

INTELIGENCIA ARTIFICIAL EN GESTIÓN DE PROYECTOS: USOS Y APLICACIONES

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Resumen

Los cambios tecnológicos han trastocado prácticamente todas las actividades de la vida diaria con la llegada de la inteligencia artificial (IA). En este nuevo contexto, la digitalización ha provocado profundas transformaciones sociales y económicas. La IA es mucho más que una serie de avances tecnológicos ya que se basa en los principios del autoaprendizaje y el diseño de algoritmos que realizan funciones tradicionalmente humanas. La IA se ha incorporado a la gestión de proyectos (PM) a través de múltiples herramientas y aplicaciones para brindar una visión holística del proyecto, monitorear el trabajo, brindar asistencia a los líderes mediante la creación de sistemas de alerta para problemas de programación y monitorear y priorizar actividades. Sus usos se extienden al análisis predictivo, la automatización de procesos, la reducción de riesgos mediante análisis prospectivos y la eliminación de tareas administrativas repetitivas. Incluso se ha comenzado a utilizar para monitorizar el trabajo dentro del proyecto, evaluando los comportamientos de los miembros y detectando hábitos y matices en la participación que el resto de los miembros del equipo normalmente pasarían por alto, todo para hacer más eficiente el trabajo colaborativo y asegurar que el proyecto se completa con base en la triple restricción basada en alcance, tiempo y costo. Muchos proyectos se basan en datos y la IA es responsable de identificar errores, aumentar la transparencia de la gestión y mejorar la precisión de la planificación. Este breve artículo presenta una recopilación de los usos y aplicaciones de IA presentes y futuros en PM para mostrar su valor y potencial en los años venideros. Sin embargo, no hay que olvidar las cuestiones éticas asociadas a la IA, concretamente los sesgos en los algoritmos que podrían tener un efecto negativo en su uso en proyectos.

Palabras clave: Gestión de proyectos; Inteligencia artificial; Gestión de proyectos; Innovación; Ética



ARTIFICIAL INTELLIGENCE IN PROJECT MANAGEMENT: USES AND APPLICATIONS

Abstract

Technological changes have disrupted practically all daily life activities with the arrival of artificial intelligence (AI). In this new context, digitization has caused profound social and economic transformations. AI is much more than a series of advances in technology since it is based on the principles of self-learning and the design of algorithms that perform traditionally human functions. AI has been incorporated into project management (PM) through multiple tools and applications to provide a holistic view of the project, monitor work, aid leaders by creating alert systems for scheduling issues, and monitor and prioritize activities. Its uses extend to predictive analysis, process automation, risk reduction through prospective analysis, and the elimination of repetitive administrative tasks. It has even begun to be used to monitor the work within the project, evaluating the behaviors of the members while detecting habits and nuances in participation that the rest of the team members would usually overlook, all to make collaborative work more efficient and ensure that the project is completed based on the triple constraint based on scope, time and cost. Many projects are data-driven, and AI is responsible for identifying errors, increasing management transparency, and improving planning precision. This short article presents a compilation of the present and future uses and AI applications in PM to show its value and potential for years to come. However, the ethical issues associated with AI must not be forgotten, specifically biases in algorithms that could have a negative effect on its use in projects.

Keywords: Project management; Artificial intelligence; Project management; Innovation; Ethics

Introduction

Digitization has been present in all fields of human activity and has recently played a central role in PM. These unprecedented changes have led to different technologies that support how projects are managed (Marques, 2021). Digital transformation provides industrial and service sectors with unparalleled opportunities for value creation as business operations have been digitized. Administrative practices have also changed. Labor markets have disrupted traditional employment and forced a reconsideration of necessary personal skills.

Constant technological developments are changing the way people communicate, carry out daily tasks, and work. Changes have led to the emergence of New Ways of Working that are shifting the prevailing paradigms of forms of employment, types of contracts, and forms of organization. What once was a business world founded on the premise of standard long-term contracts is being transformed by digital technologies, opening up the possibilities and generating opportunities for short-term, project-based, and, in many cases, even completely virtual jobs. The idea of organizations with full-time employees is no longer prevalent (Hagiu & Biederman, 2015).

Research shows that the New Ways of Working can offer employees certain benefits that include more flexible work arrangements that better fit their personal lives and greater self-control and self-management possibilities (Blok, Groenesteijn, Schelvis & Vink, 2012). These models can promote a more adaptive and productive workforce, which also stimulates the development of more diverse, agile, dynamic, and innovative organizations. In this line of thought, digitization has blurred the lines of what constitutes work, promoting advanced, effective, and efficient ways of doing things.

In this context, Project Management (PM) has become a sought-after practice in diverse businesses, sectors, and countries worldwide. Although PM is not a recent work model, the exponential growth in its

application is unprecedented. PM can be traced back to the 1940s and 1950s, where large military projects were mainly used (Montaudon, Pinto & Amsler, 2021). During those decades, the practice of PM matured and evolved into a recognized discipline with specific methodologies, tools, and techniques (Stretton, 2007). However, it was not until the 1990s that project work became recognized as the most cost-efficient organizational design to face the challenges brought about by greater complexity and uncertainty (Lambrechts, Sips, Taillieu & Grieten, 2009).

The urgent needs of a world in times of crisis helped further the consolidation of PM (Ljungblom & Lennerfors, 2018). However, its use has transcended high-pressure contexts, allowing PM to establish itself as a suitable, productive, and profitable way to organize and carry out work in diverse areas and situations (Blomquist & Söderholm, 2002), providing timely solutions and cutting-edge processes.

As organizations transition towards employment based on specific activities and specialized projects, the world is being restructured to revolve around teams and multi-team systems with particular functions instead of arrangements that revolve around schedules and broad responsibilities. The implementation of these practices has allowed but potentialized improvements related to productivity increases, time and resources optimization, cost reductions, and absenteeism decreases, among others.

Furthermore, there are constant developments that have promoted the evolution and advancement of PM. Never before has humanity lived with so much technology, flexible networks, and learning machines that facilitate specific tasks. One of the most important phenomena that impact PM directly is the growing use of Artificial Intelligence (AI). The main objective of this article is to showcase the value and potential of the use of AI in PM through the presentation of a compilation of present and possible future applications of these types of technologies in projects.

Method

For the purpose of this short article, the selected research method was a literature review that allows a deeper insight into the conditions of the current adoption of AI in PM and future conditions where its implementation would be invaluable. A brief historical analysis of PM and its characteristics is included. Articles and reviews published by bodies connected to PM were included, limiting the scope to the use of AI and predictive analytics. The most relevant applications are described to clarify the field of PM in the context of AI.

Project Management

According to the Project Management Institute (PMI, 2006), projects are collaborative activities with a limited time frame; they are designed for specific purposes, such as developing a product or service or achieving a unique result. Projects are temporary organizations (Montaudon, Pinto & Amsler, 2021) that are fluid in their operations with a short life cycle and are self-managed (Bechky, 2006). To be successful, a project needs to accomplish its scope, budget, and time frame (Pinto & Slevin, 1988).

Although PM has appeared as a methodology that helps develop work more efficiently, in reality, PM is subjected to numerous problems that can lead to project failure. Gil-Ruiz, Martínez-Torres and González-Crespo, (2020) have suggested that the main problems that lead to project failure include objectives that are either unrealistic or not thoroughly determined, lack of clear definitions or roles and responsibility, scope correction that is not appropriately assessed, problems in evaluating project risk, lack of involvement, issues with planning, unrealistic estimates inadequate methodologies, lack of templates supported on the PM criteria, lack of evidence, training, or resources, and low formalization and support. The sources of failure abound, and the failure rates of projects are monumental. The percentage of projects that fail is around 70% (Temastage, 2021). PM requires a significant amount of expertise and

knowledge for project success, making it an area with potential for applying AI techniques (Foster, 1988), potentially reducing the failure rate.

Artificial Intelligence

AI is one of the technologies increasingly being implemented and has been considered a tool to increase productivity. Based on the simulation of human intelligence processes by machines, AI includes automation, machine learning, machine vision, natural language processing, and robotics (Usher, 2021). Initially, AI was limited to academic research and restricted to solving certain real-world problems (Foster, 1988). Nowadays, it can be referred to as one of the most influential technologies (Wang, 2019), and its use has expanded to virtually all types of business.

AI is considered the capability of machines to mimic human behavior, which can be done in multiple ways that vary depending on how much intelligence is put into a specific system (Chheda, 2019) through algorithms. Algorithms have been acknowledged as the intellectual capital of the Internet (Bell, 2001), as their primary purpose is to automatically perform a task or process that involves some reasoning that people would usually carry out.

The simplest and earliest form of machine intelligence can be seen in robots that carry out repetitive tasks, usually in a production line. A step further is machine learning, which is slightly more advanced, feeding off information or detailed data to recognize trends and make predictions (Chheda, 2019). Then there is deep learning, which uses algorithms to imitate the function of the human brain, resulting in technologies like image recognition, recommendations systems, and financial fraud detection systems (Chheda, 2019).

AI has plenty of applications; it provides alternative means to use technology in order to monitor, manage, control, predict, and identify and prevent risks, among others (Rosenblat & Stark, 2016). In organizational settings, these tools can even aid in monitoring people and teams and give instructions as to how they should interact and how to select the best team members (Kleinberg et al., 2018), as well as to detect inefficiencies invisible to the human eye (Dzieza, 2020). Even systems can recognize how people work and make decisions according to their performance evaluations (Polzer, 2018). AI has been used extensively in different industries and sectors but has not progressed at the same pace in PM.

Project Management and Artificial Intelligence applications

At first glance, it might seem that PM is less suitable for automation than certain other activities in business, politics, and society due to the unique nature of projects (Auth, Jokisch & Dürk, 2019). Still, there have been significant developments. The landscape of PM is constantly mutating due to changing demands and technological advances (Ong & Uddin, 2020). The exponential growth of AI has permeated PM in numerous ways. Its uses include providing an integrated view of the project, monitoring when and how the work gets done, providing assistance through alert systems for scheduling issues or risk management, and prioritizing key activities or tasks. However, its application permeates through practices like predictive and prospective analyses, process automation, and the elimination of repetitive, time-consuming tasks. Nowadays, AI is being used to monitor, evaluate, and control work within the project and analyze the behaviors and interactions of team members while collaborating and habits and trends to facilitate collaborative work and make it more efficient. As many projects are data-driven, AI can also help to identify errors, improve precision and make better decisions (Johnsonbabu, 2017). AI can also reduce subjectivity and ambiguity in projects, making PM processes more rigorous (Skinner, 2019).

Back in 2009, Levitt and Kunz developed a philosophy for the use of AI techniques as a support for PM in engineering, suggesting that it could be done by integrating domain-specific tools, hybrid computer

systems, knowledge processing techniques, decision analysis, and network-based scheduling, which would result in new kinds of decision support. In the last decade, advances in the use of AI in PM have exceeded expectations. Some applications are still in the works or are beginning to be implemented. AIPM or Artificial Intelligence for Project Management, for example, constitutes an integrated system that can manage projects without the need for much input information. AI will provide insights and make recommendations and decisions related to the project (Munir, 2019). AIPM is an incorporated system capable of administering a project without human assistance (Elrajoubi, 2021) and the true driver of the success of AI in PM lies in the organizational and team culture and how people use the information derived from AI systems (Chheda, 2019).

AI technologies with the highest potential of improving PM as a practice include machine learning, diagnostic tools, and deep learning (International Project Management Association, 2020). AI helps lower project costs in multiple ways. It is likely to increase the productivity of projects, although it also has the potential of substituting certain members. The purposeful use of AI can help project managers to create and increase value throughout the different phases of a project cycle. Machine learning could provide project managers with the necessary instruments and knowledge to forecast risks, stakeholder behaviors, and revenue fluctuations based on historical data and other types of information (Johnsonbabu, 2017). AI can detect invisible warning signs that affect the likelihood of accidents while doing projects by registering and verifying equipment performance, unsafe environments at work, and even monitoring the air quality or meteorological conditions to prevent accidents (Munir, 2019).

AI complements existing PM skills. It is expected that by 2025, AI will be used in PM to schedule projects, assign resources, create basic cost plans, assist with contract interpretation and administration, generate earned value assessments, forecast completion costs, and assist with identifying trends for opportunity capitalization and risk mitigation (Usher, 2021). By 2030, 80% of the work in the PM discipline will be eliminated because AI will take on traditional PM functions, including data collection, tracking, and reporting (Gartner, 2019).

Collaboration between PM and AI is a partnership between the PM professional and the AI assistant that integrates analytical and creative thinking and problem-solving skills with real-time data-driven active assistance, performance and productivity, and improved collaborative decision making (IPMA & PwC, 2020). Data science techniques from AI that improve project processes have been divided into four types: integration and automation, chatbot assistance, machine-learn-based, and autonomous management of projects (Wang, 2019; Ong & Uddin, 2020). Specific AI-based technologies and their uses are presented in table 1.

Table 1. AI-based technologies and their use in PM

Technology	Application
Software Project management (SPM)	A strategy and software solutions for organizations include project planning scheduling, resources allocation, change management, task management, time tracking, documentation, reporting, project development, and delivery (Bhavsar, Shah, & Gopalan, 2019). It also helps to visualize updates and notifications, predicting deadlines that cannot be met, and correct time estimates (Munir, 2019).
Project Management AI	An integrated system that manages projects without needing input. Through AI, different insights for making the recommendations to process, decisions related to the project, and team insights will be made (Cappelli 2018; Munir, 2019).
Data-driven PM (Project intelligence)	Data is gathered from the beginning to the end of a project (Davahli, 2020) and from different sources, mainly being digitalized. New tools to process it are being incorporated in PM and used, for example, to create linear regressions to predict

	changes in costs and many other project-specific applications that could lead to what has been called <i>project intelligence</i> (Duggal, 2018; Auth, Jokisch & Dürk, 2019).
Bots and Chatbots and AI assistants	Intelligent software agents specializing in PM. PM Bots or PMB are equipped with speech or text interfaces for communicating with humans and have features of chatbots (Auth, Jokisch & Dürk, 2019). Bots can act as digital assistants; they can be integrated with existing personal assistance tools to promptly answer questions regarding when tasks must be completed and what the resource availability looks like (Johnsonbabu, 2017). Its use allows updating schedules and tasks more efficiently (Munir, 2019). AI assistants can plan and forecast the required resources based on estimation models from the project itself and other projects to determine whether the project is on track or facing some kind of risk (Johnsonbabu, 2017).
Apps or platforms for PM	Certain apps or platforms use AI to determine the time frame for tasks to be completed and how they relate to each other, helping to schedule team members' workload (Munir, 2019). They can also be used to evaluate the productivity of the team and alert of any issues the project might encounter regarding time, scope, and budget (Kyriklidi & Dounias, 2016). Big data is used for predictive project analytics using engines and comprehensive databases that help analyze complexity, success analysis, risk assessment, and HR functions for team selection (Auth, Jokisch & Dürk, 2019).
Intelligent dashboards	Intelligent dashboards can monitor project time and cost metrics in real-time and bring attention to any situation that needs further assessment. They can help release the project manager from the responsibility and effort of operational activities (Johnsonbabu, 2017).
Cloud-based tools	The cloud has the power to provide the support for new tools that can create more advantages to PM, running on the Internet rather than in members' computers, which makes collaboration easier and real-time. Cloud-based PM software makes all information available to be accessed for making different decisions in customized workflows to suit all the requirements (Glukhov et al., 2015).
Statistical algorithms	Different statistical algorithms are constantly being developed to fulfill specific PM tasks, such as cost estimation for different stages in the project lifecycle. Component regression and neural network algorithms are specific examples deployed in machine learning to forecast project costs using historical data (Johnsonbabu, 2017).
Fuzzy logic	Because AI predictions are only as good as the data they are supplied with, enhanced data results in enhanced decision-making. Incorporating Fuzzy Logic can provide recommendations to categorize, prioritize and identify dependencies between projects (PwC, 2019).

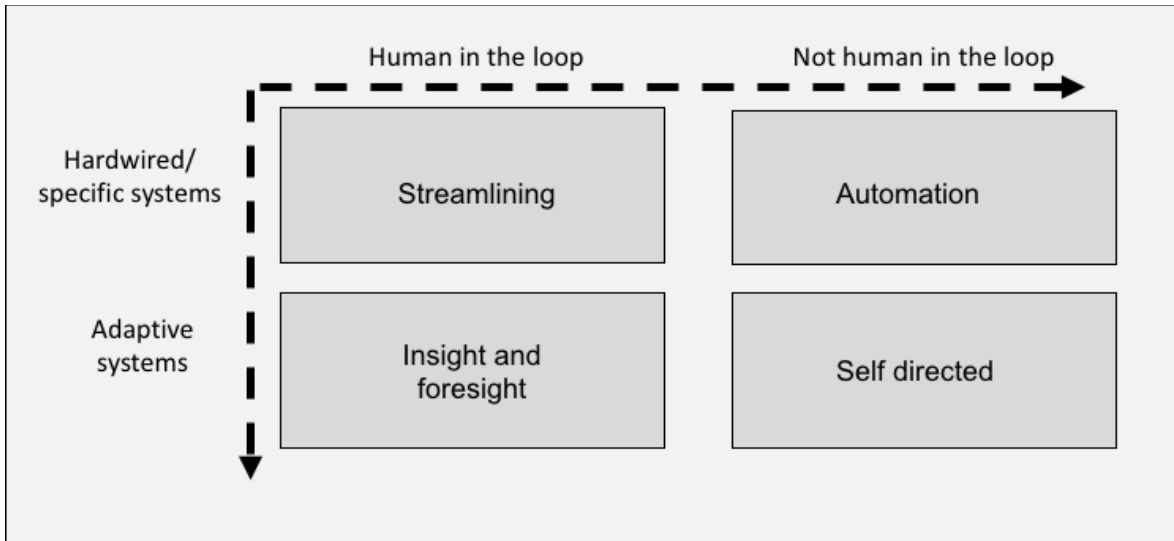
Increasing complexity in projects has made PM more challenging. Different AI tools have been developed to simplify them, positively affecting quality (Davahli, 2020) and its consistency through behavioral patterns (Cappelli, 2018). Bots, along with machine learning, will significantly impact hard and soft skills within the next five to ten years (Nimmo & Usher, 2020).

A relevant trend in the use of AI in PM is mixing or joining different tools so they can take advantage of the strengths of a tool and cover the weaknesses of the rest, and best results are obtained when fusing AI tools with specific PM tools (Martínez-Magaña, & Fernández-Rodríguez, 2015).

Although substantial advances have been made to incorporate AI in PM, critics suggest that this process is still in its infancy (Skinner, 2019). Shortly, there will be a particular technology capable of matching the right kind of resource to the appropriate role as needed (Munir, 2019). To better understand what lies ahead in the future of AI in PM, Skinner's (2019) four different stages in the evolution of AI in PM are

helpful. His diagram, based on whether or not AI in PM keeps humans in the loop and if they use hardwired/specific systems or adaptive systems.

Figure 1 Evolution of Artificial Intelligence in Project Management



Source: Skinner, 2019.

These four stages are the following:

1. Streamlining: consists of improving existing processes through better integration and collaboration. It includes tools to perform tasks such as verifying calendar availability and scheduling meetings, sending reminders, notifying future timelines, and generating reports.
2. Automation: the computer replaces human aspects of the PM process, which are simple and repetitive tasks. Includes instant messages, auto checking for data consistency, and auto checks to measure performance.
3. Insight and foresight reflect a situation in which the computer assimilates project data and provides insights and recommendations to enable predictions of outcomes and better decision-making. Some examples are software that can learn from the project history, creating regression models for future estimations.
4. Self-directed: the computer is autonomous, making project decisions and even remediating project issues that occur. These AI applications for PM are still being developed (Sinner, 2019).

As can be observed, there is still much uncertainty surrounding what AI tools will be seen in the future of PM. Autonomous systems for PM might be closer than we think. What is certain is that AI will not replace project managers because AI will be used as a tool to make better resources allocations, delegate tasks, and manage risks more effectively, but it cannot run a project (Marques, 2021), and the dynamic field of a project manager can currently only be automated in small, clearly defined areas (Auth, Jokisch & Dürk, 2019). Nevertheless, it can alter PM substantially, and although initial applications seem to be minuscule or routine, with time, they mount up, resulting in long-term competitiveness for PM (Vaghela, 2019).

Although most information regarding the use and application of AI in PM seems to be regarded in a positive light, some additional considerations of the use of AI in PM include the fact that AI is not equipped to apply law and ethics to decision-making in PM (Chen 2019) because of potential bias and information

asymmetries in the way in which algorithms are built and the opacity of how they learn. The ethical aspects of AI have become a significant issue (Vidgen, Hindle & Randolph, 2020) because ethics are customarily associated with human control (Chen, 2019), and if machines do something wrong, punishment cannot be applied; it is humans that are held accountable. AI may aggravate traditional ethical problems, transform familiar ethical problems into analogous and unfamiliar problems, create new problems, or relieve existing moral problems (Mamer, in Pecorino & Maner, 1985) unique to the digital realm. Using AI in PM also entails several risks, security being one of the most relevant, especially cybersecurity, and data privacy, because AI can collect personal or sensitive data. According to Foster (in Fridgirsson, Ingason, Jonasson & Jonsdottir, 2021), the main obstacle preventing the use of AI in PM is the lack of knowledge and understanding of AI and the time and cost of implementing an AI system. Perhaps other obstacles related to the fact that although AI tools in PM have proven helpful, they cannot predict future scenarios or proactively alert project managers before a significant issue arises (PwC, 2019).

Predictive analytics in PM

AI will be developed beyond task automation and will be used extensively in Predictive Project Analytics (PPA) for advice and actions. For instance, it can provide predictive maintenance on the system that people rely on for the project (Branscombe, 2018). Predictive analytics will provide project managers with advice regarding different actions such as steering a project according to various parameters, how to face different risks, and how to achieve better outcomes using information collected from previous projects (Lahmann, Kesier, & Stierli, 2018). Predictive tools can help better estimate the resources needed for project completion, and although each project is unique, the resources that impact progress are very similar (Ziembinski, 2020). Using predictive analytics helps gain an objective overview of project risk areas and areas of improvement and identify specific measures (Fauser, Schmidhuysen, & Scheffold, 2015).

Predictive Project Analytics is a project risk assessment methodology that emerges from data analysis and predictive analysis and aims to drive decisions empirically and supported by hard facts, offering higher value than traditional monitoring, reporting, and analysis techniques (Fauser, Schmidhuysen & Scheffold, 2015). PM can be augmented by automating sprints planning and distributing tasks in a more optimal way. Predictive analytics can also help with risk prediction before the project is launched (Ziembinski, 2020).

Predictive analytics is expected to become the most disruptive innovation in PM in the years to come, providing project managers with valuable information to face uncertainty and risks while creating value by enhancing the quality of decision making (Lahmann, Kesier, & Stierli, 2018). Predictive analytics and pattern identification can improve planning and reducing variations in schedules (Ziembinski, 2020), resulting in suggestive risk mitigation strategies (Fauser, Schmidhuysen, & Scheffold, 2015). To determine risk factors that can affect the project, team size, financial cost, accountability, and project structure are considered (Fauser, Schmidhuysen & Scheffold, 2015).

Conclusions

In the future, it is expected that the number of project managers will increase because organizations continue to move away from traditional working structures into temporary and more flexible ones that can achieve specific goals in shorter periods of time. AI tools will be helpful for project managers to lead their teams, schedule work, allocate resources, and review the progress made faster and easier, contributing to meeting project goals.

Project management is and will continue to be influenced by the AI paradigm. AI enables PM; there are a wide variety of applications of AI and machine learning that are useful in PM, and its use will undoubtedly increase. In fact, different AI-based PM tools are helping develop better results, boosting productivity.

New applications are being developed to help reduce project failure rates by simplifying and automating specific actions. The novel tools and approaches can be expected to more effectively support current activities and streamline or eliminate others while changing how PM is traditionally performed (Niederman, 2021).

Perhaps the most visible positive effects of AI in PM are reducing risks and assisting in the daily tracking of project-related activities. The importance of data is that it can be used to adjust the projects to keep them on track and assist in the management.

Although AI provides valuable tools for project managers, there are risks to be assessed, including possible bias that can have a negative effect. Further research can be done to analyze why AI has not progressed in PM as fast as it has done in other business areas.

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