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IMPACT OF ARTIFICIAL INTELLIGENCE-BASED TECHNOLOGIES IN THE OPERATIONS AND MAINTENANCE FIELD

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ABSTRACT

AI is at the forefront of productivity, streamlining work processes and women and enriching decision-making processes. With AI mapping, which can include elements of predictive analytics, ML and NLP, it is easy to enhance the supply chain functions, recognise operational deviations in time, and delegate repetitive tasks to the automation. This shift improves efficiency and allows businesses to focus human capital on generating value and adaptability. However, there are still issues of AI integration, data quality, and how to ensure that AI operations and supply chain management work in synergy with human supervisors and workers. This research used a systematic literature review approach using Google Scholar, IEEE Xplore, and Scopus. The results show that the key to successful implementation is to advance constant change and learning and cultivate good human/machine synergy for even long-term and stable growth in the current contexts of the dynamic and complex business environment.

Keywords: *Artificial Intelligence, AI-based Technologies, Operations and Maintenance, RepairEXP.*

INTRODUCTION

In the current context of global business, challenges to gain competitive advantage are enormous for entrepreneurs because to be competitive, more attention is paid to automation, quality assurance, and customer loyalty (Ramaswamy, 2019; Bacq & Lumpkin, 2021; Hassan et al., 2020). The future integration of AI into industries presents an opportunity to optimise O&M by employing AI's high execution speed. The AI-based technologies establish a certain level of automation of the processes, help the business manage the quality consistently, and improve customers' satisfaction by guaranteeing the reliability and effectiveness of the services (Bortolini, Forcada & Macarulla, 2017; Lee et al., 2019; Konstantinidis et al., 2020).

In the the O&M sector, the use of AI is not limited to customer relations management issues but rises to the level of technical and operational issues. These include diagnosing a problem with a household appliance, early identification of probable structural concerns with a building and others (Chien-Ho, 2017). These advancements are significant, especially in the countries such as Saudi Arabia, which belong to competitive markets; increasing sectors of the economy and the increase in GDP prove the need for efficient O&M solutions (Lee et al., 2019).

Specifically, one of the systems under investigation in this research is a web application called RepairEXP, which offers O&M services for residential and commercial properties. Nevertheless, the new service targets that RepairEXP offers are paraded with challenges like competitive pressure, slow service delivery, and clients' complaints (Lee et al., 2019; Naim, 2022). Therefore, adopting AI as an innovation, RepairEXP intends to redesign the business by creating a transparent and efficient technician performance tracking system that will allow customers to receive updates for repairs (Dirican, 2015; Fusko, 2018).

The study also examines how project managers are instrumental in deploying artificial intelligence technologies. This means that when dealing with data collection and training of AI models, project managers can bring efficiency in implementing the AI, leading to efficient business results and satisfied

customers (Rana et al., 2022; Rittinghouse & Ransome, 2016; Viriato, 2019). Besides, using AI in the business also helps reduce human errors, and gives freelance workers a chance to be confirmed on the business's platform to grow its network.

Methodology

Search Strategy

The studies selection process was done systematically by using a flexible approach, then qualifying the studies which are related to the applicability of AI technologies in the O&M domain of RepairEXP. To aim at the study objectives, the search strategy involved deploying specific keywords and Boolean operations to develop themes.

Keywords and Boolean operations

The keywords and the Boolean operations specified in **Table 1** were intended to cover all the aspects of AI applications in operations and maintenance. The concepts subjected to a systematic search included operation, maintenance, and customer retention Strategies based on specific keywords and Boolean operators in performing these searches to capture the most relevant articles and studies at the intersection of these ideas. This structured approach helped navigate one business process to another in searching for applicable uses of AI in maintenance approaches.

Table 1 Keywords and Boolean operations

Concept	Keywords	Boolean Operations
Operations	"Operations Management" OR "Business Operations"	("Operations Management" OR "Business Operations") AND "Efficiency"
Maintenance	"Preventive Maintenance" OR "Maintenance Strategies"	("Preventive Maintenance" AND "AI") OR "Maintenance Automation"
Artificial Intelligence	"AI Implementation" OR "Artificial Intelligence Applications"	("AI Implementation" AND "Business Processes") OR "AI in Operations"
Automation	"Business Process Automation" OR "Automation Tools"	("Business Process Automation" AND "AI") OR "Automation in Maintenance"
Customer Retention	"Customer Satisfaction" OR "Customer Loyalty"	("Customer Retention" AND "AI") OR "Customer Satisfaction Strategies"
Business Applications	"AI in Business Processes" OR "AI-driven Innovation"	("AI in Business Processes" AND "Optimisation") OR "AI in Industries"

Databases and search strings

Table 2 displays the databases included in the literature search alongside the relevant search terms specific to each database. This selective approach focused on including as many variables as possible while selecting only the best and peer-reviewed articles. Each search string was designed to encompass various approaches to, and definitions of, AI, automation, operations and maintenance so that a large body of literature was captured for review. This approach to search narrowed down the targets and ensured that important articles were sourced from some of the most credible databases, including Google Scholar, IEEE Xplore, Scopus and others

Table 2 Keywords and Boolean operations

Database	Search String
Google Scholar	("Artificial Intelligence" AND "Operations and Maintenance") OR ("Automation" AND "Customer Retention") OR ("AI in Business")
IEEE Xplore	("AI in Business" AND "Operational Efficiency") OR ("Maintenance Automation" AND "Customer Satisfaction")
Scopus	("Artificial Intelligence" AND "Automation in Operations") OR ("AI" AND "Customer Retention Strategies") OR ("Maintenance" AND "AI")
ScienceDirect	("AI Applications" AND "Operations Management") OR ("Customer Retention" AND "AI-

	driven Maintenance")
SpringerLink	("Artificial Intelligence" AND "Process Optimisation") OR ("Operations and Maintenance" AND "AI Integration")
PubMed	("AI" AND "Operational Maintenance") OR ("Automation" AND "Customer Retention in Business")

Inclusion and Exclusion Criteria

The criteria used in **Table 3** were developed to screen out literature effectively. The evaluation was limited to articles published within the last decade only in a bid to make sure that the research was up-to-date. Specific instruments, such as peer-reviewed articles and industry reports, were used to keep academic and practical orientations. Hence, articles sourced from blog sites, opinion articles, and letters were not considered, apart from papers that did not address AI in Operations and Maintenance or were written in English. This approach was followed to develop a strong and high-quality evidence base for the review.

Table 3 Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Studies published in the last 10 years	Articles older than 10 years
Peer-reviewed journals and industry reports	Blogs, opinion pieces, or non-academic sources
Focused on AI in operations and maintenance	Studies unrelated to O&M or AI applications
English-language publications	Non-English articles

Data Analysis

The approach used for the data analysis of this study was thematic analysis – a qualitative method for identifying, analysing, and reporting patterns (themes) within data. Thematic analysis was selected because of its convenience in offering a detailed and sophisticated analysis of the collected research data. This method is best suited for analysis of the themes and insights within qualitative data. It is ideally suited for assessing the relevance and application of AI technologies in Operations and Maintenance. The second step was an analysis of visual patterns of all collected material, including the identified literature and industry reports, to make annotations and assessments about the context and primary patterns. The next step was identifying codes that initially defined the appearance of the data samples in consideration of the research questions. These codes were then analysed and named to develop more significant conceptual categories like patterns. After coding the incidents, the themes were as after the coding, all the themes that had emerged were read and defined to capture the meaning embedded in them. Each theme was again studied to determine what it meant, how it related to the other themes and how it enhanced the knowledge of AI in operations and maintenance. Ultimately, the themes are defined and discussed in relation to the study objectives and questions.

Results

Theme 1 Conceptualising AI and its Significance in Business Operations

Table 4 Comparative Analysis of Studies on AI in Business Operations

Study	Method	Findings	Conclusion
Chien-Ho (2017)	Literature Review	AI helps improve efficiency, reduce operational costs, and replace human agents with chatbots.	AI is essential for business growth, streamlining processes, and enhancing customer service.
Tani et al. (2022)	Case Studies	AI boosts productivity, enables personalised services, and contributes to cost savings.	AI significantly improves business operations, driving growth and engagement.
Yu et al. (2021)	Empirical Analysis	AI enables predictive analytics, customer behaviour analysis, and service automation.	Effective use of AI supports better decision-making and marketing strategies.

Cubic (2020)	Report Analysis	Tools like Microsoft Power BI help businesses extract actionable insights and automate tasks.	AI tools are pivotal for data analysis and operational efficiency.

Chien-Ho (2017) notes that artificial intelligence can change customer support by replacing human agents entirely, reducing operational costs, and increasing service convenience. This supports the claims that AI assists with customer targeting by presenting specific products that would help engage customers, according to Tani et al. (2022). Both present AI as valuable in improving the quality of service for customers; this is agreed by Chien-Ho (2017) regarding cost optimisation; nevertheless, Tani et al. (2022) offer customer-centric advantages perceptions.

For example, Cubric (2020) brings new ideas on how organisations can use business AI tools like Microsoft Power BI. Hence, this research provides insights into how companies can use artificial intelligence in data analysis to achieve the right decision-making when it comes to the right strategies that will enhance profitability. Whereas Tani et al. (2022) and Chien-Ho (2017) emphasise the external applications of AI technology, Cubric (2020) discusses the internal side and shows how it is connected with strategic decisions.

Yu et al. (2021) expand the conversation by expounding on how AI can identify and analyse customer behaviour and how this can improve the customer marketing approach. This aligns with the literature on personalisation discussed by Tani et al. (2022) but goes an extra step to demonstrate how predictive analyses assist businesses in defining and sustaining their market relevance. At the same time, Chien-Ho (2017) discusses direct consumer engagements, Cubric (2020) Business Intelligence, and Yu et al. (2021) Competitive Advantage.

Theme 2: Application of AI Technologies in the Maintenance Field

Table 5 Application of AI Technologies in the Maintenance Field

Study	Methodology	Findings	Conclusion
Tani et al., 2022	Analysis of AI integration in IoT and maintenance	AI detects issues, estimates repair times and costs, and schedules maintenance.	AI facilitates proactive maintenance and efficient device monitoring.
Yu et al., 2021	Case study on AI use in real-time energy monitoring	AI adjusts HVAC and power systems based on usage, significantly reducing energy consumption.	AI enhances energy efficiency and operational cost savings.
Cupric, 2020	Review of AI in financial aspects of maintenance	AI improves billing processes using data analysis from past projects.	AI optimises budgeting, cost estimation, and workflow efficiency.
Chien-Ho, 2017	Survey of AI-driven automation in maintenance	AI reduces machine downtime, enabling oversight of multiple facilities.	AI improves resource management and reduces operational costs.
Yu et al., 2021	Study on AI-enhanced safety measures in maintenance	AI strengthens monitoring systems through data-driven defence technology.	AI supports robust safety practices and better security management.
Tani et al., 2022	Examination of AI's role in safety assessments	AI complements manual checks, offering advanced monitoring capabilities.	AI enhances safety and ensures continuous surveillance.

The studies reviewed provide varying insights into integrating AI technology in maintenance and operational efficiency. Tani et al. (2022) highlight the ability of AI to work seamlessly with IoT structures to monitor device and appliance conditions. This allows AI to detect anomalies, estimate repair time and costs, and schedule necessary maintenance. This proactive approach improves the efficiency of repair processes and enables predictive maintenance, preventing unexpected failures. Yu et al. (2021) also underscore the real-time monitoring capabilities of

AI in reducing energy consumption by adjusting HVAC and power systems based on usage trends, which enhances operational efficiency and cost savings.

Cubic (2020) delves into the financial implications of AI integration in maintenance, emphasising how AI streamlines billing processes by analysing past data to estimate project costs effectively. This enhances the budgeting and approval workflow, ensuring that costs are kept in check. Chien-Ho (2017) adds an important dimension by focusing on the benefits of AI-driven automation in reducing machine downtime and operational costs. The study demonstrates that AI allows limited resources to manage multiple facilities efficiently, making it easier for companies to prioritise critical issues without neglecting basic maintenance needs.

Yu et al. (2021) and Tani et al. (2022) highlight AI's role in improving safety measures in maintenance operations. While Yu et al. (2021) emphasise enhanced security through advanced data-driven defence technologies such as CCTV and access management, Tani et al. (2022) explain how AI can plug gaps in routine safety assessments. Incorporating AI can significantly strengthen security systems and make them more effective.

Theme 3: Modern Trends and Challenges of AI in Operations Department of Maintenance Companies

Table 6 Modern Trends and Challenges of AI in Operations Department of Maintenance Companies

Study	Methodology	Findings	Conclusion
Cupric, 2020	Literature review and analysis	AI supports productivity, efficiency, and workforce well-being and improves supply chain forecasting.	AI is essential for enhancing operational efficiency and strategic decision-making.
Chien-Ho, 2017	Case study and survey	AI enables real-time decision-making and task automation in Industry 4.0.	AI optimises production processes and reduces operational costs.
Yu et al., 2021	Case study and data analysis	AI enhances quality control, market forecasting, and customer support.	AI helps businesses make data-driven decisions, improve service, and maintain product quality.
Tani et al., 2022	Practical analysis of AI applications	AI monitors and detects manufacturing issues using computer vision for defect detection.	AI supports proactive maintenance, defect prevention, and real-time monitoring.

For the industrial and maintenance sectors, a plethora of literature covers the use of AI, focusing on its positive impact. According to Cubric (2020), AI is critical in enhancing productivity and utility at work, ensuring staff happiness for all roles, from sourcing to product development. Further, Chien-Ho (2017) showed interest in AI's real-time decision-making and task automation aspect, especially in Industry 4.0. Yu et al. (2021) affirm that the application of AI improves the supply chain in demand forecasting, quality assurance, and information-based improvements that inform development.

One significant finding shared by these investigations is that of the forecasting potential of AI technology in recognising when equipment is at risk of failure and when market trends are adjusting, thus avoiding costly downtime and scheduling disruptions. In their turn, Tani et al. (2022) explain how AI is useful in manufacturing process supervision through computer vision and machine learning to perform quality assurance and recognise shortcomings in a production line. Cubic (2020) and Chien-Ho (2017) note that using AI provides analytics and assists with decision-making that increases speed, thus enhancing operational performance without adding to costs. They also note that in product manufacture, visual surveillance powered by AI is also used for the identification of defects, which in turn optimises QC processes and minimises human error.

While all studies highlight AI's efficiency benefits, their approaches vary: Cubric (2020) and Yu et al. (2021) speak about AI in the context of supply chain and market analysis, while Tani et al. (2022) and Chien-Ho (2017) mainly deals with real-time production monitoring and problem-solving. In summary, the research findings demonstrate that the adoption of AI enhance industries' operations and lowers cost, quality assurance, maintenance, and strategic decision-making.

Theme 4: Potential Strategies for Sustaining AI-Technologies in Business Operations

The approaches to maintaining AI technologies in organisational processes, depicted in the literature, focus on diverse approaches that can be utilised for the optimisation of work performance, customer satisfaction, and company activities. ECC (Enterprise Cognitive Computing) is an idea that aims to incorporate algorithms into business applications to automate some prerequisite tasks and improve speed and efficiency. This approach will benefit employees by automating routine activities and allowing them to take on challenging responsibilities (Tani et al., 2022). It has a strong applicability, for instance, in finance, legal fields, production, and medical research, proving that ECC is a competent tool in a broad range of business activities (Yu et al., 2021; Chien-Ho, 2017).

Using chatbots, NLP, and deep learning in the customer's assistance and security facility is also a good approach. There are benefits of using chatbots in customer relations since they get to respond to the customer's questions immediately and are available all the time, which will increase client satisfaction and decrease response time (Tani et al., 2022). AI applications in the security area also enhance security features against threats such as spam, viruses, and phishing attacks and support predictive surveillance within high-risk areas (Cubric, 2020; Tani, 2022). Further, AI, such as supply chain optimisation through the use of automation processes, drones, and superior data processing, puts into a stand the improvement it has had on operation procedures (Chien-Ho, 2017).

The internal orientation strategy focuses on AI implementation within an organisation to enhance functions and strengthen the organisational learning approach of AI and human workers to improve organisational operation capabilities (Yu et al., 2021; Tani et al., 2022). This strategy is congruent with efforts to link up the value chain and promote skill advancement to leverage human and artificial intelligence characteristics (Chien-Ho, 2017). Whereas the ECC and the AI deployment for customer service/security involve external interface and remarkable productivity, internal orientation stresses organisational growth and accommodation in the firm.

Theme 5: Role of AI in Operations and Supply Chain Management

Table 7: Potential Strategies for Sustaining AI-Technologies in Business Operations

Study Name (Citations)	Method	Findings	Conclusion
(Tani, et al., 2022)	Integration of AI algorithms into business applications	Automates routine tasks enhance data processing, and supports decision-making; applicable in finance, legal, production, and healthcare.	ECC improves productivity, accelerates operations, and allows employees to focus on complex tasks.
(Yu, et al., 2021; Chien-Ho, 2017)	Implementation in customer service and cybersecurity	Enhances customer service with 24/7 responses and reduces wait times; strengthens cybersecurity by detecting and preventing spam, viruses, and phishing attempts.	AI-driven customer support and security tools enhance user experience and provide an effective defence against cyber threats.
(Chien-Ho, 2017; Yu, et al., 2021)	Embedding AI within company processes for continuous improvement	Facilitates skill development and streamlines internal operations; AI and human workers collaborate to improve workflows.	Promotes long-term operational enhancements by integrating AI with human expertise to optimise business processes.

The various operations and SCM research have demonstrated that integrating AI in its operations has had a considerable effect. In a related note, Tani et al. (2022) argue that its predictive capacities prevent problematic situations, reducing risk incidents and improving operations. This conflicting tone in operational management is preventive and thus helps organisations avoid many interruptions. On the other hand, Chien-Ho (2017) asserts that by self-learning, AI can make SCM strategies

responsive and self-sufficient, helping organisations accomplish business operational goals on their own. They deduce that though AI offers increased depth and adaptability in the supply chain, the idea still needs to be fully tapped within the domain, according to Yu et al., 2021. This is a clear indication that a higher level of AI applicability can revolutionise SCM through improved decision-making and cost-cutting while at the same time demonstrating that the practical application of AI is still in its nascent stage. Cubric (2020) also noted that AI needs to go beyond the single function and become part of the larger system such as procurement and client order systems to gain the optimum benefits. The aggregate findings also show that AI can potentially transform SCM and operational management by enhancing efficiency and self-sufficiency. However, the integration of various processes determining all supply chain constituent elements and the implementation challenge are still essential for achieving potential benefits.

Theme 6: Role of AI in Operations and Supply Chain Management

Table 8 Role of AI in Operations and Supply Chain Management

Study Name (Citations)	Method	Findings	Conclusion
(Tani, et al., 2022)	Predictive analysis in operations management	AI platforms can forecast operational anomalies and prevent crises, enhancing workflow.	AI-driven predictive evaluation supports proactive crisis management and operational continuity.
(Chien-Ho, 2017)	AI-enabled autonomous decision-making in SCM	AI can independently determine strategies and adapt to supply chain environments through self-learning.	AI can achieve SCM goals and make real-time adjustments, optimising operations.
(Yu, et al., 2021)	Investigation of AI in SCM integration	AI improves data access, system adaptability, and cost management but potential remains underexplored.	AI has significant promise for SCM efficiency but requires further development and adoption.
(Cubric, 2020)	AI integration in business processes	AI supports improvements in machinery, equipment, and client-supplier interactions, enhancing resource management.	Effective AI integration should encompass entire supply networks to leverage its benefits fully.

Discussion

Applying AI in business operations and operations and supply chain management (SCM) has always been valuable, allowing organisations to control processes, mitigate risks, and improve efficiency. The study by Tani et al. (2022) shows that predictive analytics driven by AI can help detect and solve operational problems at their infancy before becoming critical. That way, the processes continue the company's functioning and contribute to consistent performance, even in conditions of great uncertainty. Chien-Ho (2017) builds on this by pointing out that autonomic decision-making and real-time learning areas are crucial to SCM. Due to this feature, AI is readily capable of adapting to new conditions in the supply chain and fosters a positive attitude toward improving the chain. However, as found by Yu et al. (2021), AI has quite promising performance when applied to SCM processes; meanwhile, AI's efficiency has yet to be explored exhaustively. It is essential that, while incorporating valuable imagery, enhancing flexibility, and lessening cost, the roles of AI in SCM remain vast. There is a great potential for AI to revolutionise how organisations approach operations, but for this, means have to be taken to ensure that integration and development of the system are total. According to Cubric (2020), AI is also required to be implemented across the whole network, including procurement and customers. However, the improvements that AI can bring to the supply chain may not be as significant if the AI is not used across multiple supply chains or related functions. This suggests enabling AI to substantially improve

operational efficiency and decision-making across the SCM and operations spectrum; however, the problem emerges in designing complete AI solutions encompassing the entire suite of SCM and operation realities.

The research has revealed that AI represents a significant potential for growth across operations and SCM through aspects such as predictive analytics on supply chains, automating many of the processes involved and leveraging data to inform supply chain decisions. However, reaching and maintaining this attainment level remains contingent on sustained research and efforts to incorporate these concepts into organisational practice and address current limitations. The next level of innovation is in deep AI implementation for all links in the supply chain, including all activities to achieve better AI within the supply chain.

Conclusion

Finally, the present study reveals that implementing AI in operations and supply chain management will bring positive changes and benefits to business operations, such as operational efficiency advances, prediction, and decision-making based on big data. The research shows considerable advancements in anomaly detection and the automation and optimisation of tasks completed across the supply chain. However, integrating and creating a holistic cooperative environment between these advanced systems and human labour still poses problems. Thus, to drive maximum value from investment in AI, organisations must be committed to ongoing innovation, proper selection of applications, and extensive incorporation of systems. This way, not only will it take out the middle layer and cut down on costs and redundancies, but it will also instill agility to cope with the global changesglobal changes.

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