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EFFECTIVE ELIMINATION OF NETWORK FAILURES IN BROADCAST SYSTEM

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Abstract: Broadcast companies always aim to have as few interruptions and failures as possible. They have experts in the field of telecommunications and use the most modern technological solutions. However, that is not enough. It is necessary to organize continuous monitoring, and directing information to employees relevant to the part of the job and an activity plan to prevent the spread of consequences of incidents. It is also necessary to organize activities through the procedures and guidelines to av breakdowns. Every organization wants to improve workspace safety and efficiency and reduce costs associated with unexpected breakdowns. Preventing equipment failure should be a top priority which gives us uninterrupted work that enables user satisfaction. In this paper, one should see an organizational model that includes fault management, where every employee knows how to act to eliminate the fault promptly. Failure should last as long as possible. This procedure assigns clear roles and responsibilities to the employer. This clarity helps prevent confusion and overlap. In the event of an issue, the employee will know exactly who is responsible for addressing it, leading to quicker resolution. Broadcasting TV, radio, and mobile information is very sensitive to interruptions, so quick break resolution leads to less on-air impact.

Keywords: Broadcast, failures, incidents, interruption, prevent.

1. INTRODUCTION

Broadcasting mobile, TV, and radio information is a very complex task. In operation occur interruptions, errors, transmission losses, and breakdowns of various types of devices.

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An interrupt is a signal emitted by hardware or software when a process or event needs immediate attention (Mc Clanahan, 2021). Unwanted interruptions can occur in any type of broadcasting equipment. The equipment needed to broadcast the signal is diverse. Head-end, NMS system, IP equipment, distribution equipment, DVB-T2 transmitters, DAB+ transmitters, FM transmitters, antennas system, RF component, UPS I DPG systems… Procedures, guidelines, and instructions would determine the tasks for the group of employees who monitor the network. Another group of employees monitor remote devices and react remotely to them. They receive information from network monitoring staff about potential incidents and the equipment and services at risk. This specific information system aims to support operation, management, and decision-making (Simon, 2013). That organization and also the way in which people interact with this technology in support of business processes (Kawalek, 2008). There are several categories that determine the teams of employees who respond to incidents in the network equipment. Those categories are: regional-geographic, by territory covered by broadcast signal, number of devices, type of devices for which employees are trained, and quality of the access road to the site. This last item is very important because the broadcast sites are located on top of hills and mountains for the best possible coverage. Only the preparation of access roads is demanding both economically and physically. All the listed factors affect the effectiveness of intervention after the incident. It is also necessary to have a good overview in terms of the stability of the high-voltage and low-voltage networks that reach the broadcast site. It is not economically justifiable to use diesel generators and UPS in all locations.

Monitoring manage teams that are on duty quickly and according to the established schedule provides quality information about the incident. Groups of intervention teams are divided geographically and by the type of device for which they are responsible (due to the large number of different types of equipment). Different types of devices include radio, television equipment, mobile phone devices, internet providers devices, police, military, and radio amateur devices.

The quality information provided by the monitoring team to the intervention teams provides inputs for quality preparation. Quality preparation includes ensuring equipment, spare parts and complete replacement devices with the team goes to the intervention. Everything mentioned is analyzed, processed, and organized to provide clients with a high degree of satisfaction. There is also the economic aspect of the agreement with clients, according to which the services delivered must have a certain level of availability. In this way, the legal framework of the agreement is not exceeded and the company does not pay penalties and punishment to creditors. Clients are radio and TV companies, mobile operators, internet providers, military police, and radio amateurs. The end users of the mentioned services are also very important and they should have all the services with minimum interruption. The level of satisfaction of the end-users depends on the telecommunication providers that offer different services as well as on the broadcast providers that enable the transmission of the signal to the final destination.

In the next section, some solutions for telecommunication systems will be presented. Then the suggested solution is described in terms of connection and cooperation of employees through procedures and instructions. In the end, the solution is analyzed with its advantages and disadvantages punishment to creditors.

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2. RELATED WORKS

Well-crafted maintenance ensures a positive user experience during downtime (Hendriksen, 2024). There are three categories of maintenance in this scenario. They maintain trust and transparency with users and provide planned maintenance. Planned maintenance activities with prior notice to users. This type of maintenance has details about the expected downtime. Emergency maintenance is required to fix critical issues. Urgent maintenance due to the causes of the problem, with subsequent notification. Unexpected downtime due to unforeseen circumstances (technical failures, cyberattacks) – unplanned maintenance. This kind of organization has shown promising results for website maintenance.

The following maintenance solution is used by IT teams. Introduced elements for analysis to make maintenance easy. Planned downtime for maintenance when many users are offline (Hartland, 2022). Communication channels are selected according to the most effective communication plan. Maintenance message includes information about affected services, expected timeframe, and contact details. In the end, up-to-date message maintenance is essential, to the maintenance progress.

The integrated Public Alert and Warning System is an integration of the nation's alert and warning infrastructure that gives public safety officials an effective way to alarm and warn (Gabbert, 2017). This system integrates an emergency alert system, a Commercial mobile alert system, and a Weather radio. The authorized local government entities can provide emergency messages affecting a large area, multiple areas, or the entire area of the state. Such a system allows for the regulation and rules by which emergency warning centres and broadcast communities work together to ensure timely emergency information to take protective actions to save lives and property. This system enables the preservation of infrastructure, equipment, and population by precisely defined procedures.

IBM developed a computerized maintenance management system (CMMS). CMMS is software that centralizes maintenance information and facilitates the processes of maintenance operations (Crain, 2021). The main function of CMMS is to provide information about automated work order generation, reserve materials and equipment, schedule and assign employees, crews, and shifts, status review, and track downtime and description and priority. CMMS systems serve in industries manufacturing, oil and gas production, power generation, construction, and transportation.

The following chapter describes the idea of the realization of maintenance in broadcast systems. Other rules and procedures are applied according to the type of work that needs to be done.

3. BROADCASTING MANAGEMENT SYSTEM MAINTENANCE

The department maintenance and troubleshooting on the network works 24/7 in shifts. The responsibilities and duties of the head of the maintenance department are to determine the employees available within specific time frames. Shift must be formed so that employees are rested and focused on the problem when incidents occur. Research shows that the risk of "incidents" (accidents and injuries) is higher for the afternoon shift than for those on a morning shift, and higher still for night shifts (Folkard & Tucker, 2003) In case of unforeseen circumstances, there is a backup team of employees who take on the responsibilities according to the plan. The head of the maintenance department must assign employees according to the type of knowledge and skills to possess to work with a certain type of equipment. A monthly schedule of employees is formed for work in shifts. There are several categories of work

schedules for employees in shifts. The central shift schedule is a section for monitoring for entire equipment Figure 1.

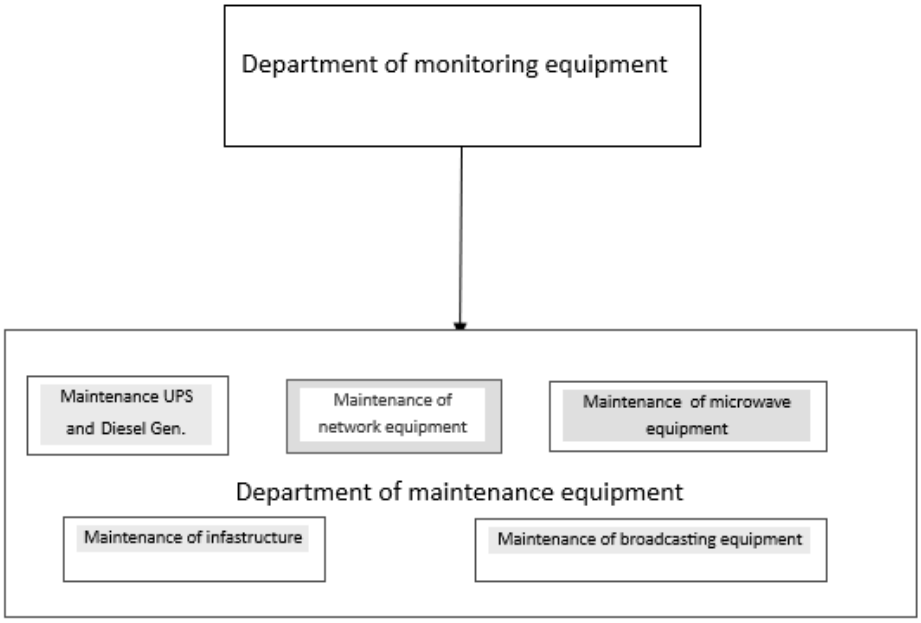

Figure 1. Connectivity department

The monitoring department receives monthly employee schedules for certain types of equipment they maintain. There are multiple organizational layers in complex telecommunications systems. The first layer is crews from high-power broadcasting sites and large-area cover-ups. As the most important points of broadcasting, they have permanent crews that change in shifts. The second layer is crews that maintain a large number of low-power broadcast sites (approximately 50). Crews take turns and solve problems as needed. They also maintain the location they are responsible for. The next layer of maintenance is remote access to devices for different types of equipment. A part of this layer of maintenance is the monitoring department. The second part of this layer is made up of employees who are divided by the type of equipment they are in charge of, figure 2. Equipment is generally divided into 5 types: network equipment, transmitter, and microwave equipment, UPS and diesel generator, and infrastructure equipment. Employees need to know something about each piece of equipment. It is very difficult for employees to be trained in every type of equipment. To make it easier to resolve the incident, employees are divided according to the type of equipment they are in charge of. In this layer, it is used the computerized maintenance management system. This system has information determining which equipment requires maintenance, and which storerooms contain the spare parts they need. Also, helps management calculate the cost of machine breakdown repair versus preventive maintenance for each machine (Kishan, 2010).

The last layer is expert teams. Spare parts management is a very important procedure related to this layer. They are linked to a computerized maintenance management system with the necessary measuring equipment and spare parts. Effective demand management and inventory control for spare parts collectively referred to as spare part management, without whom the work of the expert team is unthinkable.

These layers are the most resource-intensive and innovative solutions to equipment problems.

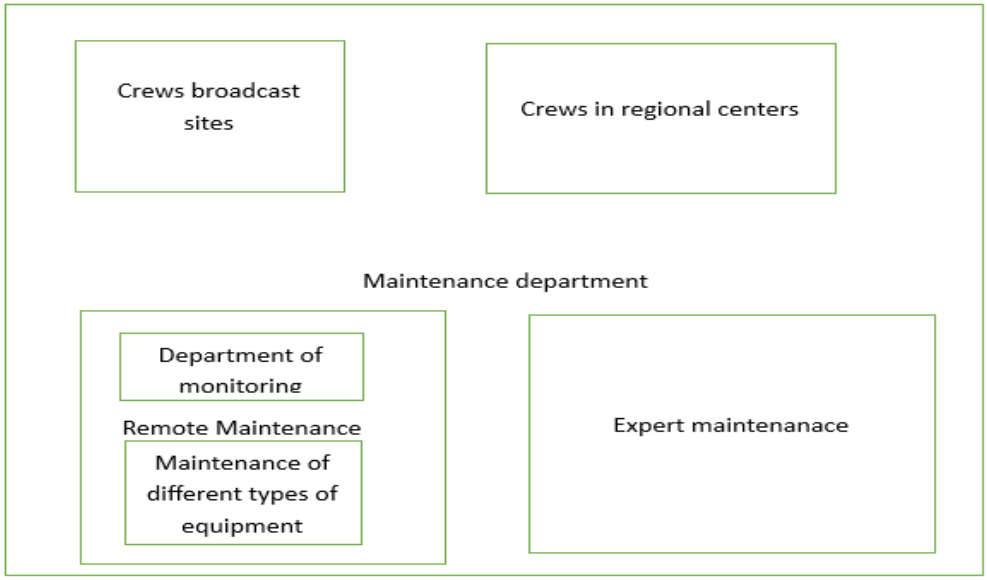

Figure 2. Maintenance department

Spare part management plays a central role in this by taking measures to achieve target service while minimizing the incurred costs (Eaves & Kingsman, 2004). In this complex telecommunication system, there are many spare parts of different equipment. Therefore, a central inventory control is needed. Central inventory control improves spare parts management. A central system allows better visibility of stock and measuring equipment across locations Figure 3. Central inventory system creates a single point of access for all inventory data.

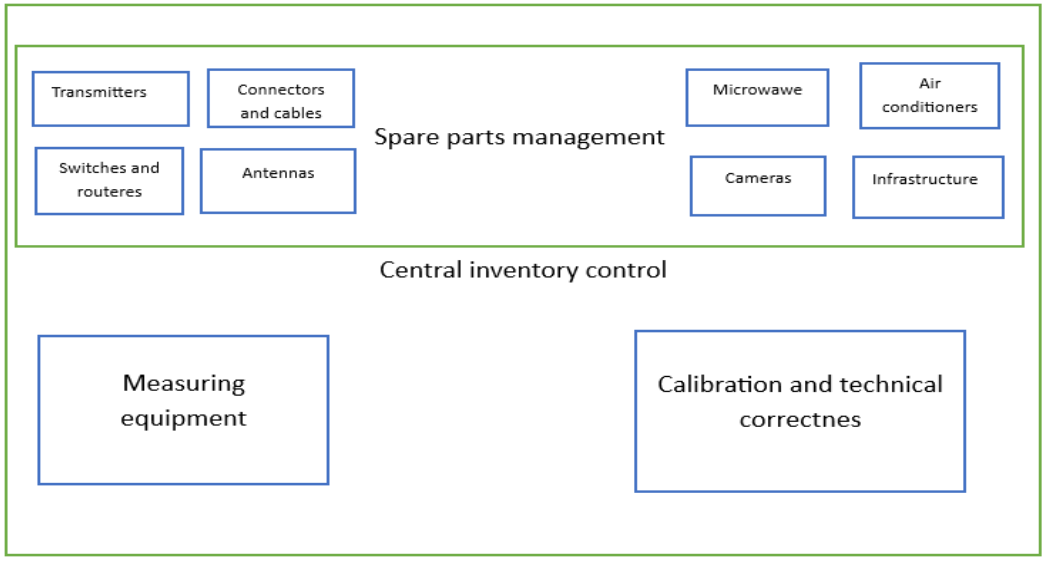

Figure 3. Central inventory control

The availability of measurement equipment for expert teams is vital in maintaining the system. Calibration ensures equipment is working as it should be. Calibration provides a safe working environment for end-users and ensures that companies are upholding their legal obligation. In this way, the central inventory system ensures the work of expert teams that know the availability and technical correctness of the equipment.

In accordance with the complex obligation, a clear plan is needed for all teams available to maintain a complex telecommunication system. Figure 4, represents part of the monthly shifts of individual teams.

Day of the month	1	2	3	4	5	6	7	8	9	10
Expert team (number)	1	2	3	4	5	1	2	3	4	5
Remote team (number)	5	4	3	2	1	5	4	3	2	1
Regional team (number)	3	1	2	4	5	3	1	2	4	5
Transmitters site team (number)	2	1	4	3	5	2	1	4	3	5
Infrastucture team (number)	4	5	1	3	2	4	5	1	3	2

Figure 4. Part of the monthly shift of different teams

Complexity and many different teams require that monthly shifts be available to managers, the monitoring department, and the maintenance department.

4. PROCEDURES AND INSTRUCTION OF THE MAINTANANCE DEPARTMENT

The maintenance intervention team composition is conducted by the maintenance department manager according to the shift schedule of employees in this section. The maintenance service manager is obliged to develop a monthly plan that determines the engagement of executors (expert team, regional team, remote team, transmitter site team, and infrastructure team) in maintaining equipment with a defined type of maintenance and execution date. Based on the type of maintenance, the specifics of the location where the maintenance is conducted, the necessary equipment, and in coordination with the manager who distributes the vehicle, the type of vehicle for each expert maintenance intervention is determined.

Based on the monthly shifts prepared by the manager of the maintenance department, the maintenance service personnel are responsible for the necessary equipment to perform the defined type of maintenance, and before going to the site, it is mandatory to check the equipment's correctness according to the specification provided by the manufacturer. For performing maintenance on antenna systems, the maintenance service manager selects employees who have a valid certificate for working at heights (coordination with the occupational safety and health department). The employees check the equipment for work at heights before going to the field – the validity of the equipment's certification.

There are two types of maintenance: planned and incidental. The planned maintenance includes preventive maintenance, predictive inspection of equipment, and preventive replacement of parts on equipment. Preventive maintenance can be categorized into three groups: age reduction models, hazard rate reduction models, and a hybrid of both (Shaomin & Zuo, 2010). Preventive maintenance of the equipment includes: checking the basic parameters of the equipment, cleaning the equipment with compressed air, and checking fluids and oils. Data on primary maintenance is entered into the document primary maintenance, which is part of CMMS, table 1. Broadcast site crews and regional centers crews do primary maintenance.

Table 1. Preventive maintenance document

Preventive maintenance				
Date	Site	Equipment	Type of work	Executors

Predictive inspection of equipment is performed when there is frequent alarm. Alarms indicate that the equipment is not operating according to the equipment manufacturer's specifications, thus affecting the quality of service. Data on predictive inspection of equipment is entered into the document intervention report, which is part CMMS, table 2. Expert team does predictive inspection maintenance.

Table 2. Intervention report document

Intervention report	
Executor/work order number	
Date (departure /return time)	
Official vehicle (license plate)	
Purpose of the intervention	
Activities perform	
Resources spent	

Preventive replacement of parts on equipment is done by the expert team and regional team. Data on preventive replacement is entered document intervention report and fault report, which is part of CMMS table 3.

Table 3. Fault report document

Fault report				
Basic information				
Reported prepared by				
Date of report				
Equipment information				
No.	Equipment name	Equipment type	Serial no.	Site
1.				
2.				
3.				
Fault description				
Other relevant information				

In accordance with the planned intervention, there may be a procedure for changing the existing situation (new equipment, a different concept of the work network…). The board of managers must approve such activities before they are implemented.

The incidental maintenance is obtained by ticket, e-mail, phone, and from the monitoring department Figure 5.

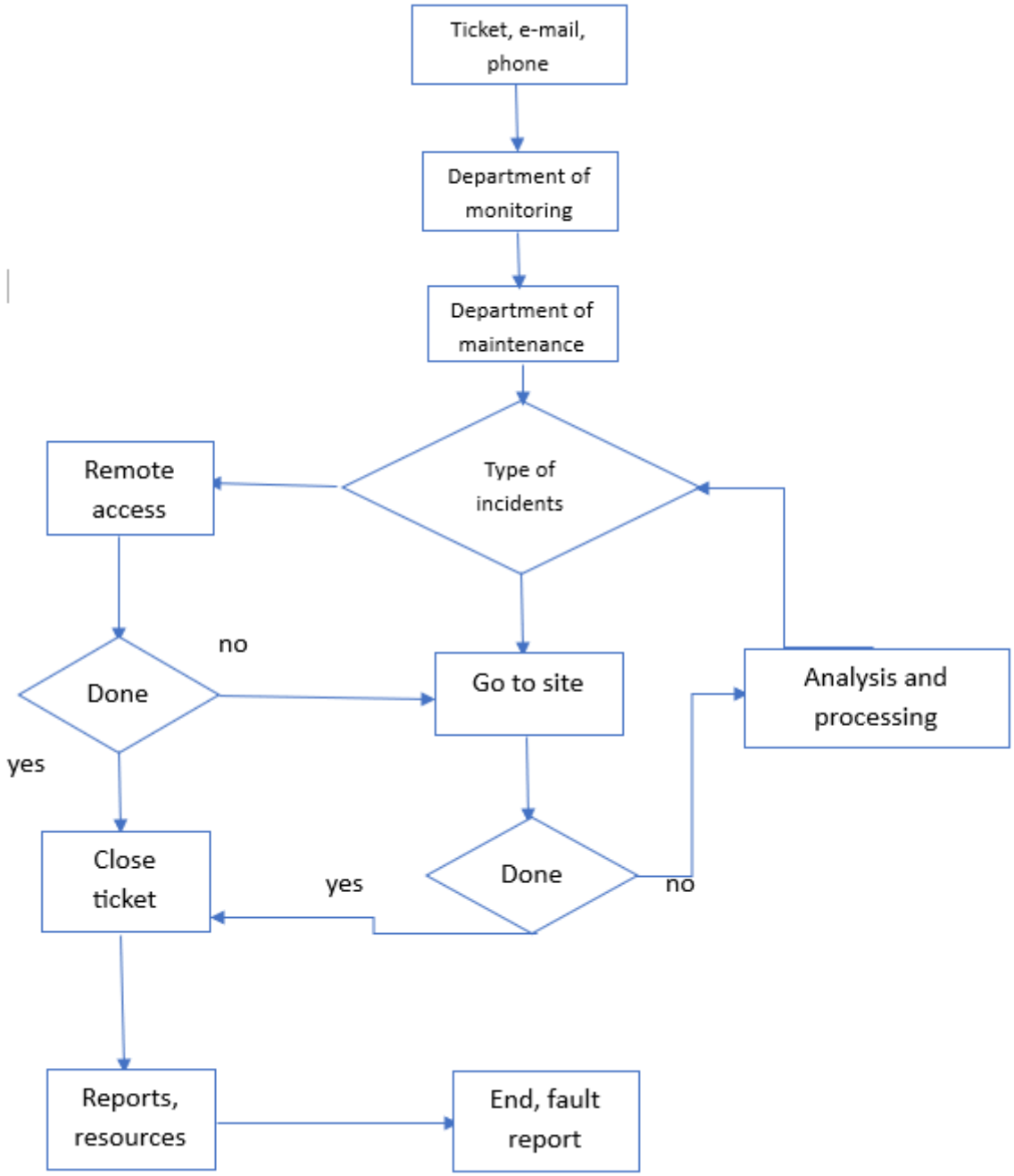

Figure 5. Incidents diagram

All teams may be doing incidental equipment maintenance. The monitoring department must be informed about the start of work on the equipment and components of the network. After the completion of the work, inform the monitoring department. The shift employee must check the correctness of the equipment on the site after the completion of the maintenance procedure. The team engaged in the maintenance of network equipment and components is of required to fill out the document intervention report after returning from the intervention.

Maintenance with the risk non-compliance in the broadcasting system are works that, in the event of a failure or error in the active equipment, could lead to service interruption on the user (diesel generator, network equipment, transmitters...), table 4.

Table 4. Maintenance network and components

Notice on maintenance network and components			
Site	Type of maintenance	Date (time)	Executors

The team of maintenance informs the monitoring department 24 hours in advance.

5. CONCLUSION

Modern wireless telecommunication technologies including television, radio, and mobile telephony are online services. This content requires as few interruptions to the service as possible. The quality of service is extremely important, but modern equipment and associated protocols follow it well. This paper describes a modern maintenance system in which every step is clear. All shifts of employees and teams have assignments and guidelines monthly. The procedures are also clearly defined. The interconnection of the teams from the maintenance department exists. There is also a connection between the departments of the company. The system operates for a certain period and there is an analysis results of the implementation. It is calculated every 6 months. Every second of interruption mobile telephony, television, and radio service counts. The first steps in the development of the existing maintenance service system were carried out about 16 000 seconds. Over the years, the system has been evaluated, procedures have been improved, mistakes have been corrected, and employees have adopted a new system of work. An analysis of the maintenance system from 2024 (6 months) shows 10 000 seconds of total downtime. Significant progress has been made with the development and implementation of this maintenance system.

In the future, work should be done on further automation of the maintenance system, correction of procedures, and wider connection with central inventory control. One of the ideas of automation is the use of artificial intelligence in the processes of the work environment, spare part management, and maintenance. Employees who are interested in this would receive information about which spare parts are missing in terms of inventory.

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