	21955.00	25000.00	312550.00	359505.00
02. Feed Roller.	02.01.2006		4948.00	25000.00	104183.00	134131.00
	06.05.2007	16	4948.00	25000.00	104183.00	134131.00
	20.08.2009	27	4948.00	25000.00	104183.00	134131.00
	25.02.2010	06	4948.00	25000.00	104183.00	134131.00
03. Stripper Roller No-1.	02.01.2006		8292.00	25000.00	104183.00	137475.00
	10.05.2007	16	8292.00	25000.00	104183.00	137475.00
	25.02.2010	34	8292.00	25000.00	104183.00	137475.00
04. Worker Roller No-1.	02.01.2006		6470.00	25000.00	104183.00	135653.00
	06.11.2006	10	6470.00	25000.00	104183.00	135653.00
	24.07.2009	32	6470.00	25000.00	104183.00	135653.00
	25.02.2010	07	6470.00	25000.00	104183.00	135653.00
05. Worker Roller No-2.	02.01.2006		6470.00	25000.00	104183.00	135653.00
	15.05.2007	16	6470.00	25000.00	104183.00	135653.00
	25.02.2010	33	6470.00	25000.00	104183.00	135653.00
	27.04.2010	02	6470.00	25000.00	104183.00	135653.00
	13.08.2010	04	6470.00	25000.00	104183.00	135653.00
06.. Worker Roller No-3.	02.01.2006		6748.00	25000.00	104183.00	135931.00
	06.05.2007	16	6748.00	25000.00	104183.00	135931.00
	25.02.2010	34	6748.00	25000.00	104183.00	135931.00
07. Worker Roller No-4.	18.07.2006		6748.00	25000.00	104183.00	135931.00
	25.02.2010	43	6748.00	25000.00	104183.00	135931.00
08. Doffer Roller No-1.	02.01.2006		11560.00	25000.00	104183.00	140743.00
	07.03.2006	02	11560.00	25000.00	104183.00	140743.00
	15.05.2007	14	11560.00	25000.00	104183.00	140743.00
	25.02.2010	33	11560.00	25000.00	104183.00	140743.00
09.. Doffer Roller No-2.	30.01.2006		11560.00	25000.00	104183.00	140743.00
	25.12.2006	11	11560.00	25000.00	104183.00	140743.00
	25.02.2010	38	11560.00	25000.00	104183.00	140743.00
10. Stripper Roller No-2.	18.07.2006		8292.00	25000.00	104183.00	137475.00
	25.02.2010	43	8292.00	25000.00	104183.00	137475.00
	27.04.2010	02	8292.00	25000.00	104183.00	137475.00
11. Stripper Roller No-3.	18.07.2006		6340.00	25000.00	104183.00	135523.00
	25.02.2010	43	6340.00	25000.00	104183.00	135523.00
12. Stripper Roller No-4.	18.07.2006		6965.00	25000.00	104183.00	136148.00
	25.02.2010	43	6965.00	25000.00	104183.00	136148.00

13. Feed Stripper Roller.	10.05.2007		4873.00	25000.00	104183.00	134056.00
Total Cost						7081535.00

Net total cost = 7081525.00 / 5 Years
= 1416307.00 / 1 Year

Table-14:
Break-down Frequency chart

Intervals (months)	Frequency
01	×
02	3
03	×
04	2
05	1
06	1
07	1
08	1
09	×
10	1
11	1
12	1
12>	17

4.21 Determination of Group maintenance, Break down maintenance and total Cost

Group Maintenance (GM) cost = Material cost + Production loss cost

Break-down Maintenance (BM) cost = Material cost + Production loss cost

Total cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of Break down

GM cost = Material cost + Production loss cost

$$= 1,11,000.00. + 200\ kg \times 95 \times \frac{70}{100} \times 23.5$$

$$= 1,11,000.00 + 3,12,550.00$$

$$= 4,23,550.00$$

Break-down Maintenance cost $= 25000.00 + \frac{3,12,550.00}{3}$

$$= 25,000.00 + 1,04,183.00$$

$$= 1,29,183.00$$

For the frequency 2 Months

BM Cost = ×

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= \quad 4{,}23{,}550.00 \times \frac{12}{2} + 0$

$= \quad 25{,}41{,}300.00$

For the frequency 3 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= \quad 4,\ 23{,}550.00 \times \frac{12}{3} + 1,\ 29{,}183.00 \times 3$

$= \quad 16{,}94{,}200.00 + 3{,}87{,}549.00$

$= \quad 20{,}81{,}749.00$

For the frequency 4 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= \quad 4,\ 23{,}550.00 \times \frac{12}{4} + 1,\ 29{,}183.00 \times 3$

$= \quad 12{,}70{,}650.00 + 3{,}87{,}549.00$

$= \quad 16{,}58{,}199.00$

For the frequency 5 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= \quad 4{,}23{,}550.00 \times \frac{12}{5} + 1{,}29{,}183.00 \times 5$

$= \quad 10{,}16{,}520.00 + 6{,}45{,}915.00$

$= \quad 16{,}62{,}435.00$

For the frequency 6 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= \quad 4{,}23{,}550.00 \times \frac{12}{6} + 1{,}29{,}183.00 \times 6$

$= \quad 8{,}47{,}100.00 + 7{,}75{,}098.00$

$= \quad 16{,}22{,}198.00$

For the frequency 7 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= \quad 4{,}23{,}550.00 \times \frac{12}{7} + 1{,}29{,}183.00 \times 7$

$= \quad 7{,}26{,}085.00 + 9{,}04{,}281.00$

$= \quad 16{,}30{,}366.00$

For the frequency 8 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost ×

Expected Frequency of Break down

$= 4,23,550.00 \times \frac{12}{8} + 1,29,183.00 \times 8$

$= 6,35,325.00 + 10,33,464.00$

$= 16,68,789.00$

For the frequency 9 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= 4,23,550.00 \times \frac{12}{9} + 1,29,183.00 \times 9$

$= 5,64,733.00 + 11,62,647.00$

$= 17,27,380.00$

For the frequency 10 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= 4,23,550.00 \times \frac{12}{10} + 1,29,183.00 \times 9$

$= 5,08,260.00 + 11,62,647.00$

$= 16,70,907.00$

For the frequency 11 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= 4,23,550.00 \times \frac{12}{11} + 1,29,183.00 \times 10$

$= 4,62,054.00 + 12,91,830.00$

$= 17,53,885.00$

For the frequency 12 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= 4,23,550.00 \times \frac{12}{12} + 1,29,183.00 \times 11$

$= 4,23,550.00 + 14,21,013.00$

$= 18,44,563.00$

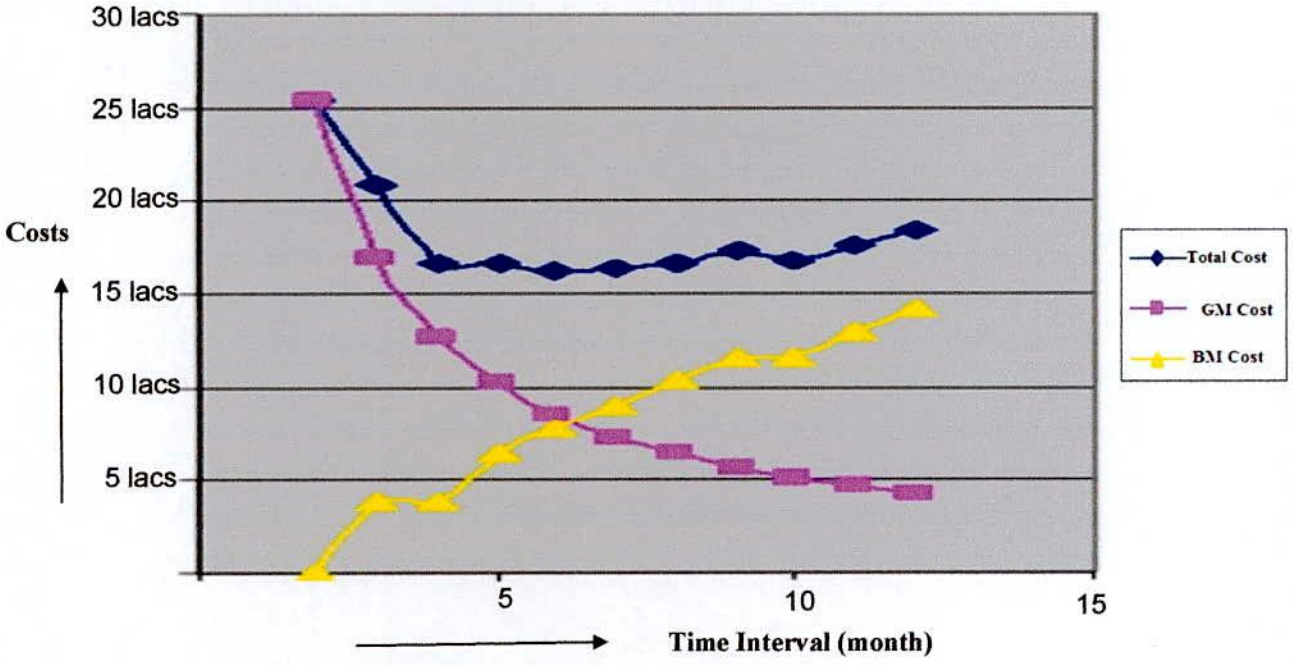


Figure 6

Graph Finisher card machine no. - 2 cost (Tk) versus interval (month)

From the figure 6, it is seen that the total maintenance cost is minimum when the group maintenance interval is 6 month with a total cost of Tk.16,22,198.00. After that the total maintenance cost increases with the increase of group maintenance interval. This is because of increasing breakdown maintenance with the increase of group maintenance interval.

4. 22 Break-down Data collection

Breakdown data from 15.01.2005 to 15.02.2010 collected from log book of Finisher Card machine no.-3 and tabulated in table15.

Table- 15:

Break-down data of Finisher card machine no.-3 from 2005 to 2010

Name of Rollers	Break down dates	Break down intervals (months)	Material Cost	Break-down Maintenance Cost	Production Loss Cost	Total Cost
01. Cylinder Roller.	15.01.2005		21955.00	25000.00	312550.00	359505.00
	23.08.2006	19	21955.00	25000.00	312550.00	359505.00
	10.06.2007	11	21955.00	25000.00	312550.00	359505.00
	21.01.2009	19	21955.00	25000.00	312550.00	359505.00
02. Feed Roller.	15.10.2005		4948.00	25000.00	104183.00	134131.00
	23.08.2006	10	4948.00	25000.00	104183.00	134131.00
	15.02.2009	30	4948.00	25000.00	104183.00	134131.00
03. Worker Roller No-1.	15.10.2005		6470.00	25000.00	104183.00	135653.00
	23.08.2006	10	6470.00	25000.00	104183.00	135653.00
	22.11.2007	15	6470.00	25000.00	104183.00	135653.00
	15.02.2009	15	6470.00	25000.00	104183.00	135653.00
04. Feed Stripper Roller.	15.10.2005		4873.00	25000.00	104183.00	134056.00
	23.06.2006	08	4873.00	25000.00	104183.00	134056.00
05. Stripper Roller No-1.	09.01.2006		8292.00	25000.00	104183.00	137475.00
	23.08.2006	07	8292.00	25000.00	104183.00	137475.00
	22.11.2007	15	8292.00	25000.00	104183.00	137475.00
	05.01.2010	25	8292.00	25000.00	104183.00	137475.00
06. Stripper Roller No-2.	09.01.2006		8292.00	25000.00	104183.00	137475.00
	23.08.2006	07	8292.00	25000.00	104183.00	137475.00
	05.07.2008	19	8292.00	25000.00	104183.00	137475.00
	15.02.2010	19	8292.00	25000.00	104183.00	137475.00
07. Stripper Roller No-3.	09.01.2006		6340.00	25000.00	104183.00	135523.00
	23.08.2006	07	6340.00	25000.00	104183.00	135523.00
	22.11.2007	15	6340.00	25000.00	104183.00	135523.00
	15.02.2009	15	6340.00	25000.00	104183.00	135523.00
08. Stripper Roller No-4.	09.01.2006		6965.00	25000.00	104183.00	136148.00
	23.08.2006	07	6965.00	25000.00	104183.00	136148.00
09. Worker Roller No-2.	09.01.2006		6470.00	25000.00	104183.00	135653.00
	23.08.2006	07	6470.00	25000.00	104183.00	135653.00
	22.11.2007	15	6470.00	25000.00	104183.00	135653.00
	05.01.2010	23	6470.00	25000.00	104183.00	135653.00
10. Worker Roller No-3.	09.01.2006		6748.00	25000.00	104183.00	135931.00
	23.08.2006	07	6748.00	25000.00	104183.00	135931.00
	22.05.2007	09	6748.00	25000.00	104183.00	135931.00
11. Worker Roller No-4.	09.01.2006		6748.00	25000.00	104183.00	135931.00
	23.08.2006	07	6748.00	25000.00	104183.00	135931.00
	22.11.2007	15	6748.00	25000.00	104183.00	135931.00
	05.01.2010	25	6748.00	25000.00	104183.00	135931.00
12. Doffer Roller No-1.	09.01.2006		11550.00	25000.00	104183.00	140733.00
	23.06.2006	05	11550.00	25000.00	104183.00	140733.00
	22.11.2007	17	11550.00	25000.00	104183.00	140733.00
	09.01.2006		11550.00	25000.00	104183.00	140733.00

13. Doffer	09.01.2006		11550.00	25000.00	104183.00	140733.00
Roller No-2.	23.06.2006	05	11550.00	25000.00	104183.00	140733.00
Total Cost						6763119.00

Net total cost = 6763119.00 / 5 Years
= 1352623.00 / 1 Year

Table-16:
Break-down Frequency chart

Intervals (months)	Frequency
04	×
05	2
06	×
07	7
08	1
09	1
10	2
11	1
12	×
12>	16

4.23 Determination of Group maintenance, Break down maintenance and total Cost

Group Maintenance cost = Material cost + Production loss cost

Break-down Maintenance cost = Material cost + Production loss cost

Total cost = GM Cost × frequency of GM / Year + BM cost × Expected Frequency of Break down

GM cost = Material cost + Production loss cost

$= 1, 11,000.00. + 200 \text{ kg} \times 95 \times \frac{70}{100} \times 23.5$

$= 1, 11,000.00 + 3,12,550.00$

$= 4,23,550.00$

Break-down Maintenance cost $= 25000.00 + \frac{3,12,550.00}{3}$

$= 25,000.00 + 1,04,183.00$

$= 1,29,183.00$

For the frequency 5 Months

BM Cost = ×

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$$= \quad 4,23,550.00 \times \frac{12}{5} + 0$$

$$= \quad 10,16,520.00 + 0$$

$$= \quad 10,16,520.00$$

For the frequency 6 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$$= \quad 4,23,550.00 \times \frac{12}{6} + 1,29,183.00 \times 2$$

$$= \quad 8,47,100.00 + 2,58,366.00$$

$$= \quad 11,05,466.00$$

For the frequency 7 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$$= \quad 4,23,550.00 \times \frac{12}{7} + 1,29,183.00 \times 2$$

$$= \quad 7,26,085.00 + 2,58,366.00$$

$$= \quad 9,84,452.00$$

For the frequency 8 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$$= \quad 4,23,550.00 \times \frac{12}{8} + 1,29,183.00 \times 9$$

$$= \quad 6,35,325.00 + 11,62,647.00$$

$$= \quad 17,97,972.00$$

For the frequency 9 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$$= \quad 4,23,550.00 \times \frac{12}{9} + 1,29,183.00 \times 10$$

$$= \quad 5,64,733.00 + 12,91,830.00$$

$$= \quad 18,56,564.00$$

For the frequency 10 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= 4,23,550.00 \times \frac{12}{10} + 1,29,183.00 \times 11$

$= 5,08,260.00 + 14,21,013.00$

$= 19,29,273.00$

For the frequency 11 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= 4,23,550.00 \times \frac{12}{11} + 1,29,183.00 \times 13$

$= 4,62,054.00 + 16,79,379.00$

$= 21,41,434.00$

For the frequency 12 Months

Total cost = GM Cost × frequency of GM / Year + BM Cost × Expected Frequency of Break down

$= 4,23,550.00 \times \frac{12}{12} + 1,29,183.00 \times 14$

$= 4,23,550.00 + 18,08,562.00$

$= 22,32,112.00$

All these calculations are given as summary in the table-17.

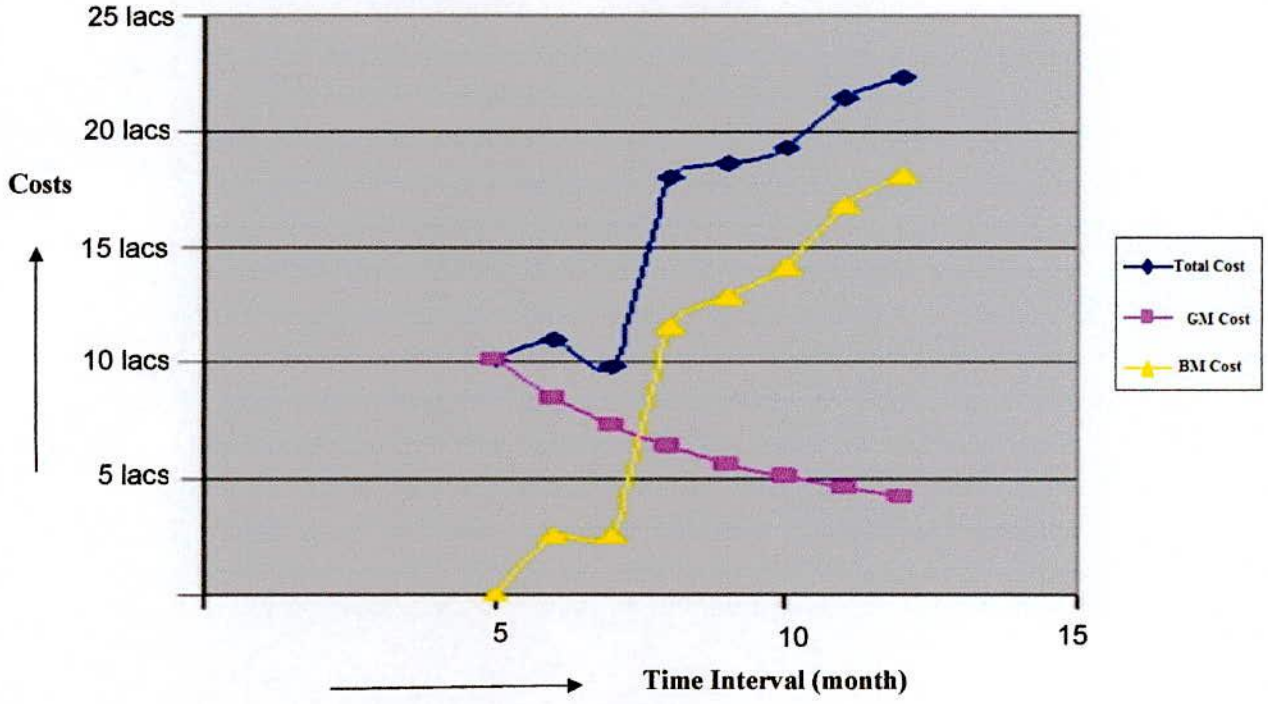


Figure 7

Graph Finisher card machine no. - 3 cost (Tk) versus interval (month)

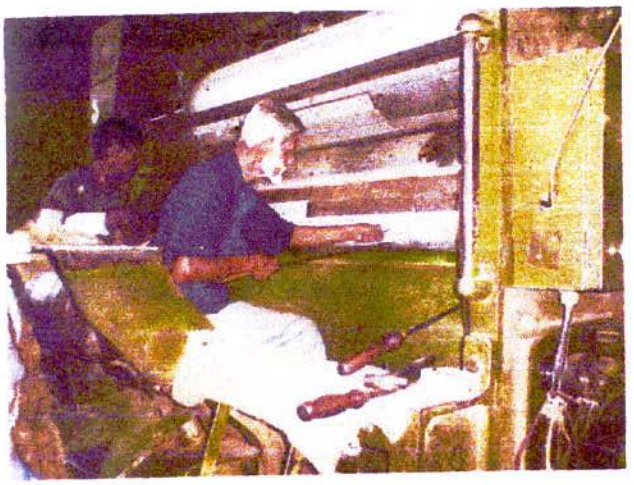
From the figure 7, it is seen that the total maintenance cost is minimum when the group maintenance interval is 7 month with a total cost of Tk. 9,84,452.00. After that the total maintenance cost increases with the increase of group maintenance interval. This is because of increasing breakdown maintenance with the increase of group maintenance interval.

Table-17:
Summary of total maintenance cost

Type of machine	Optimal group maintenance interval	Group maintenance Cost	Break-down maintenance cost	Total cost
Breaker card m/c no.1	6	10,73,650.00	0	10,73,650.00
Breaker card m/c no.2	6	10,36,825.00	5,28,825.00	16,02,475.00
Breaker card m/c no.3	6	10,73,650.00	5,28,825.00	16,02,475.00
Breaker card m/c no.4	6	10,73,650.00	12,33,925.00	23,07,575.00
Finisher card m/c no.1	7	7,26,085.00	3,87,549.00	11,13,634.00
Finisher card m/c no.2	6	8,47,100.00	7,75,098.00	16,22,198.00
Finisher card m/c no.3	7	7,26,085.00	2,58,366.00	9,84,452.00

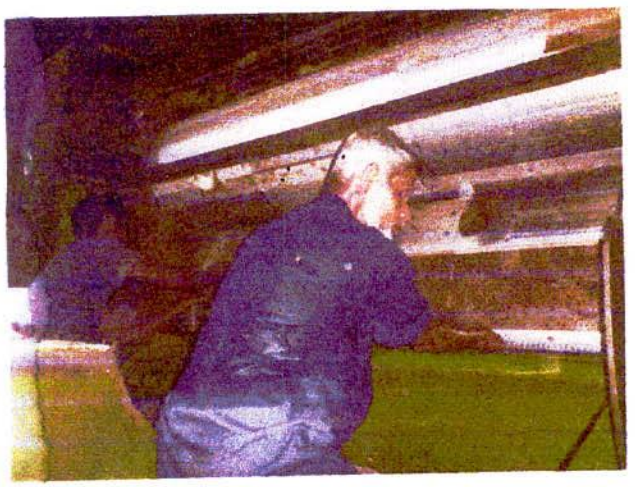
The total group maintenance cost is taka 10,73,650.00 as against Tk. 13,81,776.00, Tk. 16,02,475.00 as against 11,96,852.00, Tk.16,02,475.00 as against Tk.14,80,423.00, Tk. 23,07,575.00 as against Tk. 17,55,441.00 for B/c-1, B/c-2, B/c-3 and B/c-4 respectively when breakdown maintenance policy is followed. Similarly, the total group maintenance cost is Tk. 11,13,634.00 as against Tk. 12,44,375.00, Tk. 16,22,198.00 as against Tk. 14,16,307.00, Tk. 9,84,452.00 as against Tk. 13,52,623.00, for F/c-1, F/c-2, F/c-3 respectively when break down maintenance policy is followed.

photographs of a Breaker card machine showing different activities.

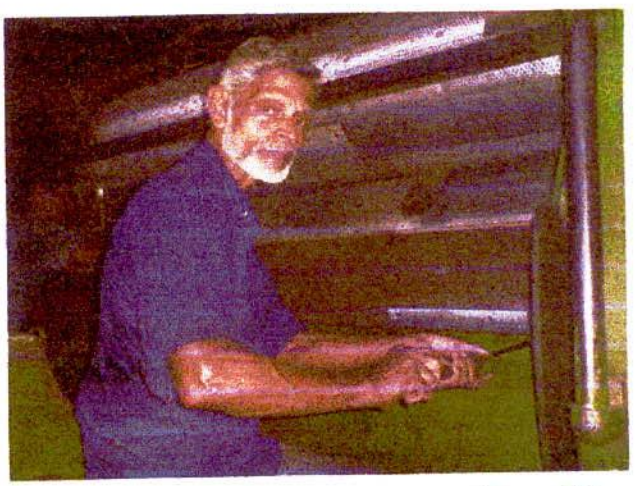


Picture-1: Fitters are fitting staves with hand tools.

Picture-2: Bland and new pinned staves are shown.



Picture-3: A breaker card machine is shown with new staves.



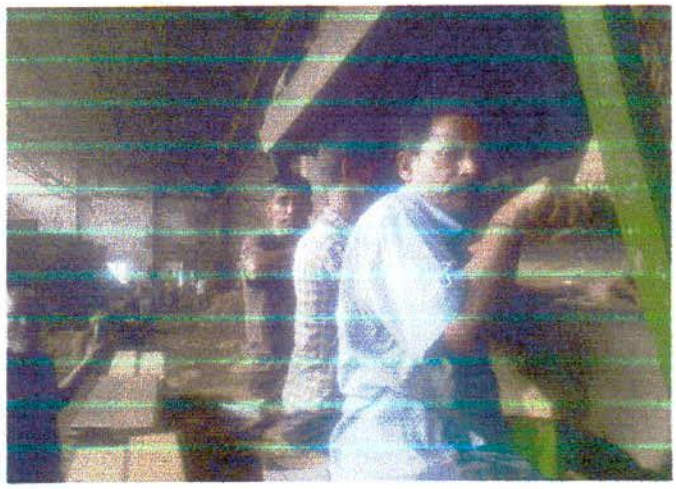
Picture-4:New staves are fitted by a fitter.

Picture-5:Steel faced wooden staves are shown.

Picture-6: fitters and a head pinbo are watching staves.

photographs of a Finisher card machine showing different activities.

Picture-1: New wooden staves are shown.



Picture-2:Fitters are watching stave

Picture-3: Bland and new pinned steavs are shown.

Picture-4: New staves are fitted by fitters.

Picture-5: A finisher card machine is shown with new staves .

Picture-6: Fitters are fitting stavs with hand tools.

CHAPTER-5

Conclusion and Recommendations

5.1 Conclusions

The study was undertaken to develop maintenance plan of Eastern Jute Mill. The analysis, comments, suggestions, action plan etc. are based on the data and information collected from the mill's log book.

The breaker card and finisher card machine play an important role in the production system of the jute mill. These types of machines are very large in size. There are 7 and 13 number of rollers in a breaker card and finisher card machine respectively. Among the 7 rollers in a breaker card machine, cylinder roller is the biggest.

At present, every 3 months interval, the cylinder roller is repined by dismantling its 150 staves. At that time, the breaker card machine is stopped completely. The rest of rollers are repined when they are broken. For this reason, the machine has to be stopped frequently. The finisher card machine is stopped every 5 months; the cylinder roller is repined by dismantling its 189 staves. As a result, the machine becomes idle and the production system is hampered severely. About four and half lack taka is lost, if production is hampered for a single day. So, it is found that the jute mill has been facing a huge amount of loss, if machines are stopped for repair frequently.

The present study investigates the possibility of group maintenance. Analysis of the collected data shows that for breaker card machine (figure 1, 2, 3 & 4) the total maintenance cost is minimum when group maintenance interval is 6 months. The total group maintenance cost is taka 10,73,650.00 as against Tk. 13,81,776.00, Tk. 16,02,475.00 as against 11,96,852.00, Tk.16,02,475.00 as against Tk.14,80,423.00, Tk. 23,07,575.00 as against Tk. 17,55,441.00 for B/c-1, B/c-2, B/c-3 and B/c-4 respectively when breakdown maintenance policy is followed. From the above information of breaker card machine no. 1, it is seen that yearly savings tk.13, 81,776.00 – 10, 73,650.00 = tk.2, 88,126.00.

Similarly, analysis of the collected data shows that for finisher card machine (figure 5, 6 & 7) the total maintenance cost is minimum when group maintenance interval is 7 month. The total group maintenance cost is Tk. 11,13,634.00 as against Tk. 12,44,375.00, Tk. 16,22,198.00 as against Tk. 14,16,307.00, Tk. 9,84,452.00 as against Tk. 13,52,623.00, for F/c-1, F/c-2, F/c-3 respectively when break down maintenance policy is followed. From the above information of finisher card machine no. 1 and 3, it is seen that yearly savings tk.(12,44,375.00 – 11,13,634.00) = tk.1,30,741.00 and tk.(13,52,623.00 – 9,84,452.00) = 3,68,171.00 respectively.

So, it may be concluded that the group maintenance policy will result in less maintenance cost if it is followed.

5.2 Limitations of the present study

Only two types of machines namely breaker card and finisher card machines have been studied and maintenance plan is developed for these machines. Other machines such as drawing, spinning and winding will also have to be studied to develop a complete maintenance plan.

5.3 Recommendations

1. In this study, maintenance plan has been developed for breaker card and finisher card machines. If this maintenance plan is implemented, a yearly savings will be tk. 2, 88,126.00 and tk. 3, 68,171.00 for a Breaker card and a Finisher card machine respectively.
2. To get a more accurate maintenance plan, data collection has to be more accurate and systematic.

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