

Optimizing Organizational Efficiency: The Strategic Necessity of Modern Industrial Asset Hierarchy Management

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Abstract: *Asset Hierarchy Management (AHM) is not just a theoretical concept but a practical tool for optimizing operations in modern businesses, particularly in sectors with intricate infrastructures such as manufacturing, utilities, and healthcare. This research paper explores the significance of AHM in standardizing and enhancing organizational efficiency. It traces AHM's evolution, delineates its benefits, and provides strategies for implementation. By emphasizing the tangible benefits of AHM, the paper aims to instill optimism in the audience about its potential impact. The paper outlines prerequisites and steps for developing a robust asset hierarchy, stressing transparent governance and integration with technology solutions like Enterprise Asset Management (EAM) software. Furthermore, it presents a detailed framework for implementing AHM in manufacturing plants, highlighting the importance of defining clear asset categories, hierarchical levels, and relationships. By adhering to best practices and leveraging advanced tools, organizations can effectively manage assets, drive operational excellence, and achieve sustainable growth.*

Keywords: Asset Hierarchy Management, manufacturing, efficiency, maintenance, standardization, implementation, framework, optimization, CMMS.

1. Introduction

In today's dynamic business landscape, companies operate within complex ecosystems comprising diverse assets spanning various functions such as manufacturing, supply chain, facilities management, and IT infrastructure. Managing these assets efficiently is not just a necessity, but a strategic imperative for maintaining competitiveness and ensuring operational excellence. Asset Hierarchy Management (AHM) emerges as a strategic approach to address this challenge by providing a structured framework for classifying, organizing, and managing assets across different organizational domains. In the modern business operations landscape, companies face the formidable task of managing diverse assets across multiple sectors and departments. The efficient management of these assets is pivotal for optimizing performance, ensuring regulatory compliance, minimizing risks, and enhancing overall productivity. In this context, asset hierarchy management emerges as a strategic approach to streamline and standardize various facets of a company's operations. This research paper delves into the intricate realm of asset hierarchy management, aiming to elucidate its significance as a fundamental framework for organizational efficiency and effectiveness. By establishing a structured hierarchy of assets, companies can gain comprehensive insights into their resources, facilitate seamless communication across departments, and foster a culture of transparency and accountability. The need for standardized asset management practices becomes increasingly pronounced in industries characterized by complex infrastructures, such as manufacturing, utilities, and healthcare. Without a cohesive hierarchy, companies risk encountering inefficiencies, redundancies, and misalignments in their operations, ultimately hindering their ability to adapt to dynamic market conditions and capitalize on emerging opportunities. Moreover, the advent of digital transformation has propelled

the importance of asset hierarchy management to new heights. With the proliferation of Internet of Things (IoT) devices, big data analytics, and cloud computing, companies possess unprecedented capabilities to gather, analyze, and leverage vast quantities of asset-related data. However, harnessing this potential necessitates a robust asset hierarchy management framework to organize disparate data sources, derive actionable insights, and drive informed decision-making.

2. Literature review and Development

The history of asset hierarchy management traces back to the early days of industrialization when companies began grappling with the challenges of organizing and managing their growing inventories of physical assets. While rudimentary forms of asset tracking and management existed, they were often decentralized and lacked standardization, leading to inefficiencies and operational silos. The early to mid-20th century witnessed significant advancements in asset management practices, driven by the emergence of scientific management principles pioneered by figures such as Frederick Winslow Taylor and Henry Ford. These principles emphasized the systematic analysis and optimization of workflows, including the management of assets, to enhance productivity and efficiency in manufacturing and other industries. During this period, asset hierarchy management began to take shape by developing hierarchical structures for organizing assets based on their functional relationships, criticality, and lifecycle stages. These hierarchical models gave companies a systematic framework for categorizing and prioritizing assets, laying the foundation for more efficient maintenance, utilization, and investment decisions. In the latter half of the 20th century, they witnessed further evolution in asset hierarchy management, driven by technological advancements and the

widespread adoption of computerized systems for asset tracking and management. With the advent of Enterprise Resource Planning (ERP) systems in the 1980s and 1990s, companies gained greater visibility and control over their assets by centralizing data and standardizing processes across different functional areas. The dawn of the 21st century brought about a paradigm shift in asset hierarchy management, fueled by the convergence of digital technologies such as IoT, big data analytics, and cloud computing. These technologies enabled companies to collect real-time data from sensors embedded in assets, analyze this data to extract actionable insights, and optimize asset performance in previously unimaginable ways.

Today, asset hierarchy management has evolved into a sophisticated discipline encompassing physical assets, digital assets, intellectual property, and human capital. Companies leverage advanced analytics, machine learning, and AI-driven algorithms to optimize asset allocation, predict maintenance needs, and mitigate risks proactively.

Looking ahead, emerging trends such as Industry 4.0 are likely to shape the future of asset hierarchy management. Industry 4.0 promises to integrate digital technologies into asset management processes further, enabling companies to achieve unprecedented efficiency, agility, and resilience in an increasingly complex and interconnected world.

AHM involves the hierarchical structuring of assets based on their attributes, relationships, and dependencies. At its core, AHM aims to establish a standardized taxonomy that defines the classification of assets at different levels, from the overarching categories to the granular components. Organizations can gain insights into their interconnections, dependencies, and utilization patterns by categorizing assets hierarchically, facilitating informed decision-making and resource optimization.

3. Advantages and Importance of AHM

Implementing a robust asset hierarchy management system in a manufacturing plant offers a multitude of benefits and advantages:

- **Improved Equipment Utilization:** Asset hierarchy management allows better equipment usage and performance tracking. Manufacturers can optimize utilization by understanding the relationships between different assets, ensuring that equipment is efficiently allocated across production processes.
- **Enhanced Maintenance Planning:** A well-structured asset hierarchy facilitates proactive maintenance planning. By organizing assets based on criticality and dependencies, maintenance teams can prioritize inspections, repairs, and replacements effectively, reducing unexpected downtime and minimizing production losses.
- **Optimized Spare Parts Management:** Asset hierarchy management enables manufacturers to maintain an accurate inventory of spare parts. By categorizing parts according to their associated assets, it becomes easier to identify critical components, track stock levels, and

ensure timely availability when needed, reducing inventory costs and preventing production delays.

- **Streamlined Workflow Management:** With a clear asset hierarchy, workflow management becomes more efficient. Maintenance tasks, work orders, and inspection schedules can be aligned with the hierarchical structure, allowing for better coordination between teams and departments and improving overall productivity.
- **Facilitated Regulatory Compliance:** Manufacturing plants are often subject to various regulatory requirements regarding equipment maintenance and safety standards. An asset hierarchy management system helps ensure compliance by documenting maintenance activities, equipment history, and safety protocols, reducing the risk of penalties or fines.
- **Enhanced Asset Performance Analysis:** Manufacturers can perform in-depth performance analysis by capturing detailed data at each level of the asset hierarchy. This includes monitoring equipment reliability, identifying recurring issues, and evaluating the effectiveness of maintenance strategies, leading to continuous improvement and optimized asset performance.
- **Reduced Downtime and Production Losses:** Proactively managing assets through a hierarchical structure minimizes unplanned downtime and production losses. By identifying potential failure points and implementing preventive maintenance measures, manufacturers can mitigate risks and ensure uninterrupted production processes, maximizing output and profitability.
- **Cost Savings and Improved ROI:** Efficient asset hierarchy management leads to cost savings across manufacturing operations. Manufacturers can achieve significant cost reductions and improve their capital assets' return on investment (ROI) by optimizing maintenance activities, reducing downtime, and prolonging equipment lifespan.
- **Enhanced Safety and Risk Mitigation:** Safety is paramount in manufacturing environments, and effective asset hierarchy management contributes to a safer workplace. By ensuring that equipment is properly maintained and operated according to safety protocols, manufacturers can minimize the risk of accidents, injuries, and hazardous incidents, safeguarding both employees and assets.
- **Support for Strategic Decision-Making:** A comprehensive asset hierarchy provides valuable insights for strategic decision-making. Manufacturers can use data collected from asset management systems to inform investment decisions, optimize resource allocation, and align maintenance strategies with broader business objectives, driving long-term growth and competitiveness.

From a maintenance perspective, an asset hierarchy allows teams to prioritize maintenance activities based on the criticality and importance of each asset. Critical assets, which are higher in the hierarchy or play essential roles in operations, can receive more attention and resources to ensure they remain in optimal condition. When issues arise with an asset, having a clear asset hierarchy enables

maintenance teams to conduct more efficient root cause analysis. They can trace problems to specific components or subsystems within the asset hierarchy, helping them identify the underlying issues more quickly and accurately. Understanding the relationships between assets allows maintenance teams to develop more effective preventative maintenance plans. They can anticipate potential failures or breakdowns based on the condition of related assets or components, enabling proactive maintenance actions to prevent costly downtime. Asset hierarchies help in allocating resources more effectively. Maintenance teams can allocate personnel, tools, and spare parts based on the criticality and maintenance needs of different assets within the hierarchy, optimizing resource utilization across the organization. Establishing a standardized asset hierarchy across multiple sites or facilities ensures consistency in maintenance practices and procedures. This standardization simplifies communication and collaboration between different teams and helps share best practices across the organization. Overall, an asset hierarchy provides a structured framework for organizing, prioritizing, and managing maintenance activities, leading to improved asset reliability, reduced downtime, and optimized maintenance costs.

4. Framework and Implementation

While the benefits of AHM are substantial, organizations often encounter challenges during the building phase and implementation, including data inconsistency, resistance to change, and integration complexities. To address these challenges, companies can adopt best practices such as Establishing clear governance structures and roles for overseeing AHM initiatives and leveraging technology solutions, such as Enterprise Asset Management (EAM) software, to automate asset classification and maintenance workflows. Conducting regular audits and data validation exercises to ensure the accuracy and completeness of asset information. Providing training and change management support to employees to foster buy-in and adoption of AHM practices. Any organization should follow some prerequisites before they dive into the norms of defining equipment or machines as part of the AHM. They are as follows:

4.1 Pre-requisites

4.1.1 Begin with an Audit

An organized, regularly updated inventory of assets serves as the foundation for effective Asset Hierarchy Management (AHM). If any significant changes have occurred in your equipment or the facility recently, keeping your asset inventory current is crucial. A comprehensive equipment asset management audit typically involves the following steps:

- Compilation of all installed equipment/machinery in the plant.
- Cataloging of auxiliary and facility-related equipment that support the plant's operations.

The objective is to establish a cohesive inventory system categorized by asset purpose, type, or assigned cost center.

For larger organizations, a hierarchical multi-branch structure often proves most effective. Subsequently, all assets are recorded following a predefined convention. Moreover, the updated inventory should reflect recent policy alterations regarding asset management across various teams, such as newly imposed usage limits for on-demand instances.

4.1.2 Implement Tagging and Naming Conventions

Structured asset metadata represents the second vital component of scalable asset management. Haphazard naming or tagging practices obscure asset visibility and impede scalability, as they preclude automated categorization and efficient filtering. Here are some best practices for asset tagging:

- Establish standardized asset categories (e.g., business application, plant site, line structure, area of the machine) and types (e.g., machine, subgroup or machine sections, equipment).
- Enforce naming conventions; commonly, organizations adopt an alphanumeric system that encodes the asset type and designation.
- Utilize descriptive tags to furnish additional contextual details. Tags should be concise and convey pertinent information immediately.
- Incorporate ownership information to facilitate cost attribution and streamline requests.

The asset naming convention should adopt a hierarchical structure, with a descriptive prefix as the primary element for search and categorization. Ensure the absence of duplicate names and implement rules to prevent their recurrence. The desired outcome is a hierarchical tree structure that promotes consistent, distinctive naming and facilitates effortless asset discovery.

4.2 Main steps to create a framework of hierarchy

After completing the prerequisites, we can define the structure and category of the various equipment in a plant or manufacturing industry. The following steps can be structurally followed to create a robust asset hierarchy structure:

- Define Specific Asset Categories: Initiate the asset hierarchy creation process by outlining distinct asset categories or types pertinent to your organization, such as equipment, facilities, vehicles, tools, and machinery.
- Identify Hierarchical Levels: Develop hierarchical levels based on location, function, departmental divisions, or the significance of assets within the organizational workflow.
- Establish Relationships and Dependencies: Clarify the connections and dependencies between various levels of the hierarchy to represent how assets interact and rely on one another accurately.
- Standardize Nomenclature: Ensure uniformity and clarity across the organization by standardizing the terminology used to refer to assets and hierarchical levels.
- Incorporate Metadata and Attributes: Enrich the hierarchy by integrating metadata and attributes, such as asset specifications, maintenance history, and performance metrics. This addition provides valuable context and insights into the assets' characteristics and usage.

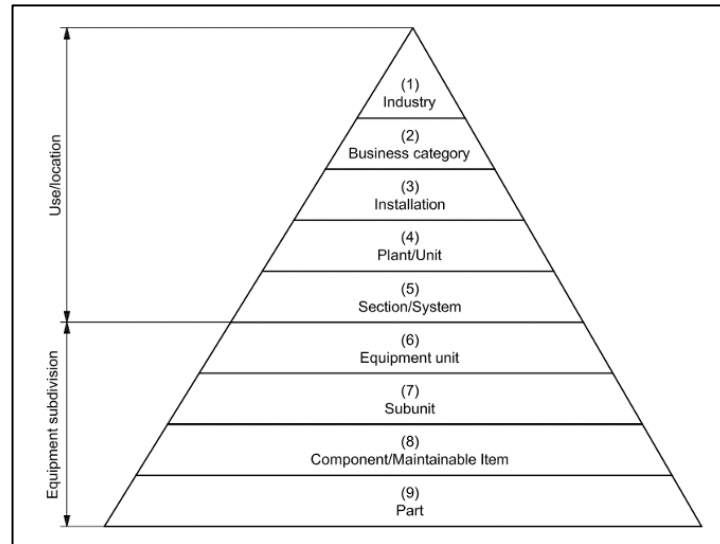


Figure 1: ISO 14224 – Equipment Taxonomy

Figure 1 explains the ISO standard developed by the Oil and gas Industry to standardize their equipment in the correct hierarchical structure to support day-to-day operations. Organizations and manufacturing sectors have adopted this standard to define their equipment hierarchy.

Establishing a structured asset hierarchy is critical to maintaining assets effectively, enhancing performance, and generating precise data and analytics on asset performance, ultimately boosting reliability. The below steps should be followed to develop an asset hierarchy:

Step 1: Identify and Categorize Assets

Begin by identifying and categorizing the assets that require meticulous tracking. Organizations must exhibit diligence in asset tracking, accurately categorizing all essential components such as equipment, facilities, and machinery to ensure precise asset management. For instance, in managing maintenance operations for a large manufacturing plant, assets can be identified, tracked, and categorized as follows:

Production equipment: conveyor belts, packaging machines, assembly lines.

Facility assets: HVAC systems, lighting, plumbing.

Support tools: forklifts, pallet jacks, hand tools.

Vehicles: delivery trucks, maintenance vehicles.

IT assets: servers, routers, networking equipment.

Step 2: Define Hierarchy Levels

Establish a hierarchy to organize and identify assets. Depending on the environment's complexity, hierarchy levels may include location, system, subsystem, and component. This step ensures efficient identification of all assets.

Step 3: Assign Unique Identifiers

Each asset must be tagged with a unique identifier, such as a barcode or serial number, to facilitate tracking and maintenance, streamline processes, and enable easy retrieval.

Step 4: Map Assets to Hierarchy Levels

Classify assets according to their hierarchical order, cataloging them based on geographic placement, system, subsystem, and entity. Proper mapping is crucial for accurate tracking.

Step 5: Establish Relationships

Define relationships between assets to monitor and track dependencies effectively. This ensures asset integrity and performance by enabling managers to oversee component connections.

Step 6: Record Asset Data

Maintain meticulous records of each asset, including maintenance history, location, and other pertinent details. This ensures accurate data for efficient management.

Step 7: Integrate with CMMS

Utilize a Computerized Maintenance Management System (CMMS) to consolidate and organize asset data, track maintenance history, and prioritize tasks. This software offers comprehensive visibility into the asset base and associated maintenance activities, optimizing operations.

Figure 2 explains the systematic approach and consideration of several vital points, as described by one of the leading CMMS manufacturers today, while defining and developing a company's robust equipment/asset hierarchy.

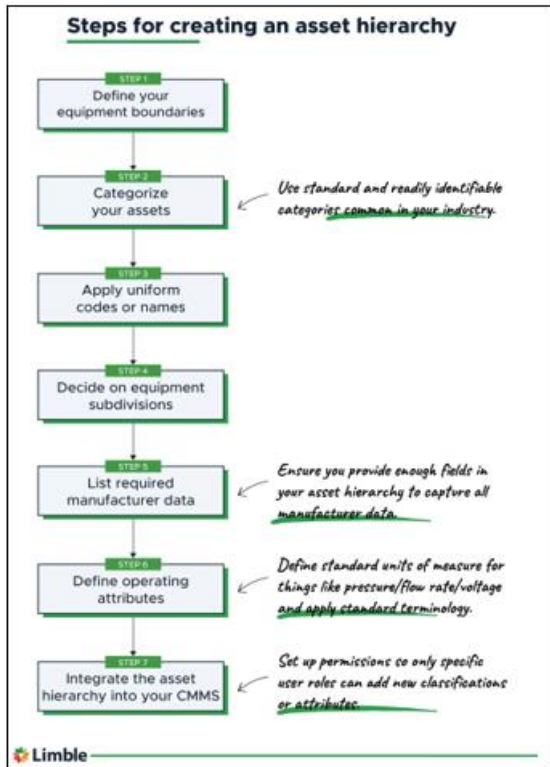


Figure 2: Steps for creating asset hierarchy

(source: <https://limblecmms.com/wp-content/uploads/Steps-for-creating-an-asset-hierarchy-01-scaled-1.webp>)

5. Implementation: A case study of the food and beverage industry

A food and beverage manufacturing company has two significant operations sections: processing and packaging. It is critical to understand these two areas carefully and identify equipment that belongs to each location, including the support equipment that is common to both regions. After completing the prerequisites mentioned in the above sections, we can start working on creating the proper structure of various assets. Figure 3 is a tree structure that explains multiple elements of the nodes that should be used for adequately defining positions and equipment in an asset hierarchy.

Company: This is the overall company/organization for which the asset hierarchy is expected to be made. Since the organization remains constant and will not change, we can define this using a combination of alphanumeric characters

or the company name.

Plant: This defines the manufacturing plant of a given organization/company for which the asset hierarchy is set up. It can be used for single or multi-plant models across a country or multiple countries.

Line: Various lines might run different products according to an organization's portfolio. The line concept is beneficial for segregating equipment hierarchy, as it helps track productivity, efficiency, expenditures, and costs associated with maintaining equipment reliability over a given period.

Operation type: Various operations are carried out in the food and beverage industry. On a higher level, they can be separated into two major types – processing and packaging. Processing includes operations like manufacturing the products, and packaging includes putting those manufactured products into pouches/bags. Packaging also includes preparing boxes and palletizing operations. It is beneficial to capture these operation types separately as it helps monitor equipment performance and reliability easily and helps provide resources and attention wherever required.

Area of machine: This section includes where a specific machine is in the manufacturing facility. For example, the processing section might include places like batching, Washing, Mixing, Utility, Wastewater, pouching, cartooning, and palletizing. This segregation helps to provide specific details about every piece of equipment and how its performance affects overall line performance, etc.

Machine: This section includes the OEM machines installed in the facility for specific operations.

Machine sub-group: This section breaks down the OEM machinery into sub-groups to facilitate understanding and capture data from both operations and financial points of view, correctly capturing performance and cost expenditures in running specific machines.

Equipment: This section defines the equipment of a given piece of machinery that entered the CMMS system. This equipment is defined as a unique internal number generated through the CMMS system or a manually generated number. These numbers are used to create maintenance orders for repairs and services.

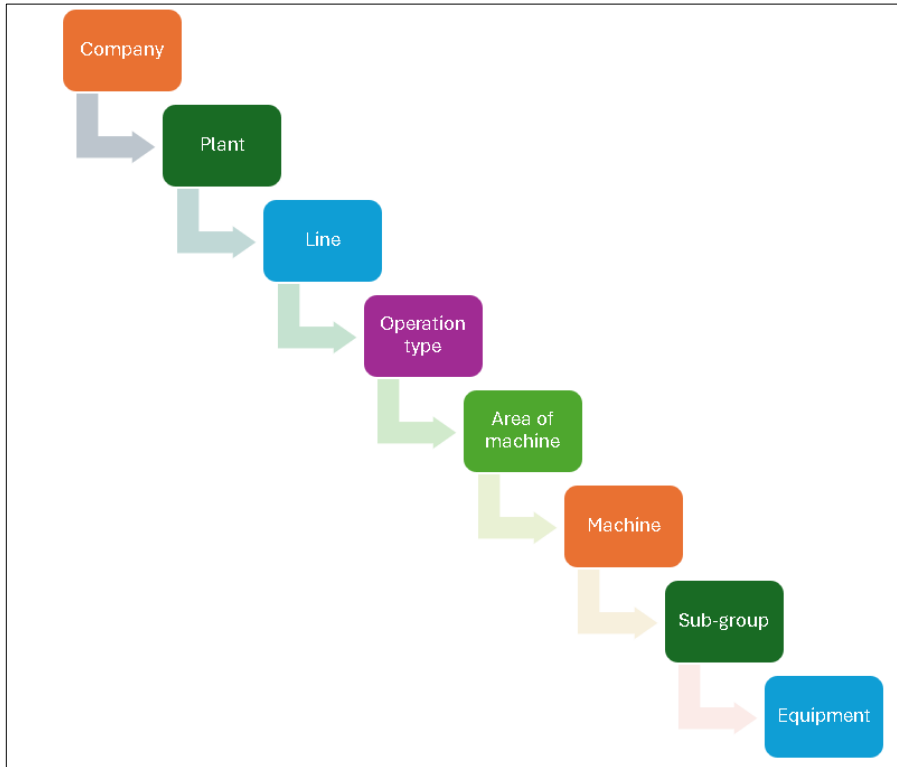


Figure 3: Asset hierarchy structure for manufacturing plants

Figure 4 shows an example of an asset hierarchy structure that can be used to define the various sections and areas of the plant, as mentioned in the above section, using a CMMS system. The number of characters and selection of character types depend on the capability of the given CMMS system. Section from the company to the subgroup can be solely

alphanumerics or a combination of alphanumeric characters. The unique identifier generated for each piece of equipment is mainly in numeric format to support the smooth and streamlined function of various transactions in the CMMS system.

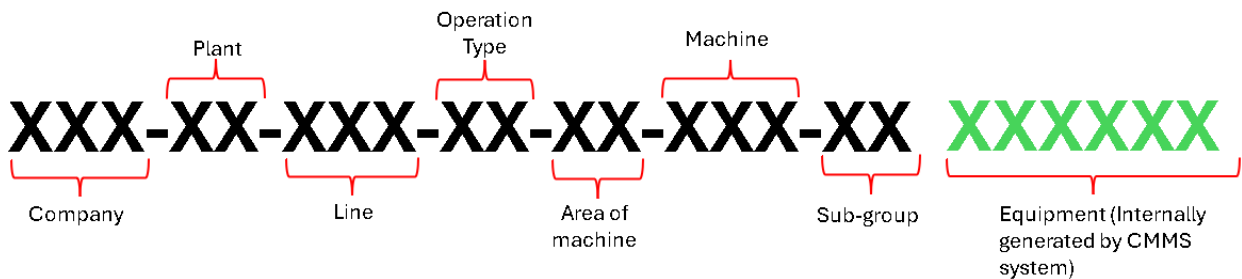


Figure 4: Nomenclature for defining locations and equipment in an asset hierarchy structure for manufacturing plants

Some additional key points should be considered when defining an asset hierarchy for the equipment. They are as follows:

- Begin by establishing clear criteria for defining a system, ensuring consistency and clarity throughout the hierarchy.
- Employ a systematic approach to categorize assets, utilizing a hierarchical structure akin to the provided diagram or defining specific asset classes (e.g., Pumps).
- Opt for standardized, industry-common categories to streamline integration for new personnel and external contractors, minimizing confusion and the use of unnecessary technical jargon.
- Develop consistent equipment names and codes for easy identification and meaningful analysis. Enforce a naming convention within your Computerized Maintenance Management System (CMMS) to maintain consistency

and avoid the proliferation of unofficial abbreviations or failure codes that could compromise data integrity.

- Utilize a predefined list of equipment subunits to ensure consistency. For example, a generic compressor may include subunits such as Compressor, Control and Monitoring, Receiver, Air Treatment, Power Transmission, and Miscellaneous. Applying these subunits uniformly within your CMMS to uphold data integrity even for simpler units.
- Ensure the asset hierarchy includes fields to capture essential manufacturer data, such as part numbers, serial numbers, and model numbers. This information is crucial for analyzing failure modes, assessing reliability, and understanding maintenance costs.
- Specify relevant data corresponding to each sub-unit, such as pressure and flow rates for hydraulic components or voltage and current for electrical devices.

- Standardize units of measure and terminology to prevent discrepancies. Consistent terms like W (watts), kW (kilowatts), or MW (megawatts) should be used. Maintain consistency in unit presentation to avoid confusion during searches or analyses.
- Seamlessly incorporate the asset hierarchy into your CMMS to establish a standardized framework for asset management.
- Users should strictly adhere to the defined hierarchy, with the CMMS restricting everyday users' creation of new classifications or attributes. Permission to modify the hierarchy should be granted or restricted based on user roles within the CMMS. Ensure the hierarchy structure accommodates all current requirements and allows for future adjustments as necessary, administered by authorized personnel.

6. Future directions

As businesses evolve in response to technological advancements and changing market dynamics, Asset Hierarchy Management (AHM) holds significant promise for further innovation and development. This research lays the groundwork for future explorations and enhancements in several key areas:

- **Integration of Emerging Technologies:** The ongoing advancement of technologies such as artificial intelligence (AI), machine learning (ML), and the Internet of Things (IoT) presents opportunities to enhance AHM systems. Future research could leverage these technologies to automate asset classification, predictive maintenance, and decision-making processes, thereby improving efficiency and reducing operational risks.
- **Enhanced Data Analytics:** The proliferation of big data analytics offers the potential to extract deeper insights from asset-related data. Future studies could explore advanced analytics techniques to uncover patterns, trends, and correlations within asset hierarchies, enabling organizations to make more informed decisions and optimize resource allocation.
- **Scalability and Flexibility:** As organizations expand and diversify their operations, AHM systems must evolve to accommodate scalability and flexibility. Future research could investigate approaches to designing AHM frameworks adaptable to changing organizational structures, industry regulations, and technological landscapes, ensuring long-term relevance and effectiveness.
- **Interoperability and Standardization:** In an increasingly interconnected business environment, interoperability and standardization are essential for seamless data exchange and collaboration. Future studies could focus on developing standardized protocols and data formats for asset hierarchies, enabling interoperability between different systems and facilitating data sharing across organizational boundaries.
- **Risk Management and Resilience:** With the growing complexity of business operations, managing risks and ensuring business continuity becomes paramount. Future research could explore how AHM systems can contribute to proactive risk management strategies, including

identifying and mitigating vulnerabilities within asset hierarchies, enhancing resilience to disruptions, and safeguarding critical assets.

- **Human Factors and Organizational Culture:** Despite technological advancements, the success of AHM initiatives ultimately depends on human factors such as organizational culture, employee skills, and change management practices. Future research could investigate strategies to foster a culture of asset management excellence within organizations, empowering employees to embrace AHM principles and contribute to continuous improvement initiatives.

7. Conclusion

Asset Hierarchy Management (AHM) emerges as a critical framework for organizations seeking to optimize efficiency, streamline operations, and ensure long-term competitiveness. Through the systematic classification and organization of assets across hierarchical levels, AHM enables companies to gain comprehensive insights into their resources, enhance decision-making processes, and mitigate operational risks. This research paper has provided a comprehensive overview of AHM, tracing its evolution, delineating its benefits, and outlining strategies for implementation.

The significance of AHM is particularly pronounced in industries characterized by complex infrastructures, such as manufacturing, utilities, and healthcare, where the efficient management of assets is essential for maintaining productivity and regulatory compliance. Organizations can achieve greater visibility and control over their assets by adopting standardized asset management practices and leveraging advanced technologies like Enterprise Asset Management (EAM) software, leading to improved maintenance planning, optimized resource allocation, and enhanced asset performance.

Looking ahead, the future of AHM holds exciting prospects for further innovation and development. Emerging technologies such as artificial intelligence, machine learning, and significant data analytics offer opportunities to automate and enhance AHM processes. At the same time, interoperability standards and scalability considerations will be crucial for accommodating evolving business needs. Moreover, addressing human factors such as organizational culture and change management will be essential for fostering an organizational culture of asset management excellence.

AHM represents a strategic imperative for organizations seeking to thrive in today's dynamic business landscape. By embracing AHM principles and investing in robust frameworks and technologies, companies can unlock new opportunities for operational efficiency, resilience, and growth, positioning themselves for success in the years to come.

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