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Developing Buildings Permits Systems Platforms (BPSP) for driving change to introduce GeoBIM potentials, challenges, and opportunities: The Case of Saudi municipalities

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Abstract

Urban growth requires development in tools and applications to manage achieving the strategic vision of cities with clear smart policies, which is challenging to achieve with traditional methods. Therefore, the importance of adopting integrated technologies like BIM, GIS, and GeoBIM is becoming essential and beneficial. Many countries have developed using such technologies to enhance the performance of Building Permits Systems (BPS). The need to build a system that unifies practices, standards, and protocols within one place in a manageable platform enhances the performance of BPS. Therefore, the aim is to assess the capabilities of implementing GeoBIM in Saudi BPSP municipalities for developing procedures and workflows and to define the potentials and barriers of change in systems. Therefore, this research focused on developing existing systems with semi-structured interviews to evaluate the capabilities and workflows for adopting GeoBIM in the Riyadh, Jeddah, and Mecca municipalities. In conclusion, the research results include 21 factors of GeoBIM implementation that initiate a foundation for further studies, which fulfil the gaps in such study areas.

Keywords: Building permits system, GeoBIM, Jeddah, data, Workflow

1. Introduction

Urban growth has been increasing rapidly in many Saudi cities, causing the need for urban planning systems, management, and control for comprehensive solutions that allow for the management of growth to achieve visions and control challenges of the country's structural planning to the local master plans [1]. The city challenges are developing systems with respect to some of the policies and regulations within the building permitting cycle or among decision-makers, and informing clients about their permit states that are long and fragmented. Additionally, many architectural firms have enhanced their capabilities to obligate municipality regulations, such as new stetting setbacks, heights, parking counts, and inspections before submittals [2]. Conversely, the roles of crosschecking the requirements by regulators of the municipalities on systems cause a waste of time and effort and jeopardize the output's quality. Therefore, many municipalities moved toward digitizing from top management, and cascading is essential for better city management and control in the sectors [3]. Ambitious countries, such as Saudi Arabia, can enhance country management by setting the vision of 2030 and launching programs that change country shapes by building specialized and complex buildings and adopting new technologies to thrive in the economy [4]. The possible challenges on the technical, organizational, and process scales in the public and private sectors are varied. Nevertheless, the traditional performance for managing the design, supervision, execution, and operations is considered poor in the automated systems cases and with time factors issues [5].

The study highlights the importance of finding solutions based on the literature showing the need to develop methods for adopting integrated platforms to perform better in data management and benefit such approaches in the city's management and defeat dilemmas of change in the social, technical, and organizational aspects in building permits releases, as the literature requires the investigation of GeoBIM adoption within local industries [6].

Hence, one of the municipalities' roles include the management, monitoring, and governing projects within the city with high performance and effective management, which are essential to achieving the countries' strategic objectives. However, some

countries have highlighted the importance of developing a framework in different environments to adapt workflows and explore the challenges and opportunities among different systems, as the lack of research for GeoBIM data management defines the need for such research to allow the city to cope with change demands within the city and similar cases around the country [7]. Saudi cities are growth contestants, and struggles to adopt new systems exist. However, significant developments in giga and mega projects, infrastructure development, and initiatives were announced as part of the 2030 vision for enhancing the quality of life in many cities by facilitating sport, entertainment, and public transportation that would be governed by various ministries and local municipalities [8]. Hence, the research aims are as follows:

- To measure the applicability for implementation of GeoBIM in PBSP

- To define the barriers and potentials for changing PBSP to GeoBIM

The research question explores the capabilities of effectively integrating building permit systems with GeoBIM. Additionally, what factors facilitate the basis for implementing GeoBIM within BPSP? The evaluation processes for Saudi municipalities shall identify the possible barriers and potentials for using integrated solutions in city management.

2. Literature review

2.1 Global GeoBIM

The integration of technologies is essential for the development of performance from the building to city scale with technologies such as GeoBIM. However, the existing data shall be automated to avoid waste of information as duplication, recreation, or non-sharing due to the lost and benefit technologies, with integrating clients of both the private and public sectors to allow permitting processes [5]. Therefore, duplication in information is generated because of fragmented departments losing data due to missing protocols, procedures, and standards for managing BIM sections [9]. Information shall serve the vision in a consistent cycle; however, there is a lack of understanding about the ability to manage information and the ability to regenerate data for better decision-making. Hence, there is a need for systems with reliable data for organizational plans and frameworks that follow the established standards and fit the challenges due to the lack of qualifications or knowledge in new technology best practices [10].

2.1.1 GeoBIM adoption

Researchers across the globe have raised the integration of GIS with BIM for benefiting the capabilities of each world, which shows a technical achievement in standardizing the process and modeling, and have developed a dataset and implementation plans among systems with many applications within local industries [10]. Additionally, a set of papers published in 2019 at the GeoBIM managerial and technical components and developed the benefits levels to examine the shadow, energy analysis and the abilities to benefit from outdoor to indoor environments [11].

Nevertheless, the GeoBIM models data performance examining the geometry, interoperability, and semantics mentioned in research and represents a critical factor in adopting GeoBIM beyond 2D planning, allowing the research field to investigate the opportunities to develop under-construction projects, helping the supervision, safety and health of the city [12]. Building permits have potential in research conducted in the processes oriented to experiment with actual BIM models in mandated BIM countries and pilot projects with possibilities of linking E-Systems, as shown in Table 1 below. Nevertheless, data governance can contribute to the comprehensive development and management of working execution plans and project supervision due to systematic processes. It can lead to the regulation of essential policies, best practices, delivery plans and programs associated with the control and protection of data values and information assets.

Table 1
GeoBIM linking to the E-system within BPS

GeoBIM Challenge	Building Permits release E-system
Server connecting	There is connectivity in the system allowing code checking
Data conversion	The data allows clear and no duplications or unclassified data
Perfect BIM models exist in academia only	There are abilities to read different formats of data
N/A	The processes support the integration among different data
Data semantics	The references of the GIS are accurate to the land permits coordinates
N/A	The data are flexible in the management local and online environment
Data harmonization	The used layers are helpful in code checking
Georeferencing	There is linking with Information technology to connect with GIS
Little Knowledge	The workers have the capabilities to manage E-Systems
Lack of standards	Code checking standards are digitized and clear to be followed
N/A	Limited human interference for final checking
Develop educational courses	There are clear procedures with the updates in the system
Practice-oriented conferences	N/A
N/A	Integrating offices is beneficial
Develop software/plug-in	The connectivity among the departments is high
Laws and regulations guiding	There is property management integration to the e-system for GIS management
Involvement of stakeholders	The compliance of regulations allows stakeholders to exchange data
Developing data	The use of IoT to reform and recommend policies and regulatory changes

Developing procedures	Legislators have a platform of the needed procedures to be enhanced
Data management practices	The dataflow is explicit and updateable for all stakeholders with their insight to enhance
Define software version	There is flexibility to use different software

2.1.2 GeoBIM challenges

The research investigating the literature that developed GeoBIM across building industries has shown difficulty in increasing awareness of developing the workflow of the existing systems and procedures for adopting GeoBIM and the necessity of technical implementation. Additionally, the development of permit systems using BIM as part of the integration is recommended [7]. Integrating the departments within the BPSP requires a connected server to provide comprehensive land and building legislation within the same location with smooth data conversion and maintain the importance of the details within the GeoBIM model and in the harmonization within the system [13].

However, some literature has mentioned a perfect model only in academic environments and calls for improving the knowledge and laws to integrate within municipalities. There are many challenges in both GeoBIM and E-systems, which shall be enhanced within the current system to prepare for changes in the GeoBIM applications.

2.2 Building Permit System (BPS)

The Building Permit System (BPS) regulates the building processes within cities to set up requirements to manage building shapes and growth of the required policies with globalization increasing as well as the exposure to cities' traditional practices in checking codes, building floor plan areas, built-up areas, and legislations with governmental bodies, which should be developed [14].

2.2.1 Traditional practices

The continuous development of the existing regulations and policies for land use, building heights, and planning dilemmas of plan implementation are considered hectic in management by governmental bodies that have not changed or developed, creating challenges between the architecture, engineering, and construction entities (AEC), as well as city planning and regulating committees. Moreover, the traditional process for permit release has a human-dependent manual process of crosschecking documents, drawings, and releases based on governmental regulations and standards in three phases starting from design, submission, and permitting, which leads to defects in integrating successful BPSs [15].

The government systems style affects the PBS, as [16] has declared that the centralization in managing a city causes poor performance due to bureaucrats making the decisions, as in the case of the discussion of a centralized management model, where the municipality mayor mainly governs the processes and there are centralizations in giving authorizations. Many countries have adopted automated code checking systems to reduce time and fatal mistakes, and the change to adopt new methods takes a sequential approach. According to [17], the steps for implementing a change in the local government start with assessment needs, system design, system implementation, building and integration,

Additionally, [18] mentioned that the transformation for information technology (IT) within a fragmented government requires a framework based on an evaluation. Moreover, Saudi municipalities are fragmented and not connected to an efficient system. Considering the elements of developing the entities, the municipality shall define the municipal business function, consider the organizational structure and hierarchy, and prioritize the overall objectives.

2.2.2 The E-systems

Developing the BPS to adopt an integrated approach allows the municipality to understand the most critical applications needed to adopt new technologies on an urban scale for city management. Additionally, to change the traditional system from manual regulation checking by an engineer to the e-system of finding the need for automation in code checking, submission system, prechecking models and more features. [19] Therefore, transformation for adopting advanced technologies highlights the need for assessment related to used technology and workers expectations. We propose an approach for data modeling for the existing computer infrastructures from available data and allow an effective data exchange. Finally, an implementation plan with the required resources and prioritization for successful integration delivery was developed [20].

According to [21], there is the potential to visualize the data and processes within GIS systems, BIM models, and advanced technologies to change the nature of work and allow the management of segregated departments for adopting enhanced processes. The traditional permitting process issues rely on the management of the paper bases for submission and manual code checking. On the other hand, the E-Systems within the BPS are diverse between the e-submission, e-checking, and e-release for and automated checking and releasing within the institution with central authorization based on management structures [22].

The management of organizations' databases as municipalities follows the procedure of each role to develop collaboration among departments to benefit E-Systems, from project procurements to land management. Therefore, there shall be a comprehensive solution for future change with integration plans for moving to the smoother permitting phases based on the automated checking allows for the validation of decisions.

2.3 Saudi Municipality workflows

The vision of national planning is one of the responsibilities of the Ministry of Municipal and Rural Affairs (MOMRA), which was founded in 1975, and aims to plan the kingdom with the Ministry of Economics and Planning (MOEP), preparing a framework of five-year development plans for the Kingdom [23]. The responsibilities of MOMRA extend from the formulation of the city strategic planning and the required policies and implementation in cities on many levels to strategic country planning to provenance structural planning to the approval of cites master planning.

Managing the development and growth of cities and implementing policies and regulations requires a framework and regulations to prevent Saudi municipalities' management complications [24]. The vision of 2030 has requested many additional aspects to be covered to enhance the quality of life, digitize government, provide housing, and achieve sustainable development by establishing programs, and initiatives to reform the country to achieve extended strategic plans launched in 2016 to 2030 [4].

2.3.1 Saudi MOMRA to municipalities

Procedures exist in traditional planning and city management for the growth and limitations of urban sprawl, as the system allows delegations of MOMRA minister tasks to mayors of the municipalities. Therefore, legislation and policies of management and planning within cities governed by municipalities, beyond the suburban areas in connecting between cities, rely on MOMRA to manage the links in roads and enroll other related governmental bodies [25].

Additionally, there are demands for housing projects [26] due to urban growth and the expansion of cities; as part of a program by the ministry to manage housing processes, partnerships with the private sector have been established. There were trails in the housing and real estate sector within cities that are part of MOMRA roles to govern for many agencies by building permits systems for investors and individuals' systems via municipalities. Residential building permitting was conducted in the digitizing processes by the e-system following a new workflow, as Table 2 shows the platform's processes for investors and individuals.

Table 2
MOMRA platform processes

Investor's system	individual system
Contracting with Architectural office	Clients select the architecture office
Architectural office request permit	Architectural office approves client request
Sub-municipality review the request	Meeting client for design
Municipality check the request	Architectural Office to Municipality
Request site inspections	Contractor and assurances
Notify of ending Archi finishes stage	Architectural office supervision

There is a common legislation between MOMRA, municipality, and courts on different hierarchies showing the importance of aligning processes, decisions, and documentation within precise data management and finding a common platform to sharpen the vision for all stakeholders. Hence, Jeddah municipality has developed an e-submission system for automated checking of architectural offices to submit permit requests, which has led to sub-municipalities taking over the roles of launching building permits by creating a central system and delegated on-site inspections [27].

Therefore, the role of submitting reports and approving construction practices in commissioning cityscapes are based on dedicated districts. Nevertheless, the city management's implementation and supervision are considered one of the most critical areas, as Saudi cities are governed by sub-municipalities that are responsible for city monitoring, performance and reporting the levels of compliance by contractors.

2.3.2 Saudi Building Code National Committee

The need to regulate the standards and the building codes within Saudi cities has been one of the MOMRA aims for an extended period. The Saudi Building Code National Committee was established in 1997 based on the demands to standardize the processes of design, building, supervision, and building operations [28, 29].

The government of Saudi Arabia mandated the implementation of the Saudi Building Codes (SBC) within five stages, starting with public governmental projects, high-rise buildings above 23 m, and special projects, such as hospitals and hotels, as the first stage. The second stage includes adding the gathering buildings, such as mosques, sports buildings, educational structures, malls, telecommunication towers, industrial heights less than 23 m, and hazardous buildings. The third stage adds more gathering buildings, such as wedding halls, cinemas, theatres, health care buildings, apartments, hotels, residential buildings, motels, and entertainment buildings. Hence, the fourth stage adds business buildings (airports, banks, and television buildings), and the fifth stage includes all buildings. Nevertheless, there are sociotechnical challenges in implementing the SBC due to a lack of training, enforcement of implementation and language, public awareness, and offices promoting benefits [30]. There is potential in developing platforms for visualization and the automated checking features, as well as possibilities to promote benefits for workers.

3. Methodology

The research methodology included a literature review about integrating GeoBIM and the Saudi workflows within the BPS with semi-structured

interviews to research the aim of measuring the applicability for the implementation of GeoBIM in PBSP and define the barriers and potentials in adopting GeoBIM.

Data collection took the form of literature reviews of GeoBIM processes, Saudi MOMRA procedures and workflows, and the local PBSP within municipalities for developing the traditional systems by forming questions to outline the adoption capabilities and the dilemmas due to disconnectivity between the legislators within the municipality to the sub-municipality buildings. The structure of questions explored technological qualifications and institutional components linked within E-Systems. As shown in the literature, the importance of finding solutions to the challenges of GeoBIM and to identify the local workflow to define the applicability of integrated management. To assure the insight of the adoption in weighing the essential factors, semi-structured interviews highlighted the municipalities and sub-municipalities, the barriers, challenges, and potentials for the transformation to adopt the GeoBIM processes within their entities. Interviews also highlighted the influential factors of the adoption and the potentials and barriers to GoeBIM transformation.

A data analysis was conducted for the literature review in the field of BPSP applications over layers of the current Saudi workflow, identifying the current practices and the quality of technology, qualifications, and the organization's procedures compared to the global E-Systems that comply with BIM integration. The review will build from an assessment forum of semi-structured interviews to measure the applicability of GeoBIM within Saudi municipalities to reduce the amount of information waste for optimum BPSP management. The semi-structured interviews targeted all workers within the Building Permits department at the Jeddah, Riyadh, and Mecca municipalities. Therefore, the interviews showed the respondents' insights on possibilities based on the mentioned bases. The five permit-releasing engineers from different ranks and roles, as well as respondents, are shown in Table 3 below. The selected sample shows a range of engineers with different experiences and years of practice to lead the change.

Table 2
MOMRA platform processes

Information	R1	R2	R3	R4	R5
Location	Mecca	Mecca	Jeddah	Riyadh	Mecca
Experience *(years)*	5	4	9	4	4
Job Title	Head of technical department	Permit releasing manger	Employ	Employ	Employ
Roles	Managing the Technical departments	Supervision of Permits releasing	Submission manager	Management of uses and codes	Releasing permits engineer
BIM work experience	No	No	No	Yes	No
GIS Work experience	No	Yes	No	No	Yes

The demographics showed the years of experience that can develop GeoBIM adoption. Additionally, it allows finding the potentials and barriers for integrating GeoBIM and facilitating the creation as a foundation for integrating the BPSP for GeoBIM to enhance the system for future studies.

4. Results and analysis

The research aimed to measure the applicability of the implementation of GeoBIM approaches within the PBSP by finding the barriers and potentials for changing PBSP to GeoBIM. The primary data found from the research methodology shed light on critical areas for GeoBIM adoption

4.1 The workflow of Saudi municipality

The workflows in permitting and releasing building licenses focus on delivering clients rights in an appropriate amount of time inaccessible system possible for both the government and people. Therefore, using an e-system is essential to preserve the quality of buildings in general and land parameters in specific weather in 2D or 3D forms; without developed permitting channels, the process will not be successful. Therefore, the development for the BPSP to adopt the GeoBIM workflow upon research literature review found that the electronic process in permitting and licensing is globally functional, as it allows minimal interference with engineers manual checking, includes fewer mistake margins, and consumes less time.

The e-process enabled Jeddah city to reach the GeoBIM stage in permitting license, due to the same factor other cities with less ability to generate the e-process, as they are enabled to reach the GeoBIM stage resulting in a more developed outlet allowing further potential in using the data. The permit engineers' officials mentioned that there is fragmentation among the workers and differentiation in the levels of work. Fig. 1 shows a different workflow of BPS among municipalities in the use of the E-Systems. Additionally, it illustrates the movement on the scales of the E-Systems from submission, checking to release to build in-depth the process and the readiness for adopting GeoBIM within the BPS to enhance Saudi municipalities' performance. Therefore, the importance of measuring the technology, qualifications of workers, and institution shall link between the mentioned categories was conducted to understand the possibility of GeoBIM governance to the existing practices and workflows.

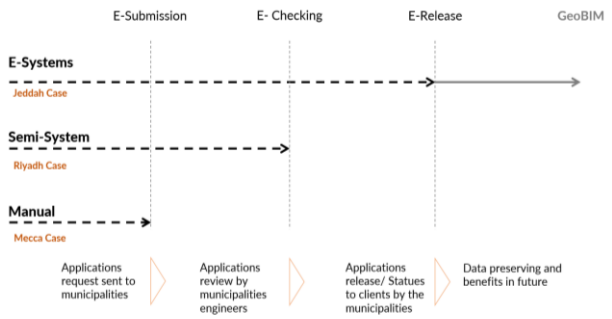

Figure 1
Saudi municipalities BPS

4.2 GeoBIM integration barriers and potentials

The review classified the integration processes into the three main categories shown in Fig. 2, starting from the institution's readiness to change. The worker's qualifications drive the change and the takeover of the leadership build the third category, including the technological infrastructure.

Such classification allowed finding the critical barriers and potentials for integration. The reviews have shown more potential to adopt the GeoBIM within BIM cultural industries or even the E-Systems to manage the effective transformation. Therefore, the system based on the comparison to the other cities shows more potential and fewer barriers for the municipality of Jeddah to move toward the implementation of GeoBIM.

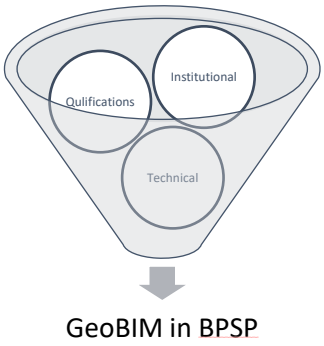

Figure 2
Classification of GeoBIM integration factors

4.2.1 Technical

There are main technical aspects for GeoBIM linked to existing systems to examine the connectivity among servers to facilitate GeoBIM adoption. Additionally, there is a need for consistent automation of codes and legislation to facilitate an automated checking system for GeoBIM. Nevertheless, the data conversion set prevents the high storage areas from duplications and unclassified data and helps develop CAD/BIM practices in drafting or modeling readable data across systems c.

Regarding the data, semantics is a critical factor in referencing data on the network in both GeoBIM and E-Systems within the Common Data Environment (CDE). The harmonization of data and the order are essential in both CAD/BIM to benefit the data and to maintain georeferencing of the model in the local GIS platform, as shown in Table 4. The mentioned aspects connect the GeoBIM to PBSP.

Table 4
Technical GeoBIM integration factors

GeoBIM Challenge	PB release E-system	GeoBIM factors
Server connecting	There is connectivity in the system allowing code checking	E-system allows more than one code-engineer for data editing at the same time
Data conversion	The data is clear and has no duplications or unclassified data	There are technical challenges in creating, sorting, modifying, or removing data from the system
Perfect BIM models exist in academia only	There is an ability to read different formats of data	The platform is flexible in accepting data in many formats with no loss of data or disorders
N/A	The process supports the integration among different data	There are clear guidelines that allow integrating new technologies like BIM, or GeoBIM
Data semantics	The references of the GIS are accurate to the Kroki coordinates	The coordinate reference systems are accurate and prevent change orders from designing offices
N/A	The data are fixable in the management of the local and online environment	The data management is flexible and efficient between local and online uses
Data harmonizatio n	The used layers are useful and prevent code checking	The standardized CAD layering works effectively and lays the foundation for further development
Georeferenci ng	There is linking with Information technology to connect with GIS	The linking of data of land existing-states with land regulations can be beneficial to insight in the building permit-release

4.2.1.1 Technical Barriers

The main barriers are based on the respondent's reflection on the lack of connectivity to the GIS servers with no consistent updates for the system imagery, layer, and legislations for decision-making. Some have required the benefit of linking databases to prevent fatal code checking engineers' mistakes by building the datasets for auto checking. Nevertheless, there is a lack of technical leaders to change and develop protocols, standards, and visual legislation to effectively manage the system and to lay the foundation for digitizing codes and policies.

Hence, an effective and capable manager allows for smooth authorization and work processes, such as linking external devices rather than rely on IT departments. Nevertheless, the system is separate with no integrations with the main legislation databases leading to issues in working with the regulatory updates done by decision-makers for internal employees. Some respondents highlighted challenges communicating the new regulations to clients due to the lack of understanding about the changes made and recommending building a clear platform that shows such information to the public.

As a result of the connectivity, one respondent mentioned the need to speed up workflow between decisions made about designs between the municipality's engineer and architectural office in informing the clients if the project is approved, needs to be resubmitted for minor redesign, or rejected.

4.2.1.1 Technical Potential

There are minor potentials and requirements for developing the system to adopt new technologies, as some departments are preparing to transform for automated code-checking practices and update the legislations of work to be integrated within the system.

Additionally, some have highlighted the importance of changing the roles of engineers to work with new processes and maintain minimal human interactions to reduce time waste. Others mentioned the importance of allowing clients to integrate with the system.

Respondent has mentioned the effectiveness of archiving adoption and the capabilities to rely on the existing system with enhancements to manage the duplication of documents uploading and submissions.

4.2.2 Qualifications

Qualified workers are employed with the E-Systems in many aspects, as shown in Table 5, from checking codes, managing systems, and coping with the update for preparedness to familiarize themselves with such practices and develop GeoBIM knowledge. Additionally, essential standards for workers moved from SBC to compliance with the e-system and was digitized. This allowance gives space for GeoBIM to digitize the codes and allow for checking standards within PBSP for limiting human interferences from manual checking to empower the automated checking of GeoBIM factors, which highly prevent human interface.

Moreover, developing educational training along with the existing procedures and updates in PBSP systems provide further clarity in the procedure, which allows for the development of training programs for workers from the existing practice, as well as effective change toward GeoBIM. The practice-oriented conference in GeoBIM technologies has been an effecting factor for GeoBIM transformation, as their checking techniques to develop buildings are highly technological. Private sector employers have been capable of adopting new technologies facilitating change for the public sector, a part of the GeoBIM factors. The importance of developing a GeoBIM software plug-in that enables connectivity among other departments with linking and merging systems results in adapting the plug-in technology and GeoBIM factors by connecting workers effectively with new technology trials.

Table 5 Qualification GeoBIM integration factors

GeoBIM Challenge	PB release E-system	GeoBIM factors
Little Knowledge	The workers capable of managing e-Systems	There are qualified workers in checking codes, managing systems, and coping with the updates
Lack of standards	Code checking standards are digitized and clear to follow	The current codes or procedures are digitized into the system, and there is space for future additions
N/A	Limited human interference for final checking	There is a code for procedures and automated checking to prevent high human interference
Develop educational courses	There are clear procedures with the updates in the system	The procedures are clear and allow for developing training programs for workers to enhance performance
Practice-oriented conferences	N/A	There are workshops or Seminars for developing building e-checking techniques
N/A	Integrating offices is beneficial	The private sector workers are capable of adopting new technologies in building permit-release
Develop software/plug-in	The connectivity among the departments is high	The system adapting plug-in allows workers to connect effectively with new technologies trials

4.2.2.1 Qualifications Barriers

There are qualification barriers due to the lack of authorization approvals and management, as there is a need for easing management systems and enhancing resources for obtaining data, such as photo imagery, clarity, and consistent updates for overlaying GIS layers.

The lack of continuous training is another barrier to qualification; along with this shortage, it has become essential to have aged expert assessments and used hardware development in parallel. To overcome the majority of training-related barriers, it is necessary to flag motivational rewards to encourage change-making and decrease employers' resistance to learning new technologies, which solves the problem of employers delaying cases.

To allow workers to make an actual change in the field, they need access to policymakers to provide them with insights into the process and vision detection, providing them with better clarity on their role in the process, which will assist them in finding their starting point to develop further.

4.2.2.2 Qualifications Potential

Enabling employers within the service of development proposes changes, such as enhancing workers' opportunities in improving integration, mandates, and delegates of the changes made. Additionally, there are periodic training programs in different areas that have an effect on workers. However, the core courses lack education in technologies that cope with aspects of implementing systems such as GeoBIM.

However, the employees' capabilities lead to an easy recognition of the system's issues that will be documented and updated to the qualifications. Nevertheless, a comprehensive need was highlighted to align a set of workshops that employers could benefit from (legislation, processes of working, system uses, and capabilities).

4.2.3 Institutional

Laws and regulation guiding are a part of GeoBIM processes, as proposed in the property management integration of E-system for GIS management in PBS releases. It allows for a continuous update of policies and regulations into the platform to manage cities. The involvement of stakeholders as a GeoBIM eases the compliance of regulations and allows data

exchange in E-Systems; this involvement results in smoother policy changes.

Data development procedures require reformation in policies and regulatory changes in E-Systems, but it will result in coherent and predictable changes based on previous regulations. Data management practices are one of GeoBIM's challenges, in contrast to E-Systems, in which data flow is clearer and updatable for all stakeholders with insight into enhancing the results in changing the practices in data flow to facilitate future enhancement, as in the institutional factors shown in Table 6.

Table 6
Institution GeoBIM integration factors

GeoBIM Challenge	PB release E-system	GeoBIM factors
Laws and regulations guiding	There is property management integration into e-system for GIS management	There is a continuous update of the policies and regulations into the GIS platform to manage cities
Involvement of stakeholders	The compliance of regulations allows stakeholders data exchange	There is a compliance of the existing regulations among different departments allowing smooth policy-changes
Developing data	The use of IoT to reform and recommend policies and regulation changes	The existing regulations and policies are changing coherently and predictable based on previous legislation
Developing procedures	Legislators have a platform of the needed procedures to be enhanced	The decision-makers have an integrated platform to facilitate enhancement of regulations
Data management practices	The dataflow is clear and updateable for all stakeholders with their insight to enhance	The change practices in data flow exchange facilitate future enhancement
Define software version	There is flexibility to use different software	There is institutional unification of data formats for future flexible changes in the system

4.2.3.1 Institutional Barriers

Stakeholders face several challenges in developing services; a part of it is concentrated in the Baladi system, specifically in setbacks, as this system does not support CAD programs or files, which are the primary format in the digitized field. Additionally, it relies on basic manual calculations by the checking engineers. Furthermore, it has poor minimal feedback spaces, which do not contribute to the development of the system or the users of the system. The development of the system requires a leader who takes the guidelines and manages them accordingly, regardless of his field of expertise. These developments generally focus on more comprehensive developed software and making these changes in all departments, which will unify the platform and then be introduced to the clients.

In detail, the development should focus on providing a format for letters between the governmental bodies, so it reduces the time of editing between them. The edits include, but are not limited to decision cancellations or continuation regarding legislation. Furthermore, the governmental hierarchy and job descriptions lack clarity, resulting in delegation issues. This lack of clarity also reaches out to the rules and explanation of the implementation and punishment legislation.

4.2.4 Institutional Potential

Proposals enable concerned parties to develop services, including linking municipality departments to distinguish a better hierarchy of governmental bodies, which will enhance the decision-making process. Further developing the platform for governmental benefits suggests showcasing legislation, policies, and procedures in a transparent platform to allow experience exchange between institutions from different perspectives. Baladi platform unification will deliver a better experience for both clients and the government, as it will be able to produce online reports via platforms and minimize client visits to sub-municipalities.

4.3 GeoBIM factors

Exploring GeoBIM adoption requires developing a rank of data and adopting E-Systems to facilitate the transformation needed. There are criteria for the evaluation. Hence, the ranking factor based on the mean will prioritize the needed areas of development, and the standard deviation shows the variance of the respondents to the factor, as shown in Table 7.

Table 7
GeoBIM adoption factors within BPSP

Code	Factors	Mean
T1	E-system allows more than one code-engineer for data editing at the same time	**4**
T3	The platform is flexible in accepting data in many formats with no loss of data or disorders	**4.4**
Q6	The private sector workers are capable of adopting new technologies in building permit-release	**4.2**
N2	There is the compliance of the existing regulations among different departments allowing smooth policy-changes	**4**
T2	There are technical challenges in creating, sorting, modifying, or removing data from the system	**3.8**
Q1	There are qualified workers in checking codes, managing systems, and coping with future updates	**3.8**
Q7	The system adapting plug-in allows workers to connect effectively with new technology trials	**3.8**
Q4	The procedures are clear and allow for the development of training programs for workers to enhance performance	**3.6**
N4	The decision-makers have an integrated platform to facilitate enhancement for regulations	**3.6**
T8	The linking of data of land existing-states with land regulations can be beneficial to building permit-release	**3.4**
N5	The change practices in data flow exchange facilitate future enhancement	**3.4**
T7	The standardized CAD layering works effectively and lays the foundation for further development	**3.2**
N3	The existing regulations and policies are changing coherently and are predictable based on previous legislations	**3.2**
T6	The data management is flexible and efficient between local and online uses	**3**
N6	There is institutional unifying of data formats for future flexible changes in the system	**3**
T5	The coordinate reference systems are accurate and prevent change orders from designing offices	**2.8**
N1	There is a continuous update of the policies and regulations into the GIS platform to manage cities	**2.6**
Q2	The current codes or procedures are digitized into the system, and there is space for future adding	**2.4**
Q5	There are workshops or seminars for developing building e-checking techniques	**2.2**

T4	There are clear guidelines that allow for integrating new technologies, like BIM or GeoBIM	**2**
Q3	There are codes for procedures and automated checking to prevent high human interference	**1.6**

5. Conclusion and discussion

The study highlights the essentiality of developing city management performance by evolving traditional practices and urges the need to integrate BPS platforms within Saudi municipalities to allow better city and data management. Moreover, many articles revealed challenges in systems and decision-making with more demands for the governance of processes, with the ambitious vision of launching giga complex developments across the country in 2030 and showing a need for fast comprehensive solutions. The research is significant in adopting integrated platforms by solving dilemmas related to changes in social, technical, and institutional aspects, as many researchers have demonstrated demands to unlock the potential of adopting GeoBIM within local industries. This study contributes to achieving successful frameworks that consider the environment and workflows and define the challenges and opportunities among different systems with a lack of literature defatting GeoBIM adoption.

To measure the applicability of GeoBIM by defining the barriers and potentials for changing PBSP, an investigation of workflows from manual to E-Systems reflected the performances of various Saudi municipalities and showed the process from submission, rechecking, and releasing to extending the utilization of data to GeoBIM for building permits. Nevertheless, a group of adoption factors covered three aspects: technical, institutional and qualifications. Initially, the technical factors of connectivity among platforms and departments underline the need to develop data semantics, harmonization. Georeferencing demonstrated the need to improve the integration of BIM in GIS environments, as researchers revealed [7]. Nevertheless, the qualifications between the private and public sectors showed potential for GeoBIM implementation, and it is important to develop training with various methods, such as workshops, seminars, and conferences, to increase awareness to achieve standardization of procedures and allow the development of best practices in data utilization. Additionally, institutional sets considered the development of the regulations and processes by utilizing technology and evolving strategic planning for easing the procedures and improving working within centralized management systems, allowing us to improve the authorization performance, as many researchers [16] highlighted, while maintaining governance with GeoBIM tools to facilitate enhancement.

On the other hand, to define the barriers and potentials for changing PBSP to GeoBIM, the research grand investigation of regulations and legislation has been conducted, along with a survey of experienced young individuals working under the existing system, leading to highlighting challenges in the workflow and technical challenges as in the Rotterdam case in technical GeoBIM adoption [6]. For instance, the model reveals several issues in the system, such as the slow adoption of new technology, the lack of understanding of GeoBIM capabilities and technical issues and the gaps in roles and responsibilities.

Therefore, the research identified four important factors with a mean equal to and greater than 4 showing the importance of technological aspects. Second, a group of eleven factors were balanced, mostly between the technological and institutional factors, with a mean equal to or ranging between 3 and 3.9. Third, there were four factors with a mean between 2 and 2.9 highlighted in the qualification factors. Last, the less valued factor was regarding compliance and automation, with a mean of 1.6. This integration of GeoBIM has demonstrated key issues that generate further development, as workflow does not depend on 3D models and BIMs alone, but they are essential for the process following it. Additionally, Europe has found it essential to design a way to encode the constraints and identify suitable software for the conversion process to standardize encoding and overcome indirect institutional and technical challenges. All previously mentioned challenges are now trackable due to the development level in Europe's workflow and framework.

Hence, the research contributed to benchmarking the BPSP by running an investigation in various areas and highlighted the possibilities and pitfalls for Saudi municipality systems, workflows, and required qualifications. Additionally, we ranked a set of factors placing priorities for easing the implementation of GeoBIM by defeating critical factors, such as segregation between working departments, gaps between the city management systems, centralized decision-making processes, and developing a platform to allow focal development in processes to reduce the consumed time and waste information that could be used to enhance the decision-making process for future legislation and achieve the aims of 2030 vision of high sequential methods that can be developed within the strategic plans of cities.

The dilemmas and potential within systems show a set of factors, including the area weaknesses and strengths, to achieve the required developments. There is a clear need to further research in the areas of BPSP to enable GeoBIM implementation between workers hierarchy in management, a strategic framework for Private–Public partnership, and for data-driven solutions and structures in GeoBIM for mature integration of technology in BPS.

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