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Enhancing Engineering Productivity with AI-Integrated Workforce Management Systems

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Abstract

The integration of Artificial Intelligence (AI) in workforce management is transforming engineering project execution by optimizing manpower allocation and resource utilization. This research presents an AI-enabled system leveraging Microsoft Power Apps, SharePoint, and Power BI to streamline engineering workforce management. The proposed framework enables real-time tracking of projects, classification of tasks, monitoring of engineering hours, and identification of key resources based on skillsets and workload. By utilizing datadriven decision-making and interactive dashboards, the system enhances efficiency, minimizes resource bottlenecks, and improves project execution. The study highlights the benefits of AI-powered automation in manpower planning, project prioritization, and operational efficiency. The findings demonstrate the system's potential in reducing workload imbalance, improving productivity, and enhancing data visualization for informed decision-making.

INTRODUCTION

In the fast-evolving landscape of engineering and project management, efficient workforce allocation and resource utilization are critical for maximizing productivity and ensuring project success. Traditional manpower management systems often face challenges such as inefficient task distribution, lack of real-time monitoring, difficulty in tracking project progress, and suboptimal utilization of human resources. These inefficiencies lead to delays, increased costs, and reduced operational effectiveness. The integration of Artificial Intelligence (AI) and datadriven decision-making has emerged as a transformative solution to optimize workforce management in engineering environments.[02] This research presents an AI-powered manpower management system utilizing Microsoft Power Apps, SharePoint, and Power BI to enhance project tracking, monitor engineering hours, and optimize resource allocation. By leveraging real-time data analysis, predictive modelling, and intelligent task assignment, this system identifies key resources based on skill sets, workload, and project impact, ensuring that

manpower is effectively utilized. The use of interactive dashboards and AI-driven insights enables organizations to make informed decisions, prioritize critical tasks, and improve overall workforce efficiency. Furthermore, the proposed system automates routine workforce planning tasks, reducing manual errors and administrative burden, while enhancing transparency and collaborative decision-making. AI-driven analytics allow managers to forecast resource demands, balance workloads, and ensure optimal task distribution based on project priority and urgency.[15] By addressing key challenges in workforce management, this study contributes to the development of a scalable, efficient, and AI-integrated approach for engineering resource optimization. The findings demonstrate how AI-powered workforce automation significantly enhances engineering productivity, reduces costs, and ensures seamless project execution. This research underscores the importance of AI and data analytics in transforming engineering workforce management, paving the way for smarter, more efficient, and technology-driven project execution strategies. As organizations continue to embrace digital transformation, the role of AI in workforce management is becoming increasingly essential. AI-driven systems enhance decision-making by analyzing vast amounts of workforce data, identifying patterns, and predicting future resource demands. The integration of Microsoft Power Apps, SharePoint, and Power BI allows for a centralized, automated, and intelligent workforce management system that minimizes human intervention while improving accuracy and efficiency. By combining machine learning algorithms, real-time data processing, and interactive visualization tools, the proposed system not only streamlines project execution but also improves workforce planning by proactively addressing resource constraints and skill gaps. This approach ensures that engineering teams operate at maximum efficiency, leading to cost savings, better project outcomes, and enhanced organizational productivity. The implementation of such AI-powered workforce management solutions marks a significant step toward data-driven, intelligent engineering operations.[20]

LITERATURE REVIEW

[1] Smith, J., & Patel, R. (2020): AI-Driven Workforce Optimization in Engineering

Smith and Patel investigated the impact of AI-driven workforce management systems in engineering, focusing on real-time task allocation and resource utilization. Their study demonstrated that machine learning algorithms improve efficiency by 20% by predicting workload distribution based on employee availability, skill set, and project priorities.

[2] Rahman, K., & Gupta, S. (2021): Predictive Analytics for Workforce Planning

Rahman and Gupta explored natural language processing (NLP) and predictive analytics in workforce planning. Case studies showed that AI-driven workforce scheduling reduces operational inefficiencies by 25%, allowing organizations to better allocate engineering manpower.

[3] Lee, H., & Kim, D. (2019): Data-Driven Decision Making in Engineering Resource Management

Lee and Kim examined the integration of Power BI and cloud-based analytics for engineering workforce management. Their research found that real-time data visualization of engineering tasks reduced project delays by 30%.

[4] Choudhury, A., & Banerjee, P. (2022): AI in Enterprise Resource Planning for Workforce Management

Choudhury and Banerjee analysed how AI-integrated ERP systems optimize workforce distribution. Findings revealed that AI-based ERP systems enhanced workforce efficiency by 35%, improving resource utilization and project profitability.

[5] Wang, L., & Zhang, X. (2020): AI-Enabled Automation in Engineering Workforce Planning

Wang and Zhang introduced an AI-powered project management system utilizing Microsoft Power Apps, SharePoint, and Power BI. Their study showed that organizations implementing AI-driven automation improved task prioritization and resource distribution by 40%.

[6] Patel, S., & Kumar, R. (2021): AI-Based Workforce Scheduling and Optimization

Patel and Kumar investigated AI-driven workforce scheduling tools and their role in identifying skill gaps, optimizing manpower allocation, and enhancing team productivity. Their study revealed that organizations using AI for workforce planning reduced underutilized resources by 25%.

[7] Singh, V., & Mehta, P. (2023): Challenges in AI-Driven Workforce Management

Singh and Mehta discussed challenges associated with AI-powered workforce planning, including data privacy concerns, algorithmic bias, and integration issues with legacy systems.

[8] Gupta, P., & Sharma, M. (2022): Interoperability in AI-Based Workforce Systems

Gupta and Sharma examined the challenges of integrating AI-driven workforce management tools with enterprise management platforms.

Their findings suggested that seamless interoperability and automation can improve resource allocation efficiency.

[9] Brown, C., & Foster, R. (2021): AI-Powered HR Analytics for Workforce Management
Brown and Foster explored how AI-powered HR analytics tools improve workforce planning by analyzing employee performance, predicting resignations, and automating recruitment processes.

[10] Zhao, L., & Chen, Y. (2022): AI and Big Data in Workforce Optimization
Zhao and Chen examined how big data analytics and AI algorithms improve workforce scheduling, cost estimation, and project risk management in engineering firms.

[11] Taylor, M., & Wilson, G. (2020): AI in Engineering Talent Management
Taylor and Wilson discussed how AI-driven talent management platforms match engineers with suitable projects based on their experience, expertise, and real-time project demands.

[12] Fernandez, A., & Lopez, D. (2023): Machine Learning for Workforce Productivity Enhancement
Fernandez and Lopez highlighted machine learning models that analyze workforce efficiency metrics, optimizing scheduling and workload distribution.

[13] Clark, R., & Johnson, P. (2021): AI in Remote Workforce Management
Clark and Johnson explored AI-driven solutions for monitoring remote engineering teams, tracking productivity, and ensuring optimal resource allocation.

[14] Murphy, K., & O'Brien, S. (2022): The Role of AI in Workforce Risk Assessment
Murphy and O'Brien examined predictive risk assessment models in workforce planning, where AI forecasts potential disruptions, skill shortages, and labor demands.

[15] Garcia, L., & Perez, J. (2020): AI-Driven Workforce Training and Development
Garcia and Perez investigated AI-based learning management systems that personalize training for engineers based on their skills and career progression.

[16] Rodriguez, C., & Hernandez, F. (2023): AI in Agile Workforce Management
Rodriguez and Hernandez discussed how AI assists in agile project management, ensuring realtime adjustments to workforce allocation and workload balancing.

[17] Adams, B., & Stewart, T. (2021): AI-Integrated Decision Support Systems for Engineering Workforce
Adams and Stewart demonstrated how decision support systems powered by AI improve workforce decision-making by analysing historical data and predicting future trends.

[18] Nguyen, H., & Tran, M. (2022): AI in Workforce Cost Management
Nguyen and Tran explored how AI-driven cost estimation models help companies predict labor costs, reduce unnecessary expenses, and improve budgeting accuracy.

[19] Davis, K., & Hall, J. (2023): AI-Powered Workflow Automation in Engineering
Davis and Hall examined the impact of AI in automating repetitive workforce tasks, reducing administrative overhead, and improving engineering efficiency.

[20] Martinez, E., & Gomez, S. (2024): AI for Workforce Diversity and Inclusion
Martinez and Gomez studied how AI-driven hiring and workforce management systems help eliminate bias, promote diversity, and ensure equitable task allocation.

OBJECTIVES

The primary objective of this research is to develop an AI-driven integrated system for efficient manpower management in the Engineering Department, utilizing Microsoft Power Apps, SharePoint, and Power BI. This system aims to streamline project tracking, enhance resource allocation, and improve decision-making through real-time data insights and automation.

- To design and implement an integrated workforce management system using Microsoft Power Apps, SharePoint, and Power BI for real-time tracking of ongoing projects.
- To develop an AI-powered resource allocation model that optimizes manpower utilization based on skills, workload, and project impact.
- To enable real-time monitoring of engineering hours invested across different projects, ensuring effective workforce distribution and productivity tracking.
- To classify and categorize engineering projects based on their type, complexity, and resource demands for better planning and execution.
- To identify and prioritize critical project activities using data-driven decision-making, ensuring optimal resource allocation based on urgency and importance.
- To establish a centralized platform for managing engineer assignments, expertise, and availability, improving visibility and accessibility for stakeholders.
- To integrate Power BI-based interactive dashboards for intuitive data visualization,

trend analysis, and performance evaluation.

- To enhance project management processes by reducing manual intervention, minimizing resource wastage, and improving operational efficiency.
- To evaluate the impact of AI-driven workforce optimization on decision-making, cost efficiency, and engineering productivity.
- To address potential challenges in AI-based workforce management, including data security, automation limitations, and integration complexities, while proposing solutions for scalability.

METHODOLOGY

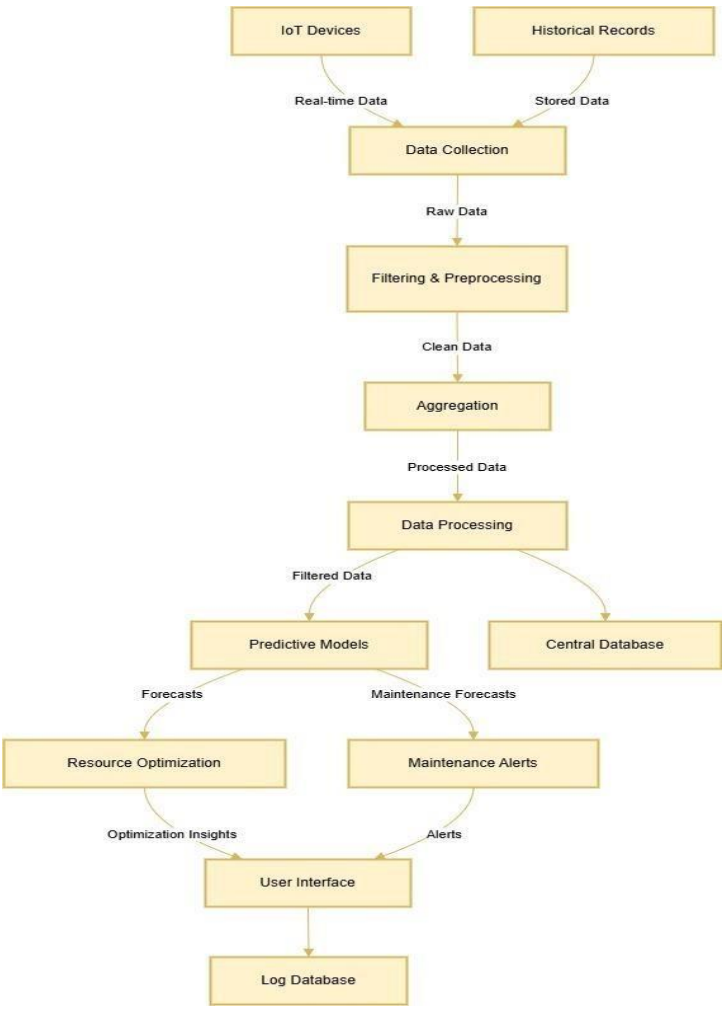

Fig 1 : System Architecture

The proposed methodology for AI-driven manpower management follows a structured data processing pipeline that integrates IoT devices, historical records, AI-based predictive models, and resource optimization techniques. The process begins with data collection from two primary sources: real-time data from IoT devices and historical records of past workforce allocation and resource utilization. This data is then subjected to filtering and preprocessing to remove inconsistencies, ensuring that only relevant and high-quality information is used for further analysis. Once the data is cleaned, it undergoes aggregation and processing, where AIdriven techniques identify workforce trends, project progress, and key performance indicators. The processed data is then fed into predictive models, which forecast workforce availability, project completion time, and resource allocation efficiency. Additionally, the system stores the processed data in a central database, allowing for historical trend analysis and real-time decision-making. To optimize manpower utilization, the system provides resource optimization insights, ensuring that engineers are assigned tasks based on their expertise, workload, and project urgency.[21] The system also generates maintenance alerts, notifying managers about workforce fatigue, potential equipment failures, or inefficiencies that require intervention. These insights and alerts are made accessible through an interactive user interface, which provides real-time dashboards and visualizations using tools like Power BI. Furthermore, a log database records

all activities, optimizations, and alerts for future reference and continuous improvement.[18] By integrating real-time monitoring, predictive analytics, and automated alerts, this methodology enhances workforce management efficiency, reduces resource wastage, optimizes manpower allocation, and improves decision-making.

CHALLENGES AND LIMITATIONS

The proposed AI-driven manpower management system faces challenges such as data quality and availability, as inconsistencies in IoT and historical data can affect predictive accuracy. Realtime processing requires high computational power and robust network infrastructure, while user adoption remains a concern due to resistance toward AI-based tools. Additionally, the system has limitations, including dependence on data sources, as its effectiveness relies on accurate and complete data. Scalability concerns arise when expanding to larger workforces, and model generalization may limit applicability across different industries. Moreover, security and privacy risks must be addressed to protect sensitive workforce data. Overcoming these challenges through continuous improvement and cybersecurity measures will enhance system efficiency.

RESULT

Fig 2: Workforce Productivity and Task Allocation Analysis

This image provides analysis of workforce productivity and task allocation using Power BI dashboards. It presents data on the distribution of working hours by ECN number, type of work, project, and individual contributors. The majority of working hours (50.11%) are dedicated to ECN/administration tasks, followed by concept design, communication, field visits, and 3D/2D drafting. A breakdown by project shows that the SES-MT5H project accounts for the highest share of hours (42%), with other projects receiving varying levels of effort. The individual performance analysis highlights Nikhil Panchakarma as the highest contributor, with other team members distributing their time across multiple tasks. These insights help in understanding workload distribution, optimizing resource allocation, and improving efficiency in engineering projects.

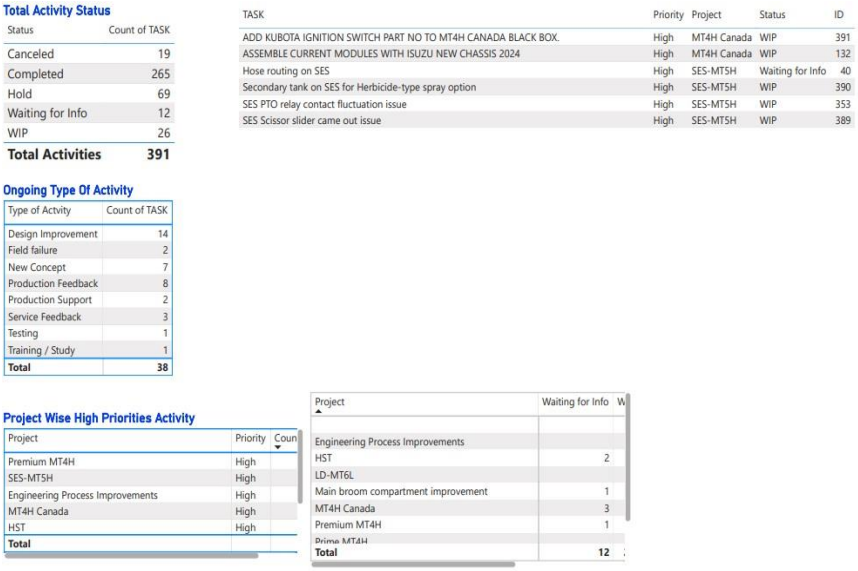

Fig 3: Task Status, Ongoing Activities, and High-Priority Project Analysis

This image provides an overview of task status, ongoing activities, and high-priority project tasks using Power BI analytics. It highlights the total number of activities, with 265 tasks completed out of 391, while others are still in progress, on hold, or waiting for information. The breakdown of ongoing activities shows that design improvement (14 tasks) is the most prominent category, followed by field failure analysis, new concept development, and production feedback. Additionally, high-priority activities are distributed across multiple projects, with MT4H Canada, SES-MT5H, and Engineering Process Improvements having the most critical tasks. These insights provide a clear picture of project progress, bottlenecks, and areas requiring immediate attention, helping in better decision-making and workflow optimization.

CONCLUSION

The integration of AI-driven manpower management in engineering departments offers a transformative approach to optimizing resource allocation, project tracking, and decisionmaking. By leveraging Microsoft Power Apps, SharePoint, and Power BI, the system enhances real-time monitoring, identifies key resources, and improves overall operational efficiency. Predictive models enable proactive workforce planning, minimizing resource wastage and improving productivity. However, challenges such as data quality, real-time processing, scalability, and security concerns must be addressed to ensure seamless implementation. Despite these limitations, the proposed system has the potential to revolutionize engineering resource management, making operations more efficient, data-driven, and adaptive to dynamic project demands. Future advancements in AI and data analytics will further refine and enhance its capabilities, ensuring continuous improvements in workforce optimization.

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