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Surgical Equipment Preventive Maintenance Information System

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ABSTRACT

Medical equipment represents a significant investment in healthcare facilities and requires significant maintenance costs. It is crucial for healthcare facilities to have a planned maintenance program to ensure the safety, quality, and usability of medical equipment. Regular maintenance is also expected to extend the lifespan of medical equipment. However, most preventive maintenance planning and reporting is done manually, resulting in suboptimal and ineffective results. To facilitate these activities, a tool is needed to create a preventive maintenance information system for surgical equipment. First, a database design is prepared, then the information system model is created using Enterprise Architect, using use case diagrams, activity diagrams, and sequence diagrams. The information system is then created using the PHP programming language and a MySQL database. Research findings suggest that a Preventive Equipment Maintenance Information System ensures equipment continues to function properly and reduces the risk of serious damage that can lead to costly repairs. Therefore, this maintenance information system is not only about keeping equipment functioning properly; routine maintenance helps extend the life of equipment and ensures the safety of patients and medical personnel.

Keywords: preventive maintenance, real time, enterprise architect, information system, modeling

BACKGROUND

The purpose of this research on a preventive maintenance information system for surgical equipment is to design, develop, and evaluate a system that can optimize the maintenance process in healthcare facilities. This research aims to create a technological solution capable of centrally integrating equipment inventory data, maintenance schedules, repair history, and spare parts management. Thus, it is expected that this system can improve the operational efficiency of technician teams, ensure adherence to maintenance schedules, and reduce the risk of sudden failure of critical surgical equipment. Furthermore, this research also aims to improve patient safety and cost-effectiveness in medical equipment management. With a structured system, preventive maintenance can be carried out according to manufacturer standards and applicable regulations, minimizing the possibility of malfunctions during surgical procedures. Furthermore, this system will provide in-depth analytical data on maintenance costs, equipment failure rates, and the effectiveness of maintenance programs, enabling hospital management to make more strategic and efficient decisions in budget allocation and future equipment investments.

This research also aims to address challenges often faced by biomedical engineering teams, such as inefficient manual record-keeping, difficulty tracking maintenance history, and delays in handling defects. By automating workflows and providing automatic notifications, the system is designed to minimize administrative burdens and allow technicians to focus on more complex technical tasks. This increased efficiency will directly reduce equipment downtime and ensure optimal surgical equipment availability at all times. Overall, the ultimate goal of this research is to provide a scientific foundation and practical implementation for the development of a robust and adaptive information system. The results of this research are expected to not only be a functioning prototype but also a model that can be adopted by various healthcare facilities to transform their surgical equipment maintenance management from a reactive to a proactive approach. Thus, this system contributes to improving the overall quality of healthcare services, ensuring that surgical equipment is always in prime condition to support the safety and success of every medical procedure.(1)

Medical equipment, particularly surgical equipment, plays a crucial role in the success of medical procedures. Optimal equipment availability and performance are crucial for patient safety and the smooth running of medical procedures. Therefore, routine and scheduled maintenance of surgical equipment is essential to ensure proper function, reduce the risk of damage, and prevent equipment failure during use.

However, in practice, surgical equipment maintenance is often neglected or only performed after a breakdown occurs, which can disrupt medical services, increase repair costs, and even threaten patient safety. The lack of a structured monitoring system for preventive maintenance is often a major cause of this problem.

While many hospitals and medical facilities have implemented some aspects of Preventive Maintenance

(PM) Information Systems, many still rely on manual systems or poorly integrated technologies. Technological advancements, such as the use of IoT, AI, cloud computing, AR/VR, and blockchain, have brought significant advances in improving the efficiency, reliability, and security of surgical equipment PM systems. These advancements have made PM systems more predictive, proactive, and integrated, ultimately leading to improved patient safety and reduced operational costs in hospitals.

With the increasing number and complexity of medical equipment in hospitals, and the need for more efficient and safe healthcare services, a system that supports preventive surgical equipment maintenance management is crucial. Therefore, the development of a Preventive Surgical Equipment Maintenance Information System is highly relevant to addressing these challenges.

METHOD

A Preventive Maintenance (PM) Information System for surgical equipment is a system designed to ensure that medical equipment, particularly surgical equipment, is always in good condition and ready for use during medical procedures. Using a preventive maintenance approach, this system focuses on routine care and maintenance to prevent breakdowns before they occur, reduce downtime, and improve equipment reliability.(2)(3)

Several methods can be applied in developing and implementing a Preventive Maintenance Information System for surgical equipment by mapping equipment needs, scheduling preventive maintenance, data collection and analysis, condition-based maintenance, documentation and reporting, cloud-based maintenance management system, HR training and management, collaboration with vendors and service providers, evaluation and continuous improvement as well as security and compliance.(1)

RESULTS AND DISCUSSION

Result

The surgical anesthesia equipment maintenance information system that has been designed and prepared includes a system to facilitate the entry of medical equipment data:

1. Login page
   On this page, users are asked to enter their registered username and password, verified by the system. This page is a crucial part of the digital system, ensuring the security and privacy of user data. The login page is shown in the image below:

Figure 1. Login page

2. Registration of equipment for maintenance process by electromedical technicians
   This refers to the process of recording and recording medical devices that will be maintained, including detailed information about the device, including the category, device code, device type, brand, and location. Registration is important to keep device data well-managed and facilitate tracking of maintenance history. The next step is to select the device code and the handling status "MAINTENANCE". First, select the device code that matches the device type, then in the handling status menu select the option "MAINTENANCE", this indicates that the device is undergoing maintenance. The display looks like the image below:

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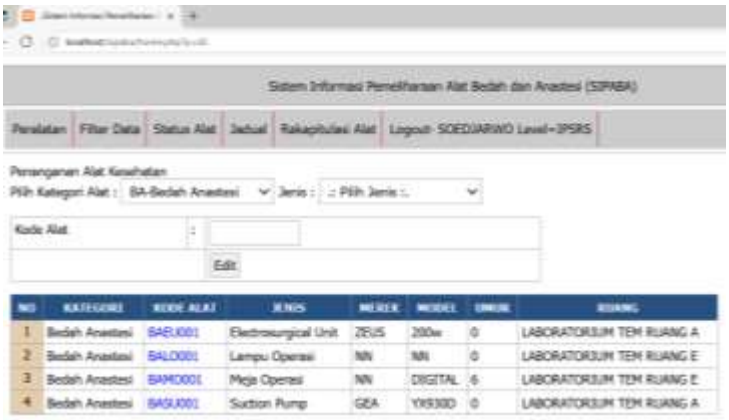

Figure 2. Tool registration for maintenance process

Figure 3. Tool code selection

3. Equipment Maintenance List
   In order to carry out maintenance, the previously registered tool will be entered into the tool maintenance list. Select or type the tool code for which the maintenance process will be carried out.

Figure 4. Equipment Maintenance Status

4. Fill in Planned Preventive Maintenance
   A proactive maintenance strategy to prevent equipment or machinery breakdowns by performing scheduled inspections, servicing, and repairs. The goal is to ensure equipment is functioning properly and avoid unexpected breakdowns and costly repairs.

Figure 5. Planned Preventive Maintenance

5. If the Planned Preventive Maintenance sheet is still incomplete (continuing), the electromedical technician must select MAINTENANCE in the status field. If it is already complete (not continuing), select COMPLETE. The entry history will be automatically saved.

6. If you want to see the history of Planned Preventive Maintenance implementation, you can select the Tool Recapitulation menu, select Tool History then select the tool code you want to display.

Figure 7. Tool history list

7. Select the maintenance history number and the details of the Planned Preventive Maintenance will be displayed.

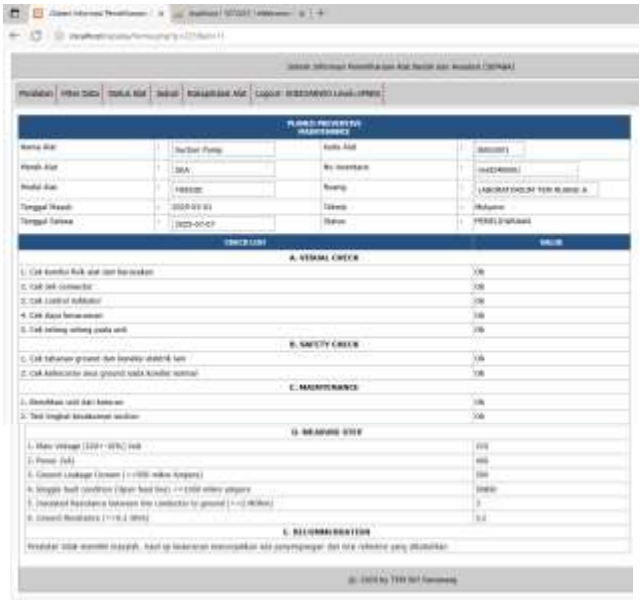

Figure 8. Equipment maintenance history list

From the resultsThe purpose of research on Preventive Equipment Maintenance Information Systems is to ensure equipment continues to function properly and reduce the risk of serious damage that can lead to expensive repair costs. Therefore, this equipment maintenance information system is not only about keeping equipment functioning properly; routine maintenance helps extend the life of the equipment and maintain the safety of patients and medical personnel.

Discussion

Surgical equipment maintenance is crucial for ensuring patient safety and smooth hospital operations. Poorly maintained surgical equipment can lead to delays in medical procedures, misdiagnosis, and even the risk of nosocomial infections. Therefore, an information system that supports preventive maintenance is a strategic solution for managing maintenance schedules efficiently and accurately.

This research is an information system application for preventive maintenance performed by electromedical technicians, particularly surgical equipment. This allows us to determine the parameters used in preventive maintenance, such as medical device data, visual checks, safety checks, maintenance, measurement steps, and recommendations on whether the device can be used or needs repair. This allows us to track the history of a device's preventive maintenance.

Previous research has developed a waterfall-based Equipment Maintenance Scheduling Information System, which aims to address human error in manual recording and improve equipment uptime efficiency. This web-based system is designed to generate structured maintenance schedules, enabling companies or healthcare institutions to reduce maintenance costs and reduce the frequency of equipment breakdowns.(4)

Meanwhile, researchers have also designed a web-based medical device maintenance and calibration scheduling information system using PHP and MySQL. This research emphasizes the importance of Equipment Management as a basis for prioritizing equipment that requires immediate inspection and calibration. Using a risk-based approach and incident history, this system helps a limited number of electromedical technicians maintain the quality of medical services.(5)

Another study also examined the use of a website-based daily maintenance information system in inpatient wards. This study demonstrated that the use of web-based software facilitates real-time monitoring of medical equipment conditions, both via computer and smartphone. The system features reporting, scheduling reminders, and maintenance history, significantly reducing downtime and improving surgical equipment readiness.(1)

From these three studies, it can be concluded that a preventive maintenance information system functions not only as a recording tool but also as a decision support system that assists hospital management in making decisions regarding surgical instrument maintenance. The integration of information technology into medical device management has been proven to improve operational efficiency, extend the lifespan of equipment, and most importantly, maintain patient safety.

CONCLUSION AND SUGGESTION

Conclusion

A medical device maintenance information system is a crucial component of modern healthcare facility management. This system makes medical device management more structured, efficient, and transparent. This ultimately improves the quality of healthcare services, costs, and patient safety. This system also makes it easier to ensure the availability and address issues with medical devices.

Suggestion

Further research could be directed at developing Internet of Things (IoT) and artificial intelligence (AI)-based systems to detect potential damage before it occurs, as well as integration with electronic medical record systems so that device maintenance can be dynamically adjusted to clinical needs.

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