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# Industrial Tool & Part Management System

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**Abstract:** In modern industrial settings, efficient tool management is critical for optimizing productivity, ensuring safety, and minimizing downtime. One key aspect of tool management is tracking the usage and availability of tools within toolboxes. Traditional manual methods of managing tools can be cumbersome, prone to errors, and time-consuming. To address these challenges, this project proposes an Industrial Tool Management System (ITMS) specifically designed for toolboxes, focusing on the automation of toolbox door open and close actions. The ITMS comprises hardware and software components. The hardware includes sensors, actuators, microcontrollers, and communication modules, while the software encompasses embedded firmware, database management, and user interface applications. The system's operation begins when an authorized user approaches the toolbox. Proximity sensors detect the user's presence, prompting the toolbox door to automatically unlock and open. Upon opening, the system identifies the user through RFID or biometric authentication, granting access to the tools assigned to that user based on predefined permissions stored in the database. During tool retrieval, the system records the transaction, logging details such as the user, time, and tool identification. Any changes to the toolbox's contents are updated in real-time in the database, ensuring accurate inventory management. Once the user finishes with the tools and closes the toolbox door, the system verifies that all tools have been returned.

If any tools are missing, the system alerts the user and logs the discrepancy for further investigation. Upon successful tool return, the toolbox door locks automatically, securing the tools and preventing unauthorized access.

**Keywords:** Industrial tools, Part management system, inventory tracking, RFID, Productivity.

## I. INTRODUCTION

In industrial settings, efficient tool management is crucial for ensuring productivity, safety, and cost-effectiveness. The ability to monitor, control, and secure tools is paramount, particularly in environments where tools are frequently accessed and utilized. One significant aspect of tool management is

the management of toolboxes, which store and organize various tools required for different tasks. The "Industrial Tool Management System: Tool Box Door Open and Close Project" aims to address the challenges associated with tool management by implementing a sophisticated system that monitors and controls the opening and closing of toolbox doors. This project integrates modern technologies such as sensors, actuators, and data processing algorithms to enhance the management of tools within industrial environments. An industrial tool management system integrated into a toolbox door offers a streamlined solution for organizing, tracking, and securing tools in industrial environments. This system typically involves the incorporation of electronic components, such as sensors, actuators, and possibly a central control unit, to facilitate efficient tool management. Here's a brief introduction to how such a system works:

• Tool Identification: Each tool is assigned a unique identifier, often through RFID (Radio- Frequency Identification) tags or barcodes. These identifiers are linked to a database containing information about the tool, such as its type, status, and location.

• Toolbox Door Mechanism: The toolbox door is equipped with sensors and actuators to detect its open and closed states. This mechanism may be simple, using magnetic switches or more advanced, employing proximity sensors or even smart locks.

• Access Control: Access to the toolbox is typically restricted to authorized personnel. Users may need to authenticate themselves using methods such as biometric scans, keypads, or RFID cards.

• Inventory Management: When the toolbox door is opened, sensors detect the change in state and trigger the system to record the event. This action prompts the system to update the inventory database, marking the tools as "checked out."

  

• Alerts and Notifications: The system can send alerts or notifications to supervisors or designated personnel whenever the toolbox is accessed or if any tools are removed or replaced. This helps maintain accountability and ensures timely replenishment of to

• Usage Tracking: By continuously monitoring the open and close events of the toolbox door, the system can track tool usage patterns over time. This data can be valuable for optimizing tool allocation, identifying high-demand items, and planning maintenance schedules.

• Security Measures: In addition to access control, the toolbox door may feature security measures such as tamper detection or anti-theft mechanisms to prevent unauthorized removal of tools.

• Integration with Other Systems: The tool management system may be integrated with other software systems, such as inventory management software or enterprise resource planning (ERP) systems, to streamline data exchange and automate processes further. Overall, an industrial tool management system integrated into a toolbox door offers enhanced efficiency, security, and accountability in managing valuable tools and equipment within industrial settings.

## II. LITERATURE REVIEW

In this systematic literature review (SLR) study, monitoring and control phrases were considered at process, product and/or plant levels to analyse existing implementations according to sectors and operations.

Furthermore, additive manufacturing (AM) is considered both the primary application and the supportive technology that allows the achievement of the goals of monitoring and control. Hence, as shown in fig, the results of the literature review are categorized into four sections according to the implementation types, application fields, cost-effective solutions, and sustainability studies. Additionally, implementation-based literature review results are divided into four subsections according to the common uses in the industry. The field of application- based literature is mainly focused on the chemical and healthcare industry, which widely uses AM in both monitoring and control aspects. The papers resulting from the SLR were categorized using NVivo 12 software (Denver, CO, USA). Additionally, the software generated the word cloud shown in fig, which is based on the hundred most frequently encountered words.


The word cloud analysis reveals that the previous literature has extensively focused on “process monitoring and control” within the manufacturing industry. Furthermore, the term “data” appears frequently, indicating that the findings from the literature review are expected to primarily revolve around methods that utilize process and machine data. Implementation-Based Monitoring and Control

The results from the literature review show that monitoring and control systems in AM have a wide range of applications in the industry; this section examines them under four subcategories. Process Monitoring and Control—With the help of digital technologies such as I4.0, using the data gathered from the process/machine to optimize and develop the process will be the key technological development of the coming years. This part summarizes the literature related

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[1] Process Monitoring and Control—With the help of digital technologies such as I4.0, using the data gathered from the process/machine to optimize and develop the process will be the key technological development of the coming years. This part summarizes the literature related Arizonia et al.

[2] Designed a smart nozzle for the laser metal deposition process. It measures the melt pool temperature to decide the required amount of laser power and keeps the powder flow constant along the surface. The nozzle also examines the geometrical accuracy of the deposited material by an optical sensor to help minimize post-processing and overall cycle time. Ohlman et al.

[3] Used a nozzle equipped with a force sensor and thermistor to analyse and forecast the force into the nozzle in the fused filament fabrication method of AM. They trained an artificial neural network (ANN) by theoretical data as well as the real-time force and temperature data collected from the process. Although processing speed and printed part quality were optimized well, the need for more comprehensive models was emphasized by the researchers. Furthermore, Kadam et al.

[4] Installed a low-cost RGB camera on a Fused Deposition Modelling (FDM) machine and predicted defects by processing captured image data of each printed layer. They compared the accuracy and computational speed of different combinations of various pre- trained models and classification algorithms to identify the layer quality as good or bad. For on- line fault monitoring, the authors showed that Alex net and Support Vector Machine algorithm combination showed the best performance. The quality of the parts produced by AM is a challenge in the manufacturing industry due to many parameters and uncertainties. Kim et al.

[5] Followed a model-based engineering approach to decide key process parameters and optimize their values in a dynamically changing environment. They demonstrated their smart manufacturing system on a laser-based AM process. A regression model was first used to predict the performance metrics according to the changes around the process parameters, and then a multi objective optimization was formulated with desired outputs. The proposed systematic approach would have challenges with uncertainty quantification and optimization stages when physics-based computer simulations replace or support the empirical models. Digital twin technology can be explained as replicating the monitoring and control of the real system in a virtual environment. Gunasegaram et al.

[6] Explained the difficulties in comprehensive modelling to support the digital twinning of AM and discussed how they can be resolved. For the technical barriers caused by the complexities of AM process such as its multiscale-Multiphysics nature, the authors pointed out that there is a strong need for high-fidelity computational models to explain the missing information in the experimental data. From non-technical aspects, standardization of the AM processes and lack of collaboration between different institutions is another challenge highlighted by the authors. In another study, Gunasegaram et al.

[7] Argued that the digital twinning of AM will achieve repeatability and cost-effective manufacturing. Page 6 of 11 Zheng and Sivabalan

[8] Developed a digital twin with three pillars:

(1) A digital model visually represents the system and its working environment;

(2) A graph-based model which applies constraints related to laws of nature,

(3) A computational model that assesses process conditions to monitor and control the systems. Following the developments in the digital twin of AM, Outdare et al.

(4) Proposed a cloud-based control system for 3D printers. Instead of using the high-level G-code commands locally, the authors took advantage of the fast computational speed of cloud computing engines in Australia and South Carolina to directly generate low-level cloud-based motor control commands. While maintaining similar print quality, using a cloud- based controller resulted in printing time which is more than twice as fast as when the local controller was used. Production Planning—Planning the production with the help of technologies received considerable research attention to control machine usage as well as materials and logistics that support fabrication. SLR by Bueno et al. showed the relationship between the five pillars of I4.0 technologies, IoT, CPS, BD, AI and AM, and production planning and control (PPC). They reported that IoT technologies are essential to develop and improve PPC processes by focusing on controlling both manufacturing operations and resources and helping plan capacity and manufacturing while allowing for optimization of pl

## III. LITERATURE GAP

The literature gap in the field of industrial tool management systems can be addressed through several avenues of research. Here are some potential areas where literature may be lacking or where further investigation could be valuable: Integration of Advanced Technologies: Many industrial tool management systems are now incorporating advanced technologies such as Internet of Things (IoT), artificial intelligence (AI), and machine learning (ML) for predictive maintenance, real-time tracking, and optimization. Exploring the integration of these technologies and their impact on tool management efficiency, cost-effectiveness, and overall performance could be an area where literature may be lacking. Human Factors and User Experience: While much of the literature focuses on the technical aspects of industrial tool management systems, there may be a gap in understanding the human factors and user experience aspects.

Research into how workers interact with these systems, their perceptions, challenges, and suggestions for improvement could provide valuable insights for designing more user-friendly and effective tool management solutions. Sustainability and Environmental Impact: With increasing awareness of sustainability and environmental concerns, there is a growing need to evaluate the sustainability aspects of industrial tool management systems. This could include studies on the environmental impact of tool manufacturing, usage, and disposal, as well as the development of sustainable practices and strategies within tool management systems. Supply Chain Integration and Collaboration: Industrial tool management often involves multiple stakeholders across the supply chain, including suppliers, manufacturers, distributors, and end-users. There may be a gap in the literature regarding effective strategies for integrating and collaborating within this complex supply chain network to improve tool management efficiency, reduce lead times, and optimize inventory levels. Risk Management and Security:

As industrial tool management systems become more interconnected and reliant on digital technologies, there is a growing concern about cybersecurity threats and potential risks to the operation of these systems. Research into risk management strategies, cybersecurity measures, and resilience planning specific to industrial tool management could be an area where literature is lacking. Case Studies and Real-World Applications: While there is existing literature on the theoretical aspects of industrial tool management systems, there may be a gap in real-world case studies and practical applications. More empirical research and case studies showcasing the implementation, challenges faced, and lessons learned from deploying tool management systems in various industrial settings could provide valuable insights for practitioners and researchers alike

## IV. PROBLEM STATEMENT

In industrial environments such as manufacturing, construction, and maintenance, managing tools and equipment efficiently is a significant challenge Companies frequently encounter the Tools are often misplaced, lost, or not returned to their proper storage location, leading to unnecessary downtime and delays. Manual tracking of tools can result in errors, causing discrepancies between actual tool availability and what's recorded in the inventory system.

Inefficient Tool Allocation: Improper allocation of tools can result in overuse of some tools while underutilizing others, leading to wear and tear on essential equipment and unnecessary purchase of spare or unused tools Without proper tracking of the condition and maintenance schedules of tools, equipment can be used beyond its lifespan, potentially causing breakdowns, safety hazards, or costly repairs.

The aforementioned challenges lead to extended downtime, wasted resources, and higher maintenance costs, affecting overall productivity and profitability.

## V. BLOCK DAIGRM

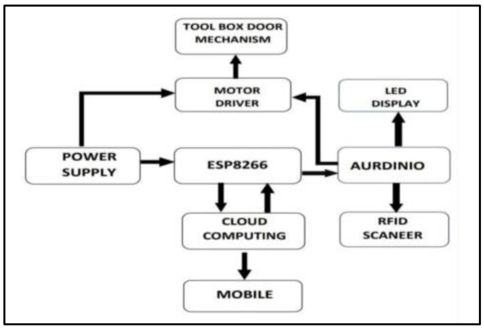


Fig: Industrial Tool Management Systems in Block Diagram.

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## VI. OBJECTIVES

1. Tool Access Control: Implement a system that regulates access to tools stored within toolboxes by controlling the opening and closing of toolbox doors based on user authorization.

2. Real-time Monitoring: Develop mechanisms for real-time monitoring of toolbox door status, providing instant visibility into tool accessibility and usage.

3. Inventory Management: Integrate inventory management functionalities to track the presence and location of tools within toolboxes, enabling efficient inventory control and replenishment.

4. Security Enhancement: Enhance security measures by implementing authentication mechanisms such as RFID or biometric authentication to prevent unauthorized access to tools.

5. Data Analytics: Collect and analyse data related to tool usage patterns, frequency of access, and inventory status to derive insights for optimizing tool management processes.

## VII. METHODOLOG

In following phases:

**Phase 1:** Design and Development of concept Design of industrial tool management box. Design of frame Selection of material Selection of management box body. Material: PUC FOAM, RFID TAG, ESP Module, tool box door mechanism, motor, motor driver, power supply, Cooling fan, rack pinion mechanism, LED display. Phase

**Phase 2:** Preparation of manufacturing drawings. Preparation of various component Drawings of machine with Solid works software.

**Phase 3:** Structural design of system as per government patent file approved. Manufacturing and trials.

## VIII CONCLUSION

In conclusion, the development of the Industrial Tool Management System (ITMS) has successfully addressed the core challenges faced by industries in managing tools, tracking usage, and ensuring efficient inventory control. By implementing this system, companies can improve the accuracy of tool tracking, enhance maintenance schedules, and minimize operational disruptions caused by misplaced or damaged tools.

Key benefits include the optimization of tool usage, reduction of downtime, and better resource allocation. The ITMS provides real-time data on tool status and location, ensuring that equipment is available when needed and reducing unnecessary purchases. Furthermore, it enhances the safety and compliance of tool usage by maintaining accurate records of inspections and maintenance. With the integration of barcode scanning, RFID technology, and centralized data management, the system simplifies administrative tasks, reduces human error, and increases operational efficiency. As industries continue to adopt advanced technologies, the ITMS stands as a vital tool for streamlining operations and contributing to cost savings and overall productivity improvements.

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