PUBLIC PROCUREMENT CONTRACTS FUTURITY: USING OF ARTIFICIAL INTELLIGENCE IN A TENDER PROCESS

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Abstract

The paper sheds light on the relationship of technology to public procurement as a type of innovation in the field of public procurement and the benefits and advantages that emerging technology, such as artificial intelligence (AI) based on robust algorithms, can bring. This paper also relied on the analytical approach in analyzing the literature related to public procurement and AI to identify the factors that help the success of the approved public procurement system supported by AI, as well as the issues raised by AI in several aspects and the advantages that AI can achieve in procurement. The paper aimed to analyze the factors affecting the adoption of the application and use of AI applications in public procurement through the digitization of public tender procedures and processes. The paper also presented the reality of public procurement in the era of digitization (Spreitzenbarth et al., 2024; Bilal et al., 2024). The paper also presented the main concerns and issues in using AI applications in public procurement. The elements of electronic public procurement systems (EPPS) and their progression were also presented. The paper concluded that technological, organizational, and political factors are the most critical factors influencing the adoption of AI techniques in public procurement.

Keywords: Artificial Intelligence, Public Procurement, Algorithm, Big Data, Data Privacy, Tender

Authors' individual contribution: Conceptualization — K.S.A.; Methodology — K.M.D.; Writing — Original Draft — K.S.A.; Write — Review & Editing — K.S.A.; Supervision — K.M.D.; Project Administration — K.M.D.

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1. INTRODUCTION

Public procurement has extreme investment power for government money and innovation. Public spending allocations from the budget for public procurement amount to more than 40% in several countries (Maulidevi et al., 2024; Tran et al., 2011; McPherson & MacSearraigh, 2007) and represent 15% to 25% in other countries (Costa et al., 2013), and in others, they reach 30% (Liu et al., 2011; Toktaş-Palut et al., 2014). All of these allocations vary from one country to another depending on the infrastructure and technology of that country, in addition to the state's development goals and the state's strategy toward construction and reconstruction (Walker & Brammer, 2012; Panayiotou et al., 2004; Adjei-Bamfo et al., 2019; Alvarez-Rodríguez et al., 2014). Governments are considered among the most purchasing clients in the market and the most highly trusted clients, whether in terms of paying money or implementing obligations in the contract (Choi et al., 2016; Siciliani et al., 2023; Jiménez et al., 2022). These things prompted the private sector to rush to engage in public procurement contracts and to rush vehemently to win government tenders and competitions to win public procurement contracts (AlNuaimi et al., 2021; Davila et al., 2003).

The current conversation that raises many questions is the public's confidence in the roles and functions of governments in society (Liu, 2023;

Aboelazm, 2023a), the quality of services provided (El Bhilat et al., 2024), the speed and efficiency in delivering public services (Dubey et al., 2021), and the costs of public spending on public procurement, the financial allocations of which are deducted from taxpayers' money (Samadhiya et al., 2023). In return, citizens want to receive good service (Aysan et al., 2024; Uzir et al., 2023). This has made governments focus significantly on the use of artificial intelligence (AI) technologies in providing public services, and the use of these technologies in public procurement processes has emerged strongly (Chang et al., 2023).

AI systems based on machine learning of algorithms and their design by the translation and processing of natural languages, semantic interpretation (Silsand et al., 2023; Kehayov et al., 2022; Guida et al., 2023), linking laws (Nagitta et al., 2022; Aboelazm, 2023b), regulations, and documents together (Spreitzenbarth et al., 2024), and extracting various concepts from the documents being processed (Bilal et al., 2024; Burger et al., 2023); all of this helps to make it possible to benefit from these technologies in public procurement (Filice et al., 2020), by during the creation and development of a system that can interact with all the data that is entered through an algorithm designed specifically for this purpose (Allal-Chérif et al., 2021; Haas, 2024; Wilkinson et al., 2024). This intelligent system can be designed and created by preparing vast amounts of data and documents that have been carefully analyzed and processed and then conducting the necessary tests for these systems (Mathew & Abdulla, 2022; Bhattacharya et al., 2024; Dubey et al., 2022). These intelligent systems use massive data from previous tenders in all government institutions and bodies (Samadhiya et al., 2023; Aboelazm, 2022). Incorporating this data into public procurement tenders ensures the development of a unique framework to enable the algorithmic system that supports AI to interact with future tenders and process this tender through a response (Uzir et al., 2023; Silsand et al., 2023). On various related inquiries, evaluating technical and financial offers (Spreitzenbarth et al., 2024; Bilal et al., 2024) and selecting the best offers to win public procurement contracts (Burger et al., 2023; Dubey et al., 2021; Liu, 2023). In addition, there is the possibility of carrying out the pre-qualification process to participate in competitions and tenders for public procurement (Song et al., 2024; Zhong et al., 2024).

On the other hand, the design and creation of public procurement systems that rely on AI techniques and their implementation are considered a major innovative (Bag et al., 2023; Ghouri et al., 2023) breakthrough in public administration in general and public procurement in particular (Sadeghi et al., 2024; Gao et al., 2023; Ahmed et al., 2023). It is also one of the fundamental technological innovations (Kassa et al., 2023; Manning et al., 2022) and a revolution in the organizational and societal culture of the public (Dubey et al., 2022). Despite all the advantages AI systems can bring to public procurement (Gupta et al., 2023), many concerns are constantly being raised (Riahi et al., 2021). There are many ethical issues, such as bias (Bhattacharya et al., 2024), data privacy (Richter et al., 2022), transparency in decision-making, and human rights. Although AI has achieved many benefits from processing massive data (Zhang et al., 2024), making speedy decisions, and saving time, money, and effort, the concerns (Qiu & Zhao, 2024; Kehayov et al., 2022; Allal-Chérif et al., 2021) and risks that could arise from its use in public procurement are numerous about the values of public administration (Wilkinson et al., 2024; Aysan et al., 2024).

These concerns about relying on AI systems in public procurement have prompted governments and companies working in technological fields (Rolf et al., 2022) to prepare ethical guidelines for the use of AI in general (Sharifmousavi et al., 2024), like the rules allotted by the European Union (Liu et al., 2022; Qiu & Zhao, 2024; Bhattacharya et al., 2024) and what was issued in Canada (Richter et al., 2022; Gupta et al., 2023) regarding the effects of big data-based algorithms and evaluating these effects. As well as UK guidance (Zhong et al., 2024) regarding the uses of AI in general and its ethics (Qi et al., 2023). These directives constitute ethical values and principles that can generally be relied upon when public governmental bodies rely on AI systems in public procurement (Zhang et al., 2024).

The main problem lies in the lack of a precise meaning for AI (Dubey et al., 2022; Qiu & Zhao, 2024). The concept of AI is still evolving and varies depending on the context used (Bhattacharya et al., 2024; Sharifmousavi et al., 2024). However, AI is "a set of digital technologies that enable machines to learn and solve cognitive problems independently without human intervention" (Liu et al., 2022, p. 13213). The context of this study is public sector procurement, public administration procurement, or government procurement. Public administration is the body, institution, or agency that works to implement government policies and can contribute to developing these policies (Allal-Chérif et al., 2021). AI techniques and related applications in public administration include automating processes, procedures, and potential customers (Burger et al., 2023); predictive analytics for decision-making in public procurement (Filice et al., 2020); and reviewing tender documents and financial and technical offers submitted by competitors (Nagitta et al., 2022; Kehayov et al., 2022). The focus here will be on the shift from traditional public procurement to electronic public procurement (Silsand et al., 2023), then the shift towards smart public procurement based on robust algorithms that are fed with big data that includes laws and regulations related to public procurement (Chang et al., 2023), data of contractors and suppliers (Uzir et al., 2023; Allal-Chérif et al., 2021), and the foundations and criteria for evaluating offers (Gao et al., 2023; Sadeghi et al., 2024).

Creating, designing, and developing AI applications in the public sector generally (Haas, 2024; Wilkinson et al., 2024; Allal-Chérif et al., 2021; Filice et al., 2020), particularly public procurement (Guida et al., 2023; Bilal et al., 2024; Burger et al., 2023), is complex for practitioners and researchers (Silsand et al., 2023; Kehayov et al., 2022; Nagitta et al., 2022). Simulating human behavior through AI algorithms and approaching them effectively in public procurement is highly complex and challenging (El Bhilat et al., 2024; Ahmed et al., 2023; Filice et al., 2020; Burger et al., 2023; Gupta et al., 2023). Supply chains and public procurement often depend on non-automated reactions and require

innovative human solutions because algorithmic interaction based on big data may not be the most appropriate option (Bag et al., 2023; Zhong et al., 2024; Silsand et al., 2023; Qi et al., 2023), given that public procurement is one of the areas that most face renewable and not recurring situations (Ghouri et al., 2023; Sadeghi et al., 2024; Richter et al., 2022).

This paper aims to fill the research gap and contribute to building theoretical assumptions for public procurement processes based on AI, pointing out the advantages and disadvantages that these systems produce and the role of knowledge and human intelligence in these systems, and thus exploring the success factors of these systems and the challenges facing the success of these systems. The following research questions will be answered:

RQ1: What is public procurement development in the digital transformation era?

RQ2: What are the impacts and benefits of combining AI and human intelligence in public procurement systems?

RQ3: What factors influence the design and implementation of public procurement systems based on AI?

RQ4: What are the benefits of using AI in public procurement?

RQ5: What issues and concerns can AI techniques raise in public procurement?

Accordingly, the structure of this paper is as follows. Section 2 reviews the relevant literature. Section 3 presents the research methodology. Section 4 provides ecological factors to create an AI procurement system. Section 5 presents the results. Section 6 concludes the paper.

2. LITERATURE REVIEW

Although much literature has highlighted the uses of AI in the public sector (El Bhilat et al., 2024; Samadhiya et al., 2023; Spreitzenbarth et al., 2024), it has not been fully addressed in either the public sector or public procurement (Bilal et al., 2024; Mathew & Abdulla, 2022; Wilkinson et al., 2024). Although governments have begun to use AI applications and technologies increasingly (Haas, 2024; Filice et al., 2020), there is minimal discussion of the role of the government or the public sector in reducing concerns about the use of AI in the public sector (Dubey et al., 2021), which includes public procurement (Bag et al., 2023). Most of the literature attempts to fill the research gap on the challenges related to the application and use of AI within public administration (Gao et al., 2023), which has prompted some to call for the necessity of developing a theoretical and ecological framework to study the factors influencing the design of AI systems to work within the government as well as provide services to the public (Kassa et al., 2023). This has prompted some to raise concerns about using AI and algorithmic technologies in public procurement and the issues these technologies raise in this field (Manning et al., 2022).

Additionally, the electronic system for public procurement is one of the essential means for governments (de Boer et al., 2002) to achieve innovation in public procurement (Fink, 2006), in addition to enhancing integrity and transparency and achieving efficiency and effectiveness in the public procurement process (Fuks et al., 2009), as these systems help achieve substantial financial savings and also reduce the time used in public procurement operations (Gupta et al., 2023; Hardy & Williams, 2008). Also, electronic systems in public procurement have helped reduce the number of human resources dealing in public procurement operations (Harink, 2003; Henriksen & Mahnke, 2005) and save effort for public procurement officials. Although the presence of the human element in public procurement processes has been reduced, it still plays a vital role in electronic platforms for public procurement as the human aspect evaluates technical and financial offers, signs, and manages contracts (McPherson & MacSearraigh, 2007).

With the emergence and development of emerging technology in general and AI technologies (Rolf et al., 2022; Liu et al., 2022), governments and the private sector have pushed hard to design AI systems that help them perform their jobs excellently (Qiu & Zhao, 2024). In light of government digitization strategies for public administration and e-government systems, AI has begun to play an essential role in all aspects of government jobs (Sharifmousavi et al., 2024), which has led some to address the phenomenon of the disappearance of jobs and the dispensing of human resources (Zhang et al., 2024; Bhattacharya et al., 2024), replacing them with AI techniques and robots that rely on various powerful algorithms, which is fed with big data (Richter et al., 2022). Public procurement is considered one of the most critical areas in which technological systems supported by AI have begun to be designed to manage and evaluate public procurement operations (Riahi et al., 2021).

Furthermore, in light of the successes of technological innovations that rely on AI techniques in many public services provided by public administration agencies (Gupta et al., 2023), we have recently witnessed in many countries (Dubey et al., 2022; Manning et al., 2022). Moreover, in light of the focus of these innovations on achieving many goals related to efficiency and effectiveness (Kassa et al., 2023; Ahmed et al., 2023), saving effort and time (Gao et al., 2023), as well as attaining money savings (Sadeghi et al., 2024), governments have been encouraged to expand the use of these advanced technologies in all government functions in general and in public procurement in particular (Ghouri et al., 2023; Bag et al., 2023). Some have called for the need to work to reduce human interference in the provision of public services (Zhong et al., 2024), especially those related to funds and fees (Song et al., 2024), and to separate the human element providing the service from the citizens receiving the service to achieve the most outstanding possible integrity in the provision of public services (Qi et al., 2023).

2.1. E-procurement

The role of electronic systems in public procurement is emphasized, as they achieve many benefits. Public procurement helps reduce the time used in public procurement processes. Electronic public procurement also helps save public spending, as the papers and tools used in public procurement operations are provided. It also saves many working hours for public procurement officials, which also helps reduce spending and exploit the effort of human resources in other matters (Panayiotou et al., 2004).

Procurement helps the e-public also enhance integrity in public procurement as the purchasing process takes place in an integrated manner within a framework far from the meeting of public procurement officials with clients from private sector companies (Reunis et al., 2006), which reduces biases in favor of one company over others. The transparency that electronic public procurement can achieve also encourages small and medium-sized companies to engage and participate in public procurement processes. The availability of information and data about tenders and public procurement operations is also considered one of the most essential advantages that electronic public procurement can achieve. In addition, the encouragement to use electronic systems in public procurement is increasing significantly (Ware et al., 2011; Walker & Harland, 2008), especially in developing countries (Walker & Brammer, 2012), in light of the successes achieved by electronic public procurement systems (EPPS) in other countries (Varney, 2011). Electronic public procurement dramatically helps achieve the best possible efficiency and effectiveness in public procurement and government tendering processes (Vaidya et al., 2006). Finally, electronic public procurement plays a vital role in reducing corruption in public procurement.

However, several studies indicate that public procurement faces challenges and risks. Electronic public procurement requires massive funding to establish secure electronic Systems and channels, especially in developing countries, which can be considered a high cost (Teich et al., 1999; Szymansk, 2007). However, the return on this cost far exceeds what is spent on designing and implementing these systems. Some point out that electronic purchasing systems must be carried out within the framework of a secure system and high electronic protection for fear of these systems being penetrated by professional hackers (Svidronova & Mikus, 2015), which is considered a significant threat to the government and the public sector in the field of public procurement (Sun et al., 2012). The issue of qualifying public procurement officials to deal with electronic systems in public procurement is also considered one of the most critical challenges facing EPPS. Changing the organizational culture that relies on the paper-based system and switching to the electronic system in public procurement is considered a challenge that cannot be overlooked.

However, some have indicated that electronic public procurement could be addressed in stages according to Table 1.

Table 1. E-procurement systems

EPPS types	*Explanation*	*Authors*
Electronic informing	Collecting and distributing procurement information from and to internal and external parties by internet technology.	de Boer et al. (2001, 2002)
Electronic sourcing	Method of differentiating new suppliers or contractors for specific categories of procurement requirement by internet technology.	Fuks et al. (2009) and de Boer et al. (2002)
Electronic tenders	The process of dispatch requests for information and prices to suppliers and contractors, and then receiving the response by internet technology.	de Boer et al. (2002) and Betts et al. (2006)
Electronic reverse auctions	Internet-based invert auction technology that concentrates on the price of the services and goods tendered.	Teich et al. (1999)
Electronic maintenance, repair, and overhaul (MRO) and web-based enterprise resource planning (ERP)	The method of establishing and approving procurement demand, placing procurement orders, and receiving the services and goods ordered by internet technology, e-MRO deals with indirect items (MRO), and web-based ERP deals with product-related items.	de Boer et al. (2002), Fink (2006)
Electronic orders	The use of the Internet to facilitate the operational procurement process, including requisitioning approval, receipt, and payment process.	Reunis et al. (2006), Harink (2003)
Electronic markets	Those meeting venues for suppliers, contractors, and purchasers, use the exchange technique to support the procurement process electronically.	Fuks et al. (2009), Block and Neumann (2008)
Electronic intelligence	Management information system with spend analysis tools.	Harink (2003)
Electronic contract management	The use of information communication technology (ICT) for developing the effectiveness and efficiency of the contracting process of companies.	Aboelazm (2022)

Source: Aboelazm (2022).

The components of the public procurement system depend on seven essential elements. The electronic publication of the tender can begin by simply making information and data about public tenders available on websites on the Internet so that they are easily accessible (Sitar, 2011). The second element is identifying potential suppliers electronically by sending an e-mail to potential suppliers participating in tenders. This feature only applies in cases of limited tenders (Maulidevi et al., 2024). The third element is for the suppliers participating in the tender to upload their documents to the website prepared specifically for this purpose (Tran et al., 2011). The fourth element consists of evaluating suppliers' technical and financial offers and selecting the winning offer electronically (Costa et al., 2013). These elements are preceded by the public procurement planning stage, in which systems enable government departments within the government agency to upload their future needs so that the public procurement department can collect requests easily (Liu et al., 2011). The sixth element lies in paying suppliers' dues during and after the contract, which is done through the electronic payments system. The final stage in managing public procurement contracts comes electronically (Toktaş-Palut et al., 2014), which begins with the electronic signing of the contract with the supplier who wins the contract, then following up on the implementation electronically by verifying the delivery quantities and dates by what is stated in the electronic contract. It should be noted that each stage can be an independent electronic system in itself, depending on the willingness and

qualification of the responsible government agency (Walker & Brammer, 2012; Panayiotou et al., 2004), and they can all form one integrated system (Adjei-Bamfo et al., 2019).

Electronic public procurement aims to increase the productivity of public administration in managing government tenders and competitions in public procurement contracts (Alvarez-Rodríguez et al., 2014) by reducing and simplifying tender procedures and accelerating communication (Choi et al., 2016; Siciliani et al., 2023) between the public and private sectors through a secure electronic system (Jiménez et al., 2022; AlNuaimi et al., 2021; Davila et al., 2003; Choi et al., 2016). The primary goal of electronic public procurement is to shift from a paper system to an electronic one that relies on advanced information and communications technology (Siciliani et al., 2023; Jiménez et al., 2022). This leads to the possibility of accessing these systems remotely (Davila et al., 2003; Hardy & Williams, 2008). Therefore, electronic public procurement constitutes a great strength regarding remote communication, which is not restricted to the workplace (AlNuaimi et al., 2021). Adopting innovative solutions for public procurement by adopting electronic procurement systems leads to many benefits, which are represented in generating massive digital data, which can help in the future in creating an AI system for public procurement (Neupane et al., 2014), which improves public procurement processes for government bodies and agencies as well as Suppliers and bidders (Block & Neumann, 2008).

The great importance that public procurement plays represents one of the most important motivations for governments (Hardy & Williams, 2008) to innovate, work to implement the tender process efficiently and effectively, and enhance government integrity and transparency in public procurement (Neupane et al., 2014), which has made governments think about digitizing public procurement processes (Betts et al., 2006) through the use of technological means to develop methods (Block & Neumann, 2008) of managing public procurement contracts (de Boer et al., 2001). Electronic public procurement, which relies on offering tenders through electronic advertising, appeared on the horizon. Then, systems were developed to enable governments to receive financial and technical offers electronically. Then, this system was designed to announce the tender, submit technical and financial offers, award contracts, and manage the contract electronically (Davila et al., 2003). Then, the planning process for public procurement was also added to be done electronically (de Boer et al., 2001).

2.2. Public procurement operations in the age of digital transformation

Working on automating public procurement digitally depends on knowledge of the internal work systems of procurement processes, their procedures, and their various stages. Public procurement processes begin with planning public procurement, selecting the supplier, managing purchase requests and delivering them to departments, and then analyzing the procurement process (Maulidevi et al., 2024; Siciliani et al., 2023). Therefore, comprehensive public procurement processes consist of the four elements above, which can be illustrated in Figure 1.

Figure 1. Inclusive public procurement stages

Source: Authors' elaboration.

The public procurement process aims to meet needs at the internal and external levels. Meeting needs at the internal level includes meeting the needs of the internal departments of the government agency (Siciliani et al., 2023). In contrast, at the external level, it includes meeting the needs of the public (Costa et al., 2013). Thus, the public procurement process is to meet needs in light of the goals and strategies of the government agency (Neupane et al., 2014). Obtaining goods, services, and businesses is the goal of public procurement to deliver these businesses, goods, and services to their final destination at the internal or external level.

Achieving public procurement objectives at the internal or external level that were previously determined is considered the primary determinant of the performance of public procurement and the extent of its efficiency and effectiveness (Henriksen & Mahnke, 2005; McPherson & MacSearraigh, 2007) in light of the resources of the relevant government agency. Public procurement performance can be measured through various indicators such as procurement cost, reliability of delivery according to the specified timetable, and the quality of public procurement officials at the professional level (Panayiotou et al., 2004). Digitizing public procurement can help improve public procurement's performance and help it achieve its goals efficiently and effectively (Svidronova & Mikus, 2015). Automating the four operating processes and activities in Figure 1 will help the government agency focus on strategic activities and pay more attention to them than public procurement operations (Spreitzenbarth et al., 2024). Therefore, public procurement officials must be developed and qualified and acquire new skills and competencies related to digitization and digital transformation (Henriksen & Mahnke, 2005). Developing government agency information structures leads to creating and enhancing transparency and integrity and increasing the growth of data and information that will help design, build, and implement an AI system for public procurement in the future (Hardy & Williams, 2008). Public procurement must be more integrated into government agencies' strategies. Public procurement can be a tool for innovation inside and outside government (Aboelazm et al., 2024; Chang et al., 2023). Innovation and digitization help implement advanced technological technologies such as AI, which helps maintain and develop relationships with suppliers (Aysan et al., 2024) and increase the number of available suppliers (Burger et al., 2023; Filice et al., 2020; Wilkinson et al., 2024), which benefits government agencies in terms of obtaining goods, works, and services (Mathew & Abdulla, 2022; Aysan et al., 2024; Bilal et al., 2024) at a lower price and with higher efficiency in light of expanding the base of competition among customers from potential suppliers (Samadhiya et al., 2023).

2.3. The role of artificial intelligence in public procurement

Public procurement processes consist of multiple parties, internal to the government agency and external from client suppliers and relevant government agencies (El Bhilat et al., 2024; Liu, 2023; Qi et al., 2023). This network of unconnected relationships provides streams of massive data that can be linked to each other through AI by taking advantage of the technological and digital development of the current era (Qi et al., 2023; Aboelazm, 2023b). Public procurement operations generally depend on effective and efficient coordination between many parties and different goods, services, businesses, and assets funds (Zhong et al., 2024). Using the emerging technology represented in this paper in AI helps enhance the performance of public procurement (Bag et al., 2023). Automating intelligent human behavior and encoding it into powerful algorithms dramatically increases the effectiveness of AI systems (Ghouri et al., 2023). Instead of training human intelligence and consuming time and effort to improve their performance and efficiency, an AI system supported by a machine learning system can be designed and created, which can address the defects of electronic public procurement based on programming (Sadeghi et al., 2024). AI based on machine learning is better than public procurement based on programming (Aboelazm, 2023b; Gao et al., 2023).

Much recent literature has indicated that public procurement is one of the best areas in which AI can be used. It is the most suitable field for using these advanced technologies (Ahmed et al., 2023). Public procurement departments, suppliers, contractors, related parties, and stakeholders generate large amounts of data (Kassa et al., 2023). This data is necessary to create any system based on AI. Most of the literature on AI and public procurement has focused on the four elements indicated in Figure 1. However, some case studies and research have recently been published that investigate expanding the use of the AI system in public procurement and not limiting it to the four elements in Figure 1. AI can be used in the negotiations stage, supplier selection mechanisms, supplier performance evaluation (Manning et al., 2022), cost-benefit analysis of the public procurement process (Dubey et al., 2022), and choosing appropriate contracting methods and approaches for the procurement process according to its financial value and importance to the government agency (Gupta et al., 2023). AI systems can play a role in developing the public procurement function in government agencies to the point of causing breakthroughs in the public procurement function (Riahi et al., 2021; Sharifmousavi et al., 2024).

This confirms that the current literature review has frequently pointed out the significant gaps in academic research and studies (Kehayov et al., 2022; Manning et al., 2022; Song et al., 2024) and between real-life practical applications regarding AI and public procurement (Dubey et al., 2022). Most of the literature in the field of public procurement revolves around the mechanisms of selecting suppliers and contractors (Riahi et al., 2021). However, when designing AI systems for public procurement, the government must consider all aspects and elements of public procurement processes and procedures (Sadeghi et al., 2024). Analyzing the advantages of AI systems, as well as the concerns that they can raise (Zhang et al., 2024), the factors that can achieve the success of AI in public procurement (Uzir et al., 2023), and the challenges likely to be faced, as well as comparison with the requirements and conditions of different public procurement processes, helps to ensure that public procurement is suitable to be automated through algorithms used by the AI system or not (Aysan et al., 2024). Moreover, several recent studies have revealed the positive effects of AI systems on the performance of public procurement and supply chains, a relationship characterized by flexibility in sourcing and purchasing (Samadhiya et al., 2023). This encourages the conduct of in-depth research to study the potential effects of AI on the performance of the public sector in the field of public procurement (Liu, 2023; Zhong et al., 2024; Liu et al., 2022) to provide the necessary advice and suggestions in decision-making to public bodies (Bag et al., 2023; Zhong et al., 2024; Silsand et al., 2023; Qi et al., 2023) and to enhance

innovation in public procurement through the development of AI systems (Sadeghi et al., 2024), which is reflected in On public procurement processes by increasing competitiveness (Gao et al., 2023), integrity (Kassa et al., 2023; Richter et al., 2022), and transparency (Dubey et al., 2022), and expanding the base of participation (Riahi et al., 2021).

In addition, the literature predicts that advanced technologies such as AI will have a substantial role in public procurement operational activities (Bhattacharya et al., 2024), reducing the use of human resources and thus creating savings in effort and money (Chang et al., 2023). AI systems cannot operate in isolation from humans and human knowledge (Sharifmousavi et al., 2024), so close cooperation between these systems and humans may help strengthen public procurement systems based on AI (Rolf et al., 2022), enhancing the human role in AI and increasing the efficiency of supply and purchasing processes (Qiu & Zhao, 2024). The knowledge of public procurement officials and practitioners can help create and design AI systems for public procurement and develop public procurement officials' professional and ethical aspects (Uzir et al., 2023). The use of AI in public procurement is limited to some aspects of procurement processes (Aysan et al., 2024), and there is no integrated system in this field (Rolf et al., 2022). This prompted researchers and practitioners to encourage conducting more research and theoretical studies using the literature review method or case studies (Chang et al., 2023), which focus on content (Spreitzenbarth et al., 2024). Here, many researchers and practitioners also point to the urgent need to have scientific theories extracted from practical reality by studying the success factors of public procurement systems based on AI and the human role in interacting with public procurement systems based on AI by exploring both sides of the purchasing parties (Haas, 2024; Wilkinson et al., 2024; Allal-Chérif et al., 2021; Filice et al., 2020), which are the public sector (buyer) and private sector supplier or contractor (seller) (Guida et al., 2023; Bilal et al., 2024; Burger et al., 2023).

3. RESEARCH METHODOLOGY

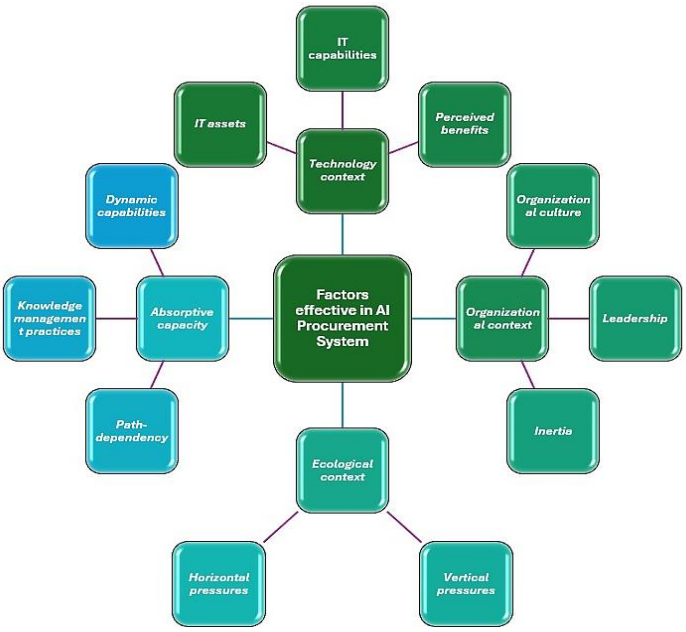
This paper relied on the descriptive approach to identify the concepts of electronic public procurement and the concept of AI in public procurement and to identify some associated concepts, such as algorithms, machine learning, big data, and supply chains. This paper also relied on the analytical approach in analyzing the literature related to public procurement and AI to identify the factors that help the success of the approved public procurement system supported by AI, as well as the issues raised by AI in several aspects, and the advantages that AI can achieve in procurement.

This paper is based on a review of several papers that dealt with traditional and emerging technologies and their uses in public procurement. In particular, the definitions of e-procurement and the various aspects of the uses of AI in public procurement, the challenges facing such practices, and the most significant challenges that may face the introduction of emerging technology in public procurement processes and state contracts.

4. ECOLOGICAL FACTORS TO CREATE ARTIFICIAL INTELLIGENCE PROCUREMENT SYSTEM

Adopting and using AI systems in public procurement depends on several ecological factors (Qiu & Zhao, 2024). The use of technology in general, and emerging technology in particular, cannot occur in isolation from surrounding factors (Gao et al., 2023). The success of these technologies, including AI technologies, depends on several factors that are not related to the technology itself but are related to the environment surrounding the use of technology. The adoption and use of AI systems in the public sector (Bag et al., 2023), primarily in public procurement (Manning et al., 2022), depends on several factors related to the absorptive capacity of the surrounding environment (Riahi et al., 2021) according to Figure 2, which will be discussed.

Figure 2. Ecological factors to create artificial intelligence procurement system



Source: Authors' elaboration.

4.1. The capacity of technology infrastructure factors

The issue of technology and its absorptive capacity for using AI systems in public procurement is one of the most critical issues constantly raised (Aysan et al., 2024; Aboelazm, 2022). The ability of governments to transform towards e-government and reach what is known as digital maturity for the government in general and the government agency (Wilkinson et al., 2024), in particular, is considered one of the factors influencing the adoption and application of AI in public procurement (Sadeghi et al., 2024; Aboelazm, 2023b). Digital and technological maturity includes government assets of information technology, and advanced communications means, such as cloud computing, technological and digital infrastructure in terms of its strength, speed, superior processing capacity, and the strength of networks (Dubey et al., 2022). These digital and technological assets must be compatible with AI techniques and applications in public procurement (Mathew & Abdulla, 2022). These assets must be able to integrate and process new big data and accommodate the new system (Uzir et al., 2023). This structure must also have a high capacity to manage databases and relevant information, whether within the government agency, between different government agencies, or between the rest of the customer and supplier parties (Bhattacharya et al., 2024).

Public procurement officials in government agencies must have some basic knowledge of the uses of AI (Sharifmousavi et al., 2024) and understand big data and how to process it algorithmically (Richter et al., 2022; Gupta et al., 2023). Their culture should be directed toward the data required to build and develop the capabilities of public procurement systems based on AI (Manning et al., 2022). The lack of experts in the field of AI in general and AI systems in public procurement in particular (Sadeghi et al., 2024; Bag et al., 2023) is one of the most critical factors affecting the success or failure of the system (Kassa et al., 2023).

4.2. Organizational factors

Accepting the idea of AI and relying on such technologies in public procurement requires a radical change in the organizational culture of government agencies (Bag et al., 2023). AI replacing public procurement officials (Zhang et al., 2024), even partially, may lead to employees not accepting this change (Bhattacharya et al., 2024). An innovative organizational culture will significantly help the success of the public procurement system based on AI (Uzir et al., 2023). This can be done through arrangements related to organizational structures and management of big data so that digital governance mandates are issued that influence innovations associated with emerging technologies such as AI (Chang et al., 2023).

The negatives of organizational culture in accepting the new system can be overcome through transformational leadership by changing the leadership style based on AI (Spreitzenbarth et al., 2024). This helps to create leaders with a strong, innovative digital identity that gives the organization a digital technological character (Sharifmousavi et al., 2024). These leaders motivate public procurement officials to think about raising their capabilities and developing their skills to learn new ways that enable them to deal with AI (Silsand et al., 2023). In this context, it must be noted that procurement officials intend to refrain from becoming technical experts in AI to deal with the new system (Manning et al., 2022; Sadeghi et al., 2024; Zhong et al., 2024). Instead, they must have a minimum of digital and technological knowledge related to AI, which will help them exploit the new system to achieve the goals of the government agency (Aboelazm, 2023b; Uzir et al., 2023).

4.3. Political factors

Senior positions in public administration, particularly public procurement departments, are always linked to political considerations (Aboelazm, 2022; Sharifmousavi et al., 2024). Voters always influence politicians through their public demands, pressure from public opinion, and the media towards the digitization of public services to provide good services to individuals in light of the tax money paid to the government (Dubey et al., 2021; Burger et al., 2023; Kehayov et al., 2022). Political pressure on the government is always related to increasing automation and digitization and shifting towards an integrated digital society (Spreitzenbarth et al., 2024). This has prompted many governments to launch national strategies for AI, such as Canada, the United States of America, the United Arab Emirates, and the European Union (Nagitta et al., 2022).

These pressures significantly affect the public sector, aiming to improve performance (Ghouri et al., 2023; Richter et al., 2022; Liu et al., 2022), achieve savings in public spending (Sharifmousavi et al., 2024), and meet the public's and society's needs (El Bhilat et al., 2024; Filice et al., 2020; Silsand et al., 2023) for high-quality public services without interruption or cessation (El Bhilat et al., 2024; Ahmed et al., 2023; Filice et al., 2020; Burger et al., 2023; Gupta et al., 2023). Providing AI applications based on algorithms and big data helps satisfy and meet these needs (Bag et al., 2023; Zhong et al., 2024; Silsand et al., 2023; Qi et al., 2023). However, citizens are concerned about data sharing, privacy, and algorithms (Spreitzenbarth et al., 2024).

4.4. Innovation factors

One of the determinants of public procurement systems based on AI is the system's ability to find innovative solutions in the face of daily and diverse problems facing public procurement stakeholders (Guida et al., 2023; Bilal et al., 2024; Burger et al., 2023), whether at the internal level in the government agency or the external level of supplier clients (Uzir et al., 2023). AI systems can find quick, innovative, and positive solutions through their powerful algorithms, big data, and ability to link data and information (Haas, 2024; Wilkinson et al., 2024; Allal-Chérif et al., 2021; Filice et al., 2020; Aboelazm, 2023b). This reduces employee concerns and enhances AI's internal and external use in public procurement (Spreitzenbarth et al., 2024). AI systems in public procurement also help government agencies exchange data and information and develop public procurement processes

(Sharifmousavi et al., 2024). In this context, it must be noted that some stressed the necessity of cooperating with private technology companies and avoiding finding solutions from within the public sector, as the public sector lacks technical expertise in dealing with the emerging technology represented by AI (Ghouri et al., 2023; Sadeghi et al., 2024; Richter et al., 2022).

5. RESULTS

Technology, in general, brings many benefits to governments and government agencies. Technology helps save time processing government procedures and reduces the bureaucracy that stagnates government departments (Kehayov et al., 2022; Silsand et al., 2023; Filice et al., 2020). Technology also provides digital services to citizens (Haas, 2024); thus, they can obtain services anytime and anywhere. They are no longer required to go to the headquarters of government agencies to obtain the service. In the field of public procurement (Silsand et al., 2023; Uzir et al., 2023), electronic systems for public procurement and AI systems for public procurement not only help to save time but also help to achieve substantial financial savings by saving the time and effort expended and getting rid of the paper system (Manning et al., 2022; Spreitzenbarth et al., 2024), which raises the cost of public procurement (Dubey et al., 2022), both in terms of tools and papers used or in terms of the time used to process each procedure or the human effort expended in processing the various tender procedures (Sharifmousavi et al., 2024; Ghouri et al., 2023).

AI systems achieve multiple advantages in finding innovative (El Bhilat et al., 2024; Ahmed et al., 2023; Filice et al., 2020; Burger et al., 2023; Gupta et al., 2023), unconventional solutions in processing procedures by relying on powerful algorithms, and through the machine learning system, AI systems develop their systems according to new data through its flow in tender processes (Kehayov et al., 2022; Manning et al., 2022; Song et al., 2024). AI systems help evaluate technical and financial offers (Ghouri et al., 2023; Sadeghi et al., 2024; Richter et al., 2022), estimate the situation (Spreitzenbarth et al., 2024; Zhong et al., 2024; Dubey et al., 2022), and calculate the return and cost in public procurement operations (Bilal et al., 2024), in addition to their ability to assess the performance of public procurement (Sharifmousavi et al., 2024). Not only that, but AI systems play a crucial role in reducing corruption in public procurement processes. AI systems in public procurement evaluate offers and make decisions independently of human intervention (Silsand et al., 2023; Kehayov et al., 2022; Nagitta et al., 2022). Therefore, the absence of bias in evaluating offers and awarding contracts is considered one of the advantages achieved by AI systems in public procurement (Uzir et al., 2023). In addition, neutralizing the human element in public procurement is one of the reasons that push governments to design and implement new applications for public procurement that rely on AI (Allal-Chérif et al., 2021).

6. CONCLUSION

The use of technology in public procurement is one of the most important reasons for innovation and development in public procurement. Electronic systems in public procurement have achieved multiple successes in saving time, effort, and public spending, reflecting innovation's role in the effectiveness and efficiency of public procurement. The success achieved by EPPS has led to a search for further development and innovation in public procurement. With governments' increasing reliance on AI as an advanced technology, demands have emerged on the horizon to rely on AI applications based on robust algorithms fed by big data as demands for the use of AI have increased significantly in public procurement through the digitization of tender procedures and feeding algorithms with laws, regulations, and guidelines for tenders, in addition to government agencies' experiences with tenders. However, using and applying AI techniques in public procurement depends on several factors. The government must have a robust technology infrastructure that qualifies it to create and use AI applications in public procurement. This is in addition to changing the organizational culture among public procurement officials to accept change to a new, integrated system and the need for genuine political will. However, AI-based public procurement systems face several hackers, data protection, and privacy concerns. However, it brings many advantages and benefits, as technology helps save time spent processing government procedures and reduces the bureaucracy that stagnates government departments. Technology also provides digital services to citizens; thus, they can obtain services anytime and anywhere. They are no longer required to go to the headquarters of government agencies to obtain the service. In the field of public procurement, electronic systems for public procurement and AI systems for public procurement not only help to save time but also help to achieve substantial financial savings by saving the time and effort expended and getting rid of the paper system, which raises the cost of public procurement, both in terms of tools and papers used, alternatively, regarding the time used to process each procedure or even the human effort expended in processing the various tender procedures.

In addition to the ability of AI to find innovative, unconventional solutions in processing procedures. Not only that, but AI systems play a crucial role in reducing corruption in public procurement processes. AI systems in public procurement evaluate offers and make decisions independently of human intervention. Therefore, the absence of bias in evaluating offers and awarding contracts is considered one of the advantages achieved by AI systems in public procurement. In addition, neutralizing the human element in public procurement is one of the reasons that push governments to design and implement new applications for public procurement that rely on AI.

Finally, using AI in public procurement has several implications, the most important of which are saving time, effort, and money consumed and spent in public procurement operations. Reducing human intervention in public procurement also

naturally reduces corruption and maximizes the benefit from public spending. Moreover, using AI in public procurement will increase transparency and integrity in public procurement, in particular, and public administration in general, facilitating the oversight and accountability processes of public procurement.

The limitations of the research were represented in reviewing the developments in the use of traditional technology, from electronic systems to AI, in public procurement and in presenting the ecological factors affecting the adoption and application of advanced technology in public procurement. It is suggested that traditional research should address the development of legal frameworks to regulate the public procurement process through AI techniques.

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