

# **The impact of plant maintenance on quality productivity in Gauteng breweries**

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## **Abstract**

Plant maintenance is the complete management of machines and equipment within the factory. It can involve prevention of machine breakdowns thorough machine lubrication, identifying small faults and replacement of outdated machines. Through the use of plant and equipment maintenance in production, this can lead to high quality products, increased production speed and the overall improvement of the performance of the plant. The implementation of Total Productive Maintenance has to do with making operators involved with maintaining their own equipment and making sure preventive and proactive maintenance will build a foundation for enhanced production (less breakdowns, stoppages and defects). Improvements in Cost reduction as well as cost reduction in total labour results from maximum utilization of maintenance resources. Total Quality Management which has to do with monitoring and enhancing production and service quality, it emphasizes increase in product efficiency hence low-cost quality production.

**Keywords:** Quality, Total Productive Maintenance, Plant maintenance.

## **1. Introduction**

Plant maintenance has to do with the dealing of all management of machineries and tools in a factory. Maintenance is defined as the function of production management concerned with the day to day challenges to maintain the physical plant in a good operating condition. Plant maintenance is having to do with the actions taken by plant user to maintain the current system and facilities or to restore it to its operating condition. This comes down to taking the form of prevention of breakdowns through extensive lubrication of machines, identification of faults, carrying out minor repairs and replacing spare parts at a given time to improve the production efficiency and improve quality and productivity. Maintenance of plant and equipment use in production results to high production quality products, the speed of production increases and improve the overall performance of plant. The maintenance resources given maximum utilization improve cost reduction or and it controls the total operating budget for the plant as well as reductions in total labour costs through increased speed and efficiency of production. The impact of plant maintenance cannot attach too much importance of the consequences in improving the quality of production. Today, companies give more and full attention to the quality of the product or services they produce. The act of management approach to long-term success through customer satisfaction by monitoring and enhancing the quality of products produced as usually known as Total Quality Management. TQM emphasizes on production efficiency which is the ability to produce at a low cost hence giving the company clear competitive advantage. It is not always the case that most companies undertake plant maintenance to manufacture high quality products with efficiency to minimize cost and make high sales, although, most companies fail to use the correct techniques of maintenance sequel to minimize cost but incur those costs through machine breakdown interacting to production which result to great loss.

### **1.1 Research Problem**

The fact that an organization is unable to effectively maintain its plant and equipment will lead to poor quality products, reduction in production speed and affect other factors that prevent overall effective plant performance. This at a later stage will lead to production failure in the market and can lead the organization to collapse, hence lack of competitive advantage.

### **1.2 Research Goal**

The comprehensive goal of this research is to examine the impact of plant and equipment maintenance on quality production in Gauteng breweries.

### **1.3 Research Objectives**

The specific objectives are to;

- Have thorough inspection of how maintenance of plant and equipment affect production standard in Gauteng breweries.
- Figure out how maintenance of plant and equipment influence efficiency and speed of production in Gauteng breweries.
- Have specific identification of the effect of plant and equipment maintenance on quality production in Gauteng breweries.
- Identify the problems preventing effective plant and equipment maintenance in Gauteng breweries.
- Find possible solutions for all four objectives.

### **1.4 Research Questions**

- How does plant equipment maintenance affect the standard of production in Gauteng breweries?
- How does maintenance of plant and equipment influence efficiency and speed of production in Gauteng breweries?
- What is the effect of plant and equipment on quality production in Gauteng breweries?
- What are the problems preventing plant and equipment maintenance in Gauteng breweries?

## **2. Literature Review**

Maintenance has to do with development of tasks and actions to extend or prolong the ability of the equipment to function for a long time along its productive life (Bann, 1997). Maintenance schedules are rather carried out on a regular (planned) daily basis to make sure that equipment are available to meet production specification and requirements. The basic meaning of maintenance involves functional and operational checks, servicing, replacement of necessary devices, equipment, machinery, building infrastructure and supporting utilities in industrial areas. It is the work of keeping something in its genuine condition. This always include the development of the document that ensures that those tasks are carried out in a proper manner consistently. In industrial areas, the key roles of maintenance have become essential part of the overall profitability of the organization. Nowadays the maintenance techniques have the capacity for significantly increasing the organization's competitive advantage in the market globe.

There is a whole lot of different reasons why maintenance should be executed in the plant or equipment of the process. The significant of upkeep can't neglect to be seen in light of the fact that it assumes such noteworthy part in the adequacy of lean assembling (Steve Krar 2008). It is required to adequately limit squander and play out an effective, persistent assembling activity or administration task. Regular maintenance is way less costly compared to the cost of serious breakdown where no production takes place. The most important purpose of frequent maintenance is to make sure that all equipment needed for production are operating at a 100% efficiency always. Though day by day inspections, greases, cleaning and making little alterations, little issues can be recognized and managed before they turn into a colossal issue that can wind up closing down the entire creation line. A proper maintenance program need all the full support from bottom management to top management, from the top executive to the shop floor personnel. Maintenance is carried out to satisfy the legal requirements of the Safety Act and Occupational Health. The objective is to provide a safe working environment for the subordinates. Although both employer and or the organization, are socially responsible for providing a safe working environment for the company's subordinates. All of this can be archived through appropriate utilization of maintenance techniques and maintenance program implementation designed to get rid of failures that can result to safety consequences (Sappi, 2001).

One other important reason for performing maintenance is that the plant and equipment that are not maintained properly become worn too early. This early deterioration has cost implications that is associated with the replacement of the equipment. The introduction of careful maintenance program can lead to the increase of the equipment lifespan which will minimize the cost of repairing. Effective maintenance activities allow equipment to be repaired before its failure hence avoid the cost of uncontrollable failures and possible revenue loss. Keeping machines very much kept up is sure thing, the most significant aspect of the nowadays industries (Dowler, 2015). The undertaking of applying stretch film is very essential and finding an opportunity to offer the machine a reprieve for an investigation can appear to be something of an issue. Be that as it may, it is exceptionally critical to have customary, booked upkeep for an extended wrap gadget. Without having normal registration, parts that are fundamental to the capacity of an organization to utilize bounding film may conceivably come up short, and at the point where parts of the machine break – the repairs can be costlier and tedious.

### **2.1 The Basis of Total Productive Maintenance**

Making operators involved with maintaining their own equipment and making sure preventive and proactive maintenance will build a foundation for enhanced production (less breakdowns, stoppages and defects). TPM developed gradually from different maintenance philosophies and improvement strategies being used in various industries. The philosophies include Total Quality Management (TQM), World Class Manufacturing (WCM) and other initiatives. Philosophies that gave more towards the development of TPM are the Reliability and Preventative maintenance.

### **2.2 Preventative Maintenance**

Preventative maintenance (or preventive maintenance) is the maintenance usually performed on a part of equipment to minimize the chances of it failing. It doesn't wait for machine to breakdown instead it is performed while the machines are running so that they don't have to breakdown unexpectedly. Planning is essential for preventative maintenance so that the needed resources are available. The first creation of maintenance was executed purely on a breakdown basis (Sappi, 2001). Plant equipment or machines were used until they breakdown or fail thereafter the repairs were taken into considerations. Behind these maintenance practices, failure process was not taken into considerations. The more the product demand, the more industrial manpower dropped significantly which led to the increase of mechanization and automation. By early 1950's all type of machines were too complex and the organizations became to dependent on them, hence this dependence grew, availability and reliability of plant equipment came into spotlight. All of that led to the idea that prevention to the equipment failure should be implemented which then led to the concept of preventive maintenance. Using preventative maintenance, equipment refurbishments are performed at constant intervals (see figure below). This is based on the point that there is a clear description life span before equipment breakdown happens (Sappi, 2001). The span can be defined in either time or usage figures.

### **2.3 Maintenance and its impact**

Maintenance is the combination of all practical, managerial and administrative actions throughout the life cycle of the equipment to maintain it in or reinstate it to a condition which it can perform the required function (EN, 2001). It is also defined as, all needed and crucial actions which are required for maintaining a system to its life cycle in operative and functional state or restoring it to a condition it can execute its intended function (Blanchard, 2004). The importance of maintenance function has over ages increased caused by its role and impact on other working environment in the organization, i.e. enhancing product quality and machine availability. Efficient maintenance contributes by putting on value through more advantageous utilization of resources, improving the quality of the product as well as reducing rework and scrap (Alsyof, 2004). Maintenance is categorized into two main areas, i.e. Preventive maintenance which include all planned maintenance actions like; condition monitoring and periodic inspection, while Corrective maintenance has to do with all unplanned maintenance activities to restore failure.

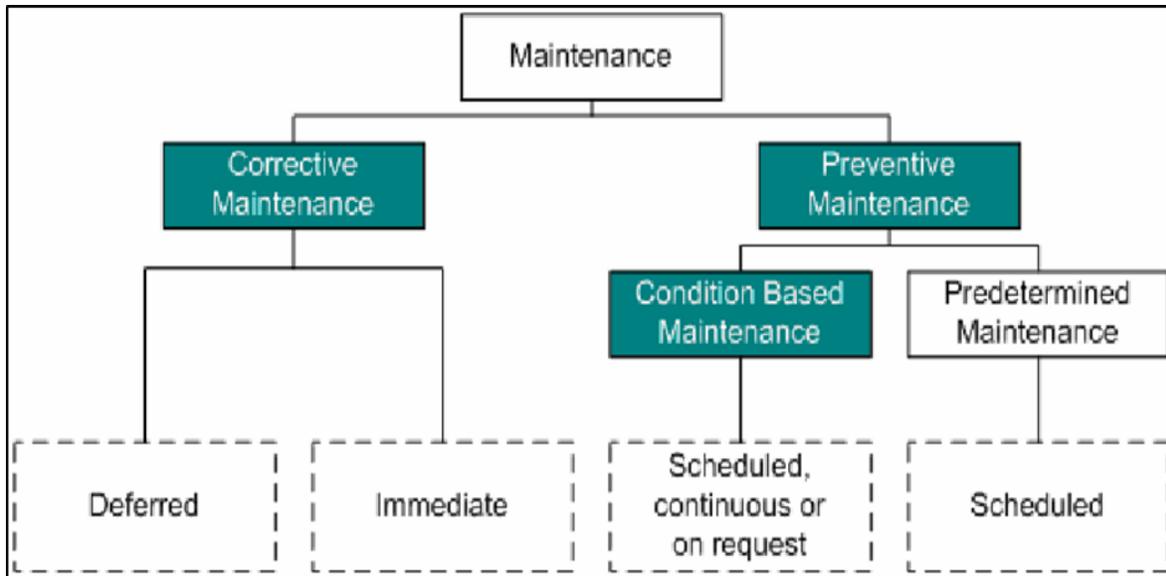


Figure 1: Overview of maintenance

## 2.4 Maintenance and Production

As always, the fundamental undertaking of creation is to deliver merchandise, however, efficient maintenance strategy impacts production capacity of the machines used for making those products (Al-Najjar, 2007). Therefore, maintenance can be contemplated as an organizational purpose that functions in accordance with production. When busy repeating that production makes products, other also say that maintenance produces the capacity for production. In this way, it can be concluded that maintenance disturb production by increasing the capacity of production at the same time also controlling the quality of the output and quality. Below is the graph that illustrate the impact of maintenance on production.

## 2.5 Maintenance and Quality

The part or role of maintenance in long-term beneficiary of the organization has been known for some time now, resulting to researchers and professionals to build maintenance strategies that contribute to company's long-term beneficiary. Profitability and survival of the company might not be maintained without sustaining the quality of the product. High quality may serve as the major edge of company's competitive advantage and long-term profitability in the modern Global economy (Daya, 1995). Total Productive Maintenance might be the only adequate model that identifies the relationship between maintenance and quality. Normally they say that equipment/machines which run short of maintenance and breaks down frequently experiences loss of speed and hence they get to produce errors (defects). Those equipments usually drives production processes out of control. Obviously, the process that is out of control is bound to produce defected products and also increasing the production cost which minimizes profit (Duffuaa, 2009).

## 2.6 Maintenance and Profitability

Profitability is the outcome of price recovery and productivity. Consequently, productivity is the one that determines the production process efficiency and effectiveness. According to APQC cited in Alsyouf (2004) repeat that when analysing maintenance profitability, the other working area's impact is also measured; for example, by guaranteeing maintenance role in the machine life cycle. The enhancement of maintenance in general aims to reduce operation cost and enhancing the quality of the products. Sure, case there is a link or rather connection between maintenance and profitability. Below is the diagram that shows how the two interlink together.

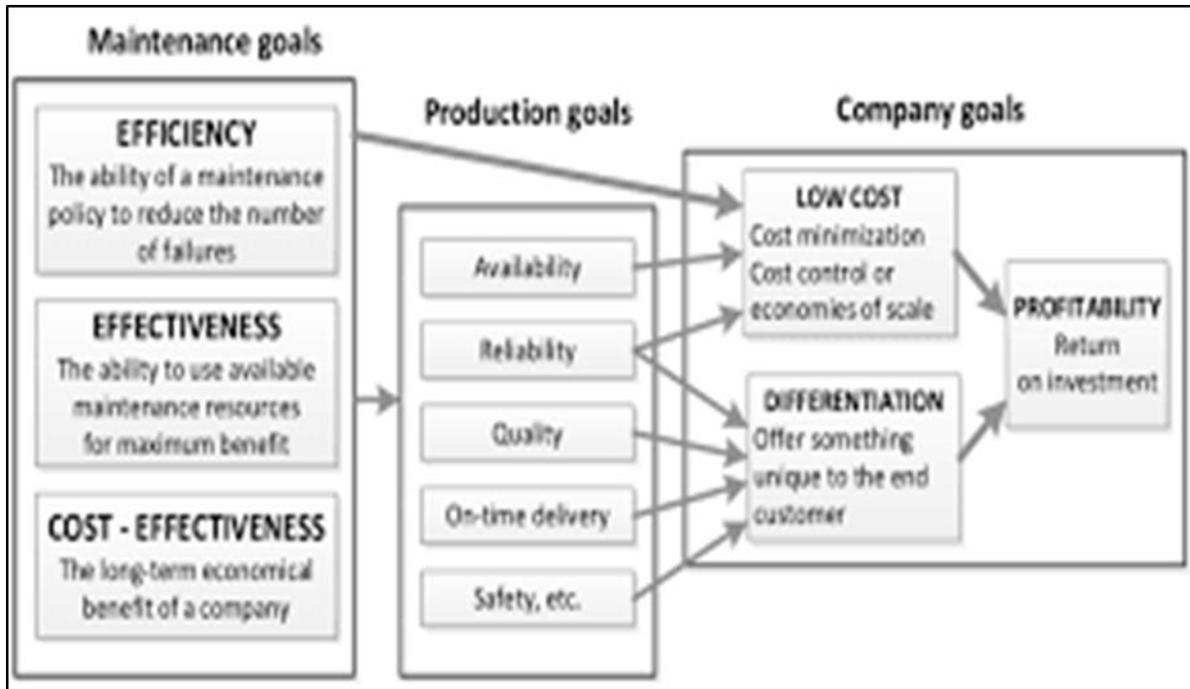


Figure 2: Connection between maintenance and profitability

## 2.7 Common maintenance problem

Today most of the maintenance department “fight fires” instead of facing their problems in a systematic way. Rather than waiting for the problems to occur, it is better to use prevention as the better objective. Even though the strategy might be a bit costly at first, but it is way less expensive compared to waiting for problems to occur (Lantz, 2017). Maintenance problem-solving is basically concerned with four areas; maintaining critical systems, securing the problem faster and quick than before, determining what causes the frequent breakdown and lastly identifying the 20% of failure that eat up the 80% of the available resources. The four most common types of maintenance problems include; identification, cause/effect, means and ends.

### 2.7.1 Identification

When you don’t get to understand a natural occurrence, or method of executing things, then your natural tendency is of interest. Even in the industrial maintenance is just like that. You have to understand and identify everything in the department or plant and if you don’t then have someone on staff who does. Whenever the problem occurs, you have to identify when and where it occurred and also where and when it did not. Above all, you need to identify why you keep doing things the way you do them when others look for better approach.

### 2.7.2 Cause and effect

Effects has to do with the way you see things through condition monitoring techniques. They often accompany or lead to a machine failure. Types of effects includes heat, vibration and noise. To illustrate this concept of cause and effect, a fish-bone can be used.

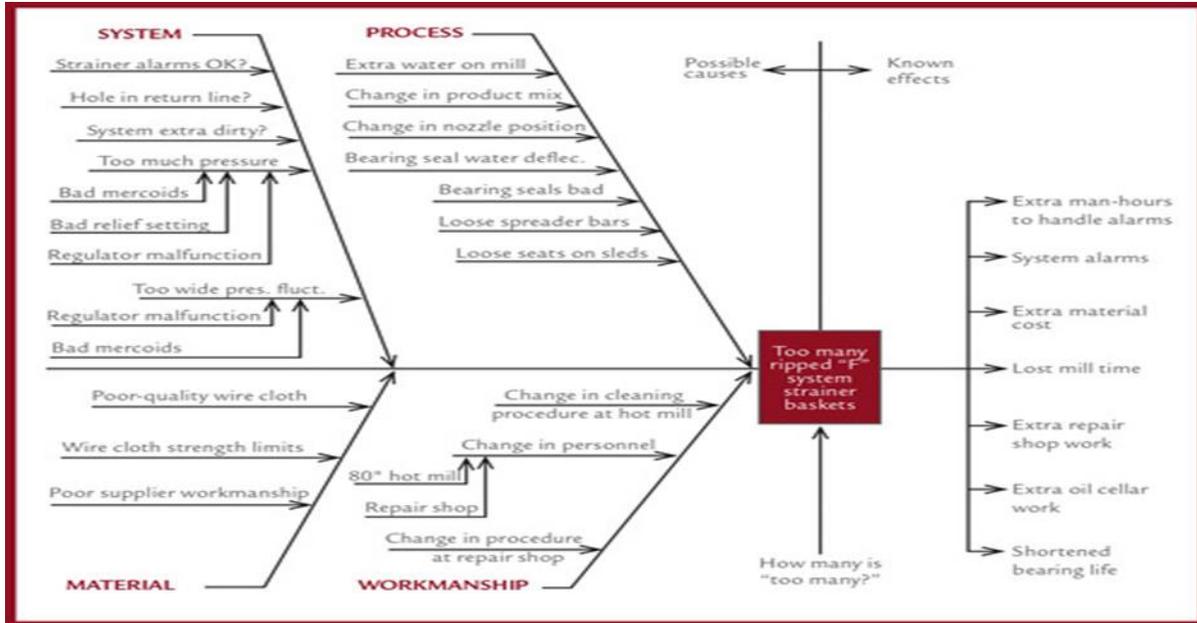


Figure 1. Cause and Effect Diagram based on Maintenance

### 2.7.3 Means

Means problems are normally identified through questions beginning with “how” such as “how that can be accomplished?” or “how one can improve that?”. They leave the option of means open-ended. Through means problem, one can try to choose how to achieve a goal. The problem of choosing a goal has been solved already, what’s left is to focus on how to achieve it. Predictable questions that describes mean problems include.

- How to minimize immoderate lubricant failures?
- How to reduce lubricant costs without compromising product quality?
- How to decrease machine downtime?
- How to enhance safety? and
- How to change the way the department thinks to prevention mode?

### 2.7.4 Ends

Ends problems or goals can be described by the question, “what goal I should give chased to?” As said before, your goals may be common at first but must be explained into comprehensive sub-goals genuinely matter. General questions asked might be;

- Which information measuring technique should be used to measure the progress?
- Which 20% of the problems are bringing about 80% of the efforts?
- What are the crucial part of the system that must be monitored continually?
- How are the problems classified in terms of criticality, importance and projects for correction?

## 3 Research Methodology

### 3.1 The research instrument

#### 3.1.1 Developing the instrument of the research

Some reflections had to be made in creating the questionnaire for this research study. Questionnaires were developed in a way that incorporates the whole concept of Total Productive Maintenance. To accomplish this, a detailed literature research was conducted, and pre-testing of the research instrument was performed on the concept matter professionals. The concept matter professionals include the TPM assistants who have high level training in Total Productive

Maintenance. Hence this helps in detecting some hidden possible areas of enhancement like areas not covered by questionnaires. And also, to go through the questions again to make sure that all the subject of this research can understand the question with ease. However, this made sure that the instrument meets all the authenticity criteria. According to Schindler (2001), a research instrument is valid if it pleases the content, the related criteria and construct validity.

- Firstly, the research instrument looks to analyze how effective the basic strategies of Total Productive maintenance are being applied.
- Secondly, seeks to assess how plant equipment maintenance affect the standard of production in Gauteng Breweries
- Seeks to evaluate the effect of plant maintenance on quality production in Gauteng Breweries.

According to Cooper and Schindler (2001), the research instrument is used in order to get both Qualitative and Quantitative data. However, where it's appropriate, unstructured interviews were coordinated to gain detailed insight into responses from the respondents. To obtain leniency and central tendency, some of the questions were rephrased which will result to checks and balances to ensure consistency of the responses through strengthening of questions.

### **3.1.2 Pretesting of research instrument**

The instrument was pretested using a sample of 7 individuals. The sample was obtained through the nonprobability sampling. The answers to the questions were provided by a group that was mainly consisting of TPM assistances. Through pretesting the research instrument, it can happen that problem areas are identified before the actual collection of data start. By doing so, it helps provide the insight and ideas for improving the instrument so that it could otherwise lead to no incorrect answers given. Another advantage of doing so, is that the analysis of the instrument can also reveal as to whether the content included by the questions is inclusive of the entire TPM concept.

## **3.2 Sampling design**

### **3.2.1 The sample population**

The population of interest in this research study is the employees of the Gauteng Breweries who are involved in the implementation of the Total Productive maintenance program within the company. The scope of this specific study will only cover Johannesburg Brewery. The figure from which the population can be gathered is roughly 100 permanent employees. Therefore, it can be rationally assumed that all of them have some exposure to the Total Productive Maintenance initiative. The size of the sample for this study will be greater than 30 percent (30 respondents) of the sample figure. The size will allow enough time to reach all the selected participants and time to make follow ups when there's a need.

### **3.2.2 Selecting the sample**

The name list from which the sample was taken from was obtained from the head of departments. Stratified random sampling was used to get the samples from each department. The process by which the sample is restricted to include the components of each portions is called Stratified random sampling (Cooper, 2001). This probability sampling technique contribute to increase in the efficiency of statistics and provide enough information which statistical inferences can be created.

## **3.3 Data collection**

The researcher used a small sample compared to other research studies that involve way larger population size, one person was assigned to collect the data in the field. The respondents of this research were attained at their various respective sections of the plant. Then the questionnaires were given to them after the daily morning meetings. Hence this was the descent place to reach all the selected respondents. To ensure that all the respondents understood how the questions were to be answered, a clearly outlined instructions accompanied the questionnaire to reduce the impact of measurement errors. The respondents were told to fill out the questionnaires in front of the researcher which made it possible to raise issues and address them at the same time. At the same time as the researcher, was able to seek clarity to the questions that were answered roughly or in a way that is uncertain. The questionnaires collected from all the respondents were checked for completeness when they the respondents returned them. Where needed, elaboration was requested to establish accuracy of data. Some few problems were encountered due to the selected respondents not being available for the administrative of the research instrument because of either being on late shift, night shift or

due to the individuals not being on the shift completely at the time when the research was conducted. Since the factory runs 24/7 during the week, to get to the issue of unavailable respondents, some phone calls were made. This was after getting certainty with other sections of the plant the time when the respondents would be available. After that was done, all the selected respondents were able to complete the questionnaires.

#### **4. Data analysis**

Because of the use of different types of questions in the research equipment, it is necessary to develop different ways to evaluate data. Below is how data will be analyzed.

##### **4.1 Presenting the TPM principles results**

To analyze this data, the data will be put in the Statistical Package for the Social Science (SPSS) software. The obtained information will categorize the answers into five specific categories, which will make it possible to accumulate the frequency tables that will summarize the all the responses. With the frequency tables, bar charts will be drawn for the results. From the bar charts, the percentage of all the categories will be shown. This will determine how the respondent's opinions are in terms of Total Maintenance Principles.

##### **4.2 Data presentation of TPM training**

This type of data analysis technique (Likert rating scale) provides nominal data where two mutually exclusive answer choices are pursued. Even here the bar chart will be used to analyze the level of Total Productive Maintenance training from the employees of Gauteng Breweries.

##### **4.3 Data presentation of TPM effectiveness**

Through the use of SPSS software, it will assist in compiling and evaluating statistical data for the survey. Then from the information gathered, the researcher will confirm using the t-test method to determine if the relationship between TPM and productivity, cost and employee safety exist or not. In this research study, a 95% level of confidence will be used on the results of the survey. Hence this means the correlating level of significance will be 0.05 (5%). We used parametric tests to test the significance level since the data is interval.

##### **4.4 TPM contributions and improvement areas**

When researchers analyze and explain the open-ended questions, researchers use the content analysis technique. This will be influential in assisting with unstructured questions analysis and necessary prescriptions of the recommendations.

#### **5 Results**

Almost 77% of the participants stated that all the disciplines were engaged with the Total Production maintenance program. Again, there is another important percentage (7%) of the participants who stated that they felt like in their sections, the maintenance disciplines are involved with the TPM program. It emerged like Gauteng Breweries employees (63% of the participants ) all maintenance disciplines contribute to the improvement suggestions initiative while others 26% feels like the improvement suggestions spread in balancing order between maintenance, management and production disciplines. Again, when it comes to equipment downtime, 47% of the respondents felt like they are responsible for the downtime while 33% of them felt that it is the maintenance department which is responsible for the machine down time, where only 4% of them felt like it is the responsibility of management to deal with downtime. It showed that 27% of the participants who have been trained in the TPM program are the ones who stated that the maintenance disciplines are involved much with TPM. The other 70 % of the participants went on to say that TPM has led to the efficiency and speed of production with reduction in the product defects hence quality product are produced.

#### **6. Conclusion and Recommendations**

The conclusions were based on the analysis of the survey:

- Researchers identified that the more people get involved with the TPM program, the initiation of improvement suggestions seems to involve all maintenance disciplines. However, some of the people feels like there are certain people who are responsible for maintenance rather than everyone. From this researchers can conclude that some of the employees are not well informed regarding the TPM principles and TPM training still lacks in other sections of the plant.

- From the statistical results it is obvious that TPM or maintenance as a whole has got positive effects or positively impact downtime, productivity, quality and machine availability. So, from the results we can conclude that without the implementation of TPM, the company won't be able to achieve the increase in productivity, quality of the product and machine downtime.
- Improved quality, run rates and machine downtime has been increased as a result of Total Productive Maintenance. So, from this researchers can conclude that there is an increase in the Overall Equipment Effectiveness of the company though reduced downtime and the increase in the availability of plant equipment.
- Lastly, from the results it shows that the operation and maintenance of plant equipment has been made easier though the implementation of Total Productive Maintenance program.

### **6.1 Recommendations**

- Gauteng Breweries should instill the TPM training to all their employees and the new ones who are joining the company and get rid of the habit of saying there are specific people who are responsible for the maintenance of the equipment.
- Gauteng Breweries should encourage the use and enhancement of visual systems.
- Whenever employees get to accomplish something out of their own effort, the company should recognize and praise their contributions and achievement. By doing so, employee morale and commitment increases and develop positive attitude.
- All the departments including maintenance, quality and production should be combined when it comes to TPM and by doing so, all the department will be actively involved in TPM program.
- Lastly, Total Productive Maintenance procedures need to be updated and revised at all times so as to seek for new ways to improve the whole process.
- Through implementing these recommendations, Gauteng breweries will gain more improved world class competitive advantage.

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