Barriers to E-Tendering Implementation in the Construction Industry: A Decade and Beyond Comprehensive Review and Analysis

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Article

Barriers to E-Tendering Implementation in the Construction Industry: A Decade and Beyond Comprehensive Review and Analysis

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Abstract: The traditional paper-based tendering processes are very fast becoming obsolete due to the advances in technology these past few years. The electronic tendering system is observed as a tool and process for improving efficiency and encouraging the construction industry stakeholders and experts to better oversee the tendering procedure, thereby minimizing project delays and increasing profits. Although e-tendering has been in operation for several years, some construction industry stakeholders are still unfamiliar with it, and its adoption and implementation have experienced many hindrances. The main aim of this paper is to discover the major barriers to electronic tendering adoption. This research used a systematic literature review technique to identify these barriers. Relevant scientific databases were employed to conduct a thorough literature review. The findings were divided into 6 geographical locations. The study found eight significant barriers were consistent across all 6 geographical locations (1) Inadequate technical/ICT skilled personnel (2) Inadequate data security (3) Inadequate policy or uniform standard and inadequate legal framework (4) Resistance to change (5) Inadequate ICT and internet infrastructure (6) High investment cost of implementation (7) Lack of support (8) Technical challenges. The study also identified the ten (10) topmost e-tendering affecting the construction industry. This adds to our understanding of barriers to e-tendering around the globe according to geographical locations in the construction sector.

Keywords: barriers; challenges; construction industry; E-Procurement; E-Tendering

1. Introduction

Tendering is perceived as the fair method for the award of contracts, both in government and private sector projects. Gong et al. (2022) defined tendering and bidding as a business process in which multiple construction companies compete for a project. The project is awarded to the company that offers the best combination of the lowest price, short period of construction, relevant experience, or high quality. Subsequently, a contract is signed between the purchasing unit and the winning bidder. Betts *et al.* (2006) buttressed that the tendering method often yields favorable results for the allocation of public funds. In this context, Du *et al.* (2005) observed that over the years, the principles and guidelines of the traditional paper-based tendering process have been implemented across various sectors of the economy, comprising the choice of consultants or contractors for construction projects, procurement of goods, seeking service providers, and engaging business consultants.

Traditional tendering processes, as noted by Arslan et al. (2006), tend to be slow and time-consuming i.e. labour-intensive. Similarly, Abdullahi *et al.* (2020) reported that paper-based manual tender processes are viewed as less effective, inadequate transparent processes, and susceptible to corruption, especially in public sector tendering. Consequently, contemporary researchers, business leaders, and marketing managers are exploring advanced techniques to be utilized for commercial business activities (Naeem, 2021). In affirmation, Ilhan and Rahim, (2017) asserted that recently, many

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firms across the world automated their manual procurement processes and streamlined them with e-procurement. According to Alsaç (2017), public procurement has recently witnessed an increasing popularity of the terms, "e-procurement or e-tendering". The literature has, therefore, outlined numerous definitions of e-tendering. Some notable definitions include: "Electronic tendering is defined as the process of submitting, receiving, storing, and making decisions regarding bids, tenders, or proposals for building projects, products, and services using electronic communication tools and systems. E-tendering, to put it simply, is a procedure done online to oversee the entire tendering process, starting from tender announcement to contract awarding (Ibem and Laryea, 2017)".

The electronic tendering has numerous benefits, including reduced costs and time, simplified procedures, increased competitiveness of proposals, enhanced tender analysis, improved collaboration among stakeholders, reduced supplier collusion, higher inquiry rate responses, the effectiveness of market engagements, decreased corruption, consistent tendering practices, and fairer tender assessments (Sunmola and Shehu 2020). According to Gong et al. (2022), electronic tendering is a development and trend in the tendering process that addresses issues of unfairness and low efficiency. Nevertheless, because most modern e-tendering systems rely on a single, centralized database, they are vulnerable to cybersecurity threats, particularly those involving data tampering. Similarly, (Ndubuaku and Jerry, 2023), supported that, despite these advantages, e-tendering faces significant challenges across different geographical regions that must be recognized and resolved to ensure its successful implementation across the board. Moreover, various stakeholders in the construction industry are still unfamiliar with electronic tendering, and its acceptance has faced numerous barriers (Khalil and Waly,2015).

Additionally, it is observed that There is increased interest in electronic tendering that has resulted in a surge of research and publications since its emergence in the construction sector. The readiness of e-tendering in the construction sector (Al-Yahya *et al.*, 2018), the barriers and drivers of electronic tendering in the UK construction firms (Eadie *et al.*, 2010), "the challenges and obstacles facing tenderers adopting e-tendering in the public sector of the construction industry in Egypt" (Khalil and Waly, 2015) are a few notable examples. Important factors for the successful implementation of electronic tendering in construction collaborative environments are also studied by (Lou and Alshawi, 2009). These studies include the barriers of e-tendering; however, they are focused on specific locations.

Similarly, Bulut and Yen, (2013) investigated a global overview of e-procurement in the public sector to give a worldwide overview of e-tendering. However, without going into great detail about the obstacles to public e-procurement adoption and implementation, the paper only offered a broad overview of recent developments and ongoing initiatives in this field. Yevu and Yu (2020) also reviewed advances in the field of study on the ecosystem of factors that propel e-procurement, specifically the adoption of e-tendering. Furthermore, Yevu *et al.*, (2021) reviewed the obstacles to electronic tendering adoption in the construction sector. Using a systematic review approach, this study categorized the obstacles to e-tendering into four categories: organizational, cultural, legal, security, and technological without giving regional specifics of the identified barriers.

In this context, a critical assessment of these studies and the body of literature generally demonstrates that researchers primarily and narrowly focused on the factors that drive e-tendering, as well as its benefits, challenges, and critical success factors, leaving several significant gaps. Furthermore, prior studies on e-tendering obstacles have primarily been carried out in specific nations, lacking a comprehensive global perspective. Therefore, this paper seeks to address the following questions.

- What are the main e-tendering implementation barriers identified in the existing literature in the construction industry?
- How can the main barriers identified be grouped based on geographical locations or regions?
- Which electronic tendering barriers are common across all the geographical regions?

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- What are the 10 crucial electronic tendering barriers that affect the tendering process in the construction industry?
- How can the organizations overcome the identified barriers

This study seeks to address the questions above by thoroughly examining electronic tendering barriers in the construction industry globally and grouping them based on geographic location. This paper conducts a systematic literature review in six geographical regions between January 2010 and December 2024 to identify and analyze the main barriers preventing the widespread adoption and implementation of electronic tendering in the construction sector. Understanding these barriers is essential to developing effective strategies for promoting e-tendering adoption and improving the overall efficiency of the construction industry worldwide. Publications between 2010 to 2024 were included for several reasons. First, significant advancements in ICT around 2010 were crucial for developing and applying e-tendering systems. Second, e-tendering gained more traction and development in the construction industry post-2010, making studies from this period more relevant. Additionally, research from 2010 onwards provides pertinent insights into current challenges and barriers, with a significant increase in published research on e-tendering since 2010. Lastly, the study aims to address modern trends and solutions relevant to today's industry landscape, as older studies might not capture the rapid changes and developments in e-tendering technology.

Relevant scientific databases were retrieved to conduct a thorough literature review in identifying the e-tendering obstacles. The study's novelty lies in its comprehensive examination of the major barriers hindering the effective adoption of electronic tendering in the construction sector across six geographical locations and identifying unique barriers that cut across all the geographical locations.

The necessity and importance of this study lie in the fact that traditional paper-based tendering methods are increasingly outdated due to technological advancements, and electronic tendering (e-tendering) is recognized for its efficiency, transparency, and oversight benefits in the construction industry. However, significant implementation barriers persist, necessitating the identification and resolution of these obstacles. Globally, e-tendering adoption varies, with many developing regions facing challenges. Understanding barriers common globally and those unique to certain geographical locations is crucial for creating targeted solutions to enhance e-tendering adoption and success. Identifying major barriers also guides stakeholders in making informed strategic investment decisions and formulating supportive policies to drive efficiency and reduce corruption in procurement processes.

The reason behind this study's motivation was that the construction industry lags in adopting digital technologies and exploring e-tendering barriers is essential for its integration and potential benefits. E-tendering can enhance transparency and reduce corruption in procurement processes, and understanding its implementation barriers can help achieve these goals. By examining barriers in different regions, the present research aims to offer a thorough comprehension that can be applied globally, allowing regions to learn from each other and adopt best practices for successful e-tendering implementation. Additionally, it will help firms identify e-tendering barriers that are common and unique to certain geographical locations.

2. Literature Review

Electronic commerce has existed in various forms since the late 1960s, including electronic mail (e-mails), e-procurement, electronic data interchange (EDI), and electronic tendering (e-tendering) (Anumba and Ruikar, 2002). Additionally, early electronic procurement is related to the growth of inter-organizational systems, virtual communities, meeting places, e-platforms, and infrastructures that many authors call electronic marketplaces (Grilo and Jardim-Goncalves, 2011).

Indeed, the mass-scale development of the Internet in the early 1990s saw the launch of Internet browsers and the World Wide Web (WWW), which provided an impulse to Internet-based electronic commerce at an amazing pace (Anumba and Ruikar, 2002). Consequently, research within the AEC (Architecture, Engineering, and Construction) sector about e-procurement emerged at the beginning

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of the 2000s (Isikdag et al, 2011). Scholars like (Neef, 2001) who observed it from the perspective of strategy to execution, and (McIntosh and Sloan, 2001) who examined the significance of e-tendering and the global sourcing procedure in the UK. They advised that construction should shift from the use of traditional procurement processes and embrace a new method of operation in the global marketplace for increased efficiencies, competitiveness, and profit margins.

Furthermore, (Goswami et al, 2020; Ibem and Laryea, 2017) noted that e-tendering has gained global recognition in recent years, primarily as a standalone tool for transforming culture and improving procedures in the construction industry. However, Isikdag (2019) contended that the use of electronic procurement to supplement the traditional tendering system has received limited acceptance. Despite the prevalent adoption of electronic tendering technology by organizations' systems, there are reports of poor performance results (Kajewski and Weippert, 2004; Oyediran and Akintola, 2011). Additionally, (Al-Yahya et al, 2018) revealed that electronic tendering lacks clear guiding principles and requirements for effective implementation, hence, confusing, particularly stakeholders intending to adopt the technology.

In this context, the construction industry stakeholders have expressed several concerns about the systems and processes, impeding their adoption (Oyediran and Akintola, 2011; Arslan et al, 2006; Ibem and Laryea, 2017). Therefore, understanding these e-tendering challenges plays a critical role in the successful adoption. The section below provides a comprehensive overview of electronic tendering barriers that affect the global construction sector from fully adopting electronic tendering.

2.1. The barriers to electronic tendering implementation

The main barriers to the successful adoption of electronic tendering are discussed in this section, focusing on the construction sector. The barriers discussed encompass a wide range of challenges faced by organizations when adopting electronic tendering processes. Understanding these barriers is essential for navigating the complexities and ensuring the effective integration of e-tendering systems. Furthermore, Naeem, (2021) outlined a reduction in time and cumbersome paperwork, a reduction in transaction costs, strengthened ties with suppliers, reduce the cycle of purchases and the overhead expenses related to the procurement process, and a boost in the effectiveness of order placement as the main reasons for adopting electronic tendering. Despite the numerous benefits derived from this technology, there exist countless challenges that need urgent solutions to enhance public confidence for adoption.

Anumba and Ruikar (2002) observed that the barriers to e-tendering can be broadly categorized into two groups: those that apply to electronic tendering applications in the construction industry and the common ones affecting all sectors, of which the construction sector is inclusive. Mohungoo et al, (2020) further revealed that the common obstacles to electronic tendering are largely divided into three groups: regulatory problems, reliability and trust concerns, and infrastructure limitations. The problems related to regulation include the need for the support of e-tendering legal frameworks and the complexities of complying with diverse regulatory environments. Trust and reliability concerns revolve around the security of online transactions, the integrity of the bidding process, and the confidence of stakeholders in the system's robustness. Infrastructure limitations often involve inadequate technological infrastructure, particularly in regions with poor internet connectivity or insufficient digital capabilities.

Moreover, in the construction sector, particular obstacles to electronic tendering consist of the significant initial expenditure needed to develop the necessary infrastructure and train workers. There are challenges in quantifying the return on investment (ROI) and integrating with legacy systems, ensuring online transaction data security, and achieving internet-based interoperability of distributed software applications. Ensuring the security of online transaction data and achieving interoperability of distributed software applications are additional concerns. These challenges highlight the need for comprehensive strategies to address both the general and sector-specific barriers to electronic tendering, including regulatory reforms, investment in technology and training, and measures to build trust and ensure data security.

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Furthermore, Goswami et al. (2020) argued that ensuring transparency throughout the tendering process is the ultimate reason for e-tendering adoption. However, it is not without its limitations, such as a centralized database is susceptible and can be attacked. According to Betts et al, (2006), security compliance is a major challenge for e-tendering systems because of the uncertainty resulting from ignorance of the legal guidelines and principles governing these systems. Three major obstacles to electronic tendering in the construction sector of South Africa have been noted by Ibem and Laryea (2015): high internet service costs, reluctance to change, as well as inadequate internet access.

Additionally, (Oyediran and Akintola, 2011) pointed out that the e-tendering process lacks essential facilities and faces a low degree of competence or proficiency in its use. The study highlighted erratic power supply, the costs associated with establishing electronic tendering infrastructure, inadequate communications facilities, as well as inadequate legal support associated with electronic transactions.

Additionally, a study published by Tran et al, (2021), discovered the main barriers to the adoption of e-tendering. These barriers were primarily human-related and included an inadequate understanding or limited information, inadequate skilled staff, a disjointed supply chain, insufficient industry standards for information transfer, and inadequate cross-disciplinary communication. Moreover, (Wimalasena and Gunatilake, 2018) researched to assess the willingness of Sri Lankan construction consultants and contractors to embrace electronic tendering. They discovered that the main barriers to adoption include inadequate legislation specifically about e-tendering and insufficient knowledge among senior management and employees.

According to the literature, despite its widespread use and potential benefits, e-tendering has faced various adoption setbacks. To address and minimize e-tendering barriers, they must first be identified and understood by the industry stakeholders. As a result, this research undertakes a thorough literature review to uncover the significant electronic tendering barriers.

3. Research Methodology

The approach used to determine and evaluate the main obstacles to the adoption and use of e-tendering in the construction sector is described in this section. The chosen research approach, data collection methods, and analytical techniques are described in detail to provide transparency and clarity regarding the study's process. This research aims to use a thorough systematic literature review to discover the obstacles preventing the use of e-tendering in the worldwide construction sector. As argued by Chan and Owusu (2022), carrying out a systematic literature review requires adopting the right approach and strategies to facilitate the review process. The methodology previously utilized by scholars (Yevu and Yu, 2019; Chan and Owusu, 2022) was adopted to give the blueprint for the selection of pertinent publications from databases and journals. The decision to employ the systematic review approach was based on its ability to compare and integrate the results of pertinent publications (Yevu and Yu, 2019). This paper implemented an in-depth and comprehensive three-phase procedure to extract related journals, which involved initially targeting specific journals, followed by a desktop search, and concluding with a specified search elaborated below.

3.1. First phase - searching for target journals

This section outlines the initial phase of our systematic literature review, which focuses on identifying and searching for target journals. The selection criteria, search strategies, and considerations involved in this phase are detailed to provide a clear understanding of how pertinent literature was identified. In this phase, the approach employed by Lu et al, (2015) was used to select relevant articles based on the top 12 construction management academic publications, as ranked by Wing (1997). These journals are widely recognized within the construction management community, and the rationale was to ensure a comprehensive search, as suggested by Yevu and Yu (2019). The targeted journals are Engineering Construction and Architectural Management, Automation in Construction, Construction Management and Economics, Journal of Construction Management and

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Engineering, Building Research and Information, Proceedings of the Institution of Civil Engineers--Civil Engineering, International Journal of Construction Information Technology, Journal of Management in Engineering, International Journal of Project Management, Journal of Construction Procurement, Transactions of the American Association of Cost Engineers, and Cost Engineering.

To identify relevant English papers in the electronic libraries of these selected journals, we utilized specific keywords and search queries. The keywords used included 'Electronic procurement' OR 'E-procurement', OR 'Electronic Tendering' OR 'E-Tendering' AND 'Barriers' OR 'Challenges' AND 'Construction Industry.' We conducted these searches in the relevant databases and search engines. For example, one query in a journal may look like this:

[All: "electronic procurement"] OR [All: "e-procurement"] OR [All: "electronic tendering"] OR [All: "e-tendering"] AND [All: "barriers"] OR [All: "challenges"] AND [All: "construction industry"] OR [All: "construction sector"] AND [in Journal: Building Research & Information] AND [Publication Date: (01/01/2010 TO 31/07/2024)]. This approach ensures a systematic and comprehensive search for pertinent literature in the selected journals.

The criteria for choosing keywords for a search query involve selecting terms that accurately represent the concepts and scope of the research. In this case, the goal is to find research articles or literature related to barriers or challenges in electronic procurement (e-procurement) or electronic tendering within the context of the construction industry. Here's how each keyword group contributes to the search

- "Electronic procurement" OR "E-procurement": These keywords encompass the concept of digital or electronic processes for procurement. Including both variations ensures that the search captures articles using either term.
- "Electronic Tendering" OR "E-Tendering": These terms represent the concept of electronic tendering processes in construction projects. Including both variations ensures that articles using either term are included in the search results.
- "Barriers" OR "Challenges": These keywords specify the focus of the research—identifying barriers or challenges related to electronic procurement and tendering. These terms indicate that the search is looking for articles discussing obstacles or difficulties faced in implementing these digital processes.
- "Construction Industry": This keyword defines the context within which the electronic procurement and tendering processes are being studied. It ensures that the search results are relevant to the construction sector.

By combining these keywords and using logical operators (AND, OR), the search query aims to retrieve articles that discuss barriers or challenges in electronic procurement and tendering specifically within the construction industry. The chosen keywords cover different aspects of the research scope, enabling a comprehensive search for relevant literature.

Building upon the insights from Yevu and Yu (2019), it's essential to acknowledge that not every potential keyword can be practically utilized in the search. Hence, the keywords chosen for this study were carefully selected to specifically represent terms describing the concept of e-tendering for construction projects. Our search parameters included publications in the English language from peer-reviewed journals, conference papers, and theses. The study focused on publications between 2010 and 2024 for several compelling reasons:

1. Significant technological changes: The chosen timeframe encapsulates a period during which there were notable advancements in technology and digital transformation. This timeframe covers a decade where the construction industry witnessed significant changes in the adoption and integration of digital tools.
2. Critical period of adoption: The years between 2010 and 2024 marked a critical period for the adoption of e-tendering practices. Many industries, including construction, were transitioning from traditional methods to digital platforms during this timeframe.
3. Timeliness: By focusing on more recent years, the study could provide insights that are relevant to current industry challenges and trends, making the findings more applicable and actionable.

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The systematic procedure for conducting the literature review is illustrated in **Error! Reference source not found.**.

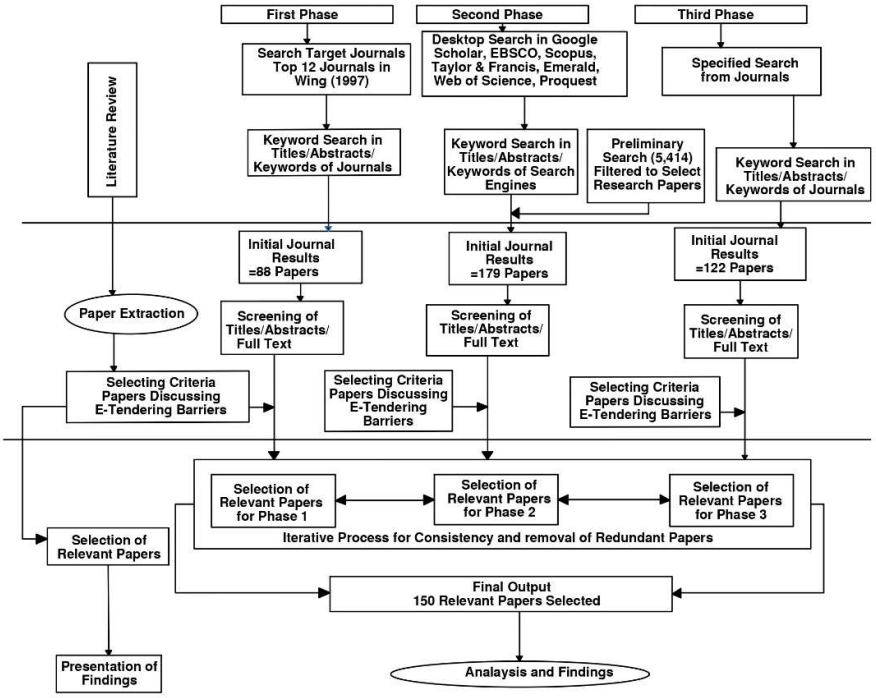

Figure 1. The methodical approach.

3.2. Second phase - desktop search

The main purpose of this phase was to address the limitations revealed in stage 1, where the 12 relevant or leading journals ranked by Wing (1997) in the construction management community did not yield a significant number of articles. Consequently, a desktop search was employed. Additionally, the second phase aimed to include more recent journals in the construction industry that were not captured in Wing's (1997) study.

In this context, this study adopted methodologies from Chan and Owusu (2017), Xiong et al, (2015), and Yevu & Yu (2019) to identify other relevant journals, conference papers, and theses. Consequently, the largest databases recognized in academia, such as Francis and Taylor, Web of Science, EBSCO, Scopus, Google Scholar, and ProQuest were used to search using the same keywords.

The criteria for selecting journals from the search engines included the requirement that journals listed on Google Scholar must be indexed in either Web of Science or Scopus for further assessment. This choice was influenced by the recognition of the Web of Science and Scopus within the construction community and academia (Lu et al., 2015). Conference papers and theses relevant to the study were also selected due to their academic recognition. Journals containing one or more papers related to the subject were selected for broader coverage, unlike the study by Yevu & Yu (2019), which considered two or more. Journals ranked by Wing in 1997, used in Phase 1, were excluded from consideration in this phase.

3.3. Third phase: the specific journal search

In the search for publications that span a broad topic while being significantly relevant to construction projects and information communication technologies, a specific search strategy was employed. This approach was guided by references from Yevu & Yu (2019) and Nasirian et al, (2019) and aimed to identify journals known for publishing content on this subject matter. Phase 2 criteria

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for the selection process were used to identify Benchmarking: An International Journal, Advanced Engineering Informatics, Journal of Organizational Computing and Electronic Commerce, and Journal of Public Procurement. This criterion was established to accommodate journals that specialize in addressing technological concerns.

Finally, Mendeley and Excel were used to analyse the acquired papers for duplication. After reviewing the papers, 150 were deemed relevant for the study. It's noteworthy that the search and examination of these journals were conducted in July 2024, contributing to the timeliness and relevance of the study's findings. Table 1 displays the count of pertinent articles found in each journal.

From the three phases of this study, six key steps were instrumental in obtaining the research results. These steps, integral to the study's methodology, can be summarized as follows:

In step 1, relevant journals were identified and the top 12 construction management academic journals were selected. The rationale was based on recognition within the construction management community.

Step 2 focused on keyword selection where the study carefully selected specific and relevant keywords to represent the concept of e-tendering for projects.

Furthermore, in step 3 that deals with search parameters, the inclusion criteria are English-language publications, peer-reviewed journals, conference papers, and theses as well as publications between 2010 and 2024. The following are rationale for selecting the timeframe, significant technological changes encompassing a period marked by notable advancements in technology and digital transformation, critical period of adoption covering years when many industries, including construction, transitioned to digital platforms, ensuring insights are relevant to current industry challenges and trends and benchmarking progress by analysing e-tendering barriers over this timeframe to assess trends, improvements, and persistent challenges.

In Step 4, a systematic literature review process was conducted by identifying and selecting pertinent papers based on the specified criteria stated above.

Finally, in step 6, data extraction and analysis were conducted to extraction of relevant information from selected papers to identify major barriers to e-tendering in the construction industry.

3.4. Trend in publications

This section gives detailed information regarding the trends in publication between January 2010 and July 2024. There was a general increasing trend from 2010 to 2016, which saw a peaking at 15 papers in 2016. This upward trajectory signifies a period of growing research activity, which can be attributed to the construction industry's increasing adoption of electronic tendering, particularly in developing countries. Gunasekaran and Ngai, (2008) suggested that such increases were often linked to the development of the Internet and the introduction of the concept of e-procurement.

After 2016, the number of publications exhibits a fluctuating downward trend, reflecting variability in annual research output. In more detail, the number of publications in 2010 was the lowest, with only 4 papers. This increased to 8 papers in 2011, followed by a slight dip to 7 papers in 2012. A significant rise occurred in 2013, reaching 11 papers. However, 2014 saw a drop back to 7 papers. The number of publications surged to 15 papers in 2015, culminating in a peak of 15 papers in 2016. From 2017 onwards, there was a decline with 11 papers in 2017 and a further drop to 11 papers in 2018. The count slightly increased to 11 papers in 2019 but decreased again to 9 papers in both 2020 and 2021. In 2022, there was a resurgence to 12 papers, followed by a slight decline to 11 papers in 2023. The data for 2024 recorded 7 papers, indicating a notable drop compared to previous years, though it may not represent the complete year's output.

The trend line suggests a rise in the number of papers until 2016, followed by a gradual decrease with some fluctuations. The years 2011, 2012, and 2014 had relatively lower publications compared to surrounding years. After 2016, the number of publications has not returned to peak levels and shows year-to-year variability. In recent years, particularly from 2022 to 2024, the publication count increased in 2022 but did not maintain the same level in subsequent years. The notable drop in 2024,

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with only 5 publications so far, could indicate a significant decrease in research activity, although it might not account for the entire year's data.

On average, approximately 10.34 papers were published annually, indicating a relatively stable publication trend. The trend and number of publications during this period are shown in Figure 2.

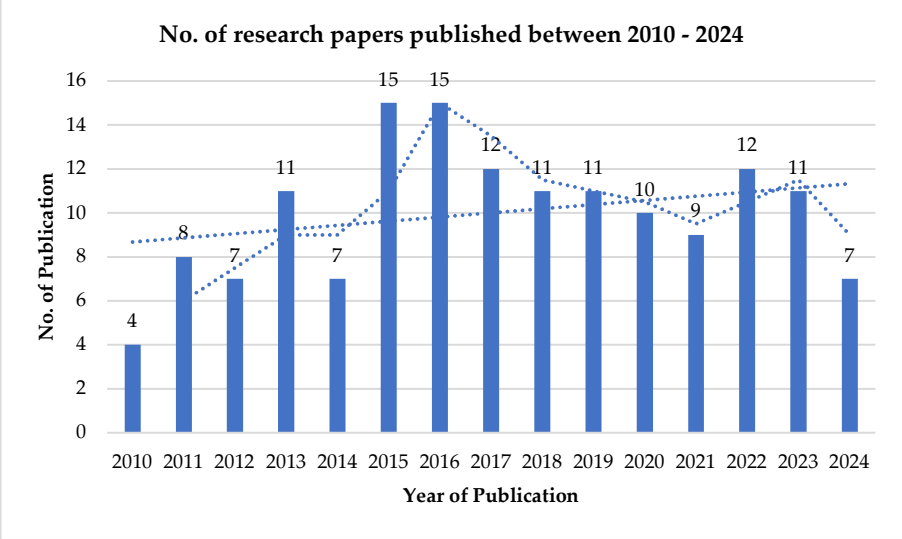

Figure 2. Publication trends between January 2010 and July 2024.

3.5 Publication by geographical regions

In this subsection, the study delves into the distribution of publications by geographical regions. The analysis provides insights into how the barriers to electronic tendering implementation in the construction sector vary across different regions. It offers a comprehensive overview of the global landscape of e-tendering research and its geographical focus.

Africa emerged as the top geographical area, recording the highest number of published papers, totalling 48. This can be linked to African nations' proactive adoption of modern technologies aimed at bridging the gap with more developed nations and enhancing construction productivity. Following Africa, Europe accounted for 36 publications. However, it is observed that research on e-tendering saw a decline after 2015, possibly indicating a shift in research focus among European scholars towards initiatives like Building Information Modelling (BIM) and other evolving software. Additionally, Asia recorded 35 publications, while the Middle East and North Africa region contributed 15. Pacific region and North America followed with 8 and 8 publications, respectively.

The distribution of papers across these geographical regions highlights the significance of the e-tendering topic in driving advancements within the industry. The number of publications based on geographical areas is shown in Figure 1. In essence, the number of papers published in each geographical region underscores the impact of e-tendering on industrial progress.

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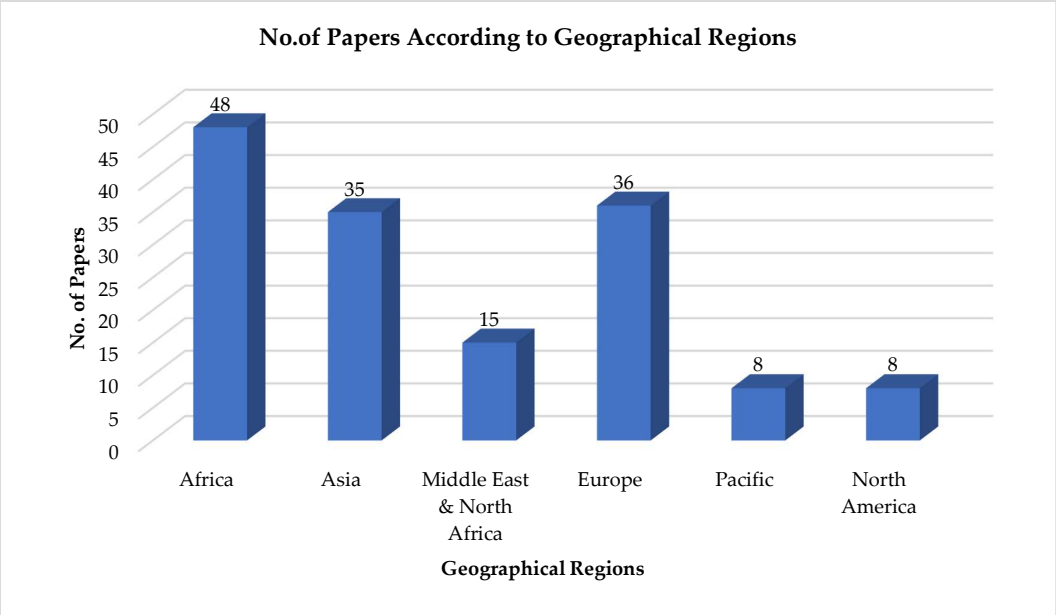

Figure 1. The number of research publications by geographical locations.

3.6 Identified barriers to e-tendering implementation by geographical regions

In this subsection, a thorough examination of e-tendering adoption and implementation barriers within specific geographical regions is presented. The findings highlight how these barriers manifest differently across various parts of the world, offering a valuable understanding of the unique barriers each region faces in the construction industry.

The identified barriers have been summarized and categorized by geographic region. 15 barriers were identified. Key barriers in this region include; Inadequate data security/Cyber security risk; Inadequate ICT and internet infrastructure; Lack of uniform standards or policies and inadequate legal frameworks; Insufficient technical/ICT skilled personnel coupled with limited professional training; Resistance to change; High implementation costs, and Lack of support; Inadequate of general awareness of benefits/information of e-tendering systems; Software non-compatibility /interoperability issues, and Unreliable electric power supply. Less dominant barriers in the African context include technical malfunctioning of the portal; The complex interface; Inadequate monitoring of supplier's compliance/lack of performance evaluation; Unethical Practices (transparency issues); and Fear of loss of jobs. Table 1 provides an overview of the main barriers identified in Africa.

3.6.1 Critical Barriers to e-tendering in Africa

Table 1. Summary of the critical barriers to e-tendering from Africa

NO.	E-tendering barriers	Author
1	Inadequate data security/ cyber security risk	[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 36, 37,38, 39, 40, 41, 42, 43, 45, 46, 47]
2	Inadequate ICT and internet infrastructure (Poor internet, High-speed expensive internet services, difficulties in transitioning from paper-based to electronic systems)	[1, 2, 4, 5, 6, 7, 8, 11, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 28, 29, 30, 31, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 48]

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3	Lack of uniform standard or policy and Inadequate legal framework	[1, 2, 3, 4, 6, 9, 8, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 22, 23, 24, 25, 26, 27, 28, 32, 33, 37, 38, 40, 42, 43, 44, 45]
4	Inadequate technical /ICT skilled personnel (lack of professional training, lack of adequate knowledge and skills, Unavailability of e-procurement experts)	[1, 2, 4, 5, 6, 7, 8, 11, 13, 15, 16, 17, 18, 19, 22, 25, 27, 28, 29, 30, 32, 33, 34, 35, 37, 38, 39, 40, 41, 42, 43, 44, 45, 47, 48,]
5	Reluctance/ resistance to change	[1, 2, 7, 9, 10, 11, 13, 14, 16, 19, 20, 21, 22, 23, 24, 25, 27, 29, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 45, 48]
6	High investment cost of implementation/High technology cost	[1, 5, 7, 9, 11,10, 14, 17, 19, 20, 21, 22, 23, 24, 25, 28, 29, 30, 31, 32, 37, 39, 40, 41, 42, 43, 45]
7	Lack of Support/Lack of Management Support	[1, 2, 3, 5, 11, 13, 15, 19, 20, 21, 22, 23, 25, 27, 31, 34, 37, 39, 40, 41, 43, 44, 45, 48]
8	Lack of general awareness of benefits/information of e-procurement systems/ Low levels of awareness and knowledge about e-procurement technology.	[7, 11, 12, 14, 15, 17, 24, 27, 28, 29, 31, 32, 37, 38, 39, 40, 42, 43, 44, 45]
9	Software non-compatibility /interoperability issues	[5, 7, 15, 21, 22, 25, 27, 28, 29, 35, 36, 37, 38, 39, 43, 47]
10	Unreliable electric power supply	[1, 5, 11,15,17,23, 25, 28,29, 39, 40, 41, 43]
11	Technical malfunctioning of the portal	[1, 2, 9, 11, 12, 15, 17, 23, 30, 37, 43]
12	The complexity and user-unfriendliness/complex interface	[38, 40, 42, 43, 46]
13	Lack of monitoring of supplier's compliance/lack of performance evaluation	[39, 41, 43]
14	Unethical Practices (transparency issues)	[42, 43, 44]
15	Fear of loss of jobs	[47]

Notes : [Saidu et al. (2020) -1, Gihozo (2020) -2, Udo et al. (2020) -3, Addo (2019) -4, Gambo et al. (2019) -5, Amuda-Yusuf et al. (2019) -6, Mukhongo & Aila (2018) -7, Dlakuseni, et al. (2018) -8, Ahimbisibwe, et al. (2018) -9, Ibem and Laryea (2017) -10, Ibem et al. (2017) -11, Mobayo and Makinde (2020) -12, Nyangaresi (2016) -13, Solanke and Fapohunda (2015) -14, Aduwo et al. (2016) -15, Isimbi Uwadede (2016) -16, Ibem and Laryea (2015) -17, Azanlerigu and Akay (2015) -18, Owusu (2015) -19, Korir et al. (2015) -20, Adebayo and Evans (2015) -21, Kamotho (2014) -22, Laryea and Ibem (2014) -23, Nkhata (2014) -24, Bala and Dahiru (2013) -25, Mohamed (2013) -26, Bello and Iyagba (2013) 27, Chilipunde (2013) -28, Oyediran and Akintola. (2011) -29, Ofori and Fuseini (2019) -30, Songok (2018) -31, AbdulAzeez et al. (2015) -32, Hamma-adama and Ahmad (2021) -33, Kanyambo (2017) -34, Sithole (2017) – 35, Yevu et al, (2022) – 36, Ozumba, & Shakantu (2018) - 37, Ibem et al., (2021) – 38, Salifu et al. (2023)- 39, Abdullahi (2023) – 40, Moges Dereje & Assefa Habete (2023) – 41, Kelechi (2024) – 42, Jama (2024) – 43, Maepa (2023) – 44, Aghimien (2020) – 45, Musa et al. (2023) – 46, Motaung et al, (2023) – 47, Bubala & Lesa (2024) - 48.

3.6.2 Critical barriers to e-tendering in Asia

In Asis, 20 major barriers were identified. The most predominant barriers include Inadequate technical/ICT skilled personnel; Lack of data security/cybersecurity risks; Lack of uniform standard or policy and Inadequate legal framework; High investment cost of implementation/Lack of financial resources; Reluctance/ resistance to change; Inadequate ICT and internet infrastructure; Lack of support; Technical malfunctioning of the portal; Lack of trust and awareness of benefits of electronic

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tendering systems; and Ineffective communication in the Asian context. Conversely, barriers such as Inadequate planning; Change management; Lack of mobile applications; Lack of best practices and pilot projects; and Dual operation mode difficulty (traditional & digital), were comparatively less prominent in Asia. Table 2 Summarizes the barriers found in Asia.

Table 2. Summary of the critical barriers to e-tendering from Asia.

No.	Factors	Author
1	Inadequate technical/ICT skilled personnel	[1, 3, 4, 6, 5, 7, 8, 11, 13, 14, 15, 16, 18, 19, 20, 22, 23, 24, 25, 26, 27, 30, 33, 34]
2	Lack of data integrity/trust/ lack of security of data/authentication/Privacy issues/Confidentiality of information/Cybersecurity Risks	[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 21, 24, 26, 27, 28, 31, 33, 34]
3	Lack of uniform standard or policy and Inadequate legal framework	[1, 3, 4, 5, 6, 7, 9, 10, 11, 12, 14, 15, 17, 20, 22, 23, 24, 25, 26, 27, 28, 30, 33, 34, 35]
4	High investment cost of implementation/Lack of financial resource	[1, 3, 4, 6, 5, 7, 8, 9, 11, 15, 16, 17, 23, 24, 25, 29, 34, 35]
5	Reluctance/ resistance to change/ internal cultural issues	[1, 2, 3, 4, 5, 6, 7, 8, 11, 18, 19, 23, 25, 29, 31, 32, 34, 35]
6	Inadequate ICT and internet infrastructure / Poor IT infrastructure to support e-tendering systems	[5, 6, 8, 10, 13, 14, 15, 16, 17, 20, 18, 21, 23, 25, 28, 30, 31, 32, 34, 35]
7	Lack of Support	[3, 4, 5, 6, 10, 11, 15, 20, 19, 23, 24, 27, 32, 34]
8	Technological updates/high maintenance cost/Technical malfunctioning of the portal	[2, 5, 7, 11, 12, 13, 15, 20, 21, 23, 34]
9	Lack of trust and awareness of benefits of e-procurement systems, skepticism/ Insufficient promotion and understanding of e-tendering among stakeholders/Difficulties in engaging stakeholders.	[1, 5, 11, 16, 19, 23, 24, 25, 27, 28, 29, 35]
10	Poor communication	[3, 4, 6, 10, 14, 15, 20, 23, 24, 25]
11	Software non-compatibility / interoperability issues	[4, 6, 9, 10, 13, 15, 19, 21, 35]
12	Complex user interface	[3, 10, 20, 23]
13	Unethical practices (transparency issues)	[23, 27]
14	Inadequate monitoring of supplier's compliance/ lack of performance evaluation	[25, 33]
15	Lack of planning	[28, 34]
16	Change Management	[29, 32]
17	Lack of mobile applications	[22]
18	Lack of best practices and pilot projects	[27]
19	Dual operation mode difficulty (traditional & digital)	[29]
20	The choice of suppliers is too arbitrary and the lack of scientific management/ many suppliers leading to the complex evaluation process	[33]

Notes: Mehdipoor et al. (2022) -1, Umi Kalsuma et al. (2021) -2, Hashim et al. (2020) -3, Jayawardhena, & Jayaratne (2019) -4, Wimalasena and Gunatilake (2018) -5, Jayawardhena & Jayaratne (2018) -6, Tan and Suhana (2016) -7, Cherian and Kumaran (2016) -8, Tran et al. (2014) -9, Tran et al. (2014a) -10, Zhou et al. (2012) -11, Chien and Barthorpe (2010) -12, Mukelas & Zawawi (2012) -13, Aman and Kasimin (2011) -14, Tran et al. (2021) -15, Hasan, (2017) -16, Mohd Nawi et al. (2017) -17, Hossain (2016) -18, Amalia (2016) -19, Siahaan and Khamdiyah

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(2017) -20, Yevu et al, (2022) – 21, Issabayeva et al. (2019)-22, Tjan (2023) -23, Ali et al. (2023)- 24, Vu (2024) – 25, Rizki (2019) – 26, Mohamad Bohari (2023)-27, Nurmandi. and Kim (2015) – 28, Bulut and Yen (2013) – 29, Premathilaka et al. (2020) – 30, Zolkafli Zulkifly, (2021) – 31, Deraman et al. (2012) – 32, Changsen (2012) – 33, Nizakat et al. (2022) – 34 - Aziz, (2024) - 35.

3.6.3. Critical Barriers to e-tendering from the Middle East and North Africa

Ten (10) significant barriers were identified in the Middle East and North Africa region. The most prominent ones include; Reluctance or resistance to change; High investment cost of implementation; Lack of uniform standard or policy and Inadequate legal framework; Data security challenges/ Cyber security risks; Insufficient ICT and internet infrastructure; Inadequate technical/ICT skilled personnel; Lack of Support; and Software non-compatibility/interoperability issues. These barriers were observed to have the most significant impact on e-tendering implementation in the region. On the other hand, barriers related to; Lack of trust and awareness of the benefits of electronic tendering technology; Technical malfunctioning of the portal/Technical Issues; and Dual operation mode difficulty (traditional & digital) appeared to be comparatively less dominant in the Middle East and North Africa. The summary of the findings can be seen in 3.

Table 3. Summary of the critical barriers to e-tendering from Middle East and North Africa

No.	Factors	Author
1	Reluctance/ resistance to change/ internal cultural Issues	[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15]
2	High investment cost of implementation/Lack of financial resource	[1, 2, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15]
3	Lack of uniform standard or policy/Inadequate legal framework	[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15]
4	Inadequate data security challenges/ Cyber security issues	[1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 15] – (11)
5	Inadequate ICT and Internet infrastructure/weak infrastructure	[1, 2, 3, 4, 5, 6, 10, 12, 13, 15]
6	Lack of Support	[2, 3, 4, 6, 7, 8, 9, 13, 14, 15]
7	Inadequate technical/skilled personnel/ lack of education and training	[1, 6, 7, 8, 9, 13, 14, 15]
8	Software non-compatibility / interoperability issues	[1, 4, 5, 6, 7, 10, 12]
9	Lack of trust and awareness of the benefits of e-procurement systems	[1, 3, 7, 9, 14]
10	Technical malfunctioning of the portal/ Internet and technical challenges	[4, 5, 7,13]
11	Dual operation mode difficulty (traditional & digital)/Deficiency in merging systems	[15]

Notes: Al-Yahya and Panuwatwanich (2018) - 1, Altayyar and Beaumont-Kerridge (2016) -2, Altayyar and Beaumont-Kerridge (2016a) -3, Khalil & Waly (2015) -4, Khalil (2015) -5, Syed (2016) -6, Alkalbani et al. (2013) -7, Baladhandayutham and Shanthi Venkatesh (2012) -8, Baladhandayutham & Shanthi Venkatesh (2012a) -9, Maleki et al. (2017) -10, Aibinu & Al-Lawati (2010) – 11, Yevu et al, (2022) – 12, Hilmi et al, (2019) – 13, Al Hazza (2023) – 14, Bahreman (2014) - 15.

3.6.4. Critical Barriers to e-tendering in Europe

In Europe, a total of 21 primary barriers to e-tendering implementation were identified. Among these, the most significant barriers that dominated the landscape included; Lack of uniform standard or policy and inadequate legal framework; Resistance to change; Inadequate technical/ICT skilled personnel; Software non-compatibility/interoperability; Inadequate data security challenges/Cyber

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security challenges; Inadequate ICT and Internet infrastructure; High investment cost of implementation; Lack of Support; Lack of trust, scepticism, and awareness of benefits electronic tendering technology; User unfriendliness and inflexibility of the electronic system / complex interface; and Infective communication. On the other hand, barriers related to; Lack of widely accepted e-procurement software; Inadequate change management; Inadequate clear identification of roles/responsibilities; Lack of production planning system; Many suppliers leading to the complex evaluation process; High transaction frequency leads to inefficient procurement; and Poor relationship with suppliers were comparatively less dominant in the European context. Table 4 gives the summary of barriers discovered in Europe.

Table 4. Summary of the critical barriers to e-tendering from Europe

No.	Factors	Author
1	Lack of uniform standard or policy and Inadequate legal framework/ Legal and regulatory challenges	[2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 20, 22, 25, 30, 31, 32, 33, 34, 36
2	Reluctance/ resistance to change	[1, 2, 4, 6, 7, 8, 9, 10, 11, 12, 16, 17, 18, 19, 23, 25, 27, 28, 29, 31, 32, 33, 36]
3	Inadequate technical/ICT skilled personnel/ Lack of knowledge regarding e-tendering/ inadequate computing skills	[1, 2, 4, 6, 7, 9, 10, 11, 12, 13, 14, 17, 18, 19, 20, 22, 25, 27, 29, 31, 32]
4	Software non-compatibility / interoperability	[1, 6, 7, 8, 9, 10, 12, 13, 16, 17, 21, 18, 22, 27, 29, 30, 31, 32, 34, 35]
5	Inadequate data security challenges/Cyber security issues	[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 27, 30, 31, 32, 34]
6	Inadequate ICT and Internet infrastructure/Undeveloped infrastructure	[1, 2, 3, 4, 5, 9, 12, 14, 16, 24, 25, 27, 28, 31, 32, 34]
7	Lack of Support	[1, 4, 5, 7, 8, 9, 10, 11, 12, 16, 17, 20, 25, 32]
8	High investment cost of implementation	[4, 5, 6, 11, 12, 13, 14, 15, 16, 17, 27, 31, 32, 33]
9	Lack of trust, skepticism, and awareness of benefits of e-procurement systems/Lack of information/ limited publicity/ Lack of commitment from suppliers	[1, 7, 8, 9, 11, 13, 16, 17, 18, 24, 25, 26, 37]
10	User unfriendliness and inflexibility of the electronic system / Complex interface	[8, 10,11,12, 25, 27, 28, 29, 31, 36]
11	Infective communication	[8, 10,11,12, 25, 27, 28, 29, 31, 36]
12	There is a lack of a forum for exchanging ideas on e-procurement/ lack of pioneering firms and pilot projects/insufficient case availability.	[8, 9, 10, 11, 26, 31]
13	Other competing initiatives, Excessive number of e-platforms, Competition amongst hub-providers	[8, 11, 12, 17, 25, 31]
14	Technical malfunctioning of the portal	[9, 10, 12, 17, 18]
15	Lack of widely accepted e-procurement software	[6, 8, 10, 11, 17]
16	Inadequate change management	[25]
17	Inadequate clear identification of roles/responsibilities	[25]
18	Lack of production planning system	[31]
19	Many suppliers leading to the complex evaluation process	[31]

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20	High transaction frequency leads to inefficient procurement	[31]
21	Poor relationship with suppliers	[32]

Note : Hassan (2021) -1, Belisari et al. (2020) -2, Isikdag (2019) -3, Gholampur (2018) -4, Sydorenko (2017) -5, Eadie and Perera (2016) -6, Pop (2011) -7, Eadie et al. (2011) -8, Isikdag et al. (2011) -9, Eadie et al. (2010) -10, Eadie et al. (2010a) -11, Eadie et al. (2010b) -12, Svidronova and Nemec (2016) -13, Gurakar and Tas (2016) -14, Svidronova & Mikus (2015) -15, Toktaş-Palut et al. (2014) -16, Costa et al. (2013) -17, Schnitzler and Österlund (2015) -18, Doherty et al. (2013) -19, Fernandes and Vieira (2015) -20, Aguiar Costa and Grilo (2015) -21, Beauvallet et al. (2011) -22, Gascó, et al. (2018) – 23, Gardenal (2013) – 24, Pala et al. (2016) – 25, Badi et.al (2021) – 26, Yevu et al, (2022) - 27, Allal-Chérif & Babai (2012) – 28, Boughzala, et al. (2012) – 29, Benzidia (2013) – 30, Gurgun et al (2024) – 31, Elsanosi (2020) – 32, Hanak et al. (2017) - 33, Hajdari (2018) – 34, Grilo and Jardim-Goncalves (2011) – 35, White & Clarkson (2024) – 36.

3.6.5. Critical barriers to e-tendering in the Pacific

In the Pacific region, 14 major barriers were identified. The most prominent major barriers to e-tendering implementation include; High investment cost of implementation/ High costs of software and hardware; Reluctance/ resistance to change; Inadequate technical/ICT skilled personnel; Inadequate or data security challenges; Lack of Support; Lack of trust and awareness of benefits of e-tendering systems; Lack of legal frameworks and standards; and technical malfunctioning of the portal. On the contrary, the High complexity of the selected technology dissemination system; Lack of widely used e-procurement software solutions; Software Compatibility Issues/Interoperability challenges; Lack of public demand for the selected technology; Inadequate research in IT in construction (R&D)/inadequate pilot studies; and Unethical practices. Table provides a concise summary of the 14 identified barriers in the Pacific region.

Table 5. The summary of the critical barriers to e-tendering from the Pacific.

No.	Factors	Author
1	High investment cost of implementation/ High costs of software and hardware	[1, 2, 3, 4, 6, 7, 8]
2	Reluctance/ resistance to change	[1, 3, 4, 5, 6, 7, 8]
3	Inadequate technical/ICT skilled personnel	[1, 2, 3, 5, 7, 8]
4	Inadequate or data security challenges	[1, 2, 3, 6, 7, 8]
5	Lack of trust and awareness of benefits of e-procurement systems/difficulty in judging the usefulness and potential of e-tendering/Lack of Information	[2, 3, 4, 6, 7, 8]
6	Lack of Support	[2, 3, 4, 7, 8]
7	Lack of legal frameworks and standards supporting the adoption of the selected technology/policies, regulations, and standards	[1, 3, 7]
8	Technical malfunctioning of the portal	[2, 3]
9	High complexity of the selected technology dissemination system/System Complexity	[7, 8]
10	Lacks widely used e-procurement software solutions	[1] – (1)
11	Software Compatibility Issues/Interoperability challenges	[7] – (1)
12	Lack of public demand for the selected technology	[7] – (1)
13	Inadequate research in IT in construction (R&D)/inadequate pilot studies	[7] – (1)
14	Unethical practices	[8] – (1)

Note: Gajendran and Perera (2017) -1, Hassan (2013) -2, Rahim and As-Saber (2011) -3, Khahro et al. (2021) -4, Zunk et al. (2014) -5, Yevu et al, (2022) – 6, Ullah et al. (2021) – 7, Hayden et al. (2023)- 8.

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3.6.6. Critical barriers to e-tendering from North America

North America, recorded 11 primary barriers. Among these, the topmost barriers are; Inadequate ICT and internet infrastructure; Inadequate data security challenges; Reluctance/ resistance to change; Complex user interface; High implementation investment cost, Inadequate technical/ICT skilled personnel, Lack of Support, Inadequate research in IT in construction (R&D)/ inadequate pilot studies. Contrary, the least dominant barriers are; Technical malfunctioning of the portal; Lack of uniform standards or policy and inadequate legal framework; and Lack of widely used e-procurement software solutions. Table presents the summary of the barriers identified in North America.

Table 6. Summary of the critical barriers to e-tendering from North America.

No.	Factors	Author
1	Inadequate ICT and Technological Capacity	[1, 2, 3, 5,7, 8]
2	Inadequate data security challenges	[1, 2, 3, 5]
3	Reluctance/ resistance to change/ internal cultural issues (Cultural elements, organization, and strategy)	[1, 3, 4, 5, 6, 7, 8]
4	User Experience Issues/Complex user interface	[1, 3, 2, 8]
5	High investment cost of implementation/ Budget Constraints	[3, 2, 5, 7, 8]
6	Lack of Support	[1, 2, 8]
7	Inadequate technical/skilled personnel/ Inadequate in-house IT personnel/Inadequate training	[1, 2, 8]
8	Inadequate research in IT in construction (R&D)/ inadequate pilot studies	[3, 5]
9	Technical malfunctioning of the portal	[2]
10	Lack of uniform standard or policy/ Complex Regulations/legal challenges	[3, 7, 8]
11	Lack of widely used e-procurement software solutions	[3]

Note: Sánchez-Rodríguez et al. (2019) -1, Abu-ELSamen et al. (2010), -2, Bowmaster et al. (2016) -3, Ahmad et al. (2019) -4, Yevu et al, (2022) – 5, 164, Lines et al., 2017 – 6, Bromberg & Manoharan (2015) – 7, Aguila, (2020) – 8.

4. Findings and Discussions

In this section, we present the key findings from our systematic literature review, discussing the identified barriers to e-tendering adoption and implementation across various geographical regions. The findings offer valuable insights into the challenges affecting the construction industry in embracing e-tendering practices globally. Additionally, we engage in a comprehensive discussion to analyse the implications of these barriers, their potential impact on the construction sector, and potential strategies for addressing them. This section serves as a critical synthesis of the research findings, providing a deeper understanding of the current landscape of e-tendering within the construction industry.

4.1. Comparison of the main barriers to e-tendering based on geographical regions.

After a comprehensive analysis and comparison of the barriers to e-tendering implementation across different geographical regions, a total of 29 main barriers to e-tendering adoption and application were identified. This section presents two main parts of the findings (1) The main barriers to e-tendering across all geographical regions and (2) The top 10 barriers frequently occurred across all regions.

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4.2. The main barriers to e-tendering across all geographical regions.

This study identified 8 main barriers that appeared consistently in all 6 geographical locations as (1) Inadequate technical/skilled personnel (2) Inadequate data security (3) Lack of uniform standard or policy and inadequate legal framework (4) Reluctance/ resistance to change (5) Inadequate ICT and internet infrastructure (6) High investment cost of implementation (7) Lack of support (8) Technical challenges. Table 8 provides a summarized overview of these dominant main barriers, highlighting their prevalence and significance in the context of e-tendering implementation. The implications of identifying the main barriers to e-tendering across various geographical locations are significant for improving the effectiveness and adoption of electronic procurement systems. Addressing these barriers can lead to increased efficiency, transparency, and fairness in procurement processes. It can also promote greater competition and better value for money in public spending. Hence, recognizing and tackling these barriers is essential for the effective execution and sustained use of e-tendering technology worldwide.

Table 8. The main barriers to e-tendering are based on geographical regions.

No.	Barrier	Frequency/ Rank	Africa	Asia	Middle East & North Africa	Europe	Pacific	North America
1.	Inadequate data security/ Cybersecurity issues	101	✓	✓	✓	✓	✓	✓
2.	Reluctance/resistance to change	101	✓	✓	✓	✓	✓	✓
3.	Inadequate legal framework or lack of uniform standards or policies	100	✓	✓	✓	✓	✓	✓
4.	Inadequate technical/ ICT skilled personnel	97	✓	✓	✓	✓	✓	✓
5.	Inadequate ICT and Internet infrastructure	88	✓	✓	✓	✓	✓	✓
6.	High investment cost of implementation/High technology cost	84	✓	✓	✓	✓	✓	✓
7.	Lack of Support/ Lack of Management Support	69	✓	✓	✓	✓	✓	✓
8.	Lack of trust and awareness of the benefits of e-procurement systems	56	✓	✓	✓	✓	✓	X
9.	Software non-compatibility /interoperability issues	53	✓	✓	✓	✓	✓	X
10.	Technical malfunctioning of the portal	34	✓	✓	✓	✓	✓	✓

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11.	Complex user interface	24	✓	✓	✓	✓	✓	X
12.	Ineffective communication	15	✓	✓	✓	✓	X	X
13.	Unreliable electric power supply	13	✓	X	X	X	X	X
14.	Insufficient forum, pioneering firms, studies, or pilot projects	10	X	✓	X	✓	✓	✓
15.	Lack of widely used e-procurement software solutions	7	X	X	X	✓	✓	✓
16.	Unethical Practices (transparency issues)	6	✓	✓	X	X	✓	X
17.	Other competing initiatives, Excessive number of e-platforms	6	X	X	X	✓	X	X
18.	Lack of monitoring of supplier's compliance/lack of performance evaluation	5	✓	✓	X	X	X	X
19.	Lack of adequate planning	3	X	✓	X	✓	X	X
20.	Inadequate change management	3	X	✓	X	✓	X	X
21.	Dual operation mode difficulty (traditional & digital)	2	X	✓	✓	X	X	X
22.	The choice of suppliers is too arbitrary and the lack of scientific management	2	X	✓	X	✓	X	X
23.	Inadequate clear identification of roles/responsibilities	1	X	X	X	✓	X	X
24.	Insufficient public demand for the selected technology	1	X	X	X	X	✓	X
25.	Fear of loss of jobs	1	✓	X	X	X	X	X
26.	Many suppliers leading to the complex evaluation process	1	X	X	X	✓	X	X
27.	High transaction frequency leads to inefficient procurement	1	X	X	X	✓	X	X

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28.	Poor Relationship with Suppliers	1	X	X	X	✓	X	X
29.	Lack of Mobile Applications	1	X	✓	X	X	X	X

Top 10 barriers across all regions with the most frequent occurrences

The ten (ten) 10 most critical barriers to e-tendering globally identified with the most frequent occurrences are (1) Inadequate data security/cybersecurity issues (101 occurrences), (2) Reluctance/resistance to change (101 occurrences), (3) Lack of uniform standard or policy and Inadequate legal framework (100 occurrences), (4) Inadequate technical/ICT skilled personnel (97 occurrences), (5) Inadequate ICT and internet infrastructure (88 occurrences), (6) High investment cost of implementation (84 occurrences), (7) Lack of Support/Lack of Management Support (69 occurrences), (8) Lack of trust and awareness of benefits of e-procurement systems (56 occurrences), (9) Software non-compatibility /interoperability issues (53 occurrences), (10) Technical malfunctioning of the portal (34 occurrences) were ranked from 1 to 10 respectively.

These findings provide insights into the primary obstacles impeding the acceptance of electronic tendering systems. Hence, the critical barriers to e-tendering have been identified for further discussion. The decision to focus on ten barriers for discussion is driven by the need to address the most critical, prevalent, and impactful challenges in e-tendering implementation. This approach ensures a clear, focused, and actionable analysis that can guide organizations in effectively overcoming these barriers and achieving successful e-tendering adoption. The justification for choosing only ten barriers for discussion is that, when analysing barriers to e-tendering implementation across various regions, it is important to focus on the most impactful and dominant challenges. The decision to limit the discussion to ten barriers is justified by several key factors such as:

- The top ten barriers were selected based on their high frequency of occurrence across different regions, indicating that these challenges are widespread and significantly affect electronic tendering adoption globally.
- Impact on electronic tendering implementation
- Focusing on the top ten barriers allows for a more in-depth discussion and recommendation of feasible solutions and strategies to overcome these challenges.
- Regional Relevance
- Limiting the discussion to ten barriers helps maintain clarity and focus and provides a clear and concise discussion that is easier for stakeholders to understand and act upon.
- Prioritization of Resources: In most cases, organizations often have limited resources to address challenges, hence, discussing the top ten barriers, can help prioritize the allocation of resources to the most pressing issues.

The most critical barriers selected for further discussion are presented below.

Inadequate data security/cyber security issues:

Inadequate data security/cyber security issues occurred 101 times and ranked 1st along with resistance to change. It covers a range of concerns related to the security of electronic tendering processes. It includes the potential risks associated with hacking, virus attacks, and data loss, as well as the fear of confidential information falling into unauthorized hands. Other aspects involve concerns about the trustworthiness of electronic documents, the risk of document tampering and online crime, and challenges related to authentication. This comprehensive view of inadequate data security underscores the critical importance of selecting well-secured alternatives when implementing e-tendering systems. As noted by Anumba and Ruikar (2002), electronic commerce researchers and analysts emphasize that security concerns constitute one of the most significant barriers preventing organizations from adopting electronic commerce measures. Consequently, both

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governments and organizations should actively take measures to mitigate these widespread fears and enhance the security of electronic tendering processes.

Resistance to change

Resistance to change (occurred 101 and was also ranked number 1). It is a significant barrier that often stems from internal cultural factors within an organization. A company's organizational culture plays a crucial role in determining how its employees conduct their business operations, and resistance to change can arise from employees' reluctance to re-engineer or adapt to new systems or working approaches, particularly when those systems are in their early stages of implementation and may require adjustments. This resistance can also be attributed to factors such as a deficiency of information system skills and anxiety about the unknown, as highlighted by Pop (2011). Employees may resist change when they lack the necessary skills and feel apprehensive about adopting new technology. Furthermore, investment cost is high for adopting and maintaining e-tendering without substantial benefits recorded can also contribute to resistance to change, as noted by Khalil and Waly (2015). Additionally, cultural elements, organizational strategies, and evolving IT technical requirements can be factors contributing to resistance to change, as suggested by Bowmaster et al. (2016). Consequently, resistance to change can lead to significant delays in the adoption of new technologies and can hinder the organization's ability to improve efficiency and reduce costs, which are often benefits of moving to electronic systems like e-tendering. To address this barrier, it is recommended that top management take proactive steps to educate the institutions regarding the benefits of electronic tendering and the reasons for its adoption.

Inadequate legal framework or lack of uniform standards or policies.

Inadequate legal framework or lack of uniform standards or policies with (100 occurrences) was ranked 3rd. It encompasses several aspects. It refers to the absence of clear legal rules and regulations governing the e-tendering process, insufficient laws or guidelines to address disputes that may arise during e-tendering or related to legal transactions, the lack of a dependable and consistent standard system, as well as the challenges associated with enforcing electronic contracts. Furthermore, this barrier extends to the insufficient development of a legal framework and the lack of a national IT strategy specifically addressing e-procurement issues. Bureaucratic inefficiencies in practice, the scarcity of relevant case law, and issues related to e-signatures also contribute to this barrier (Belisari et al. 2020; Isikdag, 2019; Gholampur, 2018). As highlighted by Anumba and Ruikar (2002), firms often perceive uncertain regulatory issues, including legal, tax, and ethical considerations, as significant deterrents to adopting e-tendering practices. The effectiveness of electronic tendering is closely linked to how the effectiveness of regulatory systems can achieve their policy objectives. Therefore, the establishment of standardized policies becomes crucial for the smooth application of e-tendering processes, ultimately reducing the likelihood of disputes and enhancing overall efficiency.

Inadequate technical / ICT skilled personnel

It occurred 97 times and ranked 4th. It poses a serious obstacle to the effective use of e-tendering procedures. This barrier encompasses several aspects related to the skills and competencies of personnel involved in e-tendering. Inadequate technical or ICT skilled personnel can significantly hinder the adoption and effective implementation of e-tendering systems. Without sufficient expertise, organizations may struggle with the setup, maintenance, and troubleshooting of these digital platforms. This can lead to inefficiencies, increased costs, and potential security vulnerabilities (Kazaz et al., 2022). Furthermore, lack of skilled personnel can result in poor user experiences and can lead to the reduction of the overall effectiveness of the e-tendering process and potentially deterring stakeholders from fully implementing the system (Mohungoo, et al., 2020). Therefore,

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paying much attention and investing in training and development for ICT skills is crucial to overcoming this barrier, hence, ensuring the successful integration of e-tendering solutions.

Inadequate ICT and Internet infrastructure in the organization to facilitate e-tendering

Inadequate ICT and internet infrastructure (88 occurrences) was ranked 5th. This barrier includes a range of challenges related to the ICT and internet infrastructure required to effectively implement e-tendering processes. Poor internet connectivity and inadequate ICT infrastructure are significant obstacles, particularly in regions with limited technological development. Reliable infrastructure is foundational for effective e-tendering. These challenges include unreliable internet connectivity, slow network connections, and the high costs associated with accessing the internet, among others. According to Mind Commence (2022), ICT infrastructure comprises the software and hardware necessary for establishing and operating communication systems, networks, and supporting applications, digital content, and e-commerce. It encompasses various components like switching, transmission/transport, signalling, network access, platforms, databases, and ICT data. Many countries still face deficiencies in their ICT infrastructure, which makes it more difficult for the building industry to fully implement e-tendering. This observation corresponds with the results of research conducted in different regions, including Sri Lanka (Wimalasena and Gunatilake, 2018), Canada (Sánchez-Rodríguez *et al.*, 2019), and Finland (Hassan, 2021). It implies that, when ICT and internet infrastructure capacity are low, it restricts the ability of users to access and utilize e-tendering systems effectively. This can result in uneven participation among stakeholders, especially those in remote or under-resourced areas. To address this barrier, governments and organizational leaders must prioritize investments in ICT infrastructure, as improving these elements can significantly fast-track the successful application of e-tendering practices within the construction industry.

High investment cost of implementation

The high investment cost of implementation (84 occurrences) was ranked 6th. This barrier encompasses various costs associated with migrating from traditional paper-based procurement procedures to digital and paperless electronic tendering systems. These costs may include: IT Systems cost, the expenses related to acquiring and setting up the necessary information technology infrastructure to support e-tendering processes such as hardware, software, and network infrastructure (Bowmaster et al, (2016), system licenses cost i.e. the fees associated with procuring licenses for e-tendering software and platforms. These licenses are often required for multiple users within an organization (Khahro et al, 2021), and training costs i.e. the investments made in training staff members to use e-tendering systems effectively. This may include training programs, workshops, and hiring trainers or consultants, change management costs i.e. the expenses associated with managing the organizational and cultural changes that come with transitioning to e-tendering. This may involve change management consultants, communication strategies, and employee engagement efforts. Furthermore, ongoing maintenance and support costs are required to maintain and support e-tendering systems, including software updates, troubleshooting, and technical support.

For many organizations, especially small and medium-sized enterprises (SMEs), initial investment costs associated with e-tendering implementation is high and can be a significant deterrent. These costs can strain budgets and resources, making it challenging for these organizations to make the transition. As a result, they may opt to stick with traditional paper-based processes, even though e-tendering could offer long-term benefits (Hassan, 2021). To address this barrier, organizations and governments may consider strategies such as providing financial incentives, grants, or subsidies to support the adoption of e-tendering, particularly among SMEs. Finally, offering cost-effective and user-friendly e-tendering solutions tailored to the needs of smaller businesses can help lower the entry barriers and promote wider adoption.

Lack of support

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Lack of support (69 occurrences) was 7th. This lack of support can manifest in various ways, including inadequate government support, lack of top management support, limited resources, and lack of capacity i.e., organizations may lack the necessary capacity and expertise to implement e-tendering effectively. Lack of support can have several significant implications for an organization and its stakeholders such as reduced adoption rates, increased user frustration, and slower problem resolution, lack of support can prevent users from fully leveraging the system's capabilities, thereby diminishing the potential benefits of e-tendering, and lack of support can hinder this process, limiting opportunities for feedback and subsequent enhancements to the system. Ibem et al, (2017) revealed that some top management are concerned that electronic tendering will reduce corruption in the construction sector in Nigeria, highlighting the potential resistance from corrupt top management. To address this barrier, it is essential for stakeholders, including both organizations and governments, to provide strong support for embracing electronic tendering. With this assistance, the challenges of the traditional paper-based tendering process can be mitigated and drive the industry towards more efficient and transparent procurement practices.

Lack of trust and awareness of benefits of e-procurement systems

Lack of confidence and knowledge of the benefits of electronic tendering systems (56 occurrences) came in eighth place. Because the traditional tendering has been utilized for some years, companies are accustomed to it and are hesitant to explore new alternatives, thus they are unaware of e-tendering. Distrust of the system and scepticism of the benefits of electronic tendering. This is supported by Khalil and Waly (2015) in Egypt, Mehdipoor et al, (2022) in Malaysia, and Hassan (2021) in Finland. Consequently, poor adoption rates among potential users may result from scepticism and ignorance of the advantages of electronic tendering. Furthermore, resistance to change can result from a lack of trust, as stakeholders may prefer to stick with familiar manual processes rather than adopt new technologies they do not fully trust or understand. This resistance can slow down digital transformation efforts within organizations. Therefore, it is recommended that, by implementing targeted communication strategies that clearly articulate the benefits and capabilities of e-procurement systems, educating all stakeholders, including suppliers, about how these systems enhance procurement processes, highlighting the security measures and transparency features of the e-procurement system, providing detailed information on data protection, audit trails, and compliance with relevant standards to build trust, demonstrating success stories, and establishing mechanisms for collecting feedback from users and make continuous improvements to the e-procurement system based on this feedback, it will help mitigate this challenge.

Software non-compatibility / interoperability challenges

Software non-compatibility /interoperability issues occurred 53 times and were ranked 9th. The interoperability of resources and tools across projects is critical because Many organizations focus on distinctive efforts in temporary groups. The exchange of data in e-tendering is crucial throughout the construction procedure. To ensure a successful data transmission and avoid information loss, stakeholders are recommended to use e-tendering system provided by compatible or the same manufacturers. Non-compatible software can lead to fragmented systems where different departments or stakeholders use different platforms that do not communicate effectively with each other. This can create silos within an organization, complicating data sharing and collaborative processes. The industry can start facilitating data exchange reasonably early by creating a specification for an open data format (Hassan, 2021). Previous studies have validated this, including those by Wimalasena and Gunatilake (2018) and Oyediran and Akintola (2011).

Portal technical malfunction and technical issues

Portal technical malfunction and technical issues were ranked 10th and occurred 34 times. It includes a variety of issues concerning the functioning and technical performance of e-tendering

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portals. These obstacles include concerns like system instability, compatibility and support, frequent system faults, technological update requirements, inexplicable system glitches, high maintenance expenses, and the possibility of the system failing on the bid deadline. Khalil and Waly, (2015) pointed out lack of trust in government-provided services in Egyptian has led to concerns that e-tendering portals may experience malfunctions, such as broken links, unavailability of service, or slow page loading, especially during the crucial tender submission process. When the portal encounters technical issues that prohibit tenderers from submitting bids, it might raise suspicions and accusations of wrongdoing against the institution in charge of operating the portal. Hence, e-tendering systems need to be user-friendly. Also, organizations should focus on enhancing system reliability through regular upgrades and maintenance. Additionally, conducting frequent system testing is crucial to identify and address potential issues proactively. Robust technical support should also be established, with site managers and technical personnel readily available and trained to provide prompt support and effectively handle issues as they arise during the e-tendering process. Maintaining transparency about system status and updates will further help prevent malfunctions, ensure system stability, and maintain user trust in the e-tendering process.

4.3. Solutions to the Barriers and Best Practices For E-tendering and The Future of E-tendering

In this section various techniques for overcoming the barriers identified in this study has been presented, as well as predicting the emerging tools and technologies that can be integrated into E-tendering to fulfill its full potential.

a. Improving ICT Infrastructure: E-tendering relies heavily on reliable ICT infrastructure. As a result, numerous governments and organizations must invest in the development of ICT infrastructure, particularly in underserved areas, in order to ensure reliable and widespread Internet access.
b. Improved Cybersecurity: Implementing sophisticated features like encryption, multi-factor authentication, and regular security audits helps safeguard E-tendering systems from cyber threats.
c. Training Program Organizations: Institutional training programs can increase acceptance rates of E-tendering systems. This can be done by providing stakeholders with workshops and training programs that improve technical proficiency and understanding of e-tendering processes.
d. Standardized Protocols Development: The establishment of well-standardized standards and regulations for e-tendering can help to streamline operations, eliminate confusion, and increase efficiency. It can be achieved through collaboration among governments, industry entities, and international organizations.
e. Promotion of Inclusivity: Implementing inclusive policies and practices, including accessible platform designs and focused outreach initiatives, can guarantee that excluded groups possess equal opportunities to engage in e-tendering.

Finally, it is foreseen that with the integration of the emerging technologies, e-tendering in the construction industry will undergo considerable advancements in the future. For instance, Blockchain technology will guarantee safe, unchangeable records, increasing transparency and trust, while artificial intelligence (AI) and data analytics will automate bid review, detect rival offers, and forecast hazards. Additionally, Mobile applications will boost flexibility and responsiveness, enabling on-the-go management, while cloud-based systems will facilitate real-time collaboration, enhance communication, and cut down on delays. Furthermore, social value and sustainability standards will assess the effects on the environment and society and promote ethical procurement practices. Finally, by automating administrative tasks, more time may be spent on strategic endeavors. When combined, these technologies have the potential to greatly improve the e-tendering process's effectiveness, security, and transparency.

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5. Conclusions and Recommendations

This study used a comprehensive analysis of the literature to discover the major barriers to electronic tendering acceptance and implementation in the worldwide construction industry. It examined six different geographic regions and identified 29 barriers, with eight major factors present in every region: (1) inadequate technical/skilled personnel, (2) inadequate data security, (3) inadequate uniform standards or policy and inadequate legal framework, (4) reluctance/resistance to change, (5) inadequate ICT and internet infrastructure, (6) high cost of implementation, (7) lack of support, and (8) technical challenges. Furthermore, the ten most frequent barriers identified across these regions were: (1) inadequate data security/cybersecurity issues, (2) lack of uniform standards or policy/inadequate legal framework, (3) reluctance/resistance to change, (4) inadequate technical/ICT skilled personnel, (5) inadequate ICT and internet infrastructure, (6) high cost of implementation, (7) lack of support, (8) a lack of trust and understanding or awareness of the advantages of e-procurement systems, (9) software non-compatibility/interoperability issues, and (10) technical malfunctioning of the portal.

Based on the study's objectives (1) to conduct a systematic literature review to identify key e-tendering implementation barriers (2) group them based on geographical regions (3) to identify barriers common to all six regions and (4) highlight the ten topmost barriers in the construction sector, it can be concluded that the global construction industry faces eight major barriers across all six regions, with ten significant challenges limiting electronic tendering adoption. Additionally, the African continent had the highest number of publications (48) and a total of 15 barriers. Europe followed with 36 publications and 21 barriers, while Asia was third with 35 publications and 20 barriers. Middle East and North Africa had the fourth highest number of publications (15) with 11 barriers. The Pacific had the least publications (8) and 15 barriers, while North America recorded 8 publications and 11 barriers.

5.1. Implication of the study

The implications of this study are significant for various stakeholders. It provides valuable information to help stakeholders in the construction sector make informed decisions and remove obstacles to e-tendering adoption. Scholars and professionals can use these findings to delve deeper into these obstacles and shape their approaches for effective implementation. Governments and policymakers can facilitate e-tendering adoption by establishing uniform standards and regulations, while technology providers can customize solutions to meet regional needs. Educational institutions should create curricula and training programs to produce professionals skilled in e-tendering technology. Additionally, the study's regional barrier classification encourages international cooperation and knowledge exchange, allowing regions to share best practices and experiences, thus aiding organizations in making strategic decisions regarding electronic tendering systems.

5.2. Contribution to the body of knowledge

This study enhances the body of knowledge by systematically identifying and analyzing 29 barriers to e-tendering adoption across six global regions. It also highlights eight major barriers across all the geographical regions and ten main barriers the construction sector faces. It offers valuable insights for stakeholders, including governments, policymakers, technology providers, and educational institutions, to make informed decisions and develop strategies for effective e-tendering implementation. Additionally, the study encourages international cooperation and lays a foundation for future research and educational initiatives, addressing the shortage of skilled personnel and the need for uniform standards and regulations.

5.3. Limitations and Future Research

This research provides insightful information about e-tendering barriers, it is important to acknowledge its limitations. The data collection through systematic literature review period was

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limited to January 2010 to December 2024, and not all publications may have been captured. Additionally, some barriers may evolve as technologies advance, regulations change, and awareness increases.

The study recommends that future studies should focus on monitoring e-tendering barriers, industry trends, and contextual considerations to gain a comprehensive understanding of e-tendering barriers and their solutions on yearly basis.

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