Synergy Between BIM and e-Procurement: A New Paradigm for Digital Procurement Management

Enrico Pasquale Zitiello(✉), Francesca Porcellini, Eliana Basile, Antonio Salzano, and Maurizio Nicolella

Department of Civil, Architectural and Environmental Engineering, University of Naples Federico II, 80125 Naples, Italy
enricopasquale.zitiello@unia.it

Abstract. The Architecture, Engineering and Construction (AEC) sector is undergoing a digital transformation thanks to Construction 4.0 technologies. Among these, e-procurement represents a key element for the optimisation of tendering procedures and the improvement of administrative transparency, through the dematerialisation of documents and the rationalisation of workflows, resulting in time and cost reductions in procurement. In parallel, Building Information Modeling (BIM), stimulated by national and international regulations, allows a more integrated management of design information, improving the quality of decisions and reducing errors and inefficiencies. However, the integration between BIM and e-procurement is still limited, as e-procurement mainly focuses on document digitisation without fully exploiting the potential of BIM for advanced data management. With this in mind, this research aims to analyse the state of the art regarding the joint application of BIM and e-procurement in the public procurement sector. Through an in-depth bibliographical analysis, the main scientific studies and existing application experiences will be examined in order to identify best practices, still existing criticalities and phases of tendering procedures where BIM can bring the greatest added value. Furthermore, in order to concretely understand the potential and limits of this integration, an application to a case study will be developed, analysing in detail the achievable advantages and the problems encountered in the operational implementation. The analysis conducted also aims to outline possible evolutionary scenarios and strategies to overcome the technological, organisational and regulatory barriers that currently hinder full interoperability between these two technologies. The final objective is to provide a comprehensive picture of the opportunities arising from the joint adoption of BIM and e-procurement, highlighting how this synergy can improve efficiency, transparency and economic sustainability in public procurement.

Keywords: e-procurment · BIM · Construction 4.0 · Digital Procurement Management

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2026
O. Gervasi et al. (Eds.): ICCSA 2025 Workshops, LNCS 15891, pp. 63–77, 2026.
https://doi.org/10.1007/978-3-031-97617-9_5

1 Introduction

Public procurement management is a complex process involving various actors such as contracting entities, economic operators and control authorities, and consists of several phases each of which plays a crucial role in ensuring transparency and fairness in the assignment of tasks. In particular the procurement phase plays a key role as it identifies the economic operator to be entrusted with the execution of works or the supply of goods or the provision of services. European public procurement law regulates two main criteria for the selection of the successful tenderer the lowest price criterion and the most economically advantageous tender (MEAT). This criterion appears to be more preferred as it allows the procuring entity to assess, in addition to the economic component, a multitude of parameters which may include technical, functional and innovative features, Criteria of environmental and social sustainability, as well as the assessment of costs throughout the life cycle (Life Cycle Costing - LCC) of the work, service or supply, thus generating a multidimensional evaluation approach.

The adoption of the MEAT criterion thus allows a comprehensive evaluation of the offer, through a single criterion it is possible to evaluate the offer on the basis of price, or cost, using a cost-effectiveness approach such as life-cycle cost, or best value for money (Forum on the Competitiveness of the European Rail Supply Industry, European Commission, October 2017). However, the effective implementation of the MEAT criterion requires the ex-ante definition of evaluation criteria (and related sub-criteria, indicators and weighting methodologies) that meet the requirements defined as fundamental principles by the 2014 European Directive such as transparency, objectivity and equal treatment, verifiability and measurability. The correct formulation of these elements is essential to ensure a fair and impartial competitive comparison between the tenders submitted by economic operators. The main challenge facing contracting authorities is precisely the definition of these criteria, which must not compromise, as highlighted by the European directive, the transparency and efficiency of the tender award process. To meet these needs, technological tools such as e-procurement platforms have emerged, which digitise the entire procurement process and minimise human interaction in order to optimise the traceability of operations and guarantee a reduction in time and greater transparency of the tender process.

Another technology that is gaining increasing importance is Building Information Modeling (BIM), thanks also to European and national regulations that require its use in public procurement; these regulations, however, incentivise the use of BIM only as a tool necessary to build the model but not as a process management tool. The objective of this paper is to highlight the potential of the combined use of e-procurement and BIM platforms in the tendering process.

In fact, BIM offers a digital and parametric representation of every aspect of a construction project and presents itself as a valuable tool for the definition and management of the bidding phase due to its ability to represent objective and quantifiable parameters, BIM allows for a more precise and automated evaluation of bids, thus simplifying the selection process, reducing time and costs, and increasing transparency in the evaluation of bids. Furthermore, the use of BIM to check compliance with tender requirements and to score bids according to defined parameters minimises the risk of errors and subjectivity,

ensuring a more objective selection. In this context, the authors present a methodological proposal that integrates BIM technology into the public procurement process using the MEAT criterion. The suggested methodology is designed to optimise the efficiency and transparency of the tendering process by reducing error margins and minimising subjectivity in tender evaluation. The authors also plan to test the proposed methodology through the analysis of case studies in order to validate it and refine the automated analysis techniques. Particular focus will be placed on the identification of parameterisable criteria - i.e. those parameters that can be translated into objective data within the BIM model - and on automated bid evaluation techniques. The ultimate goal is to develop a system that, through e-procurement platforms and BIM, allows to significantly reduce the time of procedures and the risks related to human errors or decisions influenced by subjective factors, leading to faster and more transparent public procurement management.

2 State of Art

The construction sector, globally, is known for its resistance to the adoption of new technologies. This conservative tendency is also clearly manifested in the implementation of e-procurement [1], despite the fact that procurement activities are particularly frequent and relevant in this field [2]. The concept of procurement supports a delivery relationship between buyers and sellers and can be defined as the search for information on requirements for goods/services, and the willingness to promise, i.e. the flow of information within the quotation and negotiation functions [2]. The traditional process that serves as the basis for today's e-procurement is composed of a series of well-defined activities that, although autonomous, are interconnected and organised according to a logic determined by the specific procurement strategy or procedure adopted [3]. The study [2] divides procurement into two phases: contracting and settlement. Contracting includes supplier search, supply promise and definition of goods/services requirements, managing the information flow (availability, dispatch) for quotations and negotiations. Settlement includes payment (transaction) and the physical transfer of goods/services (delivery). Other studies [4, 5] group procurement activities into four main contractual phases: the pre-contractual phase, the contractual phase, the administrative management phase of the contract and the post-contractual phase. Procurement can also be classified into two main types: structured and unstructured [6]. Structured procurement processes are highly automated in terms of requirements identification, ordering and fulfilment. In fact, if demand is regular and product specifications do not change over time, transition costs can be reduced by creating an automated order with minimal human interference [2]. Unstructured procurement occurs when products or services are not suitable for predefined automated procedures. In this case, human intervention is required to search, request, match suppliers and create the order by exploiting the best available offers, thus not constraining the procurement [2]. In summary, when discussing structured procurement, reference is made to goods with well-defined characteristics, since the delivery of such goods is faster and easier. This is due to the clarity of the technical specifications and the ease of evaluation of tenders, which reduce decision and implementation times. On the other hand, for unstructured goods, we observe an evolution that is closer to the

construction sector, it is difficult to parametrize goods and services because they are too variable.

As defined by Chan, A.P.C; Owusu, E.K e-procurement is the business-to-consumer (B2C), business-to-business (B2B) or business-to-government (B2IG) purchase, as well as the sale of goods, services, works or supplies via the Internet and other information and network systems.

The conceptual and technological origin of eprocument dates back to the 70s and 80s, that is to say the birth of EDI (Electronic Data Interchange) technologies. EDI enabled the structured exchange of standardised business documents between trading partners via dedicated networks, representing a first significant form of digitisation of B2B transactions, albeit characterised by high implementation complexity and significant costs. However, e-procurement in its modern sense, understood as the pervasive application of technologies based on Internet protocols and web interfaces for the management of purchasing processes, saw its actual genesis and diffusion from the second half of the 1990s, coinciding with the commercial expansion of the World Wide Web. This period marked a shift from closed, two-sided systems to more open, accessible and interoperable solutions (often based on client-server or web-based architectures), fostering the development of B2B marketplaces and software platforms dedicated to automating the corporate purchasing cycle. The next phase, post dot-com speculative bubble (early 2000s), saw a technological consolidation and a more mature and strategically oriented adoption of such solutions by organisations globally. The development process of e-procurement technologies over time is presented in Fig. 1 [3].

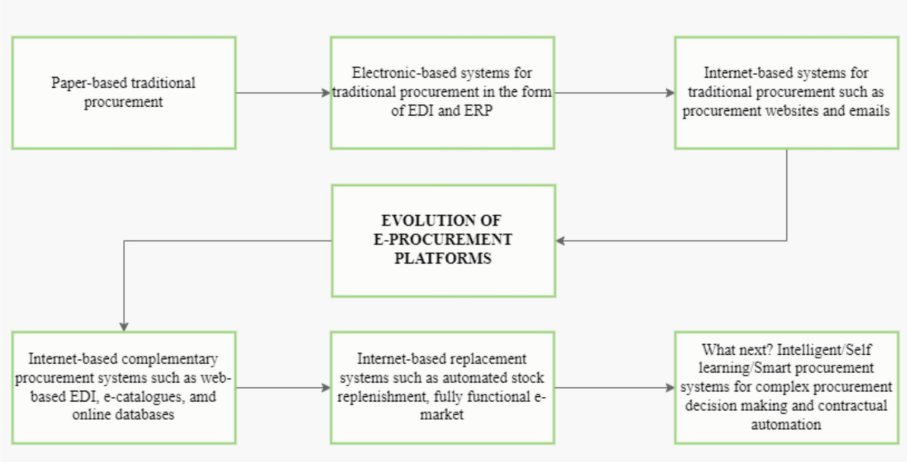

Fig. 1. Evolution of e-procurement [3]

In conclusion, the progressive technological advancement of digital tools has been the driving force behind the transformation of procurement processes. This has enabled the overcoming of manual methodologies and led to a radical digitisation of procurement activities both within the public administration and in the private business context.

According to some studies [7, 8] the e-procurement process can be described in six different phases.

- e-sourcing: this process involves the search for new potential suppliers via the Internet, either in general or through specific B2B marketplaces. It takes place in the information-gathering phase of the procurement process;
- e-tendering: it consists of sending requests for information (RFIs), requests for prices (RFPs) and other enquiries to suppliers, receiving responses via Internet technologies. The data involved are focused on the product or service. In this phase, an initial screening can be carried out to qualify a selected number of suppliers for the negotiation phase (a process generated in the supplier contact phase);
- e-informing: handles supplier information, such as quality certifications, financial status and unique capabilities, without involving transactions. Information may come from third-party suppliers or from internal company investigations;
- e-reverse auctions: e-reverse auctions allow the purchasing company to obtain goods and services at the lowest price or a combination of price and other conditions via Internet technologies. Auctions are negotiated in real time and result in a final offer between buyer and supplier. (This is how the negotiation phase is characterised);
- e-MRO and Web-based ERP (Enterprise Resource Planning): focus on the creation and approval of purchase requests. E-MRO deals with indirect items (maintenance, repair and operational materials), while the Web-based ERP deals with product-related items (order fulfilment phase);
- e-collaboration: manages the collection and dissemination of purchasing-related information, such as product versions, designs and sales forecasts, available on the purchasing company's website or extranet. This reduces errors and synchronises suppliers with the buyer.

There are, however, several variants of electronic models. According to Costa and Grilo [9], the e-procurement process consists of ten sequential activities covering the entire procurement cycle.

- ex-ante e-evaluation: i.e. the multi-criteria assessment of procurement needs and strategies;
- e-notice: the electronic publication of procurement notices;
- e-submission: the electronic submission of proposals;
- e-decision: the electronic evaluation of proposals, the subsequent communication of the evaluation results with discussion and analysis of the results;
- e-award: the electronic awarding of contracts to suppliers with the best proposals;
- e-ordering: concerning activities that include sending an order document from public buyers to suppliers and the transmission of delivery instructions for ordered goods and services;
- e-invoicing: i.e. the request for payment for goods and services ordered and delivered on agreed terms;
- e-payment: the agreed management of electronic payments and their execution;
- e-contract management: i.e. the use of electronic contract management tools to monitor and improve contract performance and document management;
- ex-post e-evaluation: multi-criteria evaluation of contract performance and generation of KPIs to support future tendering processes.

All these processes should be combined and all relevant information should be available electronically. Only in this way can a reduction of administrative work and the automation of operational processes be achieved [9]. The lack of a standardised or universally recognised framework that brings together all e-procurement variants under one source often makes it difficult to accurately identify all the different types of e-procurement actually used to support the activities of the entire e-procurement process [3]. Despite this, e-procurement can be regarded as a complete "end-to-end" solution that integrates and optimises numerous procurement processes within an organisation [10] in a way that integrates and optimises the numerous procurement-related activities within the organisation [3, 9].

In the AEC sector, e-procurement constitutes a significant innovation that, together with the development of other technologies such as BIM, contributes significantly to the ongoing digitisation process in public procurement. In particular, e-procurement, through the use of telematic platforms and dedicated information systems, enables the dematerialisation and optimisation of transactions related to the acquisition of goods and services. This approach induces the automation of operational workflows and the rationalisation of administrative processes, increasing management efficiency. In parallel, BIM, the use of which is regulated and incentivised both nationally and internationally, is increasingly integrated into public procurement procedures. It should be noted, that in the context of procurement, the use of BIM is currently focused on the creation and management of the digital "model" of the work, rather than as an integrated process management methodology. However, the operational integration between e-procurement platforms and the potential offered by the BIM model opens up new perspectives for the optimisation of procurement processes in the AEC sector. The synergetic integration of these two technological domains can evolve the role of BIM from a simple information support to a dynamic and central management tool in procurement procedures. However, an analysis of the literature and current operational practices in the AEC sector reveals a clear dichotomy in the integration of BIM within public procurement processes. On the one hand, in fact, there is an increasing adoption of the model as an integral component of tender documentation for which contracting authorities define the Employer's Information Requirements (EIR) and modelling criteria that economic operators must comply with (Geometric and Information Development Level, data structuring, to exchange formats); on the other hand, a significant gap emerges in the definition of standardised and integrated operating procedures for the effective use of the BIM model during the course of the procurement process itself. While requirements on the model are specified, there is a lack of established methodological frameworks governing how this model should be actively employed by the parties (contracting authority and bidders) within e-procurement platforms. Consequently, although BIM is present as an information artefact in tenders, its transformative potential on the procurement process remains largely unexpressed often relegating the model to an information support role rather than a central and dynamic tool of the procurement process. A factual response to the above is provided by the 'Report on Digitisation and BIM Tenders 2023' [11]. This document, now in its seventh analytical edition and edited by OICE, censuses the public tenders for Architectural and Engineering Services launched in the period between 1 January and 31 December 2023. The analysis focuses on tenders in which the use of BIM methodologies

is envisaged, aimed at the digital management of all the information related to a project, in the various phases of its life cycle. The processing of the report is based on the data collected by the OICE Tenders Office as part of its daily market monitoring activities, the results of which are published monthly in the OICE/Informatel Observatory. In the years under analysis (2015–2023), the number of tenders for Architectural and Engineering Services referring to BIM showed an overall growing trend. The tenders analysed, in the year 2023, are classified according to the four main modes of reference to BIM, two of which are related to the tender access phase and two to the tender evaluation phase.

With regard to the tender access phase.

- BIM is referred to as part of the evaluation of technical capacity and linked to the tenderer's previous experience;
- BIM is requested as a professional suitability requirement (often under penalty of exclusion), with regard to individual professional figures and linked to the possession of organisational capacities, tools necessary to carry out the required activity and possible BIM certifications.
- While for the tender evaluation phase with MEAT:
- BIM is evaluated as a sub-criterion of the 'professionalism and adequacy of the offer';
- BIM is evaluated as a sub-criterion of the 'methodological characteristics of the offer'.

In addition to these four ways of referring to BIM, a certain number of tenders can be found that refer to a generic request for design in BIM; in these cases BIM is mentioned in generic terms, i.e. as a way of carrying out the service, but without this profile being the subject of a specific score when evaluating the offer, or qualification, as a minimum level for access to the tender [11] (Fig. 2).

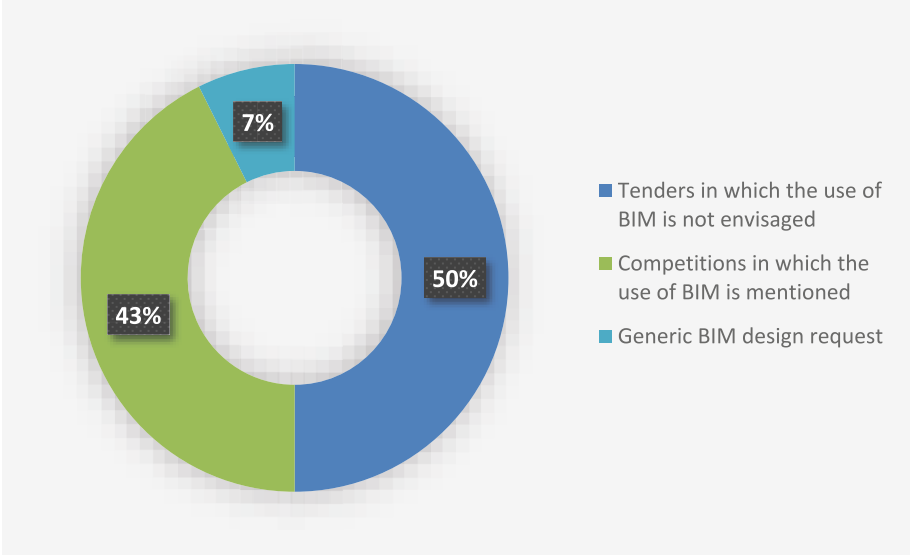

Fig. 2. Graph identifying the percentage of BIM use in tenders carried out in 2023 [11]

As can be seen from the graph, in 2023 only 14.8% of the total mention the use of BIM as a generic way, i.e. without attributing specific scores, but only considering it as a contractual element of the service, registering a decrease compared to 2022. The decrease in the percentage of the total number of notices with 'generic request for design in BIM' shows how contracting authorities are maturing, albeit slowly, a real awareness of the use of BIM, publishing, as a result, detailed notices and comprehensive annexes; in fact, in 29.4% of cases contracting authorities attached the specifications to the notice. Entering more specifically and considering, therefore, what is reported in the tender specifications, sub-classes were identified depending on the type of citation adopted that can be subdivided into two macro-categories: specific reference to BIM (BIM is cited independently regardless of the criteria), non-specific reference to BIM (BIM is cited together with other criteria). These sub-categories are: BIM process management, BIM software, experience of other projects already realised in BIM, and presence of BIM experts in the working group (Fig. 3).

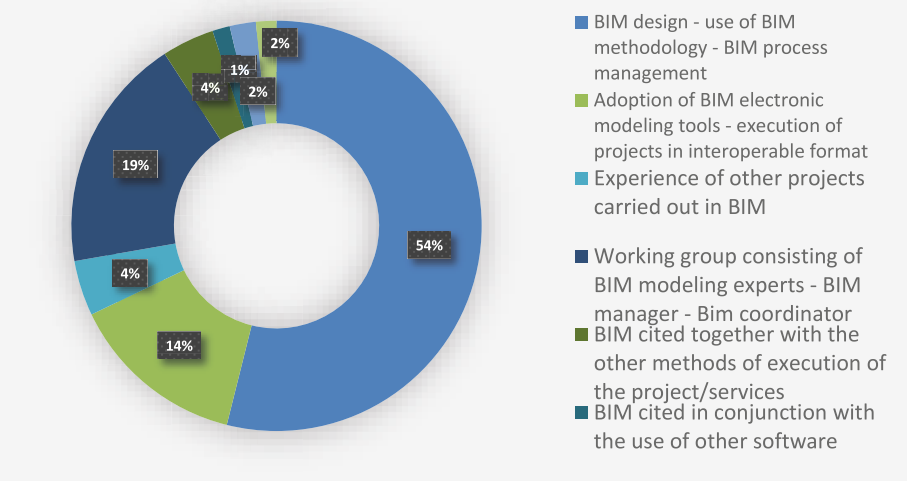

Fig. 3. Identification of subclasses in percentage of use in tenders carried out in 2023 [11]

At the conclusion of the analysis, the empirical evidence provided by the graphical representation below indicates that, although a real awareness of the importance and key role that BIM could play within public procurement is maturing, it is still evident that a proportion of public procurements retain the misconception that the adoption of BIM is merely the use of application tools or is primarily configured as a technical scoring factor in tenders, rather than as a methodological paradigm for the integrated management of the information life cycle of the work (Fig. 4).

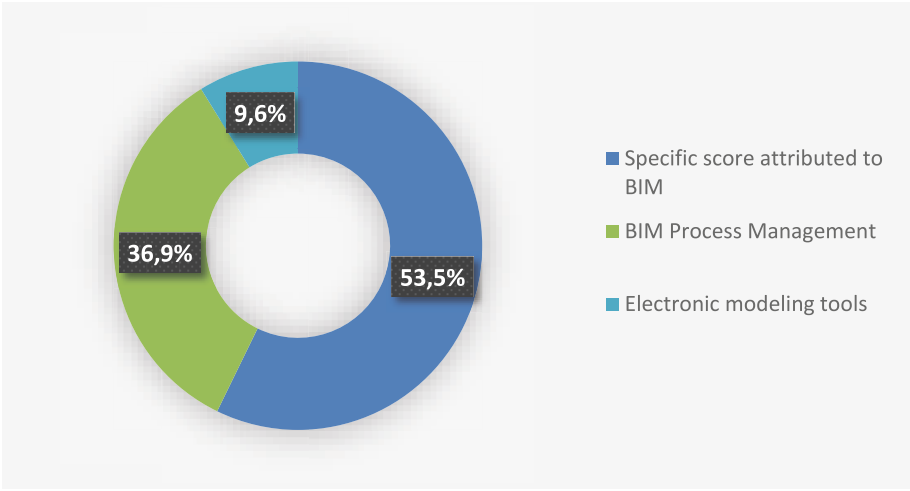

Fig. 4. Graph identifying in percentage the ways of using BIM in the tenders carried out in 2023 [11]

3 State of Art Analysis

The literature review reveals that eProcurement offers several advantages, including process automation that minimises the likelihood of human error, ensures faster delivery times and optimises overall operational efficiency. There is also increased competition among suppliers, as eProcurement systems provide a transparent platform that fosters competition for the award of contracts. Finally, eProcurement enables data-driven decision-making processes, allowing available information to be exploited to improve strategic choices. However, despite these obvious benefits, there are still significant difficulties related to the effective implementation of such procedures within public administrations. These problems are mainly related to inadequate infrastructure, insufficient staff training and resistance to change [13]. Furthermore, as discussed in the previous section, there is a lack of a real link between e-procurement procedures and BIM; although the latter is used as an information artefact in tenders, its transformative potential in the procurement process remains largely unexpressed, often relegating the model to a role of mere information support rather than a central and dynamic tool in the procurement process. As argued by Costa and Grilo [9], the application of BIM in the context of e-procurement is an enabling factor for the optimisation of e-procurement systems, allowing the adoption of more advanced approaches. Moreover, this synergy promotes the development of large electronic and interoperable networks that interact dynamically, enhancing the automation of many operational activities and improving information and knowledge management. In fact, BIM brings to e-procurement the possibility to build, within the various process activities, a more cooperative work between all specialities allowing a more efficient use of resources, a consequent decrease in time and errors due to lack of information and communication [9, 12] and an increase in transparency. With BIM-based e-procurement, information can actually travel more fluidly through the application of the various agents within procurement processes [9]. The

synergy between e-procurement and BIM is, therefore, a strategic solution to address the main issues in public procurement. ANAC data, based on the European TED platform, show, in fact, that Italy has significantly longer procurement times than France, Germany and Spain, both for MEAT (279 days) and lowest price (195 days) contracts [14]. This slowness leads to high costs for both the public administration and businesses, negatively affecting the quality of services. In parallel, the lack of transparency in the procurement system fosters corruption, undermines competition and public trust. E-procurement supported by BIM methodologies digitises and traces the entire procurement lifecycle and, thus, thanks to the increased accessibility of information and the strengthening of stakeholder control, it can contribute to a more efficient, fairer and more accountable system by reducing time and ensuring clearer decision-making processes. In conclusion, the integration of BIM in e-procurement represents a qualitative leap for e-procurement in the AEC sector. It shifts the focus from the simple digital management of documents and procedures to the digital management of integrated and structured project information, thus achieving a more intelligent, accurate, transparent and collaborative procurement process, capable not only of optimising the tendering phase, but also of laying the foundations for a more efficient management of the entire life cycle of the built work.

4 Methodological Proposal and Case Study

In the context of a public procurement procedure aimed at awarding a contract for the provision of services and/or the execution of works for the realisation of a construction project, the award phase represents a crucial moment. In particular, the choice of the winning economic operator is based on the evaluation of the tenders submitted, through which the participants propose solutions to meet the needs expressed by the public administration. In the European context, public procurement legal regimes allow for two basic types of tender selection criteria, namely the lowest price criterion and the MEAT. In particular, according to the provisions of the 2014 EU Public Procurement Directives, the MEAT is the overriding criterion, although it should be noted that it is often possible to select the tender based on its price alone [15]. The decision to make MEAT the priority criterion is linked to the fact that it does not evaluate the offer only on the basis of its price, but emphasises best value for money by taking into account different aspects, such as quality, environmental and social factors, life-cycle costs and innovation [16]. MEAT, therefore, does not only consider price, but takes into account a plurality of elements, shifting the focus from mere cost minimisation to a broader and more articulated evaluation, which allows for an analysis of the economic operator's ability to meet the entity's specific needs. Given its characteristics, the MEAT requires an evaluation process that is based on clear, transparent and objective criteria, allowing for an objective comparison between the different offers and the selection of the one that offers the best overall value. In this regard, the precise definition of evaluation criteria and their weighting is a crucial aspect for the success of the MEAT: these criteria must be relevant to the subject matter of the contract, measurable and verifiable in order to ensure a transparent and objective evaluation. Consequently, the public authority is obliged to specify the evaluation criteria in detail in the tender notice, together with the method of

tender evaluation based on these criteria. Otherwise, the lack of clear and precise criteria risks undermining the validity of the entire selection process, opening the way to possible disputes by economic operators participating in the tender procedure. Therefore, a correct application of the MEAT requires a strong commitment on the part of contracting authorities to define transparent and objective evaluation criteria and to conduct a rigorous and impartial evaluation process that is able to ensure that the final choice of tender is indeed the economically most advantageous one. In this context, BIM fits in as a potentially very useful tool to make this procedure faster and more transparent. By exploiting the parametric nature of BIM, the authors of this study identify the possibility of implementing the MEAT tender procedure in an automated manner. In particular, the parametric nature of BIM would allow the criteria defined by the contracting authority to be translated into parameters that can be modified and managed directly within the BIM model. To this end, a methodological proposal has been developed and is currently being validated through a case study simulating an "integrated tender" procedure (joint awarding of executive design and works), as defined by Italian law. The objective of this methodology is to parameterise those criteria that are objective and quantifiable, allowing the management of tender evaluation to be increasingly automated and transparent. However, it is emphasised that at this stage there is still the possibility of attaching supplementary supporting documentation through which the economic operator can submit its offer relating to those criteria that cannot be parameterised and which therefore still require an ad hoc evaluation by the examining commission. By way of example, the performance of systems or even thermal, acoustic and energy performance of the building envelope can be counted among the parameterisable criteria (Table 1.). On the contrary, solutions proposed by tradesmen to deal with the logistical criticalities inherent in site management, particularly in complex and constrained urban contexts such as historic city centres, are examples of evaluation elements which, at present, hardly lend themselves to parameterisation.

The proposed methodological framework, which entails the integration of Building Information Modelling (BIM) within the public procurement process, is structured according to a workflow illustrated in Fig. 5. Specifically, the methodology is articulated into five phases and involves two categories of stakeholders: the contracting authority, responsible for drafting and publishing the tender notice as well as evaluating the submitted proposals, and the economic operators, who participate in the tender by submitting their bids.

Phase I: Creation of the BIM Model. This phase, entirely under the responsibility of the contracting authority, entails the digitalisation of the procurement object. The public administration undertakes the development of a parametric BIM model of the building, consistent with the content of the previously developed technical and economic feasibility project. The BIM model must be produced or converted into an open format such as IFC, in order to ensure interoperability with various BIM software solutions. This facilitates communication within the design team and enables a broad range of economic operators to participate, regardless of the technological tools they employ. It is important to highlight that this digitalisation phase includes the translation of evaluation criteria and sub-criteria—intended for use in the tendering process—into parameters and properties of the BIM model elements.

Table 1. Example of parameterizable criteria.

Criterion	Description	Translation of the criterion into parameters
Technological solutions for windows and doors	Improvement proposals aimed at improving window and door frames, with reference to thermal-acoustic and environmental characteristics	Thermal transmittance of glass Thermal transmittance of the frame Thermal transmittance of the window Solar factor Air permeability Sound absorbing power
Technological solutions for insulating materials and wall finishes	Proposals aimed at improving insulating and finishing materials, in relation to their technical, energy and environmental characteristics	Thermal conductivity Thermal transmittance Phase shift and attenuation factor Sound absorbing power

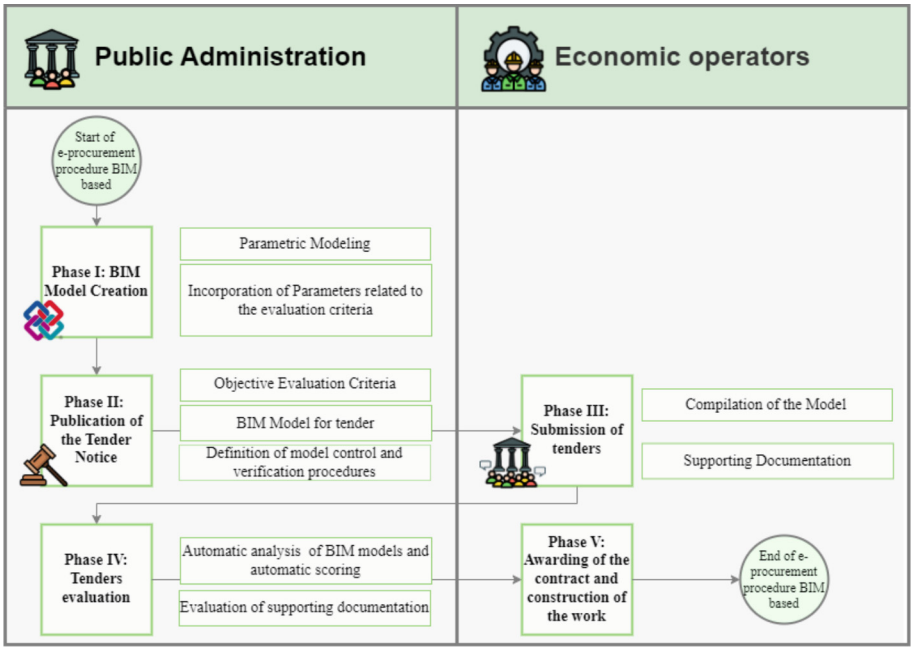

Fig. 5. Workflow of the methodological proposal – public e-procurement with MEAT award criterion, BIM-supported procedure.

Phase II: Drafting and Publication of the Tender Notice. In this phase, the public administration formalises and publishes the requirements and procedures governing the

procurement process. Among the documents provided to the economic operators are: the information specification, the bid evaluation matrix, and the BIM model. The information specification outlines the information requirements of the BIM model and defines the methodologies that the contracting authority intends to employ to verify the compliance and quality of the models submitted by the bidders.

The evaluation matrix must include the criteria and sub-criteria, along with the corresponding scores, that the contracting authority plans to adopt for assessing the bids. It is essential that the selection of these criteria prioritises quantifiable and measurable aspects, avoiding subjective or ambiguous elements. An innovative aspect of this methodological proposal lies in the use of the BIM model as part of the tender documentation: the model created by the contracting authority is provided to all competitors, ensuring that all economic operators begin with the same level of information and allowing each to develop their proposals based on a shared reference model.

Phase III: Submission of Bids. In this phase, economic operators translate their proposals into data within the provided BIM model. Participating firms complete the editable parameters within the model, entering information related to their technical offers. It is crucial at this stage to ensure that the model is completed in accordance with the standards set out in the information specification. Moreover, bidders are required to supplement the BIM model with supporting technical documentation. This documentation serves both to justify and explain the proposed technical solutions implemented within the model, and to provide information related to aspects of the proposal that, by their nature, cannot be directly parameterised within the BIM environment.

Phase IV: Evaluation of Bids. This phase—traditionally time-consuming and resource-intensive, and often subject to the subjectivity of the evaluation committee—is significantly simplified and made more transparent through the use of BIM. The evaluation committee is tasked with verifying that the BIM models submitted by the bidders comply with the requirements outlined in the information specification, ensuring adherence to the standards defined by the contracting authority. In particular, using specific tools with Model Checking capabilities, the committee assesses the consistency and completeness of the information contained in the BIM models, identifying any errors, inconsistencies or omissions. At this stage, dedicated software is employed to automatically assign scores based on the values of predefined parameters, thereby ensuring an objective and transparent evaluation process and reducing the risk of errors or partiality. In this way, the BIM model becomes a key instrument in the tender procedure for the assessment of bids.

Phase V: Contract Award and Execution of the Works. The award of the contract to the economic operator achieving the highest score marks the beginning of the execution phase. In the case of integrated procurement, this includes both the detailed design and the actual construction of the project. It is important to note that the BIM methodology continues to play a crucial role during the construction phase, serving as a tool for the management of monitoring information. It allows for the tracking of changes, the management of design variations, and the monitoring of costs and timelines.

5 Conclusions and Future Development

The public procurement sector is faced with significant challenges such as excessively long procurement times and lack of transparency in decision-making processes, therefore, a change is needed to modify the current instruments and push towards the adoption of innovative technologies and methodologies. The methodological proposal presented here, which sees the interaction between BIM and e-procurement, stands as a concrete answer to the problems encountered. However, the success of this integration depends on accurate implementation and a deep understanding of the potential offered by each technology; it is essential to precisely identify the evaluation criteria, which can be very variable and range from purely technical aspects (such as the building's energy performance and the characteristics of the materials used) to more complex elements (such as environmental sustainability and technological innovation), and parameterise them so that they can be managed within the model. Once parameterisable criteria have been defined, it is necessary to develop automated techniques for reading, checking and scoring them. In this context, current traditional Model Checking systems, while remaining useful for verifying the conformity of the BIM model, may prove insufficient to handle the complexity and variety of information to be evaluated. This may require the use of advanced programming tools, such as Python, which, due to its flexibility and powerful data analysis libraries, can be used to automatically extract relevant information from the BIM model and transform it into structured data, and artificial intelligence and machine learning techniques, which allow for analysing large amounts of data from tenders by identifying significant anomalies potentially invisible to traditional manual analysis. Furthermore, machine learning algorithms could be trained to automatically evaluate bids by reducing the risk of errors and subjective influences. Therefore, in order to validate the methodological proposal and demonstrate its effectiveness, the authors of the article propose to develop a series of case studies on real projects in order to test the integration of BIM, e-procurement and advanced analysis technologies in real-life contexts, so as to identify strengths and weaknesses of the methodology. Particular attention will be paid to the identification of the most suitable parameterizable criteria for the automated evaluation of tenders and to the development of automated analysis and scoring techniques. The expected impact is a reduction in awarding times, an increase in transparency and the guarantee of higher quality of works and services, thus offering concrete benefits for public administration and thus, demonstrating a transformation in public procurement with this methodology.

References

1. Issa, R.R.A., Flood, I., Caglasin, G.: A survey of e-business implementation in the US construction industry. ITcon **8**, 15–28 (2003). https://www.itcon.org/2003/2
2. Grilo, A., Jardim-Goncalves, R.: Challenging electronic procurement in the AEC sector: BIM-based integrated perspective. Autom. Constr. **20**, 107–114 (2011). https://doi.org/10.1016/j.autcon.2010.09.008
3. Chan, A.P.C., Owusu, E.K.: Evolution of electronic procurement: contemporary review of adoption and implementation strategies. Buildings **12**, 198 (2022). https://doi.org/10.3390/buildings12020198

4. Owusu, E.K., Chan, A.P., Ameyaw, E.: Toward a cleaner project procurement: Evaluation of construction projects' vulnerability to corruption in developing countries. J. Clean. Prod. **216**, 394–407 (2019). https://doi.org/10.1016/j.jclepro.2019.01.124
5. Ruparathna, R., Hewage, K.: Sustainable procurement in the Canadian construction industry: current practices, drivers and opportunities. J. Clean. Prod. **109**, 305–314 (2015). https://doi.org/10.1016/j.jclepro.2015.07.007
6. Subramaniam, C., Shaw, M.: The effects of process characteristics on the value of B2B e-procurement, Information Technology and Management, pp. 161–180. Khuver Academic Publishers (2004). https://doi.org/10.1023/B:ITEM.0000008080.17926.2b
7. de Boer, L., Harink, J.H.A. Heijboer, G.J.: A model for assessing the impact of electronic procurement forms. In: Proceedings of the 10th International Annual IPSERA Conference, 8 - 11 April 2001, pp. 119–130. Jonkoping, Sweden (2001)
8. Knudsen, D.: Aligning corporate strategy, procurement strategy and e-procurement tools. Int. J. Phys. Distrib. Logist. Manag. **33**, 720–734 (2003)
9. Costa, A.A.; Grilo, A.: BIM-based e-procurement: An innovative approach to construction e-procurement. Sci. World J. 1–15 (2015)
10. Vaidya, K., Sajeev, A.M., Callendar, G.: Critical factors that influence e-procurement implementation success in the public sector. J. Public Procure. **6**, 70–99 (2006)
11. Report OICE sulla digitalizzazione e sulle gare BIM 2023, OICE. https://www.oice.it/849794/2024-oice-7-rapporto-sulla-digitalizzazione-e-gare-bim
12. Grilo, A., Jardim-Goncalves, R.: Value proposition on interoperability of BIM and collaborative working environments. Autom. Construct. **19**(5), 522–530 (2010). https://doi.org/10.1016/j.autcon.2009.11.003
13. Egwim, P., Dike, B., Nmecha, M.: Adapting the e-procurement process from the private and public sector: a comprehensive overview, vol. 1, pp. 1–15. https://doi.org/10.5281/zenodo.13929696
14. Analisi dei tempi di aggiudicazione degli appalti in Italia e in Europa sulla base dei dati TED, ANAC. https://www.anticorruzione.it/-/analisi-dei-tempi-di-aggiudicazione-degli-appalti-in-italia-e-in-europa-sulla-base-dei-dati-ted-1-ottobre-2024
15. Sebastian, B., Jan, G., Monika, P., Wojciech, S.: The most economically advantageous tender in the public procurement system in the european union. In: Bilgin, M., Danis, H., Karabulut, G., Gözgor, G. (eds.) Eurasian Economic Perspectives. Eurasian Studies in Business and Economics, vol. 12/1. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-35040-6_26
16. PUBLIC PROCUREMENT CONTRACTS. Fact Sheets on the European Union (2025). www.europarl.europa.eu/factsheets/en