Mine Automation and Data Analytics

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Week-3

Lecture-11

Introduction to CMMS

Welcome back to my course, Mine Automation and Data analytics. Today in this lesson, primarily, we will discuss the computerized maintenance management system (CMMS) and how this can be done efficiently in this age of mining 4.0. So, in this lecture, we will cover the following concepts: We will introduce, what maintenance is all about for mining machines, the type of maintenance, the maintenance management plan, the fundamental steps of maintenance management, the computerized maintenance management system (CMMS), the benefits of CMMS, CMMS subsystems and modules, CMMS software models, CMMS software, new trends in CMMS or enterprise asset management industry, and EAM versus CMMS. We will introduce asset performance optimization, challenges in asset management for the mining sector, benefits of CMMS solutions for mining companies, key features of CMMS for the mining industry, implementing CMMS in mining operations, and lastly, future trends in CMMS for the mining industry.

What is maintenance? Maintenance refers to the systematic and organized control of activities necessary to preserve a facility in its original condition, ensuring it retains its productive capacity over time. Types of maintenance: the first is corrective maintenance, and the second one is preventive maintenance. So, there are some subdivisions of these two as well. So, the corrective maintenance of two types is deferred and immediate; preventive maintenance of two types is condition-based maintenance and predetermined maintenance.

Corrective maintenance is carried out reactively after a fault has been recognized. It aims to restore the equipment in question to a state in which it can again perform a required function. So, depending on the maintenance plan, corrective maintenance can be either planned or unplanned. Planned corrective maintenance is typically the result of a run-to-failure RTF maintenance plan where no maintenance is performed on the asset until the failure event. Unplanned corrective maintenance is typically the result of a breakdown not stopped by preventive maintenance. Based on the fault and the business conditions, corrective maintenance can either be done immediately after the fault occurs or delayed and performed later. Preventive maintenance is performed proactively before the equipment fails. It intends to reduce the probability of failure or degradation of the

Types of Maintenance
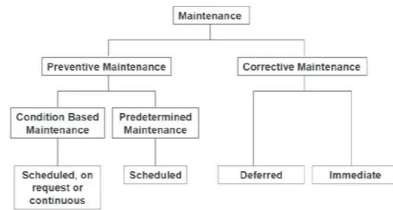
functions of an item. Predetermined maintenance is done based on an established maintenance program for intervals of time or units of use. The programs are typically provided by equipment manufacturers and are based on their knowledge of the failure mechanisms and mean time to failure MTTF statistics for the equipment and its parts. The programs are typically provided by equipment manufacturers and are based on their knowledge of the failure mechanism and mean time to failure MTTF statistics for the equipment and its parts.

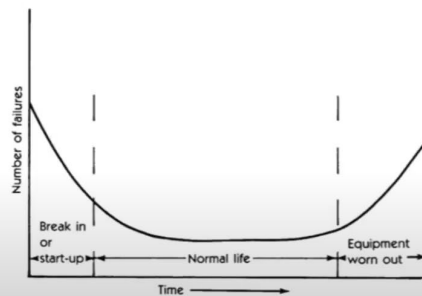Figure-Typical bathtub curve

So, this is the typical graph of the bathtub curve for the maintenance plan. The failure probability is typically higher when the equipment or parts are new or worn out. This MTTF or bathtub curve, as shown in figure. The predetermined maintenance does not guarantee that the equipment will not fail and often leads to unnecessary repairs since the program is based on failure statistics and not on the actual conditions of the equipment. So, managing predetermined maintenance can be complex since each piece of equipment has multiple maintenance programs and companies can have a large number of pieces of equipment.

Condition based maintenance- Condition-based maintenance tries to predict failures. It is based on regular monitoring of the conditions, operating efficiency, and other indications of the system. The monitoring can be done either on site or remotely via a network connection to the equipment. Monitoring can be done continuously or it can be scheduled to happen at predetermined intervals. Condition-based maintenance is the most complex maintenance type to implement but can be the most economical since only the parts needing repair or replacement are maintained.

Let us discuss a few questions

Question number 1: How is monitoring conducted in condition-based maintenance? On site only, remotely only, both on-site and remotely, Continuously, only at predetermined intervals.

The right answer is both on-site and remotely
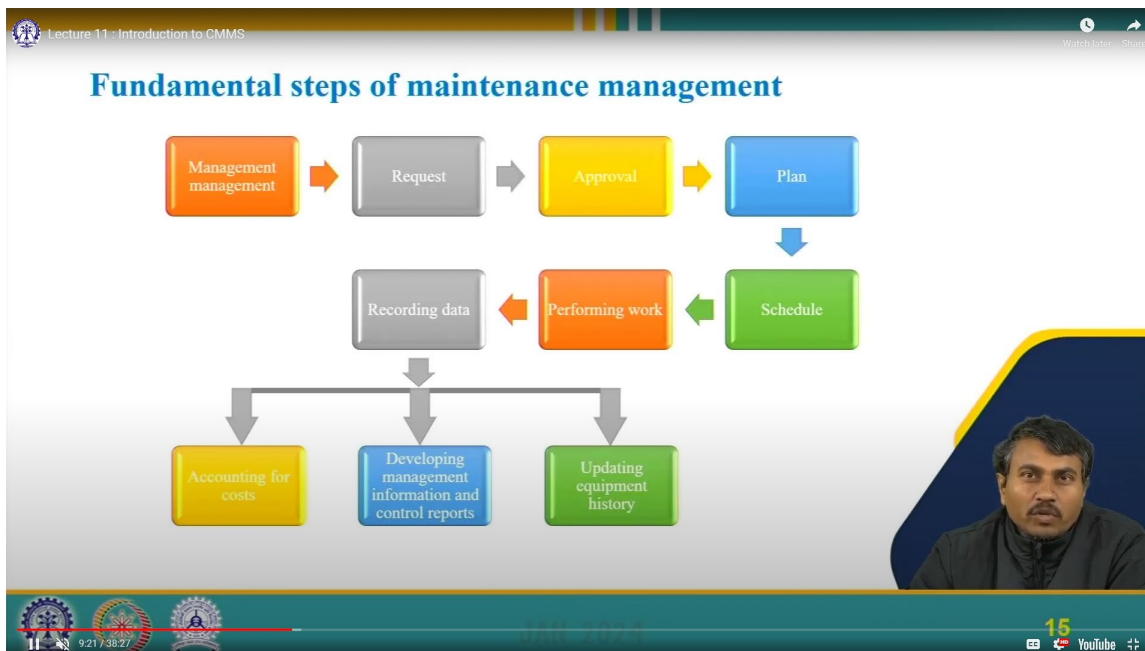
Maintenance Management: Initially, maintenance management was a manual, time-consuming task. However, it has evolved into a computerized maintenance management system (CMMS), a software that centralized planning, tracking, measuring, and optimizing all aspects of a maintenance program. There are fundamental steps in maintenance management. Management then requests, then it should be approved, then plans, then according to the plan we have to schedule, then according to the schedule we have to perform the work, and then we have to record the data and based on that, we have to account for the costs, develop management information and control reports, and update equipment history. So all are working hand in hand and connected, and the data that is recorded during the work is also useful for the maintenance management plan.
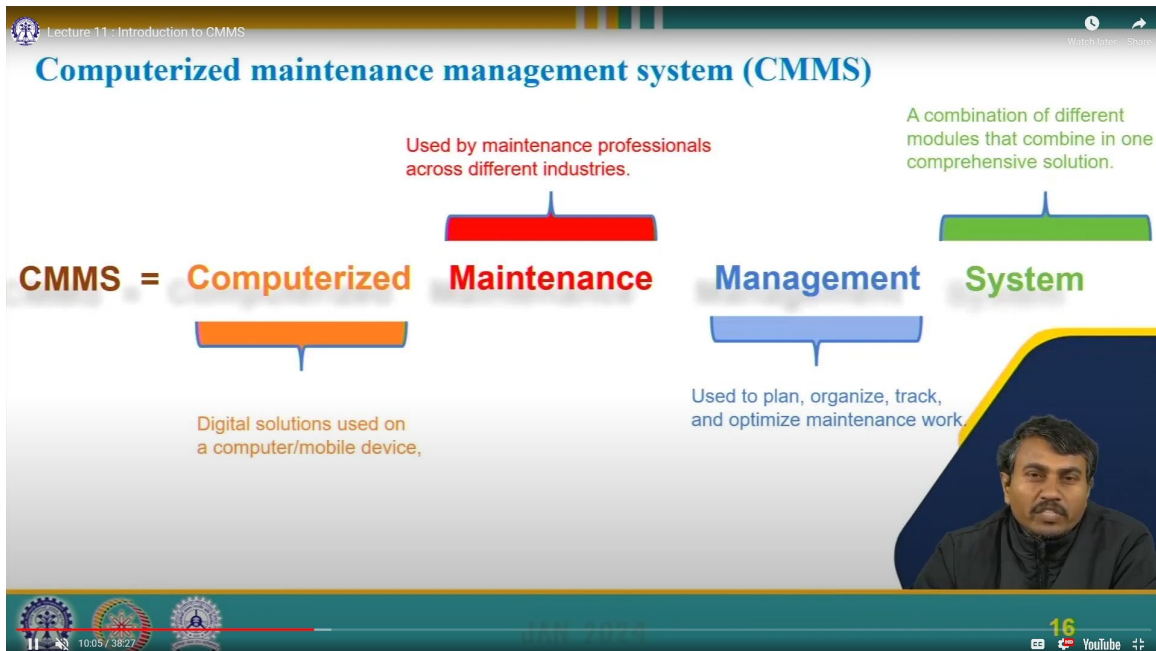
Computerized maintenance management system (CMMS): It stands for computerized, which is a digital solution used on a computer or mobile device. Maintenance means used by maintenance professionals across different industries. Management used to plan, organize, track, and optimize maintenance work. The system is a combination of different modules that combine into one comprehensive solution. A computer-managed maintenance system is an integrated set of computer programs and data files designed to provide its users with cost-effective means of managing massive amounts of maintenance, inventory control, and purchase data. So, these are the typical building blocks of the CMMS: schedule maintenance tasks, manage inventory, record asset history, and track work orders. So, all the modules of the CMMS. It helps in the systematic planning, execution, and control of maintenance activities. It provides a cost-effective way to manage human and capital resources. CMMS is a transformation from a paper-based working environment to computerized digital storage. It helps eliminate the recording of paper work. So, this is the typical work flow. All data, particularly

maintenance data, is saved on a computer and, in some cases, in the cloud. So, there was no necessity of maintaining papers for these tasks. Input and output models for an enterprise.


So this is the typical figure. The maintenance system is a subsystem of the enterprise system as well as of the production system. So, the maintenance system is the vital and most important part of an industry, a factory, or an organization. So here we need to prioritize the inputs, which are labor, materials, spares, and tools to be used, as well as the information cost and other outsource services that are used for the maintenance system and the output that comes out of this system is availability, maintainability, safety, cost recovery, or profits. So, this is the central crux of the system. The maintenance system is in the central part of the production system as well as of the enterprise system.
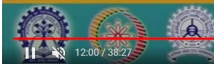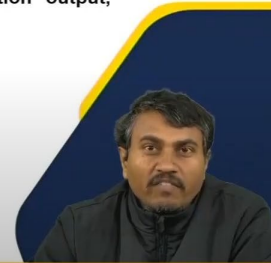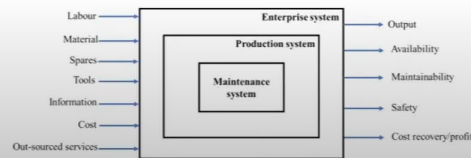
Question 2:

What does the CMMS computerized maintenance management system primarily aim to achieve? increase paperwork in the working environment, maintain the traditional paper-based record-keeping system, facilitate the transition from a paper-based to a computerized digital storage system, discourage the use of digital storage for maintenance records, promote a hybrid approach of paper and digital record keeping.

The right answer is, which facilitates the transition from a paper-based to a computerized digital storage system.

The main benefit of CMMS is a reduced maintenance backlog. It also reduces the maintenance cost. It is reduced over time. It reduced follow-up time to repair the gaps. It reduced outsource contract maintenance work. It improves maintenance planning and scheduling. It improves maintenance service tracking. It improves technician and service engineer performance and finally, it improves technician and supervisor planning. So in every aspect of the maintenance and maintenance-related activities and the manpower involved in the process, CMMS is helping to improve efficiency and performance while also reducing the effective time required for these maintenance activities.

CMMS subsystem or modules- It is about the equipment and asset registers. It is also about preventive maintenance planning. It is also with work order management because work order management is the key to all these CMMS modules. Human resource management, for maintenance you required an expert human hand to work in the process. Inventory management, Inventory is also required for an effective maintenance plan. From time to time, there should be a sufficient stock of the material so that, as and when required for the repair, that can be taken into account and repaired on the machine so that there is no delay in getting the parts from the inventory management system.

Equipment or asset register-It is a database of all equipment in the plant. All maintenance activities are linked to an asset. So, it is linked to all other databases, such as preventive maintenance planning, PM, inventory, and purchase.

Preventive maintenance planning- This module contains the PM plan for the registered asset equipment based on the maintenance checklist and frequency.

Work order management-This comprises work orders related to the equipment, preventive maintenance, labor and predictive maintenance, budget, vendor and supplier, purchasing, and inventory. So, the work order is the backbone of the CMMS system. A work order can be generated by planned PM or unplanned maintenance activity. All modules are connected and updated through a work order.

Human resource-It includes the personnel and technicians who carry out maintenance work activities.

Inventory management-It includes the warehousing, purchase, and ordering of spare parts. This is a very important component; without it, maintenance management will suffer hugely.

CMMS software models: These are of three types: lan-based or license-based software, web-based software, and software as a service model (saas). So, there are three kinds of models available across the industry. The land-based software is purchased by the company, and all the data is stored on the company server. Software maintenance of parts is carried out by company IT staff or with the help of a service vendor. Web-based software is available through a monthly or yearly subscription. Data is stored on cloud

storage, and all maintenance activities are carried out by the software provider. In the next decade, land-based CMMS software will be preferred by large organizations, while small organizations will prefer SAAS-based solutions. CMMS software vendors can be categorized into two major groups: Tier 1 and Tier 2. Tier 1 is SAP, IBM Maximo, Infor LN, and IFS; Tier 2 is Avantis, Oracle, Mainsaver, E-Maint, and Fiix.

New trends in CMMS, or enterprise asset management inventory: Industrial Internet of Things, so these modules will be added. Cloud computing is also part of it. With big data and advanced analytics, all the data that is gathered during maintenance is used for trend analysis and better optimization to get higher efficiency in the maintenance plan. Blockchain, mobility, and the SAAS model are the features that are coming into the CMMS and the enterprise asset management industry. Industrial Internet of things uses industrial Ethernet for connected devices concept. Cloud computing and big data analytics include the processing of a large amount of data for predictive analytics using machine learning algorithms. Blockchain technology is helping asset management capture all transactions and changes in the state of equipment.

EAM versus CMMS: (Enterprise asset management) EAM and CMMS were both developed to help maintain and optimize assets, but the scope and impact differ and have evolved over time. Modern EAM solutions take essential CMMS functionality and expand and integrate it across the core areas of business, addressing the complete life cycle of assets from initial research and capital planning to eventual disposal or recycling. EAM solutions leverage technologies like AI, machine learning, and advanced analytics

to provide real-time insight into asset performance and maintenance needs and can be customized to meet the specific needs of different industries and organizations. So while CMMS remains a useful and important tool, modern EAM solutions are better equipped to handle complex and dynamic business needs and deliver a more agile approach to asset management, helping to best optimize asset usage, reduce cost, and maximize return on investment.

Introduction to asset performance optimization: In the mining industry, the efficient performance of assets is critical for achieving operational excellence and maximizing productivity. Asset performance optimization refers to the strategic use of technology, data-driven insight, and maintenance practices to enhance the reliability, availability, and performance of mining assets. Understanding the importance of asset performance in the mining industry. Mining companies heavily rely on their assets to carry out various operations such as excavation, transportation, and processing. The optimal performance of assets directly impacts the overall efficiency and profitability of mining operations. So the role of a CMMS solution in enhancing asset performance. The computerized maintenance management system (CMMS) solution plays a crucial role in optimizing asset performance. These advanced software tools help mining companies efficiently manage maintenance activities, plan predictive maintenance, and monitor asset health in real time. The key objective of asset performance optimization-The primary objectives of asset performance optimization are to reduce downtime, maximize maintenance costs, improve equipment reliability, and extend the lifespan of mining assets. By achieving this goal, mining companies can maximize their return on investment and ensure sustainable operations.

Question 3. What are the primary objectives of asset performance optimization in mining? increase downtime and minimize maintenance costs, improve equipment reliability and minimize return on investment, extend the lifespan of mining assets and maximize maintenance costs, achieve sustainable operations and decrease equipment reliability, and reduce downtime, minimize maintenance costs, improve equipment reliability, and extend the lifespan of mining assets.

The right answer is reduce downtime, minimize maintenance costs, improve equipment reliability, and extend the lifespan of mining assets.

Challenges in asset management for the mining sector: The mining industry faces various challenges in effectively managing its diverse and extensive asset portfolios. These challenges can hinder asset performance and lead to increased maintenance costs over time and downtime. Managing a vast and complex asset portfolio, dealing with high maintenance costs and downtime, ensuring regulatory compliance and safety standards, and addressing the impact of environmental factors on assets. Managing vast and complex asset portfolios- Mining operations typically involve a wide range of assets,
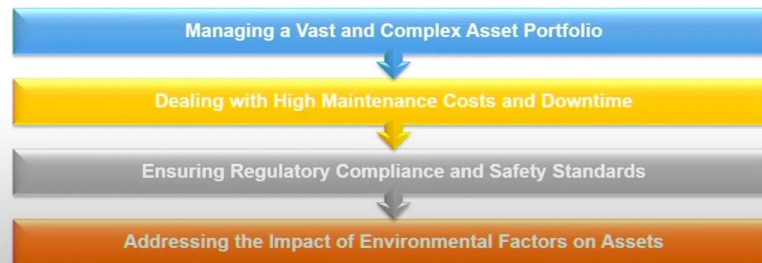
including heavy machinery, vehicles, conveyor systems, and processing equipment. Managing this vast and complex asset portfolio can be overwhelming without proper tools and strategies. Dealing with high maintenance costs and downtime- Maintenance costs can constitute a significant portion of a mining company's expenses. Unscheduled downtime due to asset failure can disrupt production schedules and result in financial losses. Ensuring regulatory compliance and safety standards. The mining industry is subject to strict regulatory requirements, standards, and safety standards. Non-compliance can lead to penalties and reputational damages. Addressing the impact of environmental factors on assets- Mining assets are exposed to harsh environmental conditions such as extreme temperatures, dust, and moisture. These factors can accelerate wear and tear, leading to premature asset failures.

Benefits of a CMMS solution for mining companies- The implementation of CMMS solutions in mining companies and operations can yield numerous benefits, including enhanced equipment reliability, maintenance efficiency, and overall asset management. So it is improved equipment reliability and availability. It enhances maintenance planning and scheduling. It enhances real-time monitoring and condition-based maintenance. It streamlines inventory and spare parts management. It also helps with data-driven decision-making and predictive analytics. Improved equipment reliability and availability. CMMS solutions enable mining companies to implement effective preventive maintenance programs, reducing the likelihood of unexpected breakdowns and improving equipment reliability and availability. Enhance maintenance planning and scheduling. CMMS tools provide advanced planning and scheduling features, allowing maintenance teams to optimize work orders, allocate resources efficiently, and reduce downtime. Real-time monitoring and condition-based maintenance-It helps with IoT

Benefits of CMMS Solutions for Mining Companies

integration, CMMS solutions enable real-time monitoring of asset performance and condition-based maintenance, allowing for timely intervention and maximizing equipment failures. Streamline inventory and spare parts management-The CMMS system helps streamline inventory management by providing accurate asset data, ensuring the availability of spare parts when needed, and reducing inventory holding costs. Data-driven decision-making and predictive analytics-CMMS solutions leverage data analytics and predictive maintenance algorithms to identify patterns, detect anomalies, and provide data-driven insights for informed decision-making.

Key feature of CMMS for the mining industry-CMMS solutions designed for the mining industry offer a comprehensive set of features tailored to meet the specific needs of asset-intensive mining operations. Asset tracking and historical maintenance data,Work order management and task assignment, Preventive maintenance and inspection checklist, Integration with IoT sensors and predictive maintenance, mobile access, and remote workforce management.

Key Features of CMMS for the Mining Industry

CMMS solutions designed for the mining industry offer a comprehensive set of features tailored to meet the specific needs of asset-intensive mining operations.

- Asset Tracking and Historical Maintenance Data
- Work Order Management and Task Assignment
- Preventive Maintenance and Inspection Checklists
- Integration with IoT Sensors and Predictive Maintenance
- Mobile Access and Remote Workforce Management
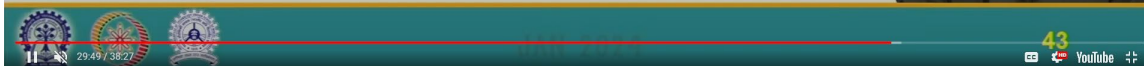
Asset tracking and historical maintenance data-CMMS systems track the complete maintenance history of mining assets, including past work orders, repairs, and inspections. This historical data helps in identifying recurring issues and planning preventive maintenance. Work order management and task assignment-CMMS solutions streamline work order management, enabling the maintenance team to create, assign, and track tasks efficiently. This feature ensures that maintenance activities are carried out promptly and in a structured manner. Preventive maintenance and inspection checklist-CMMS platforms allow the creation and scheduling of preventive maintenance tasks, along with a detailed inspection checklist. Regular inspections and maintenance activities help prevent unexpected breakdowns and extend asset life. Integration with IoT sensors and predictive maintenance-The CMMS solution can integrate with IoT sensors and other data sources to gather real-time asset performance data. This integration enables predictive maintenance, allowing mining companies to address potential issues before they escalate. Mobile access and remote workforce management-Mobile CMMS applications enable technicians to access maintenance information on the go, carry out inspections, and update work orders in real time. Remote workforce management ensures efficient collaboration among team members.

Implementing CMMS in mining operations-The successful implementation of a CMMS system in a mining operation requires careful planning, stakeholder involvement, and change management. First is assessing CMMS implementation readiness and then select the right CMMS solution for specific mining needs. Then develop a comprehensive implementation strategy. Then training and skill development for maintenance teams. Finally, overcoming resistance to change and ensuring adoption. Assessing the CMMS implementation readiness-Prior to implementation, mining companies should

assess their readiness for CMMS adoption. This involves evaluating existing processes, data quality, and the availability of resources. Selecting the right CMMS solution for specific mining needs-Choosing a CMMS solution that aligns with the unique requirements of mining operations is essential. The key factors to consider include the scalability, integration, capabilities, and industry expertise of the vendor. Developing a comprehensive implementation strategy-Successful CMMS implementation requires a well-defined strategy that includes setting clear goals, establishing timelines, allocating resources, and defining roles and responsibilities. Training and skill development for maintenance teams-Proper training and skill development are crucial for ensuring that maintenance teams can effectively use the CMMS system and leverage its features to the fullest. Overcoming resistance to change and ensuring adoption-CMMS implementation may face resistance from employees accustomed to traditional maintenance practices. Effective change management is necessary to overcome resistance and ensure adoption.

Future trends in CMMS for the mining industry-The mining industry is evolving, and future trends in CMMS solutions are poised to revolutionize asset management practices.

AI machine learning for predictive maintenance-Advances in AI and machine learning will enable more accurate predictive maintenance, minimizing asset failures and optimizing maintenance schedules.

Advanced data analytics for performance optimization-CMMS solutions will leverage advanced data analytics to provide deeper insight into asset performance, enabling proactive decision-making.

Robotics and automation in asset management-The mining industry may witness the integration of robotics and automation technologies to handle routine maintenance tasks and inspections.

Cloud-based CMMS solution and scalability-A cloud-based CMMS platform will become more prevalent, offering scalability and easy access to data for geographically dispersed mining operations.

These are the references. So let us summarize in a few sentences what we have learned in this lesson. We have discussed maintenance and its types. We have introduced the concept of managing the maintenance process in various industries. We have explored the foundational steps involving effective maintenance management, and introduced the computerized maintenance management system. We have examined advantages such as enhanced efficiency and streamlined maintenance processes. We have explored the different functional modules within a CMMS. We have discussed various models of CMMS software applications. We have introduced the software used for the implementation of CMMS. We have explored emerging trends in the CMMS and enterprise asset management industries. We have highlighted the distinction between EAM and CMMS systems. We have introduced the concept of optimizing asset performance for efficiency. We have addressed challenges specific to asset management in the mining sector. We have examined the advantages of computerized maintenance management systems in mining operations. We have explored essential features tailored for the mining industry within CMMS solutions. We have discussed the process of integrating CMMS into mining operations for improved efficiency. We have explored evolving trends shaping the future of CMMS in the mining industry. Thank you.