

Analysis of Maintenance Management Implementation: A Case Study in Smartphone Manufacturing Factory

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Abstract

Smartphone become a necessity to society not only for communication, but also to do work, business, and even school activities. Production of smartphone become higher each year therefore the smartphone manufacturing company also built in Indonesia. Manufacturing is one of the leading industries and economic contributors in the world and played a crucial role in economic growth for a country. Maintenance management is often considered as a centralized functional unit within the overall organizational structure in parallel with other functional units such as, production. Maintenance in manufacturing requires highly sophisticated level of planning and operations more than any other business environment. This study aims to identify manufacturing criteria in smartphones manufacturing factory and maintenance management implementation in smartphone manufacture. The survey results show that smartphone manufacturing factory already have a maintenance management system implemented following the preventive maintenance criteria that have been set in this study.

Keywords

Analysis Maintenance, Maintenance Management, Building Maintenance, Factory Maintenance Management and Smartphone Factory

1. Introduction

Manufacturing is one of the leading industries and economic contributors in the world. Manufacturing played a crucial role in economic growth for a country (Nurcahyo et al. 2022), as it boosts the value of investment and exports so it becomes a mainstay sector to accelerate national economic growth. The industrial sector contributes the most to Gross Domestic Product (GDP), one of which is the electronics industry.

The Ministry of Industry noted the growth in the number of national mobile phone production in the last five years. In 2013, the Ministry of Industry recorded that national production reached 105 thousand units, this figure increased to 60.5 million units at the end of 2017. At that time, in early 2017, the Ministry of Communication and Information announced that the total Local Component Requirement (LCR) regulation in Indonesia for 4G phones had taken effect in early 2017. A total of 60.5 million units are divided into 34 brands with 11 brands of which are local brands. In 2016, imported mobile phone products declined again by about 36 percent from the previous year, to 18.5 million units with a value of USD 775 million ("Kemenperin: ImporPonselTurunDrastis, Produksi Nasional Tembus 60 Juta Unit", 2018). For domestically produced mobile phones, it increased by 36 percent from 2015, to 68 million units. In 2017, imports of mobile phones fell to 11.4 million units, while domestic production of mobile phones was 60.5 million units for 34 brands. Then in 2019 there were 101.4 million units produced in Indonesia.

One of the foreign smartphone brands that opened a factory in Indonesia is XYZ company. XYZ Company opened its first factory in Indonesia in 2016. In 2016 XYZ Company built a building that functions as a production plant and warehouse. Then in 2019 a new production plant was built to support the production output needs of thousands of units per day. In 2021, XYZ company built a building that serves as the main warehouse. Thus, company XYZ has two production plant buildings and one main warehouse building. Each building has infrastructure and supporting facilities to support their respective functions. In the production building, which is divided into offices, assembly lines, testing lines, and packing lines. Assembling parts is done quickly using manual operation and assembly machine in a certain standard of time to complete each task. After that every assembled component is inspected using a very complex testing engine integrated with an intranet network to track results online. This system also

ensures that only products that pass the first stage of the test can proceed to the next test post. A series of tests are carried out at the testing stage. Then in all buildings, room temperature also has a special standard that must be maintained from time to time. To maintain the infrastructure and facilities in all buildings, the company has made operational guidelines, that supports equipment and hired a maintenance team to carry out its execution.

Maintenance is required in the production system. It needs to be carried out to keep equipment and systems running efficiently. Nurcahyo et al. 2016 said that old machines require more intensive maintenance activities because of the potential breakdown that can occur. According to Nurcahyo et al. 2018, maintenance is the production system's center point, part of a global enterprise. Maintenance is the set of activities performed during the life cycle of an item to preserve the value of an asset (Al-Turki et al. 2014). Maintenance is also a combination of administrative and technical actions intended to retain an item or restore it to a state where it could perform a required function (Nurcahyo et al. 2018). Maintenance is not just ensuring the equipment availability but also aiming to achieve the organization's goals and objectives (Velmurugan and Dhingra 2015).

Infrastructure contributes to higher productivity and growth, facilitates trade and connectivity, and promotes economic inclusion. A company's building is a foundation of a company. Maintaining such assets in good condition is important.

Several types of research have been conducted to observe and understand the practice of maintenance management in many sectors, but there is still a limited amount of research that elaborates the maintenance characteristics in the manufacturing industry. Especially in company XYZ, where there are three plants with varying maintenance needs, especially maintenance for company buildings. Besides, the lack of research observation regarding the differences in maintenance characteristics by comparing the factory plants which have implemented fully Preventive Maintenance with the other factory plan within the organization which has applied Preventive Maintenance. This paper aims to understand and identify the most critical maintenance characteristics of the plants within the company's infrastructure.

1.1 Objectives

This study aims to identify manufacturing criteria in smartphones manufacturing factory and maintenance management implementation in smartphone manufacture.

2.Literature Review

2.1 Maintenance Management

Maintenance management is the body of the organization that is in charge of planning, implementing, controlling, and improving maintenance activities (Al-Turki et al.2014). Al-Turki said maintenance management is often considered as a centralized functional unit within the overall organizational structure in parallel with other functional units such as, production. Responsibility of maintenance management include job design, time standards, and project management. Job design involves defining for each major maintenance job, the work content, the method of maintenance of required skills and the needed tools. Time standards are determined for major components of major maintenance jobs following the scientific approach. Project maintenance is used for optimizing and controlling major complex in time consuming maintenance operations (Al-Turki et al.2014). Maintenance provides critical support for heavy and capital-intensive industry by keeping machinery and equipment in a safe operating condition (Fatoni et al. 2018).

2.2 Maintenance in Manufacturing

Maintenance is becoming highly competitive with extremely high pressure in reducing cost and increasing value of assets and improving the quality of outcomes (Al-Turki et al.2014). Manufacturing environment has complicated interrelation with large number of stakeholders, internal, and external (Al-Turki et al.2014.). In manufacturing, maintenance plays a critical role in this environment. Manufacturing in manufacturing requires highly sophisticated level of planning and operations more than any other business environment. Based on Al-Turki et al., maintenance is in the heart of the production system that is part of a global enterprise. The success of the enterprise is highly dependent on the output of the production system in terms of quantity, quality, and safety. Therefore, maintenance system is composed of plans and operations that guarantees material, spares, tools, human and financial resources availability in the right time with the right quality and quantity (Al-Turki et al. 2014).Based on Nurcahyo et al 2019, maintenance benefit at least could be categorized into five: ensuring the plant functionality (such as availability,

reliability, product quality); ensuring the plant achieves its design life; ensuring cost-effectiveness in maintenance and effective use of resources.

2.3 Maintenance Characteristics

The application of Preventive Maintenance in company helps to achieve productivity. Several maintenance characteristics are identified as below:

1. Maintenance equipment

Maintenance equipment and techniques relate to the equipment and techniques in performing preventive maintenance. Equipment maintenance involves the use of maintenance methods and procedures to keep the organization's equipment in good working condition. The budget allocated for the procurement of tools and equipment to carry out maintenance must be ensured to meet the needs (Au-Yong et al., 2014). Technical capability and maintenance equipment are supporting elements in preventive maintenance activities in the field. The use of tools and equipment to perform qualified machine maintenance will have an impact on increasing the efficiency of maintenance work time and the accuracy of the work results to be achieved (Au-Yong et al. 2014; Basri et al. 2017).

2. Spare parts and material

The management of spare parts and materials is an important factor to improve maintenance performance and the quality of production results (Au-Yong et al. 2014; Basri et al. 2017; Chua et al. 2018). Chua et. al. said maintenance requires several categories of spare parts, such as replacement parts, lubricants, and other materials. Therefore, achieving optimal performance requires sufficient budget allocation to purchase spare parts, availability of spare parts and materials, and guaranteed quality of spare parts and materials (Au-Yong et al. 2014).

3. Maintenance data acquire

An organization's proper maintenance and safety policies are critical to achieving operational excellence. These policies help optimize the use of resources and ensure that equipment and processes operate efficiently (Tri Setyoko et al. 2022).

4. Maintenance policy

Maintenance policy is a tool that maintenance personnel can use to plan effective maintenance strategies that have a direct influence on plant efficiency and economy (Aulia et al. 2022; Fore and Msipha 2010). The selection of a maintenance strategy, the definition of maintenance standards, and the allocation of maintenance resources are three important elements in developing a maintenance policy that allows maintenance activities to be properly planned and implemented. Maintenance procedures are important because this process requires detailed knowledge of maintenance requirements as well as the resources needed to perform maintenance (Aulia et al. 2022).

5. Monitoring and inspections

Monitoring is an activity intended to measure the physical state of an item at predetermined intervals. This is usually done under various operating conditions. The characteristics of the item are evaluated during various stages of its life cycle (Tri Setyoko et al. 2022).

6. Maintenance schedule

A job schedule is a job-to-job sequence of preventive maintenance actions within a range of time intervals (Cassady and Kutanoglu 2005). The development of a work assignment schedule is done by minimizing delays and maximizing the utilization of resources such as manpower, spare parts, and equipment (Basri et al. 2017). Determination of preventive maintenance intervals produces an impact on the results of maintenance activities. Preventive maintenance is carried out at certain intervals to reduce the risk of failure in production operations (Au-Yong et al. 2014; Chua et al. 2018). The determination of the interval is determined and related to determine the value of the total maintenance cost per unit time that is efficient depending on the company's conditions.

7. Financial aspect

Maintenance costs are costs incurred to perform maintenance. The maintenance decision-making process aims to determine the optimal maintenance policy that aims to provide optimal system reliability or availability and safety performance at the lowest possible maintenance cost (Pham and Wang, 1996). Cost minimization is the most common in maintenance (Van Horenbeek et al. 2010). Costs are divided into two major groups, maintenance costs and cost minimization

8. Costs are divided into two major groups, maintenance costs and inventory costs (Horenbeek et al. 2010). The cost-benefit analysis should also consider the cost of labor and spare parts that will affect the overall total maintenance cost due to different systems consisting of different components and spare parts (Basri et al. 2017).

3. Methodology

The methodology of this research comprises the following steps:

1. Literature review

Purpose of this step is to find characteristics maintenance management and its application in industries.

2. Development of survey questionnaire

After literature review several criteria of maintenance characteristics is identified, the researchers developed questionnaire questions that divided into those characteristics.

The questionnaire questions are shown in Table 1.

Table 1. Questionnaire Questions

No	Criteria	Questionnaire Questions
1	Maintenance Equipment	Complete maintenance equipment is available.
		Regular inspection of maintenance equipment.
2	Spare Parts and Material	The number of spare parts and materials is sufficient.
		Quality of spare parts and materials in good condition
3	Maintenance Data Acquire	Data completeness based on checking parameters
		Data analysis can be done
4	Maintenance Policy	Operational guideline is clear.
		Management involvement
5	Monitoring and Inspection	Ensure the schedule is running
		Maintenance report
6	Maintenance Schedule	Maintenance priority
		Scheduled maintenance interval time
7	Financial Aspect	Maintenance cost allocation
		Personnel feel constrained by the current equipment budget situation when needed

4. Data Collection

The data was collected by questionnaires. This study was conducted on a cellular phone manufacturing company from foreign manufacturer in Indonesia, where it included thirty maintenance staffs across three sites in the company. The percentage of each criterion is shown in Table 2.

Table 2. Maintenance Criteria Value Based on Survey Results

Criteria	Code	Questions	Percentage	Percentage of Each Criterion
Maintenance Equipment	Q1	Complete maintenance equipment is available.	50,76%	15,38%
	Q2	Regular inspection of maintenance equipment.	49,24%	
Spare Parts and Material	Q3	The number of spare parts and materials is sufficient.	50,39%	15,03%
	Q4	Quality of spare parts and materials in good condition	49,61%	
Maintenance Data Acquire	Q5	Data completeness based on checking parameters	51,00%	14,62%
	Q6	Data analysis can be done	49,00%	
Maintenance Policy	Q7	Operational guideline is clear.	50,86%	13,62%
	Q8	Management involvement	49,14%	
Monitoring and Inspection	Q9	Ensure the schedule is running	50,21%	13,80%
	Q10	Maintenance report is clear	49,79%	

Maintenance Schedule	Q11	Maintenance priority is set up	50,41%	14,33%
	Q12	Scheduled maintenance interval time is set up	49,59%	
Financial Aspect	Q13	Maintenance cost allocation is right on target	49,78%	13,21%
	Q14	Personnel don't feel constrained by the current equipment budget situation when needed	50,22%	

The maintenance criteria in the form of a pie chart is shown in Figure 1.

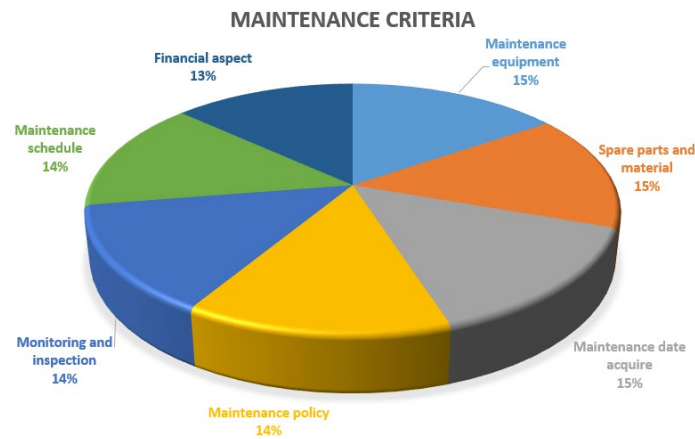


Figure 1. Pie Chart of Maintenance Criteria Value Based on Survey Results

5. Results and Discussion

Based on the survey, the criterion with highest percentage is Maintenance Equipment. This is because the supporting equipment used in maintenance operations is sufficient, with complete equipment and good quality. Supported by complete and good quality maintenance equipment, checking and retrieving data when carrying out maintenance activities becomes more effective and accurate. This supports the Maintenance Data Acquire criterion, which has an impact on the ease and fulfillment of the completeness of the Data Acquire criteria. When carrying out maintenance activities, various checking parameters can be obtained, so that aspects of maintenance activities in the form of data can be easily obtained. Based on the maintenance data obtained, the analysis process for decision making can be carried out properly. After the analysis and decision making is made, if it is necessary to replace spare parts at the facility, based on the Spare Part and Material criterion, this company already has a sufficient number of spare parts and good quality.

For the Maintenance Policy criterion, the operational guidelines for the operation of maintenance activities are in accordance with the standard and it covers all activities that must be carried out, where maintenance staff have clear guidelines for carrying out their work. On the other hand, management involvement in maintenance activities is still not fully carried out, because the Management Department rarely inspects the plant site directly. As management in charge of maintenance activities, the Manager must ensure that all operational activities have been carried out correctly, through inspections at the plant site directly on a regular basis.

For the Maintenance Schedule criterion, plant maintenance has clearly set the management priority scale, as well as scheduling intervals to carry out maintenance on facilities. The company must be able to ensure that management and maintenance staff carry out plant maintenance that has been made efficiently.

For the Monitoring and Inspection criterion, derived from the Maintenance Plant, the management and maintenance staff must ensure that the schedule that has been made runs smoothly. Every maintenance job must produce an output in the form of a clear and structured report, which will then be reported and published in the office system. This report will be used for evaluation and decision making of future maintenance activities.

The last criterion is Financial Aspect, where the cost allocation has actually met the target, because in maintenance activities, there are no significant obstacles, such as the availability of equipment and spare parts, for personnel who carry out maintenance activities. Although the maintenance staff does not given the authority to make decisions in the purchase of the required spare parts, the maintenance staff must have knowledge of the types and sizes of spare parts needed. Maintenance staff must also be equipped with knowledge related to costs in the process of procuring spare parts. For example, the maintenance staff provides input regarding whether the procurement of spare parts is purchased from local suppliers or exported from abroad, so that there is a gap to lower costs in the procurement of spare parts, where a decrease in spare part costs has an impact on the overall cost of maintenance activities.

6. Conclusion

This study aims to identify manufacturing criteria in smartphones manufacturing factory and maintenance management implementation in smartphone manufacture. According to this study was conducted on a cellular phone manufacturing company from foreign manufacturers in Indonesia, where it included thirty maintenance staffs across three sites in the company. In this study there are seven criteria, namely Maintenance Equipment, Spare Parts and Materials, Maintenance Data Acquire, Maintenance Policy, Monitoring and Inspection, Maintenance Schedule, and Financial Aspect. The criterion with the highest percentage is Maintenance Equipment with a percentage of 15.38%, which means that maintenance activities are supported by complete equipment so that maintenance data collection can be carried out completely. Equipment maintenance has an impact on complete data collection, so the analysis can be carried out based on data to obtain accurate analysis results. The result of the analysis aims to make maintenance decisions. For example, whether to replace components or replace units.

The criterion with the lowest percentage is Financial Aspect with a percentage of 13.21%, this is because the maintenance staff is not involved and authorized in determining the procurement of spare parts. It would be better if maintenance could be given space in discussing the determination of the goods to be purchased and the source of procurement, according to the conditions at the plant site. Thus, with discussions between the procurement team and the maintenance team, maintenance staff can find out the cost budget and can get quality spare parts at a lower cost. For example, maintenance staff can provide advice on purchasing spare parts locally or imported, taking into account function, cost, and delivery time. In this case, there should be management involvement, where the maintenance manager can facilitate this discussion, to improve maintenance activities in the future.

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