OPENING MINDS: RESEARCH FOR SUSTAINABLE DEVELOPMENT

# Identifying Factors that Affect the Downtime of a Production Process

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## 1 INTRODUCTION

In this competitive world, manufactures always try to make their productions a top priority. Production efficiency is vital in this regard. Unplanned downtime is the major contributing factor for loss of profit even with new technologies. Unplanned downtimes occur by machine breakdown, delaying materials, failures, and defects. The overall production depends on the effective operation of machineries, tools and etc. Equipment downtime occurs mostly due to unplanned actions. To maximize profits, companies have made operational efficiency a top priority. Even if a company had installed new technological methods, more often the planned production does not exceed 50%. This may be due to the downtime of failures, defects, and machinery problems. However, the unplanned stops are the most common unexpected factors that effect on the overall productivity. The requirements of outstanding performance force, companies need to reduce their total downtime frequency. In this study we used six sigma tools to understand the major factors that affect the total down time of a production process of a world class apparel manufacturer in Sri Lanka.

## 2 METHODOLOGY

In this study we received data from a world-class apparel manufacturer operating in Sri Lanka who is engaged in product design, development, execution and marketing to global super brands. We used three year production performance evaluation data, in this case total down time per month since 2014 January to 2016 December. There are 31 downtime types including this data set (including the responsible department) as well. There are nine departments.

**Downtime (target<2%):** We defined the downtime as “the period during which an equipment or machine is not functional or cannot work”. We have noticed that technical failures, machine adjustments, maintenance and missing raw materials, labor and power. The required production capacity and efficiency is not achieved due to the total downtime (Table 1).

**The fishbone diagram:** Fish bone diagram is a six sigma tool that used for statistical process control. This can be used to understand the major causes behind the effect. In a fish bone diagram the problem statement (effect) is written first. A circle is drawn around it and horizontal arrow running into it. Major categories (causes) were discussed. Usually, Methods, Machines, People, Materials, Measurement, Environment are the major bones of the fish diagram. Sub-causes are branching off the major causes.

**Pareto Charts:** Pareto Analysis is a simple technique that used 80:20 Rule. Pareto (1897) assumed that 80% percent of the effects are due to 20% of causes and vice versa. Pareto analysis is very useful in the control phases of the Six Sigma methodology. In Pareto analysis cumulative percentage are given in a line chart and percentage of causes explain by each effects are plotted in bars. Causes are listed in the X-axis and percentage of effects is given in the Y-axis (Scrucca, 2004).

**ABC-Analysis:** ABC analysis is an extension of the Pareto chart that groups causes in to three groups. A stands for the most important causes (important few), B for moderate and C for least important. Two axis's *X* and *Y* represent effort ($E_i$) and yield ($Y_i$) respectively. The algorithm is based on an *ABC* analysis and calculates these limits on the basis of the mathematical properties of the distribution of the analyzed items. The ABC analysis compares the increase in yield (importance) to the required effort. Let $X_1, X_2, ..., X_n$ be a set of n positive values ($X_i > 0$) of n different variables of an empirical data set with respect to the property important. The distribution of the values xi is unequal (few large values and many small values (Thrun, Lotsch and Ultsch 2017).

xi's are sorted in descending order ($X_i > X_{i+1}$). The fraction of the first i elements to $n$ represent the effort $\left(E_i = i/n\right)$ and yield is represented by $Y_i = \frac{\sum_{k=1}^{i} x_i}{\sum_{i=1}^{k} x_i}$. All the analysis were performed using software R (R Core Team 2017).

**Table 1:** Downtime type department wise.

| Department | Downtime Type |
|---|---|
| Engineering | Bundle time due to machine problem, machine adjustment, thread unbalance, uneven measurement.<br>needle cut and needle hole, needle breakages, burn mark and lue mark,<br>Tape unbalance, cracking, stain ,skip, uneven edge, stain, bundle time due to machine problem, |
| Cutting | Input delay, cutting defects |
| Planning | No input, planning issue |
| Material and Quality Assurance (MQA) | MQA defect |
| Raw Material Warehouse (RMW) | RMW defects, accessory delay ,label delay , |
| Customer service | External operations issues, customer service issue, development issues, |
| Production | Layout changes, NSU bonding issues , machine try out time ,soup time , |
| CTP | Planning issues, under production, no input , |
| Production development Center (PDC) | Technical issues ,development issue |
| Purchasing | Purchasing issue, material development issue |
| FGW | FGW delays |
| IT | SAP issue |
| PNA | Power failure |
| WRK | General downtime |


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# 3 RESULTS AND DISCUSSION

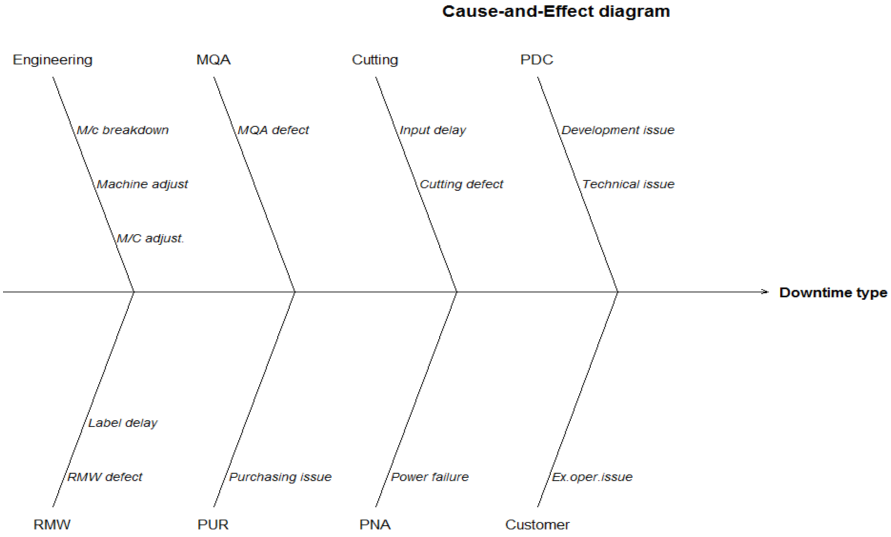


**Figure 1:** Fishbone diagram (Departments are listed in main bones, down time types are listed in sub bones)

According to fishbone diagram (Figure 1) we noticed eight departments contributed for downtime in year 2014. Engineering and Raw Material Warehouse shows number of down times. However, department contribution to the total downtime hour is not clear.

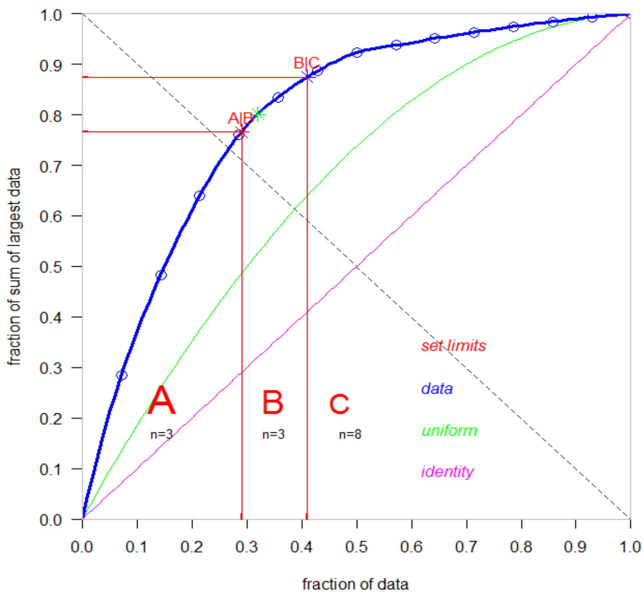


**Figure 2:** ABC plot under different distributions. Observe distribution (blue line), Proportional (magenta line), uniform distribution (green line). The Break-Even point: point at slope of the ABC curve at this equal to one (green star). The limits of three sets A, B and C for the downtime data (red lines) (Thrun *et al.*, 2017).

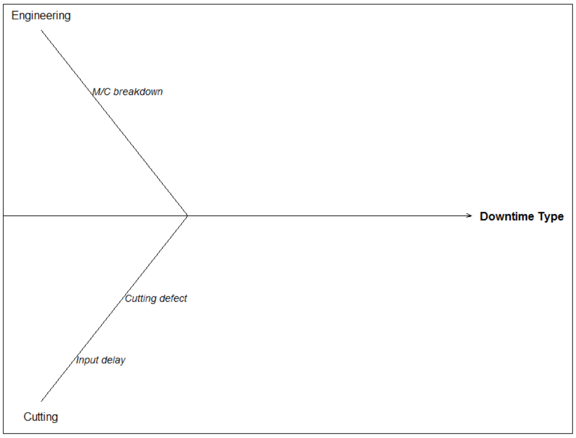


**Figure 3:** Revise fishbone diagram after with vital few down types (in Engineering and Cutting)

ABC analysis is performed for year 2014 and we found that three down types contribute for more than 75% of the total downtime (Fig. 2) and other eight down types contribute for 10% total downtime. Figure 3 shows fish bone diagram for revised analysis (after ABC) with three vital breakdowns three namely, M/C breakdown, cutting defects and input delay from two departments Engineering and Cutting. Pareto chart is given in Figure 3 and we found that three downtime types (i.e. B3, L1 and C3) contribute to 75% of the total down time. Figure 4 shows downtime as a percentage of total production hrs. We noticed that out of 36 months eight months their downtime percentage is higher than the Bootstrap upper and lower control limits (see, Efron, B. 1979).

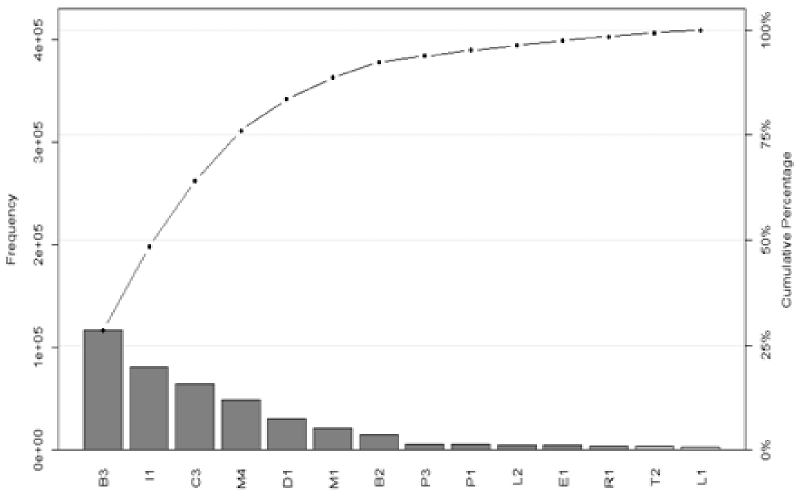


**Figure 3:** X Axis: Pareto chart for 14 down types. Y Axis: Down time as percentage of total down time.


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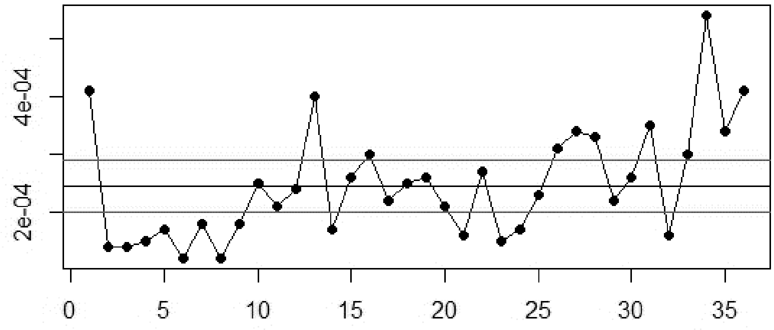


**Figure 4:** Percentage of down time for each month (2014-2016 years) and their bootstrap confidence intervals.

## 4 CONCLUSIONS AND RECOMMENDATIONS

Our study indicates that most of the downtimes are due to few vital down types. Therefore, a company can increase its downtime efficiency to 75% by controlling 3 down types. It is necessary to perform detail an analysis to understand out of control signals in the control chart.

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