Towards Digitization of Hospital Maintenance in Economic Community of West African States

[1]Bousso Niang, [2]Thierno Ousmane Gueye, [3]Magaye Thiam

[1] Biomedical Engineer, Trainer, Polytechnic University of West Africa, located in Almadies, Dakar/Senegal, Email: bousso7@yahoo.fr, 00221774425427

[2] Quality Expert, Teacher, Polytechnic University of West Africa, located in Almadies, Dakar/Senegal, Email: thousmanegueye@gmail.com, 00221775394845

[3] Computerized Maintenance Management System Expert, Trainer, Polytechnic University of West Africa, located in Almadies, Dakar/Senegal, Email: magayethiam@gmail.com, 00221776517569

Abstract - The physical recording of maintenance activities in hospitals through the use of registers or other hard media is subject to the problem of Quality archiving. To meet these challenges, it is necessary to encourage Computer-aided Maintenance Management System. Over the past decade, software has been installed and the actors concerned have been trained, but the challenge to be met is the sustainable use of these tools. An emulation strategy is envisaged. It consists in organizing a champions league. To argue this ranking, performance indicators are identified. A completeness rate of more than 95% refers to the highest score, in this case 4. A score of 3 is reserved for effective entry between 95% and 75%. The score of 2 is given to the digitized recording of more than 50% of the information and less than 75%. The unit note is aligned in the range from 50% to 35%. Finally, the zero score represents an entry of less than 35% of the package. Similar reasoning is used for the readiness rate. The results are represented in the form of a color map. Red cards will be awarded to structures with a zero score. Yellow cards will be assigned to score 1. The color codes for scores 2, 3 and 4 will be orange, blue and green respectively. In short, the digitization of activities around this technical service must be motivated to perpetuate information and have reliable data to better size the hospital maintenance budget, among others.

Keywords – Computer-aided Maintenance Management System, Hospital maintenance, Quality.

INTRODUCTION

Health data is crucial for improving the quality of care, guiding public health policies, and ensuring personalized patient follow-up. It enables the early detection of diseases, optimizes the management of hospital resources, and facilitates evidence-based decision-making to prevent epidemics. Hospital maintenance is a strategic pillar of the healthcare system. It ensures the continuous operation, safety, and compliance of infrastructure and biomedical equipment. Essential for continuity of care, it combines preventive and corrective maintenance, guaranteeing the quality of care and patient safety. Biomedical equipment encompasses the instruments, machines, and electrical/electronic devices used for diagnosis, treatment, patient monitoring, and rehabilitation. They are essential in the hospital setting, ranging from imaging (endoscopy, echography, scanners) to therapy (lasers, infusion pumps) including sterilization (autoclaves, microbiological safety cabinets). Rigorous maintenance and compliance are crucial for security. Hospital infrastructure encompasses buildings and facilities. It also includes medical gas network, water and electricity supply.

The digitalization of hospital and biomedical maintenance involves replacing manual processes with digital tools to ensure the availability and safety of medical equipment or infrastructure. It relies primarily on the use of a Computerized Maintenance

Management System (CMMS). The latter emerged in the 1980s to replace paper-based management, evolving from simple equipment inventories to comprehensive solutions. Historically linked to increasing industrial complexity, it has followed the evolution of information technology: local software (1990s), web/SaaS (2000s), and mobile/Internet of Things (2010s) to optimize preventive maintenance [1]. In Economic Community of West African States (ECOWAS), a number of CMMS systems have been installed but are quickly destined for lethargy in use.

Currently, a consolidated CMMS is a sustainable solution to the problem of information loss related to manually recorded hospital maintenance which is faced with the insufficiency of dedicated spaces, the humidity of the premises deteriorating over time the writings.

The main objective is to classify the technical maintenance services of national hospitals in CMMS through supervision. The methodology adopted will therefore consist of implementing a quality assurance approach. This will include an evaluation followed by a ranking of national hospitals according to their level of commitment to the digitalization of their biomedical maintenance activities. First, the characteristics and advantages of CMMS will be discussed. Then, the expected results will be mapped out. Finally, recommendations based on this process will be formulated.

I. COMPUTER-AIDED MAINTENANCE MANAGEMENT SYSTEM CHARACTERISTICS

Computerized maintenance management system characteristics integrate equipment, human resources, purchasing, inventory and dashboards for visualization.

I.1 Equipment and human resources management

Human resource management and equipment management involve strategically organizing, deploying, and maintaining an organization's personnel and physical assets to maximize productivity and achieve goals [2].

The equipment tracking offered by CMMS tools allows for a complete inventory of machines, including their condition and maintenance history, as well as all technical documentation. Thanks to this tool, equipment can be immediately located for a clear understanding of its use and for rapid maintenance.

Maintenance management itself is handled in depth, with immediate alerts for maintenance needs, tracking of past operations, and predictive analytics based on this intervention history. These analytics enable better management of actions and the forecasting of appropriate resources.

Maintenance is also a matter of team organization. The scheduling of interventions is better optimized thanks to CMMS tools, which structure operations through a comprehensive plan. This plan includes not only planning assistance but also tools for estimating intervention times, in order to better coordinate field technicians. CMMS software optimizes technician availability to perform all maintenance operations on time and reduce costs.

I.2 Purchasing and inventory management

Purchasing and inventory management involves the strategic acquisition, tracking, and control of goods to ensure operational efficiency, minimizing costs by preventing overstock or stockouts [3].

CMMS solutions now provide support for managing machine and parts inventory, whether expanding existing equipment or renewing existing stock. Reviewing supplier terms and prices, along with comparative analysis, guides users toward the most suitable solution in terms of quality and price. Purchase requests are centralized within the tool, ensuring efficient tracking and timely delivery.

The software can also provide intelligent inventory management, taking into account future maintenance needs, current requests, and identifying all potentially needed parts to expedite future order processing.

I.3 Dashboards

Dashboards are graphic user interfaces which comprise a combination of information and geographical visualization methods for creating metrics, benchmarks, and indicators to assist in monitoring and decision-making [4].

By Analyzing performance indicators is a key feature of CMMS software. This allows for detailed insights into technician intervention times, the individual and overall condition of the equipment fleet, current spare parts consumption, and the most significant cost centers. Highly visual, CMMS dashboards also provide a concrete view of real-world operations, ensuring that business decisions are aligned with daily needs. Constantly evolving, predictive analytics helps anticipate and reduce breakdowns, while also further automating future interventions and orders.

The software can also provide intelligent inventory management by considering future maintenance needs, current requests, and identifying all potentially needed parts to expedite future order processing.

II. COMPUTER-AIDED MAINTENANCE MANAGEMENT SYSTEM ADVANTAGES

Hospital maintenance modeling, mobility, real-time updates and teambuilding are all advantageous aspects of computerized maintenance management system.

II.1 A Computer-aided maintenance management system, solution tailored to hospital maintenance

Computerized Maintenance Management System for hospital maintenance streamlines clinical and facilities operations by tracking medical equipment, managing preventive maintenance, and ensuring regulatory compliance [5].

CMMS enables the monitoring and maintenance of a wide variety of equipment. IT systems, medical equipment, and production infrastructure all involve diverse needs. The chosen software must therefore take into account the type of activity and installations to be maintained, as well as the company's operating methods and the personnel responsible for monitoring. Sector-specific solutions and modules exist, adapting to particular requirements. Companies must therefore choose a software vendor that is relevant to their needs: understanding their customer profile will provide initial guidance.

II.2 The mobility requirements of CMMS

Mobility requirements for a Computerized Maintenance Management System (CMMS) ensure field technicians can access, update, and capture data in real-time via smartphones or tablets [6].

Sustainable Maintenance is a field-based job. Technicians and operators are required to use CMMS software on-site or while traveling. Therefore, it is essential that the solution be adapted for mobile use. It must be accessible and intuitive from any type of device, allowing for both clear access to technical documentation and history, and the secure addition of maintenance items. The user experience and onboarding process must be quick and easy so that users can be operational immediately.

II.3 Real-time updates and collaboration

Computerized Maintenance Management System real-time updates and collaboration tools create a centralized hub that boosts productivity by providing instant visibility into work orders, assets, and inventory [7].

Collaborative tools, now indispensable, offer significant added value for maintenance operations. For field staff and decision-makers seeking better planning, information must be up-to-date at all times, and monitoring must be facilitated by stakeholder feedback. SaaS solutions promote sharing through shared tools and real-time updates for all stakeholders. This collaborative approach allows for the involvement of every user or technician and makes it easier to contextualize maintenance operations.

II.4 Speed and availability of the application

Computerized maintenance management system reduces unplanned downtime and improve technician efficiency, allowing for rapid response to failures [8].

At a time when fleet management operations must be carried out quickly and efficiently, all information must be accessible without limitation. The need is twofold: software that is accessible at all times, but also efficient navigation once connected. In the case of SaaS solutions, accessibility will be better guaranteed if the hosting provider relies on a robust network and is capable of intervening at any time to ensure data availability. Regarding the intuitiveness of the solution, it is important to choose a customizable application that is immediately understandable by users. In addition to the speed of the CMMS itself, the vendor must offer responsive support when needed.

II.5 Additional features

A well-implemented CMMS system acts as the central nervous system of maintenance operations. It digitizes, automates, and connects every part of your maintenance workflow [9].

Often, a company's needs extend beyond simply managing technician interventions. While traceability and maintenance history are invaluable, additional features are generally very useful, even essential. Inventory tracking, support for future purchases, detailed dashboards, and powerful predictive analytics can make all the difference. The goal of CMMS software is not only to provide a comprehensive overview of equipment but also to support companies in maximizing its value. If needed, the software vendor can also offer custom development, ensuring a solution perfectly tailored to the specific requirements.

Regulatory audits and safety inspections demand traceability. A CMMS provides the documentation and history needed to prove that maintenance was performed correctly and on schedule, protecting both equipment and the organization [10].

III. METHODOLOGY

The physical recording of maintenance activities in hospitals through the use of registers or other hard media is subject to the problem of Quality archiving. Indeed, the latter is confronted with the insufficiency of dedicated spaces, the humidity of the premises deteriorating over time the writings, the congestion and the loss of time generated by the search for previous information. The exhaustive history of maintenance activities is a key element allowing to capitalize the information which becomes the raw material, thus the base or the foundation of any planning policy. Similarly, updating the data of a technical hospital maintenance service is essential. It represents a guarantee of real-time recording of information. To meet these challenges, it is necessary to encourage Computer-aided Maintenance Management System. Over the past decade, software has been installed and the actors concerned have been trained, but the challenge to be met is the sustainable use of these tools.

To embed the culture of digitalizing hospital maintenance within the ECOWAS region and consolidate the use of CMMS, strong guidelines must be developed. To ensure their implementation, simple and efficient instructions must be established.

Therefore, key performance indicators must be implemented. Before scaling up, it is preferable to begin with a pilot phase. A national reference hospital will be selected in each member state. Supervision will be conducted quarterly during the pilot phase before being set at twice-yearly intervals. A local jury will be formed in each country. The WAHO Quality Authority will be responsible for overseeing all aspects of the process and will publish the ranking of all healthcare facilities participating in a CMMS Champions League on the ECOWAS website.

With the aim of motivating and boosting the enrollment of all relevant healthcare facilities in this CMMS Champions League, the indicators considered for aligning with standards and assessing the gap between hard-screen archiving and digitization are as follows:

- A completeness rate of more than 95% refers to the highest score, in this case 4;

- A score of 3 is reserved for effective entry between 95% and 75%;

- The score of 2 is given to the digitized recording of more than 50% of the information and less than 75%;

- The unit note is aligned in the range from 50% to 35%;

- Finally, the zero score represents an entry of less than 35% of the package.

Similar reasoning is used for the readiness rate. The results are represented in the form of a color map:

- Red cards will be awarded to structures with a zero score;

- Yellow cards will be assigned to score 1;

- The color codes for scores 2, 3 and 4 will be orange, blue and green respectively.

IV. EXPECTED RESULTS AND DISCUSSION

After reviewing the key indicators, the expected response profile could be simulated. To graphically represent the completeness rate, a maximum rate of 95% and a minimum percentage below 35% should be considered. Thus, the average value is around 65%. This maximum rate means that if the item is biomedical equipment:

- Its coding must be complete;

- Its name must be written exactly;

- Its location must be clearly specified;

- Its technical specifications must be fully provided;

- Spare parts must be listed exhaustively;

- All items must be valued in currency.
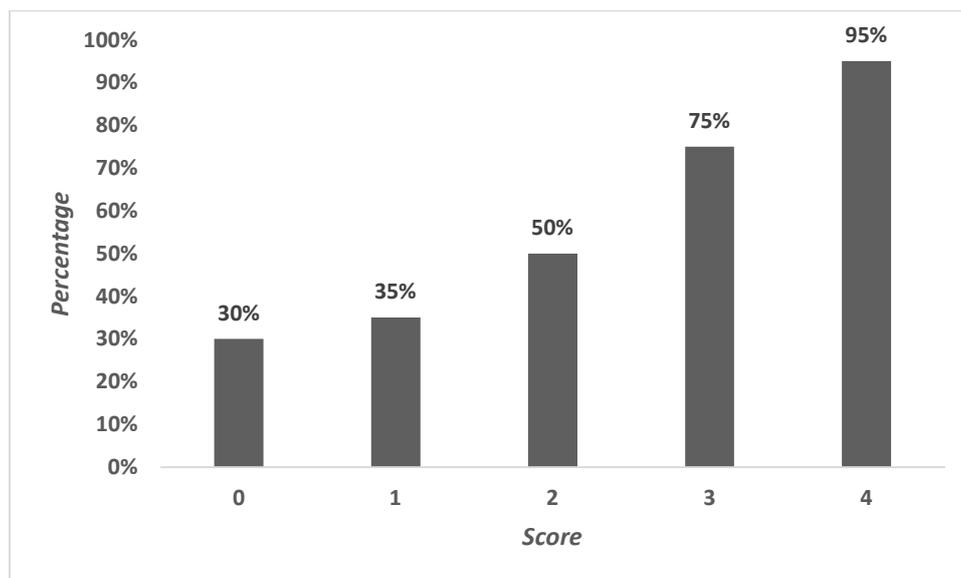
Source: Our data

Figure 1: *Completeness Perception*

Regarding the readiness rate, its graphical representation could also be simulated. A maximum rate of 95%, a minimum percentage below 35%, and an average value around 65% should be taken into account. The maximum rate justifies that all data, already exhaustively recorded, be consistent and synchronized.
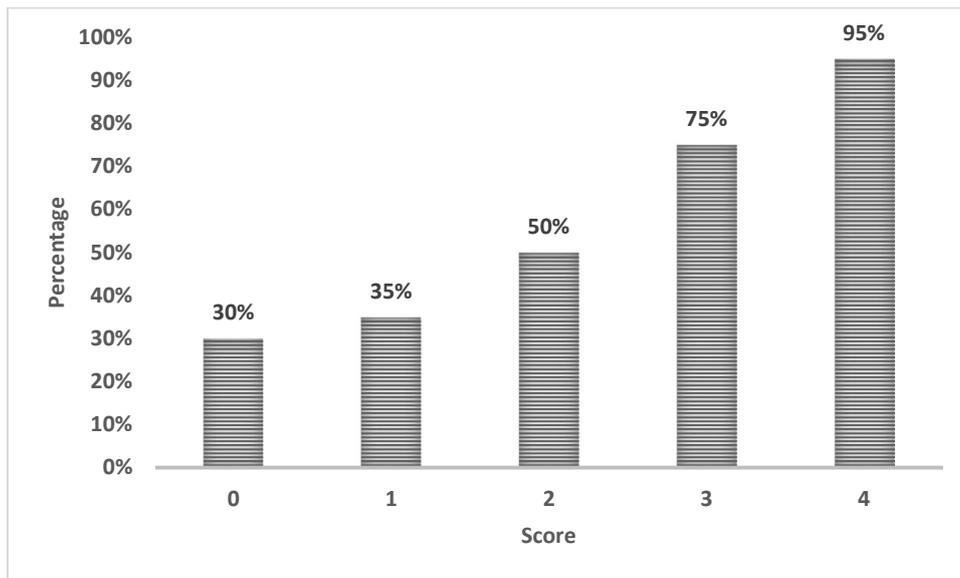
Source: Our data

Figure 2: *Readiness Perception*

To visualize the ranking using color codes, a matrix representation is easier to use. Each cell of the matrix would then be colored according to its assessment. A set of colors ranging from green to red, including yellow, orange, and blue, is linked to the different scores obtained.

Source: Our data

Figure 3: *Color Matrix*

The best national hospitals that are permanently digitizing their maintenance-related activities are located in the green area. All this information combined would allow for an objective ranking of all the healthcare facilities involved in this CMMS Champions League.

V. CONCLUSION AND RECOMMANDATIONS

The successful implementation of a CMMS relies on a rigorous some-step path: needs assessment, solution selection, data structuring (tree structure), configuration/migration, training, and monitoring. It requires the full involvement of management and

field teams to ensure adoption and improved maintenance practices. The expected results could include reduced breakdowns, improved inventory management, cost tracking, and enhanced compliance.

This approach to digitizing hospital maintenance in the ECOWAS region will ensure the long-term preservation of data on biomedical equipment and healthcare infrastructure. It also fosters a healthy environment of fair competition through this "sporting spirit" of the Champions League.

Several key recommendations can be made to guarantee the effectiveness of this initiative, namely:

-   Opt for offline CMMS systems to reduce reliance on the internet;

-   Implement interoperability, which is essential to ensure the CMMS software is fed with data quickly and comprehensively. Furthermore, this communication between applications creates a seamless flow of information and contributes to more effective maintenance;

-   Penalize hospitals that are not diligent in their compliance.

Increasingly informed and now ultra-mobile, CMMS solutions cover a vast range of applications, becoming inseparable from the equipment they monitor. The market continues to evolve, poised to integrate rapidly growing technologies such as connected objects, Big Data, and augmented reality. The new data provided by innovative systems presents both a significant opportunity and a challenge for software vendors. Faced with the wealth of information at their disposal, future CMMS software will need to adapt technically and intelligently synthesize the data. The goal for decision-makers is to rely on richer and more predictive reports than ever before, without sacrificing readability.

As a key prospect, this pilot phase should be rolled out to university health facilities in each country of the ECOWAS zone.

REFERENCES

[1] Comment choisir son logiciel GMAO ? https://www.cloudlist.fr/decryptages-logiciels/metier/gmao/#:~:text=Le%20besoin%20en%20maintenance%20lui,facilitent%20l'entretien%20des%20machines. [How to choose your own CMMS?]

[2] Fortune Business Insights. "Human Resource (HR) Technology Market Size, Share & Industry Analysis, https://www.fortunebusinessinsights.com/human-resource-hr-technology-market-105437." Accessed August 5, 2025.

[3] How to Integrate Purchasing Management into Your Inventory Management Process? https://rackbeat.com/en/how-to-integrate-purchasing-management-into-your-inventory-management-process/#:~:text=Purchasing%20management%20involves%20planning%2C%20coordinating,delivery%2C%20and%20lower%20shipping%20costs.

[4] Pettit, C., Leao, S.Z. (2017). Dashboard. In: Schintler, L., McNeely, C. (eds) Encyclopedia of Big Data. Springer, Cham. https://doi.org/10.1007/978-3-319-32001-4_295-1.

[5] SafetyCulture. 6 Best Healthcare CMMS of 2026. https://safetyculture.com/apps/healthcare-cmms.

[6] How do I choose the best CMMS software? 2020. https://www.mobility-work.com/en/blog/find-best-cmms#:~:text=The%20new%20CMMS%20solutions,effective%20answers%20to%20industrial%20companies.

[7] How a CMMS helps move maintenance teams from confusion to coordination? 2025. https://eptura.com/our-platform/

[8] Determination of Benefits of the Application of CMMS Database Improvement Proposals

by Ladislav Stazić *ORCID,Nikola Račić,Tatjana StanivukORCID andĐorđe Dobrota Faculty of Maritime Studies, University of Split, 21000 Split, Croatia Author to whom correspondence should be addressed. Appl. Sci. 2023, 13(4), 2731; https://doi.org/10.3390/app13042731

[9] Rossi K. 2025. 10 Must-Have Features in a CMMS System for 2025. https://llumin.com/blog/10-must-have-features-in-a-cmms-system-for-2025

[10] Vedan A. 2026. 8 CMMS Best Practices to Boost Maintenance Efficiency. https://tractian.com/en/blog/8-cmms-best-practices-to-boost-maintenance-efficiency.