# Downtime Analysis of Tube Filling and Carton Packing Machine at FMCG Company

Paragjyoti Baishya[1], Ajoy Krishna Dutta[2]

[1]*Masters in Production & Industrial Engineering, Jorhat Engineering College,*
[2]*Assistant Professor, Mechanical Engineering Department, Jorhat Engineering College*

***Abstract:*** *Improvement of both the product quality and productivity is mandatory for a company in order to sustain in this competitive market. In the recent times, manufacturing industries have to face a tough competition from its rivals for its existence in the market. This can be done only with the availability of machines in the industry. One can also say that by making the machines available for long time without breakdown can improve both its quality and productivity. Total Productive Maintenance aims to increase the availability of machines by the reduction of Downtime or Breakdown time of machines. The aim of this study is to find out the major breakdown that causes maximum production loss of the company using Pareto Analysis. Also Cause and Effect Diagram is conducted to explore the possible causes for the breakdown. Some counter measures are suggested as corrective action towards the end so that Downtime of machine can be reduced.*

**Keywords:** *Downtime, Total Productive Maintenance, Pareto Analysis, Cause and Effect Diagram.*

## I. INTRODUCTION

The manufacturing industry has gone significant changes in the recent times since new industries are rising dramatically in the market day by day. Competition between them increases as most of them focuses on product quality, production time and cost of product. So to remain in the market, a company has to give quality product and for that a system should be introduce in the company so that product quality and productivity both will increase.

Total Productive Maintenance (TPM) is a methodology which aim is to increase the availability of existing equipment so as to reduce the need for further capital investment. The aim of TPM is to maximize equipment effectiveness [2]. It is a function of availability, performance rate and quality.

To identify different defects and classify them according to their significance, Pareto analysis is a very helpful tool [1]. These defects often lead to the production downtime, which in turn, affect the product quality and productivity.

Root Cause Analysis tries to solve problems by attempting to identify and correct the root of events, as opposed to simply addressing their symptoms [2]. Cause and Effect Diagram is a very useful tool to determine the possible root causes of machine downtime. So it helps in identifying and sorting and also display causes of a specific problem. It illustrates the relationship between a given outcome and all factors that influence the outcome and hence to identify the possible root causes [1].

In this paper, production line of tube section of a Fast Moving Consumer Goods (FMCG) company is studied. In this study Pareto Analysis and Cause and Effect Diagram has been used to identify and classify the reasons responsible for machine downtime in production process and some solutions are suggested as counter measures to minimize the effect.

## II. LITERATURE REVIEW

Productivity can be increased by adopting practices to reduce the downtime of machines which will ultimately reduce the cost of final product. In order to distinguish properly the reason of downtime, it is necessary to know all the operations required in the manufacturing of the final product. Then corrective and preventive actions should be taken for future.

Pareto analysis becomes a more useful tool to distinguish the major losses due to machine downtime from the various losses. Pareto analysis helps to identify various defects and classify them according to their significance using Cause and Effect Diagram to determine the global risk of an event with multiple relevant causes, relatively easy to apply [4]. The use of Pareto Analysis & Cause and Effect Diagram for identifying root causes is widely spread in various fields and literature is abundant in this field. In a manufacturing industry breakdowns can be found by cting Root Cause analysis and some parallel improvement opportunities were also identified for implementation to reduce the downtime [2]. A comprehensive, systematic review of critical incidents can be done by Root-Cause analysis which includes the identification of the most contributing factors, determining strategies for risk reduction and action plans were developed along with measurement strategies to evaluate its effectiveness [3].

**Bose, Tarun Kanti (2012)** had done a case study in a hospital which reveals that the main problems of the hospital was lack of proper equipment and misdirected people with faulty process, poor material management with improper environment. The analysis on different classic categories of the fishbone outline the causes [5]. **Chandna, Pankaj et al (2009)** studied six forging operation in trucks and buses where Pareto diagrams are used to identify critical areas and then Cause and Effect Diagram is applied to explore the cause of defects that contribute the most in their decreasing order. The corrective measures decrease the defect rate from 2.43% to 0.21% [8]. **Mahto, Dalgobind et al (2008)** applied the Root-Cause analysis methodology to eliminate the defects in cutting operation in CNC oxy flame cutting machine. The rejection rate has been reduced from 11.87% to 1.92% on an average [9]. **Kiran, M. et al (2013)** had done a studying a manufacturing industry to identify the root cause for reducing the downtime. They found that in case of end roller, belt deterioration and improper alignment checking of the unit after readjustment were the root cause for edge roller breakdown. They suggested the implementation of direct drive for each edge roller unit which will reduce the breakdown to zero and increase the profit by Rs.2,10,000 per month [2].

From the literature review, it is clear that successful application of Pareto analysis and Cause-Effect Diagram will reduce the machine downtime and increases the availability of machine for long period, thereby increases productivity. In this work these tools are used to improve the condition of machines in a FMCG company.

## III. METHODOLOGY

This study contains the use of quality tools to minimize the machine downtime in a FMCG company. It includes various factors causing downtime of machines, various quality tools specially Pareto analysis and Cause and Effect Diagram. The study was conducted in a FMCG company. This segment includes about the quality control system of the selected factory and how this can be improved. The conceptual development includes the generation of ideas for

minimizing the machine downtime by identifying major concerning areas and by providing respective suggestions. Steps involved in the study:

**Step1:** Factory selection- After gathering information, a company is tried to be selected where works are mostly done by machines and also where we can utilize our knowledge for the development of the factory. Thus a FMCG company was selected.

**Step2:** Conducting of case study- This study was conducted on a FMCG company established in 2008. Table1 below shows the demography of the organization.

Table1. Demography of the company

| | |
|---|---|
| Company Name | ******* |
| Location | ******* |
| Established | 2008 |
| Product Type | Personal & Healthcare |
| Number of Production Line | 2 |
| Total Workers per Line | 12 |
| Production Capacity per min. | 160 pc. |
| Working Hours per day | 24 |

**Step3:** Gather Information- In this step, information are gathered on the production system of the Tube Filling & Carton Packing section of the selected factory. Here various data are collected on Tube Filling & Carton Packing section provided by the management which is used for the analysis purpose of the study.

**Step4:** Identify the problem- Major concerning areas have to be identified to minimize the machine downtime was the next step. By the observation and using management data we have seen some repetitive factors causing machine downtime in the Tube Filling & Carton Packing section.

**Step5:** Analysis and Suggestions- In this step, Pareto analysis is performed to identify the major causes contributing machine downtime. Also Cause and Effect Diagram have been constructed to identify the root causes. Then some suggestions are provided for the respective cause to minimize the machine downtime.

## IV. DATA COLLECTION & ANALYSIS

In the previous section we have discussed about the study of some repetitive factors causing machine downtime in the Tube Filling & Carton Packing section of a particular product. From observation and data given by the management we saw that there are several factors which causes downtime of machines in the production line, that leads to waste of time as well as decrease in productivity. By concentrating on these factors, most of them can be minimized. So with this respect, we have tried to identify major factors contributing downtime by Pareto analysis and then Cause and Effect Diagram will be used to detect the root causes. Finally some counter measures will be suggested in relation to those factors.

**Data collection**: For the study, five months data on machine downtime have been collected from the management starting from January2015 to May2015. The data have been taken from the two Tube Filling and Carton Packing sections from which out of the9 losses, major concerning loss for downtime has been identified by Pareto analysis and by the major loss, in terms of cost, associated with those losses. Again by observation and data collected from management, 25 factors causing machine downtime has been identified. Then again Pareto analysis is used to identify the most important factors contributing the downtime. Since the two lines are exactly same, therefore the line for which the company incurred a maximum loss is shown in this paper. Table2. Show the summarized data collected for

the five months.Fig.1 shows the major concerning line.
downtime losses of the machine for five months for the

Table2. Summarized 5 months data for the line

| Causes | Total Downtime (min.) | Cumulative downtime | Cumulative % |
|---|---|---|---|
| Equipment breakdown(Mech.) | 7162 | 7162 | 51.30 |
| Utility failure | 1937 | 9099 | 65.18 |
| Set up & adjustment | 1472 | 10571 | 75.72 |
| Equipment breakdown(Elec.) | 1003 | 11574 | 82.90 |
| Balance packing | 885 | 12459 | 89.24 |
| Equipment breakdown(Coding m/c) | 862 | 13321 | 95.42 |
| Equipment breakdown(others) | 333 | 13654 | 97.80 |
| Filling bluck stock out | 216 | 13870 | 99.36 |
| Changeovers | 90 | 13960 | 100 |

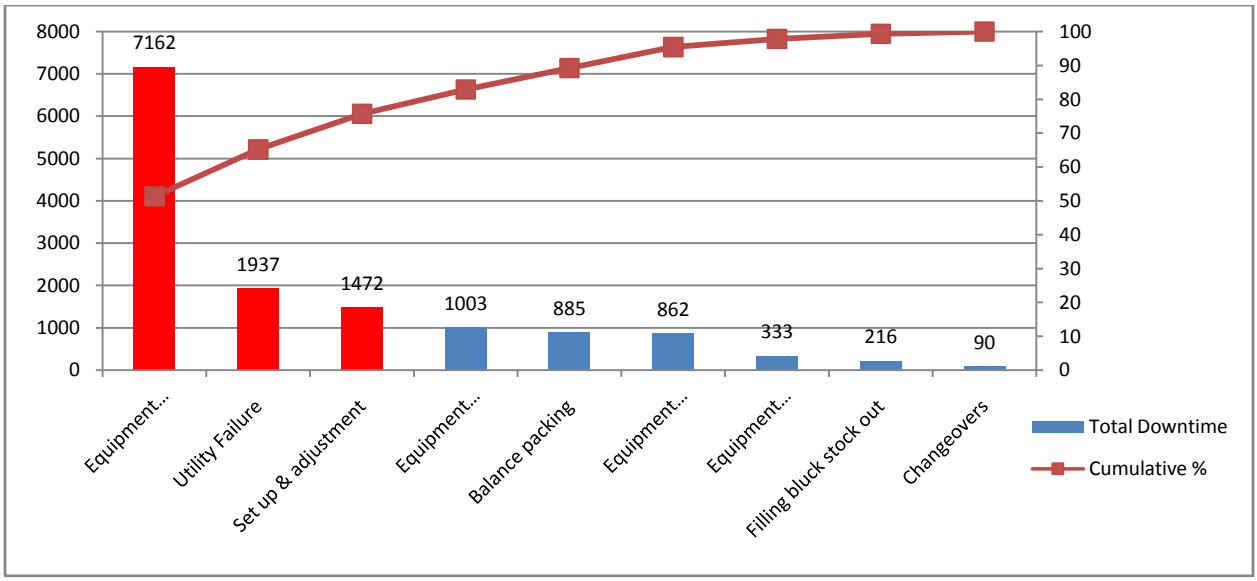


Fig.1 Pareto Diagram showing major losses of the line

From the Fig.1 it was observed that the major losses contributing the machine downtime were Equipment breakdown (Mechanical), Utility failure and Set up & adjustment shown by the red

bars. The maximum losses that the company has to incurred is due to Equipment breakdown (Mechanical), Utility failure and Set up & adjustment and were found to be Rs.81056183.70, Rs.21922064.80 and Rs.16659411.10 respectively. Since the loss due to Equipment breakdown (Mechanical) was found maximum, therefore this loss was taken for further analysis.

From the observation and data provided by management, it was found that there were 25 factors or problems that contribute to lead Equipment breakdown (Mechanical). Tube holding, Holder jam, Off-center, Cam lever, Filling, Vacuum pump, Cutting, Coding, Cam bearing, Timing out, Motor, Heater, Sealing and Tube dropping were problems associated with Pacmac tube filling machine while Tube pushing, SPC closing, Timing out, Vacuum problem, Carrier angle, Conveyor, Magazine setting, Divider, Closing guide and Drum timing were problems for the Hicart carton packing machineand also the Auto-collator machine problem. Again Pareto analysis was done to identify the most important factors among them. Fig.2 shows the major concerning factors which lead to machine downtime by Pareto Diagram. In Fig.2, the red bars show the major concerning areas and the bars show minor factors for the line that lie under Equipment breakdown (Mechanical) loss. The red bars consists 80% of the total loss contributing to the machine downtime.

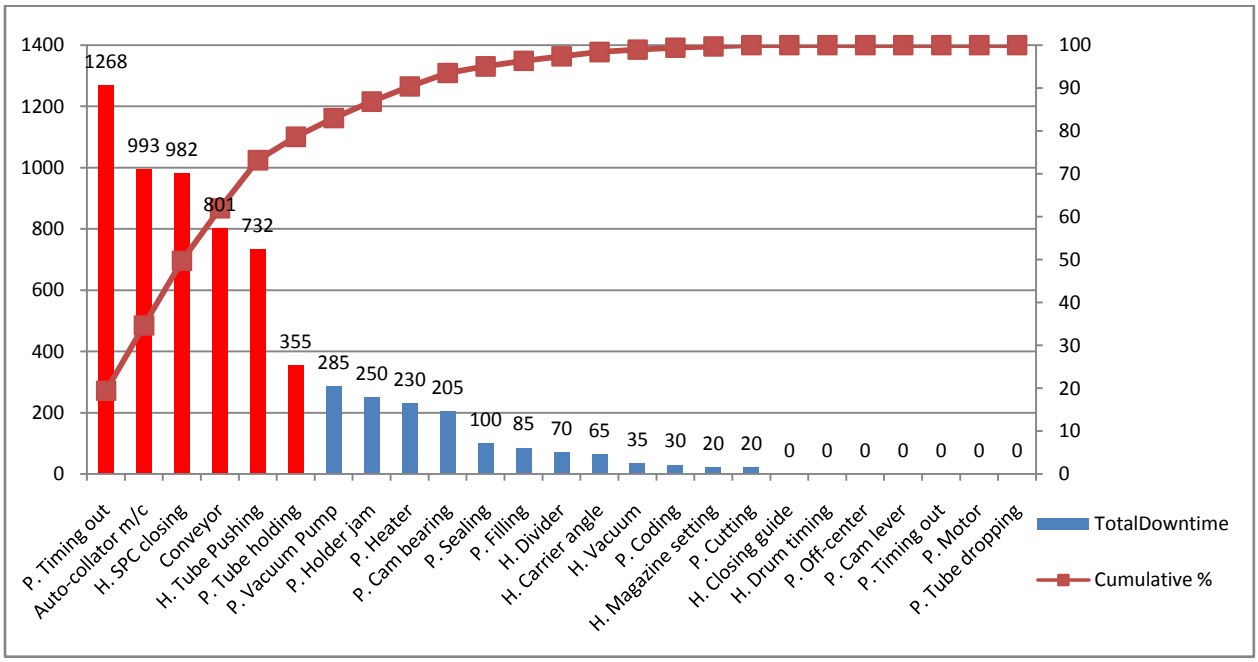


Fig.2 Pareto Diagram showing major concerning areas of factors

The next step is to find out the root causes for the major concerning areas. For this, Cause and Effect Diagram or Fishbone Diagram was used. In the Fig.3 and in Fig.4, Cause and Effect Diagram for Hicart SPC closing problem and Auto-collator machine problem are shown.

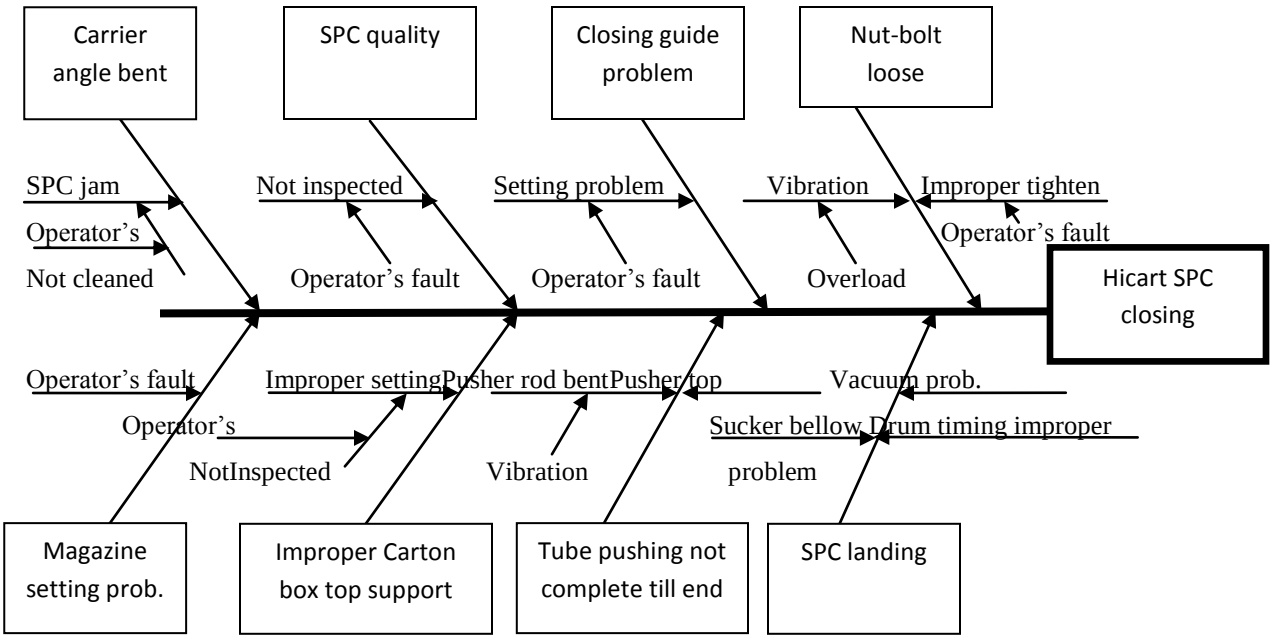


Fig.3 Cause and Effect Diagram for Hicart SPC closing problem

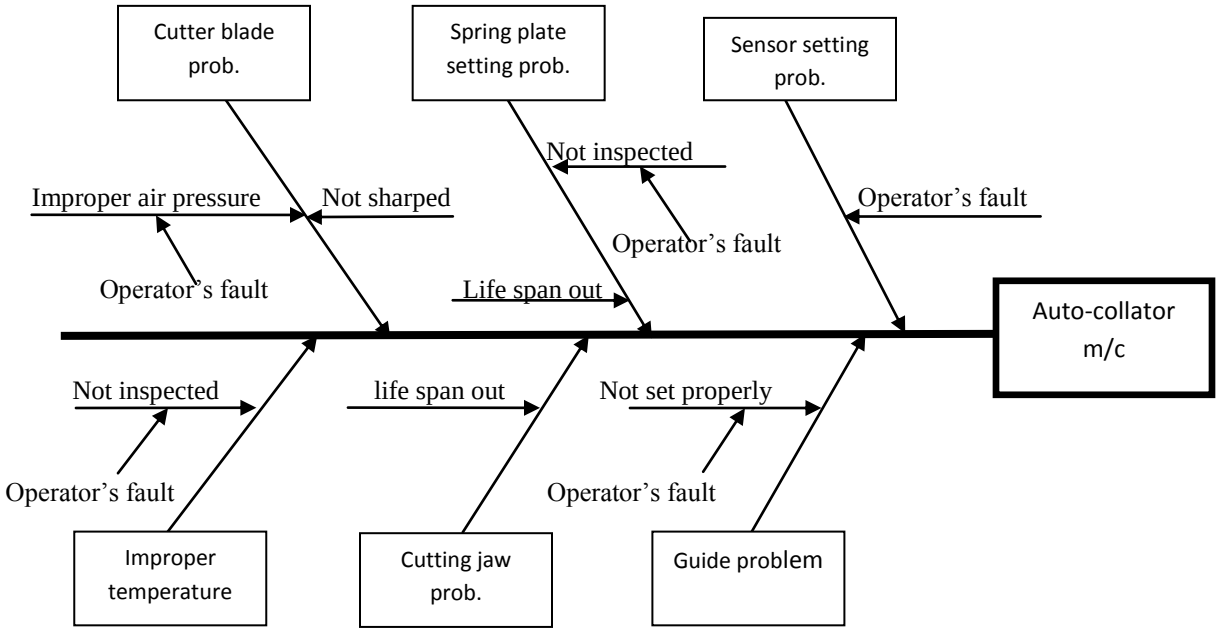


Fig.4 Cause and Effect Diagram for Auto-collator machine problem

From the Fig.3 and Fig.4 the root causes for Hicart SPC closing problem and Auto-collar machine problem are shown. Likewise, by using the Cause and Effect Diagram root causes for all major concerning areas, shown by red bars in Fig.2, were found. These causes were found by observation and

data provided by the engineers and operators of maintenance department.

## V. SUGGESTIONS AS COUNTER MEASURES

From the observation and consultation with the maintenance department, some suggestions to reduce the factors of the loss due to Equipment breakdown (Mechanical) are suggested and are shown in Table3, Table4, Table5, Table6, Table7 and Table8.

Table3. Suggested solutions for Hicart SPC closing problem.

| Effect | Causes | Suggested solutions |
|---|---|---|
| Improper tightening | Nut-bolt loose | Check nut-bolt before operating the machine. |
| Vibration | | Not too much load to be given. |
| Improper setting | Closing guide problem | Check whether closing guide is in proper position or not. |
| Not checked | SPC quality | Inspect the SPC before operation. |
| SPC dropped on running machine | Carrier angle bent | Clean the dropped SPC before running the machine. |
| Vacuum not proper | SPC landing | Check for proper vacuum. |
| Drum timing not proper | | Provide adequate training to operator on Drum timing. |
| Sucker bellow cannot hold SPC properly | | Check & replace sucker bellow if needed. |
| Pusher rod bent | Tube pushing incomplete | Repair or replacement required. |
| | | Replacement required |
| Improper setting | Improper carton box top support | Provide adequate training to operator. |
| Lack of knowledge | Magazine setting problem | Provide adequate training to operator. |

Table4. Suggested solutions for Auto-collator machine problem.

| Effect | Causes | Suggested solutions |
|---|---|---|
| Lack of knowledge | Sensor setting problem | Provide adequate training to operator. |
| Not inspected properly | Spring plate setting problem | Improve supervision. |
| Life span out | | Replacement required. |
| Improper air pressure | Cutter blade problem | Provide adequate training to operator. |
| Not sharpen | | Repair required. |
| Improper setting | Guide problem | Improve setting knowledge. |
| Life span out | Cutting jaw problem | Replacement required. |
| Lack of proper knowledge | Improper temperature | Provide adequate training to operator. |

Table5. Suggested solutions for Conveyor problem.

| Effect | Causes | Suggested solutions |
|---|---|---|
| Vibration | Pusher rod jam | Not too much load to be given. |
| Nut-bolt loose | Chain tension not proper | Nut-bolt be tightened before operation. |
| Overload | | Not too much load be given. |
| Pusher rod bent | Conveyor plate damage | Repair or replacement required. |
| Chain tension loose | | Check chain tension before operation. |

Table6. Suggested solutions for Hicart tube pushing problem.

| Effect | Causes | Suggested solutions |
|---|---|---|
| Improper chain timing setting | Chain timing fast | Provide adequate training to the operator. |
| Drum timing setting problem | SPC landing not proper | Provide adequate training to the operator. |
| Pusher assembly problem | Pusher timing late | Provide adequate training to the operator. |
| Life span out | Sensor problem | Replacement required. |
| Improper chain tension | Conveyor plate damage | Check chain tension before operation. |
| Vibration | Pusher rod bent | Repair or replacement required. |
| Life span out | Pusher top damage | Replacement required. |
| Not inspected properly | Filled tube bent | Improve supervision. |

Table7. Suggested solutions for Pacmac tube holding problem.

| Effect | Causes | Suggested solutions |
|---|---|---|
| Not inspected properly | Tube cap loose | Improve supervision. |
| Not inspected properly | Tube end oval | Improve supervision. |
| Improper setting | Tilter to holder center out | Provide adequate training to the operator. |
| Air filter jam | Vacuum problem | Cleaning should be done periodically. |

Table8. Suggested solutions for Pacmac timing out problem.

| Effect | Causes | Suggested solutions |
|---|---|---|
| Holder not fitted properly in position | Holder jam | Improve supervision. |
| Tube not fitted properly in holder | | Improve supervision. |
| Chain tension loose | Chain stretch | Repair or replacement required. |

## VI. Results and Discussion:

From the above study we have seen that 6 factors of Equipment breakdown (Mechanical) lead to the maximum of total downtime calculated for 5 months. So the company had to incur maximum loss for those factors.

% of downtime for those 6 factors $=\frac{5131\ min.}{13960\ min.} * 100\% = 36.75\%$

% Cost incurred for those losses= $\frac{Rs.58070200}{Rs.157992800} * 100\% = 36.75\%$

From the Table3, Table4, Table5, Table6, Table7 and Table8 it is found that adequate training to the operator is required in most of the cases followed by repair or replacement of machine parts. Also Inspection, Tightening, Cleaning and in some case Lubrication are important tool for long life of machines.

If this 36.75% of breakdown time can be reduce then the company can increase its production for those 5 months = $\frac{5131*160}{24*60*125*160} * 100\% = 2.85\%$

(Production capacity= 160 units/min.)

## VII. CONCLUSION

Reducing downtime or making machines available for longer period in an industry is the one way of increasing product quality and productivity. In this study, we had analyzed the downtime of machines in a production line of a FMCG company. Various losses were found from which major loss was identified by Pareto analysis and the cost associated with them. After identifying the major loss, Pareto analysis was done again to explore the major concerning factors of the loss where 6 factors

were identified which contribute 78.62% of the total loss. Then Cause and Effect Diagram shows the root causes of those 6 factors and some suggestions were provided towards the end. This downtime is 36.75% of the total downtime which can be reduced by following the suggestions for each causes mentioned in the Table.3, Table.4, Table.5, Table.6, Table.7 & Table.8. If this downtime can be reduce then the production capacity of the line will be increase by 2.85%.

Also from the study we can say that Autonomous Maintenance and Education & Training are the two important TPM pillars in an industry for increasing product quality and productivity. Thus this study will provide good idea in reducing the downtime of machines in an industry.

## ACKNOWLEDGEMENT

I would like to acknowledge the support of EMAMI Ltd., Abhoypur, North Guwahati Unit and all the faculty members of Mechanical Engineering Department, Jorhat Engineering College (Assam).

## REFERENCES

[1] Ahmed,Tanvir;Acharjee, Raj Narayan; Rahhim, MD. Abdur; Sikder, Noman; Akhter,Taslima; Khan,Mohd. Rifat; Rabbi, MD.Fajle; Saha,Anup; "An Application of Pareto Analysis and Cause-Effect Diagram for Minimizing Defects in Sewing Section of a Garment Factory in Bangladesh", International Journal for Modern Engineering Research, Vol. 3, Issue 6, 2013, pp.3700-3715.

[2]Kiran, M; Mathew,Cijo; Kuriakose, Jacob;"Root Cause Analysis for Reducing Breakdowns in a Manufacturing industry", International Journal for Emerging Technology and Advanced Engineering, Vol. 3, Issue 1, 2013, pp.211-216.

[3] Ahmed, Mohiuddin; Ahmad, Nafis; "An Application of Pareto Analysis and Cause-and-Effect Diagram (CED) for Minimizing Rejection of Raw Materials in Lamp Production Process" Management Science and Engineering, Vol. 5, No. 3, 2011, pp.87-95.

[4] Ilie, Gheorghe; Ciocoiu, Carmen Nadia; "Application of Fishbone Diagram to Determine the Risk of an Event with Multiple Causes", Management Research and Practice, Vol. 2, Issue 1, 2010, pp.1-20.

[5] Bose,TarunKanti; "Application of Fishbone Analysis for Evaluating Supply Chain and Business Process-A Case Study on the St. James Hospital", International Journal of Managing Value and Supply Chains, Vol. 3, No. 2, 2012, pp.17-24.

[6] Gupta,Amit Kumar; Garg, R.K; "OEE Improvement by TPM Implementation: A Case Study", International Journal of IT, engineering and Applied Sciences Research, Vol. 1, No. 1, 2012, pp.115-124.

[7] Joshi,Aniruddha; Kadam,Pritam;"An Application of Pareto Analysis and Cause Effect Diagram for Minimization of Defects in Manual Casting Process", Proceedings of IRF International Conference, 2014, pp.110-115.

[8]Chandna,Pankaj; Chandra,Arunesh;"Quality Tools to Produce Crankshaft Forging Defects: An Industrial Case Study", Journal of Industrial and Systems Engineering, Vol. 3, No. 1, 2009, pp.27-37.

[9]Mahto,Dalgobind; Kumar,Anjani; "Application of Root Cause Analysis in Improvement of Product Quality and Productivity", Journal of Industrial Engineering and Management, Vol. 1, No. 2, 2008, pp.16-53.