CHALLENGES AND SOLUTIONS FOR IMPLEMENTING COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM IN MANUFACTURING INDUSTRIES

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ABSTRACT

Manufacturing industries are concentrating on increasing productivity, reducing downtime, reducing maintenance and operation costs, and ultimately achieving profitability, competitiveness, and sustainability. These goals can be achieved through the application of maintenance management package like Computerized maintenance management system (CMMS) in the industry for automating maintenance activities. CMMS is a maintenance software for handling all types of maintenance activities in the manufacturing industry. But there are several challenges with the implementation of CMMS in any organization. In this paper, nine barriers concerned with the CMMS are identified through literature and the possible solutions are suggested to address these barriers for the smooth functioning of CMMS. to determine the barriers and solutions lead to the multiple advantages of implementing CMMS in industries. The benefits may vary for different industries.

Keywords: Computerized Maintenance Management System, Barriers, Solutions, Maintenance Management

1. INTRODUCTION

The computerized maintenance management system (CMMS) can have a big impact on productivity in a lot of different industries [1]. Through the automation of maintenance procedures and the reduction of downtime, CMMS software can assist organizations in increasing productivity [2]. CMMS software may help businesses optimize their maintenance operations and use fewer resources and time on manual maintenance tasks by collecting equipment and asset data, planning maintenance activities, and managing work orders [3]. Organizations can increase efficiency by using CMMS, which gives real-time visibility into maintenance processes [4]. Through data-driven decision-making, organizations can use this visibility to find bottlenecks and inefficiencies in their maintenance processes [5]. Additionally, by ensuring that assets and equipment are properly maintained, CMMS software can assist organizations in lengthening the lifespan of their assets and machinery [6]. Organizations can prevent expensive repairs and replacements by lowering the frequency of breakdowns and extending the life of their assets, thereby increasing their overall productivity and profitability [7]. Overall, a CMMS implementation can increase productivity by streamlining maintenance procedures, enhancing asset management, and decreasing downtime [8].

1.1. OBJECTIVES OF THE RESEARCH PAPER

1) To determine the barriers faced by the manufacturing industries, which are going to implement CMMS (a professional software for maintenance management) in the organization.
2) To propose appropriate solutions for overcoming the barriers in the implementation of CMMS for the manufacturing industry.

1.2. MAIN PROBLEMS FACED BY THE MANUFACTURING INDUSTRIES WHILE IMPLEMENTING CMMS

1) Resistance to change: One of the primary barriers faced by manufacturing industries when implementing CMMS is resistance to change. As employees are habituated to traditional maintenance processes and may be resistant to adopting new technology and workflows. Overcoming the resistance requires effective change in management strategies and clear communication to highlight the benefits of CMMS implementation [9]. Resistance to change is a common problem faced by manufacturing industries when implementing CMMS. Employees may be resistant to adopting new technology and workflows due to various reasons [10, 11, 12, 13,14] including:

- **Fear of Job Loss:** Employees may fear that the usage of CMMS will automate their tasks, lead to job redundancy. They may resist the system to protect their job security.
- **Lack of Understanding:** Employees may not fully understand the benefits and purpose of CMMS. They may perceive it as an additional burden or disruption to their existing work processes.
- **Comfort with Existing Systems:** Some employees may have grown accustomed to the traditional paper-based or manual maintenance processes. They may resist changing their familiar routines and adapting to a new digital system.
- **Technological Challenges:** Employees who are not tech-savvy or have limited experience with digital systems may feel intimidated by the CMMS implementation. They may resist using the system due to a lack of confidence in their technical skills.
- **Change in Work Habits:** Implementing CMMS often requires changes in work habits and procedures. Employees may be resistant to altering their established routines and adopting new ways of working.

2) Addressing resistance to change: To overcome resistance to change during CMMS implementation, manufacturing industries can employ various strategies [15,16,17,18,19,20]:

- Clear Communication: Effective communication is crucial to address employees' concerns and explain the benefits of CMMS implementation. Transparent communication about the reasons behind the change, its impact on employees, and the long-term benefits can help alleviate resistance.
- Involvement and Participation: Involvements of employees in the decision-making process and seeking their input will increase their ownership and commitment to CMMS implementation. It can also help address their concerns and build trust in the new system.
- Training and Support: Providing comprehensive training on how to use the CMMS and addressing employees' skill gaps can increase their confidence and reduce resistance. Ongoing support and guidance during the implementation process and after can help employees navigate the transition effectively.
- Change Champions: Identifying the champions within the organization can help drive acceptance and adoption of the CMMS. These individuals can advocate for the system, address concerns, and encourage others to embrace the change.
- Gradual Implementation: Implementing CMMS in phases or piloting the system in a specific area or department can help employees gradually adapt to the change. It allows for learning and adjustments before full-scale implementation, reducing resistance and mitigating risks.

- Recognizing and Rewarding Adoption: Acknowledging and rewarding employees who embrace and effectively use the CMMS can reinforce positive behavior and motivate others to follow suit. Recognizing early adopters and showcasing success stories can create a positive narrative around the system.

3) Data integration and migration: Integrating existing data from legacy systems into the CMMS can be a difficult and time taking process. Manufacturing industries often have a vast amount of historical maintenance data stored in different formats and systems [21]. Ensuring seamless data migration and integration with the CMMS needs careful planning, data cleansing, and mapping to ensure accuracy and consistency. Data integration and migration pose significant challenges for manufacturing industries when implementing CMMS. The following problems are commonly encountered [22, 23, 24, 25, 26, 27]:

- **Legacy Systems and Data Formats:** Manufacturing industries often have existing legacy systems that store maintenance data in various formats and structures. Integrating data from these systems into the CMMS can be complex, as the data may need to be transformed, cleansed, and mapped to fit the new system's requirements.
- **Data Quality and Completeness:** Data quality and completeness issues can arise during the integration and migration process. Inaccurate, inconsistent, or incomplete data can hinder the effectiveness of the CMMS. Data cleansing and validation are essential to ensure data accuracy and integrity.
- **Complex Data Relationships:** Manufacturing industries deal with complex relationships among different data entities, such as equipment, parts, maintenance tasks, and work orders. Capturing and maintaining these relationships accurately in the CMMS can be challenging, especially when migrating data from multiple systems with different data structures.
- **Data Volume and Scalability:** Manufacturing operations generate vast amounts of maintenance data. When migrating data to the CMMS, handling large volumes of data can lead to performance issues and delays. Ensuring scalability and efficient data migration processes is crucial for a smooth implementation.
- **Disparate Data Sources:** Manufacturing industries may have maintenance data stored across multiple sources, such as spread sheets, databases, and paper records. Consolidating and integrating data from these disparate sources into a centralized CMMS can be time-consuming and require careful data extraction, transformation, and loading (ETL) processes.
- **Data Security and Privacy:** During data integration and migration, ensuring the security as well as privacy of sensitive maintenance data is paramount. Manufacturers need to implement appropriate data encryption, access controls, and data anonymization techniques to protect information during the migration process.
- **Downtime and Disruptions:** The process of integrating and migrating data to the CMMS may require temporary downtime or disruptions to the maintenance operations. Minimizing these interruptions and ensuring a smooth transition is crucial to prevent negative impacts on production and maintenance activities.

4) Addressing data integration and migration challenges: To address data integration and migration challenges during CMMS implementation, manufacturing industries can adopt the following strategies [28, 29]:

- **Data Mapping and Transformation:** Execute a thorough analysis of existing data sources and identify the necessary data mapping and transformation requirements. Develop a clear plan for mapping data fields, ensuring data consistency, and transforming data formats as needed.
- **Data Cleansing and Validation:** Implement data cleansing processes to identify and rectify data quality issues. Validate data for accuracy, completeness, and consistency before migrating it to the CMMS.
- **Data Migration Tools and Techniques:** Leverage data migration tools and techniques that streamline the process and minimize disruptions. These tools can automate data extraction, transformation, and loading tasks, reducing manual effort and potential errors.
- **Phased Approach:** Implement data integration and migration in a phased approach. Prioritize critical data elements and functionalities, and gradually migrate data in stages. This approach allows for better control, testing, and validation of the migrated data.
- **Data Governance and Standards:** Generate data standards and governance practices to ensure consistent data management and quality control. Define data ownership, establish data validation processes, and implement data standards across the organization to maintain data integrity.

- **Data Security Measures:** Implement robust data security actions during data integration and migration. Encrypt sensitive data, restrict access to authorized personnel, and implement audit trails to track data movement and access.
- **Training and User Adoption:** Provide training and support to employees involved in data integration and migration. Ensure they understand the new CMMS data structure, the importance of data quality, and the processes for data entry and maintenance.

5) SYSTEM CUSTOMIZATION AND CONFIGURATION: Manufacturing processes vary widely across industries and even within individual organizations. Customizing and configuring the CMMS to align with specific maintenance workflows, equipment, and business rules can be a significant challenge. It needs a deep understanding of the organization's requirements and collaboration between maintenance teams, IT departments, and CMMS vendors. Manufacturing industries often encounter challenges related to system customization and configuration when implementing CMMS in the industries. The following problems are commonly faced [30, 31 32]:

- Diverse Maintenance Workflows: Manufacturing operations can have diverse maintenance workflows and processes based on the type of equipment, production lines, or specific industry requirements. Customizing the CMMS to align with these workflows can be complex, requiring careful analysis and configuration.
- Equipment and Asset Variability: Manufacturing industries typically have a wide range of equipment and assets with varying maintenance requirements. Configuring the CMMS to accommodate these diverse assets, their maintenance schedules, and specific maintenance tasks can be challenging.
- Business Rules and Procedures: Each manufacturing industry may have its own unique business rules and procedures for maintenance management. Customizing the CMMS to incorporate these rules and ensure compliance with industry regulations and internal policies can be a complex task.
- Integration with Existing Systems: Manufacturing industries have existing systems and software that need to be integrated with the CMMS, such as Enterprise Resource Planning (ERP) systems or production management software. Ensuring seamless integration and data flow between these systems and the CMMS requires customization and configuration.
- User Interface and User Experience: Designing a user-friendly interface that meets the specific needs of maintenance personnel is crucial for user adoption and system efficiency. Customizing the CMMS interface to align with the roles and responsibilities of different users, as well as their preferences, can be a challenge.
- Reporting and Analytics: Manufacturing industries often require customized reports and analytics to gain insights into maintenance performance, equipment downtime, spare parts usage, and other critical metrics. Configuring the CMMS to generate relevant reports and analytics tailored to specific business requirements can be complex.
- Maintenance Data Standards: Establishing consistent data standards for maintenance tasks, equipment data, spare parts, and other relevant information is essential for effective CMMS implementation. Configuring the system to adhere to these data standards and ensuring data consistency across the organization can be a challenge.

6) Addressing system customization and configuration challenges: To address the challenges related to system customization and configuration during CMMS implementation, manufacturing industries can consider the following strategies [32, 33]:

- Requirements Analysis: Conduct a comprehensive analysis of the organization's maintenance workflows, equipment, and specific business rules. Identify the customization and configuration requirements based on this analysis to ensure the CMMS aligns with the organization's needs.
- Collaboration with Vendors: Collaborate closely with CMMS vendors or implementation partners to leverage their expertise in system customization and configuration. Work together to define the customization requirements and ensure the CMMS is tailored to meet specific business needs.
- Prototyping and Testing: Develop prototypes or test environments to evaluate different customization options and configurations. Conduct thorough testing to validate the system's functionality, user experience, and adherence to business rules before full-scale implementation.

- User Involvement and Feedback: Involve key users and stakeholders in the customization and configuration process. Gather feedback and insights from maintenance personnel to ensure the system meets their requirements and preferences.
- Configuration Flexibility: Select a CMMS solution that offers flexibility in configuration and customization. Look for systems that allow for easy modification of workflows, data fields, user roles, and other configuration parameters to accommodate changing business needs.
- Training and Support: Provide complete training to operators on how to effectively use the customized CMMS. Ensure they understand the new workflows, configurations, and business rules. Ongoing support and guidance can help employees adapt to the changes and maximize the benefits of the system.
- Continuous Improvement: CMMS customization and configuration should be viewed as an iterative process. Regularly assess the system's effectiveness, gather user feedback, and make necessary adjustments to optimize workflows, configurations, and data standards.

7) USER TRAINING AND ADOPTION: Providing comprehensive training and support to users is crucial for successful CMMS implementation. Employees at different levels and roles within the organization must be trained for effectively utilization of the system and understand its benefits [34]. Lack of proper training and user adoption can hinder the successful implementation of CMMS and limit its potential benefits. Manufacturing industries often encounter challenges related to user training and adoption when implementing CMMS [35]. The following problems are commonly faced [34, 35, 36, 37]:

- **Lack of Familiarity with Technology:** Some employees may have limited experience or comfort with using digital systems. They may be unfamiliar with CMMS software and require comprehensive training to understand its features and functionalities.
- **Resistance to Change:** Employees may resist adopting the CMMS due to a fear of technology, job security concerns, or a preference for familiar manual processes. Overcoming resistance to change and gaining user acceptance is crucial for successful implementation.
- **Varied Skill Levels:** Maintenance personnel in manufacturing industries have different levels of technical proficiency. Training needs may vary depending on the user's skill level, requiring customized training programs to address individual knowledge gaps.
- **Time Constraints:** Manufacturing environments are often fast-paced, and maintenance personnel may have limited time for training due to operational demands. Finding the right balance between training and maintaining productivity can be a challenge.
- **Training Resource Availability:** Adequate resources, such as trainers, training materials, and dedicated training environments, may not be readily available within the organization. This can delay or hinder the training process.
- **Insufficient Training Coverage:** Incomplete or inadequate training can lead to underutilization of the CMMS or incorrect use of its features. Lack of comprehensive training coverage may limit the system's effectiveness and prevent users from fully benefiting from its capabilities.
- **Lack of User Engagement:** Active engagement and involvement of users in the training process are essential for successful CMMS adoption. If users feel disengaged from the implementation process, they may not embrace the system or understand its value.

8) Addressing user training and adoption challenges: To address the challenges related to user training and adoption during CMMS implementation, manufacturing industries can consider the following strategies:

- **Comprehensive Training Schedule:** Develop a comprehensive training schedule that encompasses all concerned aspects of CMMS usage, including basic navigation, data entry, reporting, and analysis. Tailor the training content to address different user roles and skill levels.
- **Hands-On Training:** Provide hands-on training sessions that allow users to practice using the CMMS in a simulated or real environment. This practical approach helps users gain confidence and proficiency in using the system.

- **User-Centric Approach:** Customize training programs to address specific user needs and job requirements. Focus on demonstrating how the CMMS can simplify their tasks, improve efficiency, and enhance decision-making.
- **Training Documentation and Resources:** Develop user-friendly training materials, such as user manuals, quick reference guides, and video tutorials, to supplement the training sessions. Make these resources readily accessible to users for ongoing reference and self-paced learning.
- **Train-the-Trainer Approach:** If resources are limited, consider implementing a train-the-trainer approach where a select group of employees are trained extensively to become internal CMMS trainers. These trainers can then provide training sessions to other users within the organization.
- **Ongoing Support and Help Desk:** Establish a enthusiastic support team to solve user queries and provide ongoing assistance. Promptly addressing user concerns and providing continuous support can boost user confidence and adoption.
- **User Engagement and Communication:** Engage users in the early stage of implementation process by soliciting their feedback, involving users in taking decisions, and clearly communicating the benefits of the CMMS. Create a sense of ownership and involvement to foster user engagement and acceptance.
- **Continuous Learning and Improvement:** Encourage users to continuously learn and explore the CMMS capabilities beyond the initial training phase. Provide opportunities for advanced training, webinars, or workshops to enhance users' proficiency and keep them updated with new features.

9) **TECHNICAL INFRASTRUCTURE AND CONNECTIVITY:** Manufacturing environments often have complex machinery and equipment, some of which may be located in remote or challenging locations. Ensuring reliable connectivity and technical infrastructure to support real-time data collection, communication, and integration with the CMMS can be a challenge. Adequate network infrastructure, robust connectivity solutions, and proper device integration are crucial for seamless CMMS implementation [38]. Manufacturing industries often face challenges related to technical infrastructure and connectivity when implementing a Computerized Maintenance Management System (CMMS). The following problems are commonly encountered [38, 39, 40]:

- Legacy Systems and Compatibility: Manufacturing facilities may have legacy systems or outdated infrastructure that is not compatible with modern CMMS software. Integrating the CMMS with existing systems can be challenging, requiring upgrades or replacements to ensure compatibility.
- Network and Connectivity Issues: Manufacturing environments often have complex and extensive networks with multiple devices and equipment. Network issues, such as weak signal strength, connectivity interruptions, or limited range in certain areas, can affect the smooth operation of the CMMS.
- Mobile Device Support: Mobile devices play a crucial role in accessing and using the CMMS in real-time on the shop floor. However, compatibility issues with mobile devices, such as operating system versions, hardware limitations, or connectivity problems, can hinder user adoption and mobility.
- Scalability and Capacity Planning: Manufacturing operations may have fluctuating demands or plans for expansion. Ensuring that the CMMS infrastructure is scalable and can handle increased data volume, user access, and system performance is essential for long-term success.
- Data Security and Privacy: Manufacturing industries deal with sensitive data related to equipment, maintenance activities, and production processes. Ensuring data security and privacy when accessing the CMMS from different devices, locations, or remote connections is critical to protect confidential information.
- System Downtime and Reliability: Manufacturing operations often run 24/7, and any system downtime or reliability issues can disrupt maintenance operations and impact productivity. Ensuring a robust and reliable technical infrastructure for the CMMS is vital to minimize downtime and maximize system availability.
- Training and Support Infrastructure: Adequate technical infrastructure is needed to support training and ongoing user support for the CMMS. This includes training environments, hardware resources, software licenses, and support personnel to address technical issues and user queries.

10) Addressing technical infrastructure and connectivity challenges: To address technical infrastructure and connectivity challenges during CMMS implementation, manufacturing industries can adopt the succeeding strategies:

- Infrastructure Assessment: Execute a thorough assessment of the existing technical infrastructure, including network capabilities, hardware, and software systems. Identify gaps or areas that need upgrades or enhancements to ensure compatibility and performance.
- Compatibility Testing: Prior to CMMS implementation, perform compatibility testing between the CMMS software and existing systems, devices, and networks. Identify and resolve any compatibility issues to ensure seamless integration.
- Network Optimization: Work with network specialists to optimize the network infrastructure for reliable and stable connectivity. This may involve upgrading network equipment, enhancing coverage in critical areas, or implementing redundancy measures to minimize connectivity disruptions.
- Mobile Device Compatibility: Select a CMMS solution that supports mobile devices and other operating systems. Ensure compatibility testing with different mobile devices to address any compatibility issues and ensure smooth mobile access to the CMMS.
- Scalability Planning: Consider future scalability needs when designing the CMMS infrastructure. Ensure that the system can handle increasing data volume, user traffic, and system performance requirements. Implement a scalable infrastructure that allows for easy expansion and resource allocation.
- Data Security Measures: Install a strong data security procedure to protect sensitive information within the CMMS. This contains secure authentication protocols, data encryption, data backups, and controls to prevent unauthorized admittance of data fissures.
- Redundancy and Disaster Recovery: Implement redundancy measures, such as backup servers or cloud-based infrastructure, to minimize system downtime in case of hardware failures or disasters. Establish a disaster recovery plan to quickly restore CMMS functionality in the event of system disruptions.
- Training and Support Infrastructure: Ensure that the necessary infrastructure, such as training environments, hardware resources, and software licenses, is available to support user training and ongoing technical support. Allocate resources and personnel to address technical issues and provide timely support to users.

11) RETURN ON INVESTMENT (ROI) AND COST: Installation of CMMS involves upfront costs, including software licenses, hardware, training, and implementation services. Calculating the return on investment and justifying these costs can be a challenge for manufacturing industries. It requires careful evaluation of the potential benefits, such as reduced downtime, improved maintenance planning, and increased equipment lifespan, to demonstrate the long-term value of CMMS implementation [41]. Manufacturing industries often face challenges related to cost and return on investment (ROI) when implementing CMMS. The following problems are commonly encountered [41, 42, 43]:

mplementing a CMMS requires a significant initial investment, including software licenses, hardware infrastructure, training, ces. The upfront costs can be a barrier for small and medium manufacturing industries with inadequate budgets.

ting the CMMS with existing arrangements, particularly enterprise resource planning (ERP), resource and asset management sts. Customization, data migration, and integration with other software or equipment can increase the overall implementation

Support Costs: The CMMS requires ongoing maintenance, updates, and technical support to ensure its smooth operation. These intenance fees, support contracts, and hardware upgrades, should be considered for long-term sustainability.

n Costs: Providing comprehensive user training and support to ensure proper adoption of the CMMS can add to the overall costs. ials, and dedicated resources for user support may be necessary to maximize the system's benefits.

ges: Measuring the ROI for the CMMS can be a problem when quantifying the cost savings, productivity improvements, and ins. Identifying and collecting relevant data for ROI analysis can be time-consuming and complex.

tion: Implementing a CMMS requires dedicated time and resources from the maintenance team and other stakeholders. Balancing with ongoing maintenance and operational demands can be challenging and may impact productivity during the transition

: Implementing a CMMS often involves changes in work processes and workflows. Some employees may resist these changes or e new system, which can affect productivity and potentially delay the realization of expected benefits.

12) Addressing ROI and cost challenges: To address cost and ROI challenges during CMMS implementation, manufacturing industries can consider the following strategies [43, 44, 45, 46]:

- Cost-Benefit Analysis: Execute a thorough cost-benefit analysis to assess the potential impact of finances and return on investment of implementing the CMMS. Evaluate both tangible and intangible benefits, like reduced maintenance costs, increased uptime, improved labor efficiency, and better decision-making capabilities.
- Vendor Evaluation: Evaluate different CMMS vendors and their pricing models to find the most cost-effective solution that aligns with the organization's needs. Consider factors such as license fees, implementation services, ongoing maintenance costs, and support contracts.
- Prioritize Key Functionality: Prioritize the essential CMMS functionalities that align with the organization's maintenance goals and requirements. Investing in critical features that provide the most significant impact can help optimize costs and ensure a higher ROI.
- Phased Implementation Approach: Implement the CMMS in phases rather than attempting a full-scale deployment. This approach allows for better resource allocation, manageable costs, and the ability to learn from each phase before moving to the next.

13) Training and Change Management: Allocate sufficient resources for user training and change management activities. Ensure that employees understand the benefits of the CMMS and receive proper training to maximize its usage and adoption. This can help minimize resistance to change and speed up the realization of ROI.

14) ORGANIZATIONAL ALIGNMENT AND COLLABORATION: CMMS implementation often requires close collaboration and alignment between maintenance departments, IT teams, and other stakeholders. Organizational silos, lack of communication, and struggle to collaboration can hamper the successful adoption of CMMS. It is crucial to foster a culture of cross-functional collaboration and ensure that all stakeholders are actively involved and invested in the implementation process [47]. Implementing a CMMS package in manufacturing industries can face challenges related to organizational alignment and collaboration. The following problems are commonly encountered [47, 48, 49, 50, 51]:

- **Lack of Top-Down Support:** Without support from top-level management, it can be difficult to gain the necessary resources, budget, and commitment for successful CMMS implementation. Lack of buy-in and alignment from management can hinder the adoption and integration of the CMMS into the organization's overall maintenance strategy.
- **Siloed Departments and Communication Gaps:** Manufacturing industries often have different departments and teams involved in maintenance activities, such as maintenance, production, and purchasing. Siloed departments and communication gaps can lead to fragmented information sharing, conflicting priorities, and a lack of collaboration, which can impede the effective implementation and utilization of the CMMS.
- **Resistance to Change:** Employing CMMS requires changes in processes and workflows. Employees who are accustomed to old maintenance practices can hamper the adoption and integration of the CMMS. Lack of proper change management strategies and communication can exacerbate this problem.
- **Lack of Standardized Processes:** Inconsistent or poorly defined maintenance processes across different departments or locations can pose challenges during CMMS implementation. Without standardized processes, it becomes difficult to configure and align the CMMS with the organization's specific needs. It can also impede data integration, reporting, and collaboration.
- **Limited Collaboration and Information Sharing:** Lack of collaboration and information sharing among maintenance personnel, technicians, and other stakeholders can hinder the effectiveness of the CMMS. If information is not shared or updated in a timely manner, it can lead to inaccurate data, inefficient workflows, and missed maintenance tasks.
- **Cultural Resistance and Training Needs:** Some organizations may have a culture that is resistant to new technologies or processes. Overcoming cultural resistance to change and ensuring proper training for employees to use and benefit from the CMMS is crucial. Insufficient training can lead to underutilization of the CMMS and hamper its effectiveness.
- **Lack of Clear Roles and Responsibilities:** Randomly defined roles and responsibilities for CMMS users and administrators can lead to confusion and inefficiencies. Without clear accountability, tasks may be overlooked or duplicated, and the system may not be effectively utilized or maintained.

15) Addressing organizational alignment and collaboration challenges: To address organizational alignment and collaboration challenges during CMMS implementation, manufacturing industries can consider the following strategies:

- **Leadership Support and Communication:** Obtain support from top-level management and ensure clear communication about the goals, benefits, and expectations of CMMS implementation. Engage leadership in the process and secure their commitment to drive organizational alignment.
- **Cross-Functional Collaboration:** Adopt collaboration and clear communication between diverse departments involved in maintenance activities. Establish cross-functional teams or committees to facilitate coordination, information sharing, and decision-making related to the CMMS.
- **Change Management and Training:** Implement modification in management strategy to resolve resistance to change and promote acceptance of the CMMS. Comprehensive training schedules provide employees good estimation of the benefits, and functionalities of the CMMS. Address training needs based on different user roles and skill levels.

16) SCALABILITY AND FUTURE GROWTH: Manufacturing industries are dynamic and continually evolving, with new equipment, processes, and facilities being added over time. Ensuring that the CMMS can scale and accommodate future growth and changes is an important consideration. It requires selecting a flexible and scalable CMMS solution and regularly evaluating and updating the system to meet changing business needs. Implementing CMMS in manufacturing industries can face challenges related to scalability and future growth. The following problems are commonly encountered[52, 53, 54]:

- **Limited System Scalability:** Some CMMS softwares may have limitations like scalability, particularly when it need to handle large data, accommodating increased user access, or supporting additional functionalities. As the manufacturing operation expands, the CMMS may struggle to meet the increasing demands.
- **Complex Data Management:** Manufacturing industries generate vast data related to maintenance activities, equipment performance, and inventory management. Managing and organizing this data within the CMMS can become challenging, especially when complexity and the volume of data increase. Without a scalable and efficient data management approach, the CMMS may become less effective in providing accurate and timely information.
- **Integration with New Technologies:** As manufacturing industries adopt latest technologies like Internet of Things (IoT), smart sensors, Artificial Intelligence (AI), or predictive analytics, there is a need for the CMMS to integrate with these technologies seamlessly. Lack of scalability in the CMMS can hinder integration efforts, limiting the organization's ability to leverage emerging technologies for maintenance optimization and future growth.
- **Adaptability to Changing Processes:** Manufacturing processes and maintenance requirements evolve over time due to factors such as changes in production lines, introduction of new equipment, or modifications in maintenance strategies. The CMMS should be adaptable and flexible enough to accommodate these changes without significant disruptions. Limited scalability can impede the system's ability to adapt to evolving processes and hinder future growth.
- **User Access and Performance:** As the number of CMMS users increases, ensuring consistent and reliable system performance becomes crucial. Scalability issues can result in slower response times, system lags, or even system crashes, impacting user experience and productivity. Inadequate scalability may require additional hardware investments or system upgrades to maintain optimal performance.
- **Cost of Scalability:** Scaling the CMMS to meet the growing needs of the manufacturing industry often incurs additional costs. These costs may include hardware upgrades, software licenses, infrastructure enhancements, or additional training and support resources. Limited scalability can make it challenging for organizations to manage the associated costs effectively.
- **Planning for Future Growth:** Manufacturers need to anticipate and plan for future growth and expansion. However, if the CMMS lacks scalability, it can become a bottleneck rather than an enabler for future growth initiatives. Inadequate scalability may require organizations to seek alternative CMMS solutions or invest in costly migration processes to support their long-term growth plans.

17) Addressing scalability and future growth challenges: To address scalability and future growth challenges during CMMS implementation, manufacturing industries may emphasize on the following strategies[55, 56]:

- Scalability Assessment: Execute full assessment of the CMMS's scalability capabilities. Evaluate its performance, data handling capabilities, user access management, and integration potential with new technologies. Identify any scalability limitations and assess the impact on future growth requirements.
- Scalable Infrastructure Design: Plan and design a scalable infrastructure to support the CMMS. Consider factors such as server capacity, database performance, network bandwidth, and storage requirements. Implement a robust and scalable infrastructure that can accommodate the anticipated growth in data volume and user access.
- Flexible Data Management: Develop a flexible and scalable data management strategy within the CMMS. Implement data archiving, purging, and optimization techniques to handle the increasing volume of data effectively. Ensure that data can be easily retrieved, analyzed, and integrated with other systems as the organization grows.

18) MAINTENANCE PROCESS STANDARDIZATION: Manufacturing industries often have multiple sites or facilities with different maintenance practices and processes. Implementing a standardized maintenance process across all locations can be a significant challenge. It requires aligning maintenance strategies, workflows, and procedures to ensure consistency and maximize the benefits of CMMS implementation [57]. Implementing CMMS in manufacturing industries can face challenges related to maintenance process standardization. The following problems are commonly encountered [57, 58, 59, 60]:

- **Lack of Consistent Processes:** Manufacturing industries often have multiple locations, departments, or teams involved in maintenance activities. In the absence of standardized processes, each location or team may follow different maintenance practices, leading to inconsistencies and inefficiencies. Implementing a CMMS requires aligning and standardizing these processes across the organization.
- **Resistance to Change:** Introducing standardized maintenance processes to implement CMMS sometimes face resistance from employees who are comfortable to existing practices. Employees may be resistant to changing their established workflows, resulting in slower adoption and potential inefficiencies during the transition period.
- **Complexity of Existing Processes:** Manufacturing maintenance processes can be complex, involving various tasks, schedules, resources, and dependencies. Mapping and standardizing these complex processes within the CMMS can be challenging and time-consuming. Failure to address this complexity may result in incomplete or inadequate process standardization.
- **Inefficient Workflows:** In the absence of standardized maintenance processes, workflows can become inefficient and prone to errors. Lack of clarity in roles, responsibilities, and task sequences can lead to delays, redundant work, or missed maintenance activities. Standardizing processes through the CMMS implementation helps optimize workflows and improve efficiency.
- **Training and Adoption Challenges:** Standardizing maintenance processes requires training employees on the new processes and ensuring their adoption. Inadequate training and dearth of employee engagement can delay the successful implementation of standardized processes through the CMMS. Employees need to understand the benefits of standardization and be adequately trained to use the CMMS effectively.
- **Sustaining Standardization:** Once standardized processes are implemented through the CMMS, sustaining them becomes essential. Without ongoing monitoring, reinforcement, and continuous improvement efforts, standardization efforts may erode over time. Ensuring consistent adherence to standardized processes is crucial for long-term success.
- **Balancing Flexibility and Standardization:** While standardizing maintenance processes is important for consistency and efficiency, there is also a need to balance standardization with flexibility. Different maintenance scenarios, equipment types, or operational requirements may necessitate some level of process customization within the CMMS. Striking the right balance between standardization and flexibility can be a challenge.

2. FUTURE SCOPE

- The identified barriers can be analyzed for the relative priority.
- Using AI and machine learning informed decision making may be adopted.
- A model can be proposed for the effective utilization of CMMS

3. CONCLUSION

In conclusion, implementing CMMS in manufacturing industries presents numerous challenges that need to be addressed for successful utilization and implementation. These problems include resistance to change, data integration and migration complexities, system customization and configuration, user training and adoption, technical infrastructure and connectivity issues, cost and return on investment considerations, organizational alignment and collaboration, and scalability for future growth. Overcoming these challenges requires a holistic approach that includes effective change management strategies, thorough planning and execution of data integration and migration, careful customization and configuration of the CMMS to align with specific industry needs, comprehensive user training programs, data validation processes to ensure, robust technical infrastructure and connectivity, accurate cost analysis and ROI assessment, fostering organizational alignment and collaboration, and designing the CMMS to be scalable for future growth. By resolving these challenges, manufacturing industries can reveal the full potential of CMMS, streamline maintenance processes, enhance operational efficiency, reduce downtime, and optimize asset management. It is essential for organizations to invest time, resources, and expertise in navigating these challenges to ensure a successful CMMS implementation and achieve long-term benefits for their maintenance management practices in terms of profitability, competitiveness and sustainability.

CONFLICT OF INTERESTS

None.

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