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How Artificial Intelligence can Leverage Project Management Information System (PMIS) and Data Driven Decision Making in Project Management

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A B S T R A C T

This article focuses on the opportunities of utilizing Artificial intelligence in project management in general. Special emphasis to project management data driven decision making and the relevant tools represented in processes, tools and techniques of PMIS. The data used to support this research is collected from primary and secondary sources to emphasize the research paper results. The approach used in data collection was a qualitative method where interviews conducted. Advanced projects and cases from Dubai and UAE were also investigated. The results showed that with the creation of big data, AI can now be more than just technology and is capable of performing more complex tasks using advanced techniques and algorithms. AI helps more effectively through integrating project management phases and the entire project lifecycle process. Bringing AI to the project management domain across the world can provide a sustainable world for future generations. It also assists in faster and smarter decisions. It is recommended to monitor AI until users are satisfied and can trust the systems outcome. AI will have a tremendous growth as projects in smart cities are growing bigger, complex and demanding.

1. INTRODUCTION

There is no doubt that artificial intelligence plays a vital role in various sectors and dimensions in most countries around the world. Artificial intelligence is commonly known as AI. AI is widely used in our societies and it has a huge impact on the social, economic, and political sectors. Some of these impacts of implementing AI are benefits and optimistic, while others are not, and there are some ethical issues as well related to AI (Koroteev and Tekic, 2021). Artificial intelligence can be defined as the machines that are created to simulate human intelligence to do and learn as a brain of human do (Mentzas, 1994). These machines can perform multi-tasks in intelligent ways by adapting to several situations (Hani Al-Kassem, 2021). AI has the potential influences on the project management field in a positive way. Implementing AI in the project management field will help in a wide range of missions and tasks, such as increasing automation, productivity, help in making intelligent decisions, solving complex problems, managing repetitive missions and tasks, enhancing lifestyle, and assisting in complex analysis (Jiang et al., 2017; Ribeiro et al., 2021).

The Usages and Serving of AI Tools in Project Management and implementing AI tools in the project management field comes with a different number of utilizations and they are as following:

1. AI in engineering design. The usage of AI in PM helps in developing applications that will assist project managers to use them through Artificial Neural Network and Genetic Algorithm tools (Al-Kassem, 2014; Sun et al., 2019). These tools help to select the best structure system for the building, and it has been used to optimize the building life cycle cost in changing climate like hot weathers.
2. AI in planning and scheduling. Some of these tools are:
    - Knowledge Based Expert System (KBES) provides the estimation of the resources needs and the duration of project activities based on the knowledge of experts (Ghazal and Taleb, 2022).
    - Fuzzy Logic which decides the project priorities in the process of portfolio management.
    - Artificial Neural Networks (ANN). Provide the sequence automation of the project activities based on functional needs (Abiodun et al., 2019; Al-Kassem et al., 2013).
    - Genetic Algorithm (GA) optimizes the schedule of the project activities in construction to reduce total cost and resource constraints.
3. AI in estimating cost. ANN and Fuzzy Logic tools have the same benefits and effects as they do in planning and scheduling.
4. AI in risk management. Assigning risks, estimating the probability and assessing the impact of the risks via using ANN, the integration between ANN and Monte Carlo Simulation, and Fuzzy Logic (Mat Som and Kassem, 2013).
5. AI in performance prediction management. Fuzzy Logic, KBES, and ANN help to improve the efficiency of the project management and provide a better prediction of the future project performance based on the previous projects that have been done (Asadullah et al., 2020).
6. AI in monitoring and controlling project which can be used to better manage the monitoring process in a project lifecycle.

The varieties of AI applications and tools enable better project performance as well as enhance the efficiency of the project management implementation (Al-Kassem, 2017; Caniëls and Bakens, 2012; Elkhatib, M., Al Hosani, A., Al Hosani, I., & Albuflasa, 2022). This research paper will try to answer the following research questions:

- How can AI effect Project Management?
- How to improve AI effect on Project Management?

This research will identify initially the literature review, the types of projects that require AI, demonstrates how AI can serve and improve PM. Finally, it discusses the challenges of AI implementation which draws the conclusion and recommendations.

2. LITERATURE REVIEW

One of the main essential concerns in construction is how to make buildings smart and sustainable (I. Akour et al., 2022) stated that automation based on artificial intelligence has a significant role in adopting smart cities and buildings. These hardware and software are capable of doing things automatically, which will save time, effort, money as well as generating sustainability (Al-Awamleh et al., 2022; Al-Dmour et al., 2023; M. El Khatib et al., 2021; Mubeen et al., 2022; Sakkthivel et al., 2022). AI tools and techniques are helpful and essential for the project manager in controlling and monitoring the project. The integration between different types of AI tools will provide the highest benefit of the strengths tools and obtain the best outcomes in some particular projects, such as:

- Continuous Assessment of Project Performance (CAPP) is providing the actual time analysis.
- Project Definition Rating Index (PDRI) is assessing the definition of the project in the early phases before starting the project.

Nowadays, the implementation of AI is expanding in different fields in order to assist and make our jobs better and more useful (M. Alshurideh et al., 2023; Khan et al., 2022). AI tools and techniques are very expensive, so, AI has been invested in the most viable and commercially huge projects like machine learning field that has great consumption

in AI-powered, project management, complex and sustainable projects, innovative fields, supply chain and logistics, chatbots, streamlined manufacturing, and many more (Ahmad Ibrahim Aljumah et al., 2022a; M. T. Alshurideh et al., 2023a; Bawaneh et al., 2023; Louzi et al., 2022b; Nuseir et al., 2020; Yasir et al., 2022). In addition, assessing the effect of implementing AI tools initiatives is significant. This can be achieved through assessing the labor and cost saving, generating revenue, increasing productivity, reducing errors and biases, and many other operations (A I Aljumah et al., 2022a; Amiri et al., 2020).

(Aljumah et al., 2021a; H. M. Alzoubi et al., 2022d; El Khatib and Opulencia, 2015; Khatib et al., 2022b) reported that AI is capturing what the human is doing to automate these processes through using machine learning in order to build models. An example of implementing AI tools is making the decisions faster based on the enormous volume of data (Al-Maroof et al., 2022b; Ahmad Ibrahim Aljumah et al., 2022b; T M Ghazal et al., 2023a; Nuseir, 2020). In addition, these big data from the smart building systems provide an organization's infrastructure the intelligent controls for buildings, for instants grid stability, reducing energy, and occupant comfort (H. M. Alzoubi et al., 2022a, 2022e). Also, the integration between the AI technology and the smart building system enhance to intelligently analyze, interpret, and distribute effective and efficient actions in real-time (Al-Maroof et al., 2022b; Khatib, 2022). According to Sinclair (2019), there are four core values to make a city intelligent including sustainability, workability, learnability, and livability (AlDhaheri et al., 2023; Alzoubi and Ahmed, 2019; Louzi et al., 2022a).

Furthermore, Software Defined Networking (SDN) is an example of a smart city deployment (M. T. Alshurideh et al., 2023b; Taher M. Ghazal et al., 2023; Varma et al., 2023). The SDN creates and deploys the systems as well as the programmable networks to logically centralize controller to the program network equipment (Abudaqa et al., 2021; El Khatib et al., 2021, 2020a). The operation of SDN can be achieved through using the protocol and the well-known interface (Akour et al., 2023; Al-Kassem et al., 2012; R. S. Al-Maroof et al., 2021a; H. M. Alzoubi et al., 2022f; Khatib et al., 2016; Nuseir and Aljumah, 2020). So, SDN can support and enhance the project developments of the smart city among the three deployment levels; physical element level, communication level, and application and big data level.

3. RESEARCH METHODOLOGY

This research paper aims to identify the core benefits of AI in Project Management aspects and find how using AI can help improve the way project management is handled. The data used to support this research is collected from primary and secondary sources to emphasize the research paper results. The approach used in data collection was a qualitative method where an interview was conducted with an employee in Smart Dubai to discuss AI implementation, benefits and challenges involved. As a result, this choice was made to give a better understanding of the effectiveness of implementing AI in project management in real life and to find ways to better make use of it. In addition to the interview, Google Scholar and HBMSU Library databases were both used to find more about the topic to support the research.

4. TYPES OF PROJECTS THAT NEED AI

4.1 Complex Project

Why innovative/Strategic project need AI? In the current hi-tech world and with the existence of competitiveness among the entrepreneurs, companies intend to move towards developing strategic and innovative projects to benefit by adopting innovation and complexity to their plans. In large projects, innovation is taking part in several elements including big data to emphasize their distinctive (A I Aljumah et al., 2022a; El Khatib and Ahmed, 2020; Emad Tariq et al., 2022). Complex innovative projects defined as the ability to implement a business strategy using different frameworks and tools to integrate challenges of innovation, complexity and deal with uncertainties (A I Aljumah et al., 2022b; H. M. Alzoubi et al., 2020; Gulseven and Ahmed, 2022). Projects with big data are classified based on process technology, degree of complexity, speed, and how do all these categories relate to innovation (Abudaqa et al., 2022; Almasaeid et al., 2022; T M Ghazal et al., 2023b; Nadzri et al., 2023). Each independent project has a specific nature and its level of complexity and variability. In order to simplify such elements, there is a need for utilizing AI (Al-Maroof et al., 2022a; M T Nuseir et al., 2022a; Nuseir and Aljumah, 2022). Furthermore, human

beings are likely to make mistakes and they lack experience. Such projects can't afford these faults; therefore, AI has to be equipped when the business is planning for critical goals (Ahmed et al., 2022; Alzoubi et al., 2019; El Khatib et al., 2020b; Raja et al., 2020).

4.2 Areas of using AI

Artificial Intelligence can be adopted in industries that create a good and sustainable environment for Artificial Intelligence. Big projects can benefit from utilizing AI due to the complexity of their systems, particularly if the industry is shifting towards smart technology (Muhammad Turki Alshurideh et al., 2022c; H. Alzoubi et al., 2020; Aziz et al., 2023). Innovative projects experience potential challenges in implementing new business processes. For these reasons, AI can be viewed in such areas as a solution (A. Al-Maroof et al., 2021; M. T. Alshurideh et al., 2023c; Alzoubi et al., 2021; Ghazal et al., 2021; Kassem and Martinez, 2022).

Complex strategic projects have the nature of developing projects tasks with highly innovative output. Smart city as a complete strategy is a clear example of a complex project that needs the use of AI (El Khatib et al., 2019; Khatib et al., 2022a). Dubai City is planning strategically to move towards developing an integrated smart city. In the following section case studies in UAE will be demonstrated.

4.3 Innovative, strategic projects: The cases of Smart City and Smart Building

In past decades, UAE set a vision in looking ahead toward prospecting future and devoting this to future generations, today, citizens are able to realize the mission implemented in reality. This section shows the findings of two case studies that implement a smart city (R. S. Al-Maroof et al., 2021b; H. M. Alzoubi et al., 2022c, 2022h; Farrukh et al., 2023; Gaytan et al., 2023). Smart Dubai has been a success in achieving its goals by implementing integrated systems using artificial intelligence. In addition, New York University in Abu Dhabi, launched fully integrated smart building system to support the adoption of AI.

4.3.1 Smart Dubai

Due to the developments and fast businesses entering the local market, Dubai City detected issues in the city old processes, where it reduces efficiency because traditional processes take long durations. Dubai came to a solution by implementing the new technologies in the business and adopting innovative smart projects that transform the city into a digital city that serve the citizens. In the beginning of the journey in 2016, and in cooperation with DED and IBM, Smart Dubai guided to establish the first AI-based machine called 'Saad'. Saad works for the businesses community where it enables the other businesses to get the latest documents on businesses accreditations and authorizations. Saad is an integrated system that provides a solution to the clients on decision makings (Aljumah et al., 2021b; E Tariq et al., 2022). Smart Dubai explored the latest innovation and their possibilities to develop this city (Ahmed and Nabeel Al Amiri, 2022; E. Khatib et al., 2021). The adoption of the blockchain strategy in the smart city resulted in an increase in investment by 1.1 billion in 2016. Smart Dubai main mission is the implementation of innovative technologies that lead in making Dubai the happiest city. This mission made Smart Dubai set its goals that reflect this mission (Al-Kassem et al., 2022; M. T. Alshurideh et al., 2023d; Muhammad Turki Alshurideh et al., 2022a; Arshad et al., 2023). In the next step of implementing big tasks, Smart Dubai came up with launching the AI road-map, its task is to rapidly support serving Dubai citizens by the use of AI. Smart Dubai also released the strategy to build the 'AI Lab' to be the first AI supportive lab that supports all the AI processing in Dubai. Dubai Government was involved in this by enabling its employees and clients to apply all their needs through AI-enabled services (H. M. Alzoubi et al., 2022b; Nuseir, 2021).

4.3.2 Smart Building-New York University in Abu Dhabi

The second case covers the development of smart buildings in Abu Dhabi. As part of developing a smart city, there should be construction and maintenance of smart buildings (H. M. Alzoubi et al., 2022g; El Khatib and Ahmed, 2018; Mohammed T. Nuseir et al., 2022). It requires to take into consideration smart living and environment in the building. smart buildings require intelligent monitoring of the building elements such as structure. New York University in Abu Dhabi has created a smart environment by integrating the structure of the campus with the interior and exterior design. When the University management is done with the construction phase, they began

addressing an intelligent system for security (Aityassine et al., 2022; Akour et al., 2021; Lee et al., 2023; Nuseira and Aljumahb, 2020). They created the Smart Lift Control System. that included a smart card scanner. Its main function is to identify the residents of the building and calculate the number of available residents. Besides this card, a security monitoring control system, SEC is added, and it functions smartly. The smart integration between the structural elements in New York University defined the campus as an Intelligent Building (H. Alzoubi et al., 2022; El Khatib, 2015; M T Nuseir et al., 2022b).

5. HOW CAN AI SERVE/IMPROVE PM

5.1 AI in complex decision making

The use of Artificial Intelligence in constructing smart cities help to ensure infrastructure lifecycle management, operational management, and delivery performance align with the project portfolio and objectives. Due to its vital necessity because such projects considered complex as they contain big data that requires more attention from project managers. Therefore, project managers should be able to provide real-time information on cost, schedule, and risks to stakeholders and be able to track processes and workflows of the project. From smart cities perspectives and while managing such complex projects with variety of parameters, managers and planners should consider number of capabilities to ensure a successful project such as ease of use, accessibility of project information, and having an enterprise wide-view for a holistic view to ensure efficient portfolio management and be able to identify opportunities to help in decision making (Alshawabkeh et al., 2021; M. Alshurideh et al., 2022; Muhammad Turki Alshurideh et al., 2022d; T M Ghazal et al., 2023c). Having this amount of data can be a helpful asset in adopting AI for such projects.

In most project activities and areas there is the availability of data that helps in using resources for decision making which can be seen in adopting the Internet of Things in smart cities development projects. The availability of connectivity led to the mass creation of data around the world and data became the most important source of a leading economy and innovation (Aljumah et al., 2020; El Khatib and Ahmed, 2019). A report published by Smart Dubai stated that the amount of data created will be around 180 zettabytes by the year 2025 which is equal to a billion terabytes (I. A. Akour et al., 2022; Nuseir et al., 2021). The huge amount of data available will need to be interpreted and analyzed in order to help in making the decisions, therefore, artificial intelligence can be utilized as a tool for such role. An example of using big data can be seen in the city of Calgary in Canada where they developed a PI System to gather updated information about the city water system to be able to monitor it and take preventive actions against flood (Muhammad Turki Alshurideh et al., 2022b; Blooshi et al., 2023)as cities are being digitized using technologies and AI to analyze data allowed planners and decision makers to collect data and formulate suitable policies to help solve different kind of issues.

From another perspective, how can big data and AI help in the development of smart cities? Smart Dubai can be used as an example to illustrate the creation of a Smart city using big data management. A smart City as defined by (M T Alshurideh et al., 2022; Nuseir et al., 2021) is not about technology but it is more like a set of complex interrelated city areas each with its own constraints and adoption possibilities. The authors explained further the big data concept and its use in Smart cities as a utilization tool for innovative and creative solutions for digitized wealth. Dubai as well has developed an open and shared Data framework and a special department that is focusing on Data management as they believe that technologies should be fed with as much data as possible to reveal their real abilities (Aljumah et al., 2023). It can be observed from Smart Dubai that the available data alone and technology alone will not be sufficient, however, they should be combined as data should be interpreted and provided to technology to make better use of them and help in making decision regarding different areas in the city.

5.2 Reasons of utilizing AI in PMIS

The use of artificial intelligence in project management can drive the industry toward a magnificent project outcome. Using AI in managing projects can help identify critical issues, make predictions, speed up processes, and many more. AI will affect project management in all its disciplines using machine learning algorithms through risk management and project estimation.

Project management then will rely on artificial intelligence in assessing project performance to help in predicting risks through the project life cycle (Khatib et al., 2016). Including artificial intelligence is an essential involvement in managing projects as new technologies are arising and depending on old style tools and techniques will no longer work for new complex projects. The reasons of utilizing artificial intelligence in project management information system are to help make better use of data and be more productive. For example, many companies like Amazon and Ocado are using artificial intelligence in managing their warehouses and many other firms in examining legal documents and record through data analysis. Moreover, AI can help in the integration process as it can be seen form cost management perspective in where budget updates in databases are simultaneously updated in the forecast report without any human input. AI can also be applied in what is called the autonomous project management system where it has to understand the stakeholders' communication and be able to meet their satisfaction criteria.

Moreover, AI will be a big help in project management throughout the project planning phase where project manager will need to plan and assign activities and resources to better achieve project goals. In addition to that, changes might happen to the project timeline so activities' assignment will be a recurring process, but this is not the issue. The main challenge in here is having wrong estimation and as a human being might overlook some details, AI can take this responsibility in managing project plan, predicting duration and cost, and maintaining project schedule through the use of big data. Another advantage of using AI in project management is in risk management where risks exist and that can lead to the project failure, therefore, adopting AI in predicting risks through historical data analysis and issue logs can save effort, resources, cost, and identify possible project threats to plan for preventive actions or redevelop a better mitigation plan.

5.3 Use of AI in Decision Making in PMIS

Due to the huge amount of complex data and information, Decision Support System tools help project managers analyze these data to assist in better decision making. According to (Nuseir et al., 2021), decision support systems, information technology, and artificial intelligence can all be utilized for knowledge and data management purposes. These 3 combinations can make a support system that helps in analyzing data, finding relationships and patterns, and new information that can be a help in making decisions in projects. For example, Artificial intelligence can be used in complex data analysis as according to report publisher, AI can help in detecting issues and alert users when they need to interfere, and plan and schedule resources based on the project goals. Artificial intelligence can be used as a collaborative design tool as well to help in managing projects and the Tangible User Interface (TUI) system can be an example. The TUI system is a control and visualization tool to help novice users to design neighborhoods to ensure building high-quality communities. The tool has been used to simulate and help improve decision making process for urban planning in many cities around the world. It helps identify better cities' solutions as it encourages machine learning and search algorithms to assist non-experts in having accurate and cost-effective approach to deliver real-time information that can contribute to performance and decisions evaluation. The Tangible User Interface was used in designing one of the neighborhoods in Riyadh city. The project included many parameters that the developers need to consider when planning such as energy efficiency, walkability, and daylighting. As a result, the system helped the planners to visualize their ideas and provide them with design feedback regarding their parameters, accuracy planning, and costs to help them make better decisions.

5.4 How can AI improve project selection criteria?

Project selection is quite a complex type of decision-making process as it requires to look at variety of criteria that can influence the selection process. Artificial Intelligence can be used in different project management areas and phases like selecting projects. Artificial Neural Network can be one tool to help in selection process and it is a knowledge base tool that uses learning algorithms to use and store data. Artificial Intelligence in that case, can help in project selection criteria through the use of artificial neural network (ANN) in predicting the success rate of a project for example. A study conducted in Nigeria

to test the efficiency of using ANN, the study was done to solve the issue of the increasing number of accidents and as ANN learn from historical data the tool used data from 1998 to 2010. The study included number of parameters that can be a cause of accidents such as population, vehicle quantity, and traffic. To train the tool to function, data sets of car accidents were clustered and mapped to a specific type of accidents criteria and then used by the ANN. As a result, the ANN provided them with feedback regarding their study and comparing it to the other models used, using ANN showed its advantage in suggesting solutions for the problem they had through connecting input with output. Such tool helped them to decide what policies or procedures to regulate in order to reduce accidents rate which consequently will decrease death and injuries rate which is a big concern for the government of Nigeria. Adopting AI in project management areas can support in such complex decision making and selection management.

5.5. Challenges of AI Implementation

Artificial intelligence can improve project management in many ways and at the same time, implementing AI in project management can encounter number of challenges. One major challenge when implementing AI in project management is receiving wrong data due to insufficient system training. (Khatib et al., 2022a) suggests that implementing AI in PM should be taken slowly and carefully otherwise project details might be false or incorrect. Moreover, implementing artificial intelligence in project management might require high level of project management maturity and heavy set of data to help in implementing it efficiently. Another challenge is the integration of the AI into our communities. Changing to a smart city using AI requires the community to adapt to the changes in management aspects of transportation and buildings. The adopting of AI in such aspects will require residents to follow the new regime regulations. One obvious issue that struggle the process are considered the global challenges like climate change and migration. The environment department would address significant suffer from applying a quick response in the time the city is changing fast. The new developments require high capacity of data storage and effective management of data to be able to use them as a value-based toward the technologies.

6. CONCLUSION AND RECOMMENDATIONS

In conclusion, this research discussed the use of Artificial Intelligence in project management and how it can help and improve project in its wide and different areas. It also discussed some of the challenges that can prevent the beneficial use of AI. The demonstrated case studies show that there is a need for AI in the implementation of new business management. The case studies indicated that much more is yet to come by the beginning of 2021 following the UAE Vision 2021. Previously or maybe even now, most people are thinking that artificial intelligence is about robotic system and they are programmed to do certain activities. However, with the creation of big data, AI can now be more than just technology and is capable of performing more complex tasks using advanced techniques and algorithms. AI helps more effectively through integrating project management phases and the entire project lifecycle process. Bringing AI to the project management domain across the world can provide a sustainable world for future generations. The AI capabilities and features can help the project managers on gearing the project management through developing a list of the project concerns until deciding the team training needs. It also assists in faster and smarter decisions making. Managing projects can use the benefits of AI, at the same time it still needs to be monitored at least at the beginning of the implementation as users are still not confident about the performance of such AI system. Therefore, it is recommended to monitor AI until users are satisfied and can trust the systems outcome.

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