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EVALUATING THE E-PERMIT SYSTEM IN CONSTRUCTION USING STAKEHOLDER ANALYSIS AND NETWORK THEORY

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Abstract. Electronic building permit systems, integral to e-government services, aim to enhance the efficiency and user experience of the permit process. Despite their widespread adoption, these systems often fall short, complicating and delaying the process. The presence of a variety of stakeholders in such permit systems complicates interactions between actors; nevertheless, no research has examined permit systems from a stakeholder analysis approach. This gap is filled by a formal social network analysis that thoroughly investigates interconnected and multi-level governing systems. This study investigates the electronic building permit system's successes and failures in the construction industry. A mixed-methods approach was used, including interviews with applicants and employees, process mining analysis of event logs from 50 projects, case study observation, and social network analysis. The findings highlight significant barriers: poor communication and coordination among different agency employees, and a lack of adherence to established timeframes. Additionally, the study reveals that these systems are largely automated versions of their traditional counterparts, lacking substantial redesign or restructuring. Consequently, the researchers recommend a thorough re-evaluation and redesign of the electronic building permit system and propose implementing a one-stop-shop platform to facilitate inter-agency collaboration and streamline both internal and external communications and coordination.

Keywords: stakeholder analysis, network theory, electronic permit, building permit, construction industry, e-government.

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1. Introduction

Obtaining a building permit is a critical aspect of a country's business regulatory environment, as it allows construction to proceed and ensures that the building in question meets health and safety standards and regulatory requirements (Chognard et al., 2018; Noardo et al., 2022). A building permit is required for any construction project and must be applied for during the planning phase (Carlander & Thollander, 2022; Noardo et al., 2020a).

Determining the exact start date for construction can be challenging due to the uncertainty surrounding the length of the building permit process (Ullah et al., 2022). This process is controlled by the authorities and depends on organizational workflow, communication, and collaboration among stakeholders within and across involved agencies (Celoza et al., 2023; Chognard et al., 2018). Delays in construction permits are often attributed to various issues and deficiencies that can vary from one country to another. Both city and national governments recognize the impact of these delays on the economy, and many attempts have been made to highlight this impact (Alenazi et al., 2022; Jussila & Lähtine, 2020; Srdić & Šelih, 2015).

Research has shown that the effective use of digital information systems can improve the efficiency of the building permit process (Plazza et al., 2019; Sacks et al., 2020). As a result, many city and governments have implemented full electronic building permit systems in order to streamline the process (Golias et al., 2021; Noardo et al., 2020b) and adapt to the digitalized economy in the post-COVID-19 era (Hwang & Kim, 2022).

A building permit is a formal document issued by a local governmental entity that grants permission for construction, modification, or demolition of a building (Guler & Yomralioglu, 2021; Olsson et al., 2018). This document acts as a legal endorsement attesting to the fact that the proposed project adheres to building codes and regulatory standards, and it assures that the construction process will be executed in a safe and orderly manner, with appropriate oversight and inspection (Lee et al., 2016). The acquisition of a building permit is generally mandatory prior to the initiation of any construction work (Shenhar et al., 2001).

Electronic building permit (e-permit) systems are designed to reduce the time required for the permit process, improve customer service and communication between customers and responsible authorities, increase transparency and availability of information, and enhance internal management among departments (Chelladurai & Pandian, 2022; Meijer, 2005; Plazza et al., 2019). The successful implementation of an electronic system requires a comprehensive analysis of related procedures, workflow, and stakeholders (D'Angelo et al., 2022). Failing to consider these factors could result in this technological automation causing additional problems (Plazza et al., 2019).

Technology is only effective if people can effectively utilize it (Whitelaw et al., 2020), and, in practice, digitalization does not always result in all intended goals being met (Weingarth et al., 2019). This is particularly relevant in the case of Jordan, which the World Bank Group (2019) report ranked 138th out of 190 countries in terms of dealing with construction permits. The country recently finished implementing an e-permit system, which began in 2019 with the Jordanian Engineering Association (JEA) and was completed by the Greater Amman Municipality (GAM) in coordination with other involved agencies in May 2020. It is crucial to assess this transition's degree of success, especially given the shortcomings of the traditional system (i.e., its time-consuming nature) and the fact that this digitalization was motivated by applicants' demand for full e-permit services (Ministry of Digital Economy and Entrepreneurship [MoDEE], 2021).

Implementation of this e-permit system in Amman has not met expectations; on the contrary, both applicants and authorities have expressed dissatisfaction (Adaileh & Alshawawreh, 2021). This study aims to understand the experience of applicants for building permits in Amman. It will evaluate the new e-permit system, investigate the factors contributing to its success or failure, and compare it to the traditional system. Based on these analyses, the study will suggest improvements and recommendations for optimizing the processing time before permits are issued.

To the authors' best knowledge, there is limited academic research on the topic of building permit processes, and much of it has focused on identifying challenges and deficiencies, as well as on the adoption of electronic systems as a means of streamlining the process. However, very few studies have examined the factors leading to an e-permit system's success or failure, and none at all have focused on the context of Amman. Additionally, there has been a lack of research incorporating the tools of stakeholder analysis (SA), workflow analysis, and social network analysis (SNA) (Bellos et al., 2015; Jovanović et al., 2016; Majuri et al., 2020; Plazza et al., 2019).

The contribution of this study is twofold. First, it adopts SA and workflow analysis to a newly launched e-permit system. Second, it sheds light on the e-permit system's relationship to user satisfaction, something that, to the best of the authors' knowledge, no previous study has done.

This study aims to examine the effectiveness of an e-permit system in Amman and its current state, using SA, SNA, and workflow analysis. These methods were chosen due to the involvement of multiple authorities in the building permit process and the stakeholders' desire to improve communication and management through the e-permit system. The results of these analyses will provide insight into the system's successes and failures and also suggest possible improvements.

This study aims to address the following questions to achieve its objectives:

- Who are the stakeholders in the building permit process, and what are their roles?
- What are the current procedures for issuing a building permit in Amman?
- What are the main differences between the traditional and the new e-permit system?
- What are the advantages and disadvantages of the e-permit system compared to the traditional system?
- To what extent are the authorities in the decision-making process integrated and collaborative?
- What aspects of the current system can be improved or enhanced?

2. Literature review

2.1. Construction permits

The state of construction permits is one of the primary business indicators in a country's business environment (Hallward-Driemeier & Pritchett, 2015; Safapour et al., 2020). However, the uncertainty concerning the permit duration makes it hard to specify a starting day for construction (Meex et al., 2018; Sami Ur Rehman et al., 2022), and it is argued that the time and cost associated with building permit acquisition correlate with economic variables that impact interest rates and that delays in obtaining a building permit cause delays in the economy's responsiveness to interest rate fluctuations (Gete, 2014; Shibani et al., 2022).

Various studies are being conducted to explore and investigate the challenges of dealing with construction permits. Demirciefe (2009) explained that obtaining a building permit in Turkey necessitates a series of complex activities that are time-consuming and involve multiple stakeholders, resulting in delays that lead to increased costs and frustration, thereby harming the economy; she described the process as an excessive maze of regulations and paperwork. Another study by Martin et al. (2015), which examined the permit acquisition procedure in five Dutch municipalities, called the process "complicated and unstructured", with a wide variety of conceivable activity arrangements. Furthermore, Tasantab (2016) argued that developers consider the lengthy waiting time as an excuse for not following the development control process and proceeding without a permit. Hammah and Ibrahim (2014) attributed Ghana's housing shortage and illegal construction to the tedious permit procedure, as well. To take this a step further, in the Philippines, 57% of building is deemed unlawful, while in Egypt, 90% of construction is considered illegal (The World Bank Group, 2019).

Part of the building permit procedure's complexity is that it involves multiple different authorities. In Malaysia, there are nine authorities involved in the process, and according to Ahmed (2018), it is not a smooth process; rather, it is a complicated and interdependent framework involving numerous organizations and ministries. Research in Ghana has also found that a primary problem in obtaining a construction permit there is the lack of integration among the relevant authorities, along with other issues, such as an ineffective feedback system and a large number of required steps (Agyeman et al., 2016). Table 1 highlights some of the challenges involved in obtaining building permits in various countries.

2.2. Electronic permit systems

There has been a longstanding effort to digitalize the permit process, from application to final decision (Plazza et al., 2019). The goals of such e-permit services include reducing processing time, improving customer service and the quality of the application process, eliminating the need for paperwork and travel, improving communication and transparency among stakeholders, and providing progress tracking (Mapila, 2021). These systems have evolved from task-specific solutions to more integrated platforms that facilitate the exchange of information among all relevant parties (Chakaroun et al., 2020).

The CORENT e-permit platform implemented in Singapore is a highly effective example of a streamlined building permit process and has significantly reduced the time and number of steps required to obtain a permit. One key feature of the CORENT platform is its ability to accept building information modeling (BIM) files as part of the permit application process, as well as to provide templates for various BIM software programs (Chakaroun et al., 2020). In addition, the platform includes a tracking system that allows applicants to monitor the progress of their application. Other successful examples of e-permit systems include Hong Kong's "Be the Smart Regulator" program, which merged traditional permit procedures into a one-stop shop and streamlined the process to just six steps (Govada et al., 2022). Other countries such as Burkina Faso, Taiwan, and Mauritania have also implemented similar one-stop-shop systems for building permit applications. Table 2 presents features of successful e-permit systems.

Table 1. Building permit deficiencies in different countries

Deficiencies	Country	Reference
▪ Lack of follow-up on site investigations ▪ Lack of coordination among departments ▪ Ineffective information management and duplicate clearances	India	Chakaroun et al. (2020)
▪ Lack of compliance with regulations ▪ Not all required documents provided on time by applicants ▪ Insufficient staff ▪ Staff not kept up to date on current permit regulations	Ghana	Tasantab (2016)
▪ Unclear and complicated regulations ▪ Processing uncertainty ▪ Lack of coordination among several agencies ▪ Multiple bureaucratic procedures	Ghana	Hammah and Ibrahim (2014)
▪ Complicated verification procedures ▪ Complicated zoning maps ▪ Nonexistent electronic forms of zoning maps ▪ Poor communication among authorities	Slovenia and Croatia	Jovanović et al. (2016)
▪ Complex and expanding regulations ▪ Out-of-date building approval system ▪ Lack of transparency and predictability in the procedures	Canada	Duong and Amborski (2017)
▪ Human interaction between public and private sectors ▪ Multiple agencies and ministries involved in the process	Malaysia	Ahmed (2018)
▪ Difficulty in interpreting the building codes ▪ Communication gap	Canada	Al-Hussein et al. (2006)
▪ Inconsistent evaluation of proposals ▪ Failure to make decisions on time ▪ Enormous number of regulations ▪ Inconsistent and contradictory comments from different departments	Canada	Shahi et al. (2019)
▪ Traditional permit system ▪ Long reviewing time	Kuwait	Nawari and Alsaffar (2017)

Table 2. E-permit features implemented in various economies

Electronic Building Permit Features	Country	Reference
Instant communication channels between the private sector and public agencies	Indonesia	Natsir and Mangngasing (2020)
Geographic Information System (GIS) system, which includes comprehensive information on land plots and details on electricity grids and the water network	Canada	Shahi (2018)
	UK, Netherlands, Sweden, Slovenia	Noardo et al. (2020a)
	Sweden	Olsson et al. (2018)
High levels of site inspections and monitoring	United States of America	Rakha and Gorodetsky (2018)
	United Arab Emirates	Ashour et al. (2016)
Availability of online payments	Indonesia	Lionardo et al. (2020)
Automated BIM model checking	Canada	Shahi (2018)
	UK, Netherlands, Sweden, Slovenia	Noardo et al. (2020a)
	Kuwait	Nawari and Alsaffar (2017)
Automatic approval/rejection after a defined period	European Union	Pedro et al. (2011)
Pre-consolation of the drawings	European Union	Pedro et al. (2011)
	Slovenia and Croatia	Jovanović et al. (2016)

2.3. Building permit in Jordan

The World Bank (2019) report cited previously indicates that it takes a building permit applicant in Jordan a total of 20 steps to complete the process, averaging 66 days to obtain approval for construction of a two-story warehouse.

Jordan has recently begun to transition to a digital system for obtaining building permits, which has been in development for a long time (Ottoum, 2011). However, due to the involvement of multiple stakeholders in the permit process, the transition has been implemented in separate phases. The first phase, initiated by the JEA, involved trial stages that were made available to applicants in early 2019. The second phase, which involved collaboration between the GAM, the JEA, the Civil Defense Department (CDD), and other stakeholders, involved the creation of a new electronic platform separate from the JEA site. This platform allowed applicants to submit their applications to the GAM and obtain approvals from both the GAM and the CDD electronically, with a link established between the two sites. The second phase was completed in May 2020; in the meantime, the CDD continued to accept applications using the traditional procedure.

2.4. Stakeholder analysis

Workflow management systems that integrate the human component as well as process and technology are often referred to as "people systems" (Russell, 2007). These systems should be understood within the context of their social and organizational structure. The building permit process involves multiple authorities and stakeholders, making it complex and challenging. Ahmed (2018) described the permit process as a "complex interdependent framework" that requires involvement from various agencies and ministries. The length of the process depends on the administrative workflow, communication, and collaboration among involved authorities (Chakaroun et al., 2020).

To effectively manage such a complex system, it is important to identify the stakeholders and their roles. SA is an approach that identifies key actors and evaluates their individual interests in a system (Grimble & Wellard, 1997). The general purpose of SA, as mentioned in Grimble and Wellard's (Chakaroun et al., 2020) classic paper, is to understand the interests of the different stakeholders at various levels and identify their influence in the decision-making process (Brugha & Varvasovszky, 2000). SA is also applied to a wide range of management issues and decision-making processes where a complex spectrum of interactions among stakeholders can emerge.

Bendtsen et al. (2021) broke down the SA process into three main steps: (a) identifying stakeholders, (b) collecting data, and (c) data analysis. Their study discovered that the most often-used technique for identifying stakeholders is snowball sampling, while the most commonly used methods for data gathering are interviews, questionnaires, focus groups, and relevant literature. When it comes to interpretation, researchers have utilized many traditional methods; of these, attribute-based stakeholder classification is one of the most common (Bendtsen et al., 2021). It is also widely employed in the construction management field (Berscheid et al., 1973), where stakeholders are asked to evaluate and classify themselves and other stakeholders. However, this method is perception driven, which may result in bias (Mok et al., 2016). The impact-probability matrix is another method; it asks the project team to assess stakeholders in terms of their level of impact on the project and the probability that this impact will occur (Olander & Landin, 2008). A final method is the stakeholder circle tool, a visual representation of the stakeholders that prioritizes them and indicates their power, influence, and homogeneity based on their proximity to the circle (Bourne & Walker, 2005).

In the domain of construction research, Abdelaal and Guo (2022) argued that SA must be integrated with BIM and life cycle assessment (LCA) to take into account the perceptions of stakeholders on BIM and LCA, as their values are essential in improving green construction.

These traditional methods of SA have been criticized as being linear, and critics have said that they overlook the complexity of interactions among stakeholders (Mok & Shen, 2016). As a result, Mok and Shen (2016) introduced another method based on SNA, claiming that a network theory-based approach to SA would grasp the interactions and relationships among stakeholders and help to pinpoint where decision-makers might give more attention based on the network's characteristics (Prell et al., 2021).

2.5. Social network theory

SNA provides the ability to map out and visualize relationships: nodes in a graph represent actors, and the links between the nodes represent the relationships between them (Chinowsky & Taylor, 2012).

Networks are all around us, including such connections as the internet, public transportation routes, water and drainage infrastructure, or even social interactions such as business relations within an organization (Holme, 2019). The study of networks was first introduced by Lundberg and Moreno (1937) and has since grown significantly in popularity and application across various disciplines (Liu et al., 2017). SNA has been used in a variety of research contexts, including a study by Lienert et al. (2013) that combined SNA with SA to examine the fragmentation and collaboration among stakeholders involved in water infrastructure planning. SNA has also been applied in numerous construction project studies due to the complexity and uncertainty of these projects, which require effective stakeholder relationship management (Mok & Shen, 2016). Additionally, SNA has been used to identify and manage risks in construction projects (Guan et al., 2022).

Recently, researchers have also adopted network theory in the construction management domain. For instance, Al Hattab (2021) mapped the association between sustainability in construction and BIM and how their synergies changed over three specific periods (2005–2010, 2010–2015, and 2015–2020).

To further the application of SNA, it is necessary to identify and highlight the key measures of analysis. These measures, which include degree centrality, betweenness centrality, closeness centrality, and eigenvalue centrality, are widely used in academic research and are particularly useful for the current study (Kim & Hastak, 2018). Degree centrality measures the importance of a particular node within the network, with a higher degree centrality indicating a more significant role (Radziszewska-Zielina et al., 2019). Betweenness centrality, on the other hand, is based on the shortest paths between nodes and reflects the role of a node as a mediator or bridge in the flow of information within the network (Radziszewska-Zielina et al., 2019). Closeness centrality assesses the proximity of a node to other nodes in the network, with a higher closeness centrality indicating a shorter distance to other nodes. Finally, eigenvalue centrality reflects the connectivity of a node to other well-connected nodes, making it particularly useful for analyzing complex communication networks (Golbeck, 2013).

2.6. Research gap

The existing literature predominantly focuses on the challenges and adoption of electronic building permit (e-permit) systems in the construction industry, yet a comprehensive understanding of their practical implementation and efficacy, particularly in developing countries, remains largely underexplored. Further, the research incorporates different tools to better understand the processes of the e-permit, in an attempt to investigate its efficiency and potential areas of improvements. This research aims to address this gap by adopting a mixed-methods approach, integrating SA, workflow analysis, and social network analysis SNA, to critically evaluate the effectiveness of the e-permit system in Amman. The pivotal research question investigates the operational effectiveness of the e-permit system and identifies the key factors influencing its success or failure in comparison to conventional permit systems.

3. Materials and methods

3.1. Methodological approach and framework

The objective of this study is to examine the effect of digitalizing the building permit process in terms of processing time and customer satisfaction. A multifaceted approach that addresses all aspects of an organization is often necessary to achieve success and customer satisfaction, particularly during times of change. To effectively analyze and modify the various elements of an organization during a period of change, such as the adoption of electronic forms in this case, the study employs a theoretical framework originally developed by Leavitt and Bass (1964) and refined by numerous businesses (Hoyer et al., 2020). This framework includes three main components: process (i.e., the permit process), people (i.e., the stakeholders involved in the process), and technology (i.e., the electronic platform used for the process). All three components must be modified simultaneously to effectively implement the change, so this study adopts a multidimensional approach that takes all the three components into account.

Given the complexity of the building permit process, which involves interactions among multiple stakeholders at various hierarchical levels and across multiple organizations, this study employed a mixed-methods approach that combines both qualitative and quantitative methods. More specifically, the study utilized a combination of semi-structured interviews for qualitative data collection, workflow analysis for evaluating the flow of the process and identifying bottlenecks, and SNA for a quantitative examination of interdependent relationships among the various actors. The methodology framework used in this study is depicted in Figure 1.

3.2. Data collection

This research employed a multifaceted approach to data collection that included a comprehensive literature review, interviews conducted at various stages, event log collection, and a case study. Research started with the literature

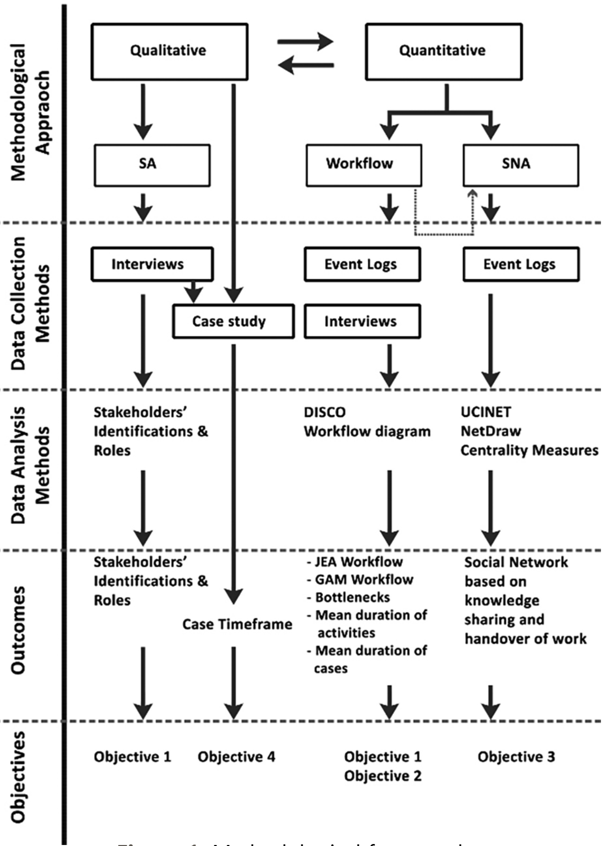

Figure 1. Methodological framework

review to gather information on current practices, challenges, deficiencies, and the adoption of online building permits globally, as well as to explore the successes and failures of other cases (Mandi et al., 2019). The next step was data collection methods, which are detailed and divided into interviews, case study, and event logs, all of which were used to form a thorough understanding of the topic.

Interviews were conducted with both applicants and official staff in order to gather a comprehensive understanding of their experiences and perceptions of the building permit process and the adoption of electronic forms.

The development of interview questions and the overall inquiry direction were profoundly informed and shaped by the comprehensive literature review conducted. To elaborate more, the development of interview questions was guided by the identification of challenges and deficiencies in obtaining building permits across various cities as summarized in Table 1. Furthermore, the literature review identified the intended goals of implementing the electronic system, successful instances of e-permit implementation, and the features associated with e-permits in various cities as discussed in Section 1.2. This information guided the interview questions, which aimed to uncover whether these goals were achieved and to explore strategies for applying these features to enhance the overall success of the e-permit system. The interviews were designed to address key aspects related to the challenges, goals, and successful implementations of electronic systems in the context of acquiring building permits.

This foundational knowledge not only directed the construction of a targeted interview framework but also ensured that the inquiries were precisely aligned with the research objectives. The integration of literature review insights was instrumental in formulating questions that were both focused and relevant, thereby significantly enhancing the ability to extract meaningful and contextually rich data from the interviews.

These interviews took place in three stages:

Stage 1: A sample of experts in the field of building permit application, specifically engineers working at authorized consulting offices or companies registered with the JEA, were interviewed using snowball sampling (Vindrola-Padros et al., 2020). These semi-structured interviews were conducted in person and via phone and focused on getting the perspective of the applicants on the adoption of e-permit systems, including their overall satisfaction with the system and whether it reduced the time and number of steps required to obtain a permit.

The interviews also covered the differences between the traditional and new e-permit systems, the challenges faced during the new permit acquisition process, and suggestions on improving the process. The duration of the interviews ranged from 20–40 minutes, and the sample consisted of experts with a range of years of experience from 6 to 17 years. After collecting the perspective of the applicants, the next step was to interview official staff.

Stage 2: For the second stage of data collection, interviews were conducted with official staff to gain a thorough understanding of the process, workflow, and involved stakeholders and their roles, as well as to obtain their insights on the transformation process and the electronic system. A stratified sampling technique was employed, in which respondents from different authorities (the JEA, the CDD, and the GAM) were selected in approximately equal numbers.

In total, 16 semi-structured interviews were conducted in person and via phone calls, lasting from 20–60 minutes each. Notes were taken, and the interviews followed guidelines covering questions related to satisfaction with the e-permit system, involvement of applicants in improving the procedure and providing feedback, employee satisfaction with the system, potential resistance to change, identification of stakeholders and their roles, information exchange among stakeholders, impact of the electronic system on time delay and number of steps required to complete the e-permit process, and challenges and reasons for the system not reaching its full potential.

Stage 3: Face validation, in the form of interviews, were conducted with six experts in the field. The purpose of these interviews was to confirm the findings from the SA, workflow analysis, and SNA through presentation of the study's results to the participants.

Table 3 summarizes the information of the interviewees and their role in data collection.

Following the interviews and analysis of the building permit process, an *observational* case study was conducted for a small residential project in Rabwet Abdoun, Amman.

Table 3. Interviewees and their relation to the current study

	Number	Position	Years of Experience	Relation to the subject
Stage 1	1	Architect/ Company A CEO	16	All are Engineers who work at authorized consulting offices or companies registered with JEA and applied for building permit for different types of projects in Amman using both the traditional paperwork system and the new electronic system.
	2	Architect/ Company B CEO	17	
	3	Architect/ Company C CEO	15	
	4	Architect/ Company D CEO	14	
	5	Senior Architect	10	
	6	Senior Architect	8	
	7	Senior Architect	7	
	8	Senior Architect	6	
	9	Junior Architect	6	
	10	Junior Architect	6	
Stage 2 (Staff Authorities)	1	JEA front desk Employee (Management information)	3	Arrange and check all submitted documents from applicants
	2	JEA Civil Department Engineer	7	Check submitted civil drawings
	3	JEA Architecture Department Engineer	16	Check submitted Architecture drawings
	4	JEA Electrical Department Engineer	NA	Check submitted Electrical drawings
	5	JEA Mechanical Department Engineer	NA	Check submitted Mechanical drawings
	6	JEA Electronic system Organizer	2	In contact with companies and the IT department to solve issues related to the electronic system
	7	JEA Head of Supervision Department	7	Technical and management audits of the submitted projects
	8	JEA Head of committee of electronic system	2*	In contact with all authorities and involved parties of enhancing the electronic system
	9	GAM Head of the buildings permit Department	2*	One of the initiatives of the electronic system
	10	Engineer	1*	Works at enhancing the GAM electronic system
	11	Inspector	NA	Engineers who audit the submitted drawings and worked with both the traditional and electronic system
	12	Engineer in Municipality	NA	
	13	Engineer in Municipality	NA	
	14	Engineer in Municipality	NA	
	15	Civil Defense Engineer	NA	
	16	Civil Defense Engineer	NA	
Stage 3 (face validation)	1	Architect/ Company A CEO	16	All are expert in the building permit and its procedure
	2	Architect/ Company B CEO	17	
	3	Architect/ Company C CEO	15	
	4	Architect/ Company D CEO	14	
	5	JEA Head of committee of electronic system	2*	
	6	JEA Architecture Department Engineer	16	

The project, a single-residence villa with a 300 m^2 footprint on an 800 sqm plot, was selected to investigate the timeframe for granting a building permit in a typical small residential project. The data were collected on the process, as was the time required to obtain the building permit and initiate construction. The primary objective of this case study was to gain a comprehensive understanding of the procedure and identify any challenges or factors that could contribute to delays in the workflow.

Event logs from both the JEA and the GAM were collected, totaling 50 projects from each platform. These event logs were analyzed to create a workflow and identify the involved stakeholders to build the social network. This method, known as sociogram construction, was previously employed by Van Der Aalst et al. (2005) to extract information from event logs. Each event log represented one construction project seeking a permit with the following: (a) activities (processes involved in obtaining final approval), (b) timestamps (end times of each activity), and (c) resources (individuals or departments involved). These event logs were used to understand the progression of projects through the permit acquisition process and identify any challenges or delays. An example of a collected event log is provided in Table 4.

Table 4. Example of a collected event log

Case ID	Activity	Resources	Timestamp
1	Approve and Transfer	JEA/R	2020.06.15 09:48 a.m.
1	Check Architecture	JEA/A	2020.06.29 09:30 a.m.
1	Approve Architecture	JEA/A	2020.06.30 10:15 a.m.
2	Reject Civil	JEA/C	2021.02.14 09:40 a.m.
3	LM- Financial	GAM/F	2021.04.10 12:30 p.m.

The event logs were collected in two stages; the first stage involved collecting event logs from the JEA for 50 residential projects ranging from 1,000 to 2,000 m^2 in size, approved between 2019 and 2021. The second stage involved collecting event logs from the GAM for an additional 50 residential projects, also ranging from 1,000 to 2,000 sqm, which included data from both the GAM and the CDD.

4. Data analysis and discussion

4.1. Stakeholder analysis

The main stakeholders involved in the building permit process and their respective roles are outlined below:

- Authorized Offices: These engineering offices, which are registered with the JEA, initiate the permit process and act as a third party to verify the drawings and ensure compliance with codes and regulations.
- Surveyor: A topographic survey of the property must be obtained before the design process begins, and the surveyor must be certified by the Department of Land and Surveys.
- Soil Investigation Office: A soil investigation report is required and must be performed by a certified private engineer.
- JEA: The JEA's technical audits and code compliance with the Jordanian National Building Code involve all engineering departments (architecture, structure, electrical, and mechanical). The National Construction Law of Jordan establishes the JEA's involvement in the building permit process.
- Preventive Security Department: This department inspects buildings for safety and anti-crime measures.
- CDD: The CDD is responsible for fire safety clearance and checking the drawings for compliance with safety codes.
- Local/District committees and the GAM: Both the local committee and the GAM have the same role of checking the application for compliance with Amman building and planning regulations.
- Water Authority of Jordan (WAJ): The WAJ provides approval and clearance for the applied land plot during the building permit process.
- Jordanian Electric Power Co., Ltd. (JEPCO): The JEPCO provides approval and clearance for the applied land plot during the building permit process.
- Department of Antiquities: This department examines the land before construction to protect cultural heritage and ensure that the land to be authorized for construction does not contain any antiquities or artifacts. It provides a clearance letter and requires a pledge from the landowner to stop excavation if any traces of antiquities or artifacts are discovered.
- Jordan Telecom Group: The group provides approval and clearance for the applied land plot during the building permit process.
- Supervision Office: An authorized supervision engineer, registered with the JEA, is responsible for inspecting the construction process on-site to ensure that it is built per the codes and the building permit stamped drawings.
- Jordanian Construction Contractors Association: Authorized contractors are responsible for completing the project per the approved building permit drawings while adhering to the standards and codes specified in the contract.
- Municipal building inspector: This inspector is responsible for inspecting the construction process on-site to ensure that it is being carried out per the approved building permit drawings.

Table 5 presents a comprehensive overview of stakeholders, along with their respective roles in the organization.

According to interviews with specialists from the GAM, three stakeholders have been removed from the building permit procedure due to the lack of legislation requiring their involvement and as a means of reducing the time required to receive a permit. GAM's decision to remove key utility stakeholders from the building permit procedure aligns with contemporary stakeholder prioritization strategies (Bourne, 2016). This approach involves strategically managing stakeholder engagement based on their potential impact and influence on project outcomes. However, the removal of these key stakeholders – the WAJ, the JEPCO, and Jordan Telecom Group, all utility officials – may have negative consequences for the permit procedure during construction and occupancy, despite it appearing at present to be a beneficial step due to the decrease in the effort and time required. Recent stakeholder theory emphasizes the importance of comprehensive stakeholder consideration throughout a project's lifecycle (Miles, 2017). The removal of utility providers from early stages may create what Eskerod et al. (2016) term "stakeholder blindness", where important stakeholders are overlooked, potentially leading to future complications.

Table 5. List of stakeholders and their roles

Stakeholders		Role
Office		Prepares drawings and documents
Surveyor		Carries out plot survey and topography
Soil Engineer		Examines soil
JEA	Front desk	Checks documents
	Preventive security	Responsible for code compliance
	Architecture	
	Civil	
	Mechanical	
	Electrical	
	Supervision	Calculates areas and payments
CDD	Front desk	Responsible for safety and fire prevention
	Engineers	
	Bureau	
	Head of department	
	Financial Department	
GAM	Front desk	Checks land documents
	Urban planners	Checks the land plot regulations based on its location
	Supervision Department	Carries out site inspection
	Financial Department	Checks for any taxes on the landowner or the plot
	District engineers	Checks the architectural drawings and their compliance with regulations
	District head of engineers	Approves or denies the comments received by the engineer
	GAM main building	Checks the application if the local committee rejects it
	Head of Permit Department	Distributes the application to engineers
	Engineers	Checks the architectural drawings and their compliance with regulations
	Head of engineers	Approves or denies the comments received by the engineer
	Inspector	Checks the drawings and the plot for compliance, has the right to reject
	District Committee/ GAM Committee	Holds weekly meetings to discuss applications before approval or rejection
	Accounting Department	Calculates the application fees and building violations, if any
WAJ		No longer part of the process
JEPCO		No longer part of the process
Department of Antiquities		Examines the land before construction to protect cultural heritage
Jordan Telecom Group		No longer part of the process
Supervision Office		Supervises the construction on site
Contractors Association		Manages construction work

While some interviewees believed this removal to be a positive step, the majority emphasized the importance of involving utility officials in the early stages of design and construction, suggesting that their role be expanded to include actual infrastructure planning, as is the case in cities such as Doha and Dubai. Without the involvement of these officials, the approved utility plans may be incomplete, leading to construction without a clear understanding of the location of main utility connections. Additionally, each authority has a distinct role: the JEA reviews code compliance and technical drawings; the GAM reviews building regulations, but only architectural drawings; and the CDD reviews fire safety compliance.

The interviewees' emphasis on early utility official involvement reflects current best practices in stakeholder engagement. Mok et al. (2015) highlight that early and continuous stakeholder engagement in complex projects leads to better outcomes and reduced conflicts. The suggestion to expand utility officials' roles aligns with Aaltonen's et al. (2016) concept of "stakeholder landscape navigation", which involves proactively adapting stakeholder management strategies throughout a project's phases.

When asked if it would make a difference if the authorities reviewed the application simultaneously or if the GAM reviewed the application before the JEA, all ten interviewed experts agreed that it would not be a problem and would actually be preferable for the application to be reviewed by all authorities at the same time.

The current division of responsibilities among various authorities represents a form of stakeholder network governance (Haarich, 2018). This approach recognizes the interconnected nature of stakeholder relationships and the need for coordinated decision-making in complex environments.

The proposal for simultaneous review by all authorities reflects the growing emphasis on collaborative stakeholder management in project governance (Ismail et al., 2021). This approach stresses the benefits of stakeholder cooperation in complex urban development projects. The potential streamlining of the permit approval procedure through concurrent review aligns with the concept of value co-creation through stakeholder interactions (Freudenreich et al., 2020).

While simplifying procedures by removing utility providers from the initial permit process may seem beneficial, it contradicts current stakeholder management best practices. A more integrated approach, as suggested by the interviewees, better aligns with contemporary stakeholder theory and empirical findings in project management research.

4.2. Workflow analysis

Due to the challenges of obtaining a comparable set of projects from both the JEA and the GAM, the 50 projects collected from the JEA are distinct from the 50 projects collected from the GAM. Despite this, the workflow for the JEA is presented and analyzed first, followed by the GAM workflow. Bottlenecks within the process are identified and highlighted in both cases.

While each of the various agencies reviews the application, the authorities have established defined timetables for the maximum number of days required to finish the entire review process. It should be noted that they rarely adhere to these timeframes, resulting in unjustifiable delays.

Based on the interviews, the events logs from the collected projects, and the case study, this research was able to present the following:

1. An overview of the building permit process.
2. The complete workflow for issuing a building permit using electronic services.
3. The duration of activities.
4. The activities that have not yet been digitalized.
5. The main differences between the traditional permit system and the e-permit system in terms of workflow.

A *case study* approach was used to examine the process of obtaining a building permit in Amman, Jordan. The project began with the submission of architectural drawings for preliminary approval in June. However, the municipality did not have an online portal at the time of submission, so the submission and review process was done manually, using hard copies. The project received preliminary approval in August, and full documents, including architectural, structural, electrical, and mechanical drawings, were submitted in September. The documents underwent multiple stages of review and approval, including review by the JEA, preventive security, and the Supervision Department. Payment was also required as part of this process. In November, the process was completed, but it took longer than the average expected timeline of 36 days, due to various delays and challenges.

Some of the challenges faced during the process included the lack of an online portal for permit submission, the need for multiple stages of review and approval, and the requirement to visit the municipality and collect invoices. The process also involved transferring the application between the JEA and the GAM portals. Overall, this case study highlights the complexities and challenges involved in obtaining a building permit in Amman and the importance of understanding the entire process to identify and address any issues or delays. It took a total of 189 days to complete the process and issue the building permit. The timeline for this project is depicted in Figure 2 below.

Figure 3 depicts the abovementioned steps and workflow of issuing a building permit, with all possible scenarios represented. It displays two separate series of steps, one for the JEA and one for the GAM, with the CDD steps integrated into the GAM series.

The process of obtaining a building permit begins with the *JEA*, as the law requires that no documents or drawings be accepted by the CDD or the GAM unless they have been approved and stamped by the JEA. The JEA has established an online portal for building permit applications, but it is only valid for JEA-assisted processes.

Figure 4 illustrates the performance analysis of the JEA workflow, showing the average duration of each event, which were calculated by entering the logs of these events manually into Disco software, a process mining program which stands for "Discover your process", to calculate the average duration for each specific activity or stage in the permit process (Fluxicon, 2018).

In describing the flow of the application, the applicant first submits the application through the online portal, and the front desk employees check the land and owner documents, which can take up to 21 days if corrections are needed. If not, the application is transferred to the next step, which on average takes 30 minutes. The application is then received by the engineers for review, which takes an average of 52 working hours for the architecture engineer, 50 working hours for the civil engineer, 9 working hours for the mechanical engineer, and 10 working hours for the electrical engineer. On average, it takes 4 working days and up to 20 weeks to receive approval from all engineers and the Preventative Security Department. All units referenced in this research are based on standard business days and hours.

If the application is approved, it is sent to the Supervision Department to calculate and approve the payment based on the permitted areas. This can take up to 39 days and an average of 47 hours. The final step is for the office to pay, which can take up to 19 days and an average of 4.4 days to complete. The delay in this step is due to the fact that the JEA system does not provide a payment number, requiring the applicant to communicate through email or phone to obtain it. A study by Demirciefe (2009) found that insufficient personnel is a common problem in many economies when it comes to building permit issues.

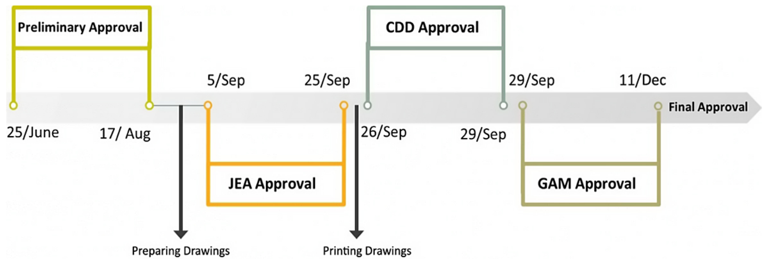

Figure 2. Project timeline

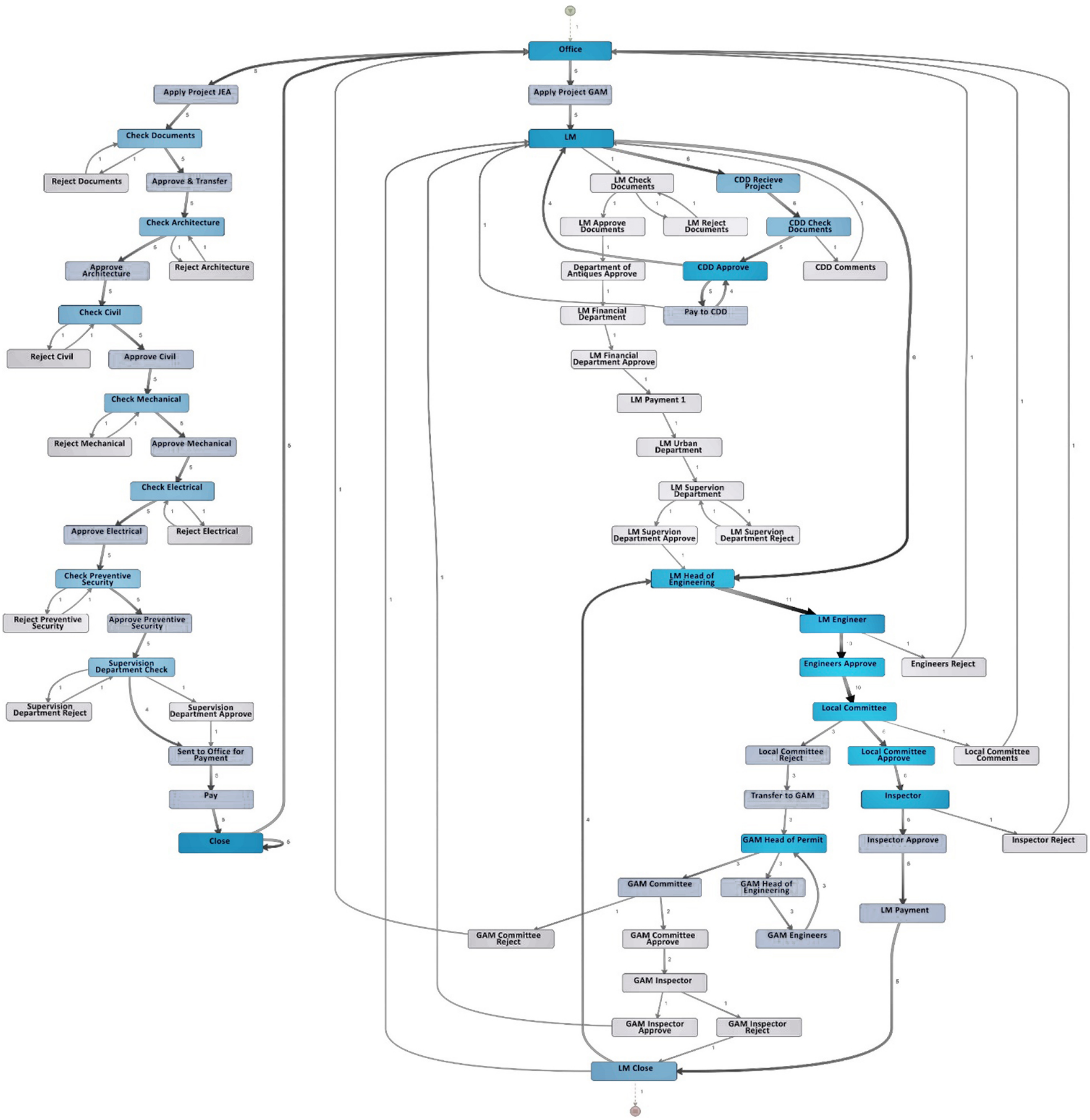

Figure 3. E-permit full workflow

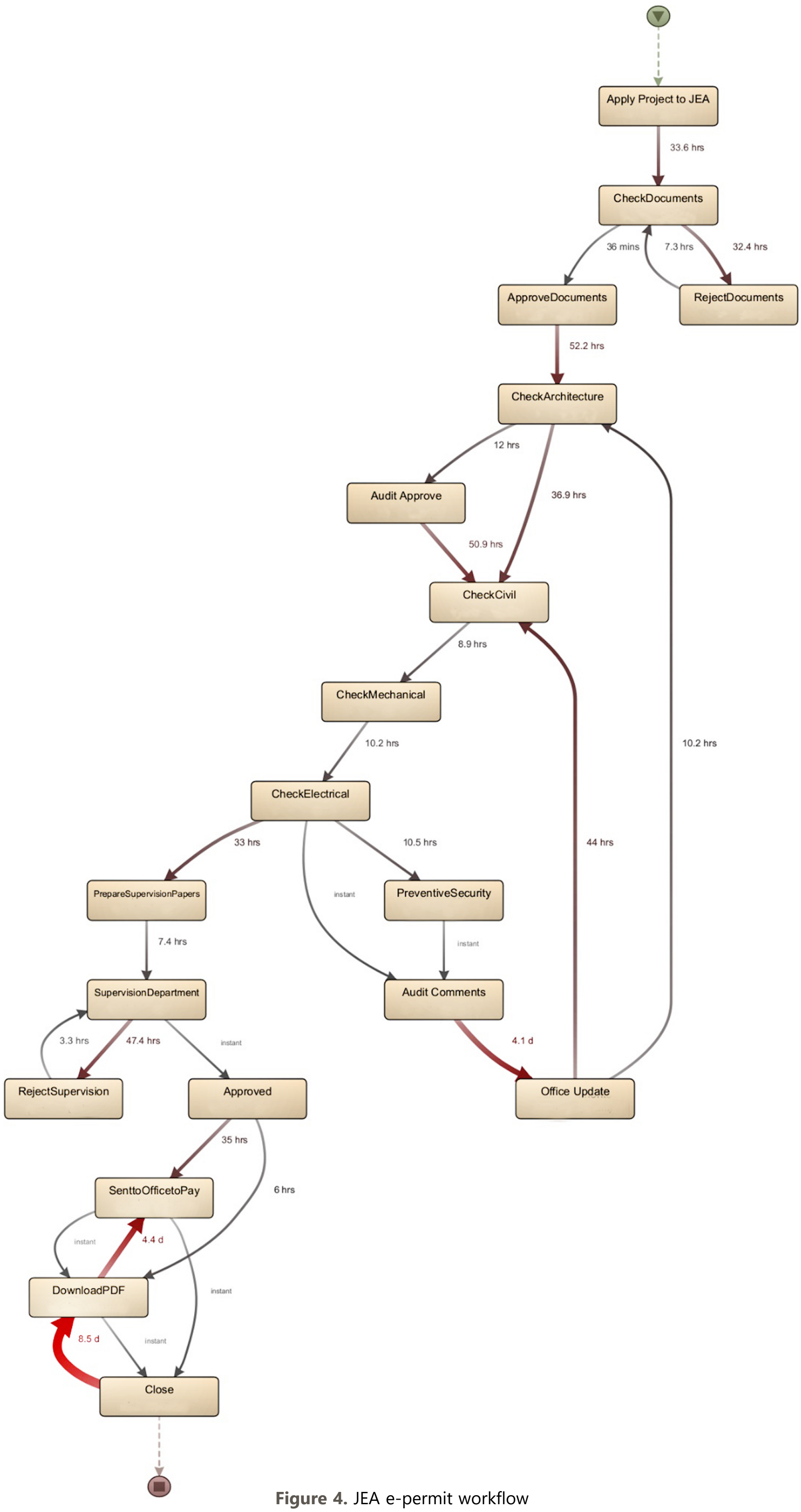

Figure 4. JEA e-permit workflow

The varying intensity of the red color used to represent the arrows in Figure 4 indicates the length of time required to complete the corresponding activity. In addition, Figure 4 illustrates the workflow bottlenecks, or the most delayed activities, which are listed in Table 6.

Table 6. JEA's most delayed activities

No.	Activity	Mean Duration
1	Sent to office for payment	4.4 days
2	Auditor's comments	4.2 days
3	Received by architecture	2.2 days
4	Received by civil	2.1 days
5	Office update	2 days

The analysis of event logs revealed that the approval process for projects by the JEA took significantly longer than the timeline outlined in procedural guidelines, with a mean average of 36 days for the 50 projects studied, with some permits taking as long as 178 days and others taking as few as 7 days. This represents a delay of over a month on average for this stakeholder.

Additionally, the range of activities per case was found to vary significantly, with a minimum of 19 activities and a maximum of 41, including repetitive tasks. This variation is likely due to the differing number of comments received for each project and the number of repetitive activities. The frequency of application handling by various parties was also analyzed, with the front desk employees having the highest frequency (220 reviews of the 50 projects), followed by the Applicant Office (212 reviews), the Supervision Department, and the four engineering departments. The Preventive Security Department had the lowest frequency of 50 reviews, indicating that each project was reviewed once by preventive security employees. These findings provide insight into the workload at each department.

After obtaining approval from the JEA, the applicant must also seek approval from *both* the *CDD* and the *GAM*. The GAM online portal, which was launched 1 year after the JEA online portal, connects the CDD and the Department of Antiquities to the process. The applicant submits office and property information through the portal, which is linked to the Department of Land and Survey, and enters the contract number they had signed by the JEA.

An analysis of event logs from 50 projects was used in the performance workflow diagram in Figure 5 to illustrate the sequence of activities and bottlenecks in the GAM procedure.

According to the performance workflow, the most time-consuming activity is the recertification of the project after receiving comments from the engineers. Upon receiving comments from the GAM, the office must correct the drawings and re-upload the project to the JEA system. The recertification process involves sequential recertification by the relevant authorities, beginning with the JEA, then the CDD, and finally the GAM. This process takes an average of 10 days and can take up to 24 days.

The next lengthy activities are the approval and checking of the drawings by the engineer and head of the Engineering Department, which can take an average of 9.5 and 9.8 days, respectively, or up to one month. This is followed by a review by the engineers at the main municipality, which can result in a delay of 20 days on average, with the GAM engineer accounting for 8.5 of those days.

The workflow at the Supervision Department is also delayed by an average of 6.2 days, but this step is only relevant for occupancy permit applications and is instantaneous for building permit applications.

The final major delay is obtaining the CDD's approval, which takes an average of 5.8 days. The authorities have set a deadline of 1 day to complete this phase, regardless of the project or location. The delay is due to the CDD's use of traditional procedures, including printing documents and requiring the applicant to complete the process physically. Therefore, it takes time to prepare and print documents and visit the JEA to collect invoices as required by the CDD. The remaining activities can typically be completed within 2 days.

In addition, the GAM's project approval process may take as long as 7 months or as few as 21 days, with a mean average of 3.5 months for the 50 projects studied. The GAM has set a timeframe of 10 to 21 working days for this stage, equivalent to a maximum of 1 month. However, it is typically delayed by more than 2.5 months. When combined with the 1-month delay in the JEA phase, this amounts to an average of 3.5 months of project delays. The range of activities per case varied significantly, with a maximum of 100 and a minimum of 36.

According to the GAM's procedure, the application may be transferred from the district municipality to the main municipality if the district committee disapproves or does not make a decision on it. If an application is transferred from the district municipality to the main municipality, it goes through the same process, which takes an average of 22 days. Interviews indicate that this stage is time-consuming and causes significant difficulties. This occurs because district engineers are often less qualified or hesitant to issue permissions for complex situations. In these cases, the application is reviewed twice by different personnel, leading to inconsistent feedback from engineers. This problem, identified by the interviewed experts, results in rejections for bureaucratic reasons and a lack of transparency in the feedback system, leading to delays and a lack of streamlining in the process. In the case study, despite receiving preliminary approval and being transferred to the main municipality during the preliminary phase, the application was still transferred during the original permit process due to being reviewed by different personnel.

It is frequently the case that stakeholders involved in the decision-making process, such as the GAM, the CDD, and the JEA, provide comments on or rejections of applications. When this occurs, the applicant must revise and resubmit the changes to all involved authorities for further evaluation.

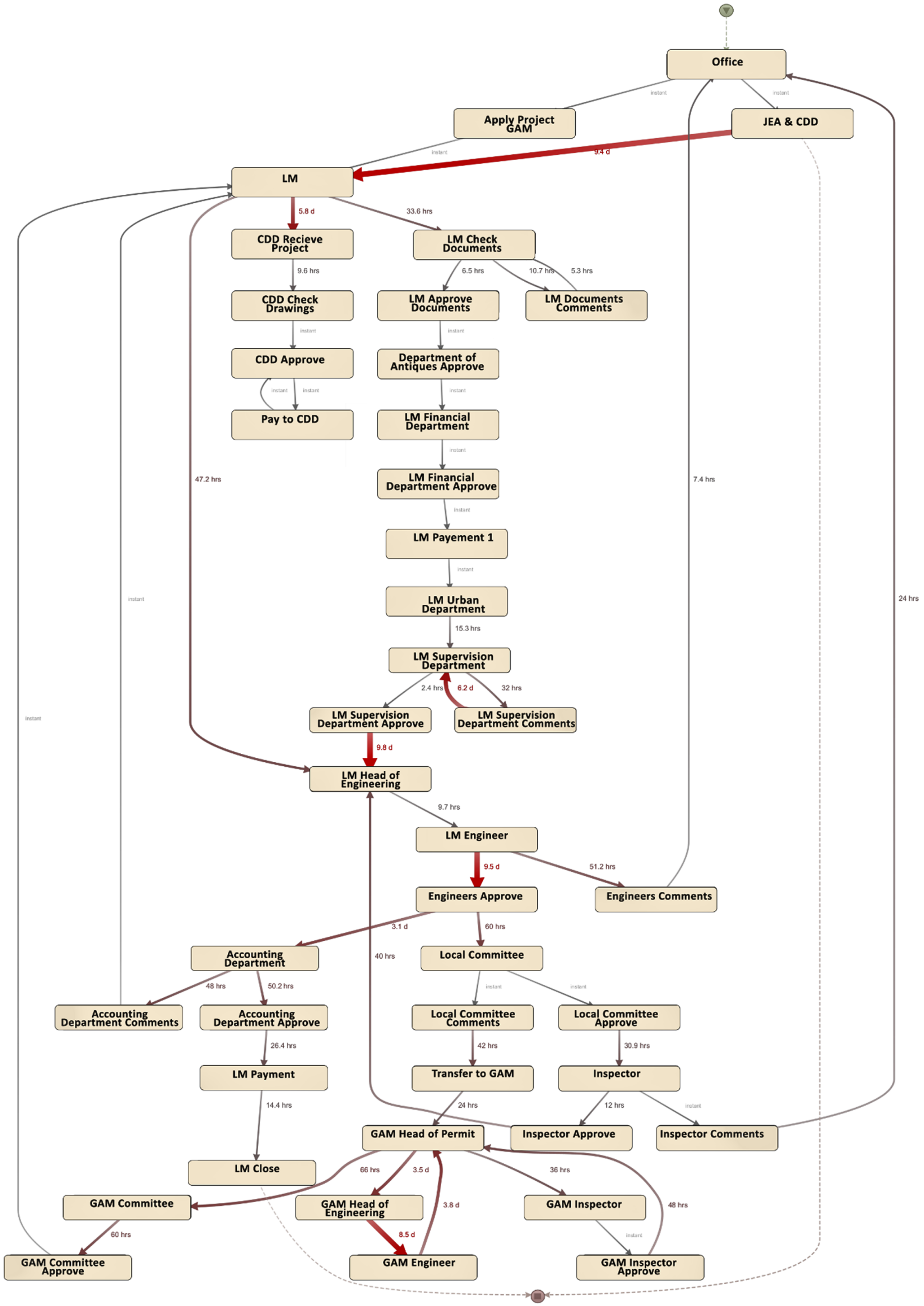

Figure 5. GAM e-permit workflow

This process, known as *recertification*, involves reviewing the updated documents to ensure they still meet the requirements and regulations. The authority that initially requested the change will resume its review of the application from the point at which it was paused for recertification.

As an example, before reviewing an application, the CDD requires a stamped drawing from the JEA. If any comments are provided to the office, the updated drawings must also have the JEA stamp. Similarly, the GAM requires a CDD and JEA stamp on drawings before they are reviewed. If any comments are received from the GAM, whether from the engineers, the committee, the inspector, or the Accounting Department, the office must obtain the approval and stamp of the JEA and the CDD before submitting the modified drawings to the GAM.

The recertification process is similar to submitting a project for the first time, with the exception that only the updated drawings are reviewed to ensure compliance with codes and regulations after modification. This process is expedited due to the limited scope of review but can still delay a project by up to 24 days of its total permit time. The adoption of an e-permit system has highlighted the significant bottleneck in this process, which was previously not as apparent when using the traditional system of reviewing, correcting, and stamping documents in the final stages. This step is legally required but has proven to be a hindrance in the permit process.

According to interviews with employees from the JEA and the CDD, the adoption of e-permits has led to a dramatic increase in workload due to the recertification process. This process requires the office to reapply for approval whenever a comment is received, resulting in a cycle of repeated reviews by these authorities. When asked if reordering the workflow to begin with the GAM rather than the JEA would streamline the process, all respondents agreed that it would. This arrangement is intended to shorten the recertification process, as most comments are received from the GAM engineers and this stage is the longest in the workflow. Therefore, the current research proposes to expedite the permit process framework as shown in Figure 6.

In comparison to the current JEA and GAM procedures, the workflow shown in Figure 6 represents an optimized approach to the building permit process. Based on a thorough data analysis of event logs, interviews, and case studies, this suggested workflow identifies critical inefficiencies and bottlenecks in the existing systems.

The following justifies why the suggested workflow is superior: (1) integration and streamlining: as it more effectively integrates different steps and stakeholders, minimizing redundancies and enabling more seamless transitions between stages, (2) time efficiency: as it resolves observed delays and inefficiencies, seeking to lower the overall time required for permit processing, (3) stakeholder feedback: to better match the workflow with user needs and expectations, important stakeholders' perspectives from interviews

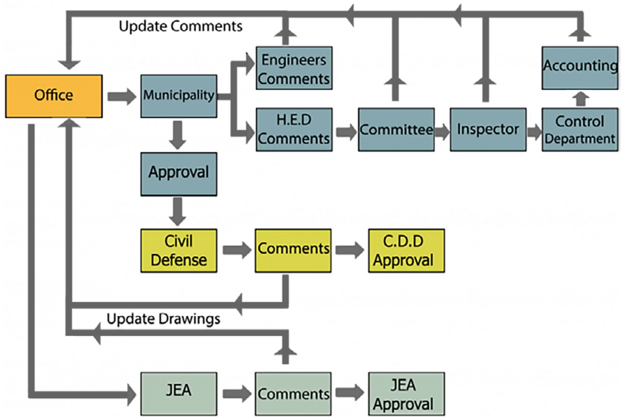

Figure 6. Suggested workflow framework

were taken into consideration during design, and (4) the proposed process uses a one-stop shop approach, where applicants and several authorities communicate through a single window. This has been shown to be an effective way to handle electronic permit systems, as exemplified by Hong Kong (The World Bank, 2019).

To sum up, the workflow shown in Figure 6 is intended to greatly enhance the efficacy and efficiency of the building permit procedure. It is the outcome of a thorough examination and comprehension of the existing systems. This makes it a better option than the JEA and GAM procedures that are already in use.

There is a large degree of similarity between the traditional and e-permit processes. According to interviews with staff personnel, the workflow has not undergone significant alteration for several reasons, including legal requirements dictating a specific order of processes as well as the rushed digitalization of the process due to the COVID-19 quarantine. The changes to the workflow are outlined in Table 7.

4.3. Social network analysis

The SNA in this study focuses on two aspects: handover of work and information exchange among stakeholders. Handover of work refers to the transfer of an activity to another actor after the first actor has finished their part in it, while information exchange involves the sharing of data, decisions, and other information that may impact the outcome of the preceding activity. The handover of work network was developed using collected event logs and only considers the new e-permit process, as the procedures and workflow are not significantly different from the traditional systems. Three networks were created for the information exchange network using collected data on stakeholder interactions and interviews.

The handover of work network was created using collected project event logs to merge the event logs from the JEA and the GAM to create a comprehensive network linking all activities and their resources. The event log data were input into UCINET, an SNA and visualization software (Apostolato, 2015), and the resulting network visualizes the handover of work among stakeholders, illustrating the transfer of activities (see Figure 7). In this handover of work network, green nodes represent actors from the JEA, blue nodes represent actors from the GAM, yellow nodes represent actors from the CDD, and grey nodes represent other stakeholders. Moreover, this network shows the betweenness centrality measure, which is defined as the extent to which an actor serves as a bridge for the distribution of information to others (Chinowsky et al., 2008). Abbreviations are listed in Table 8.

Table 7. Difference between traditional and E-permit systems

No.	Traditional System	E-Permit System	Reason
1	The office must bring a white book from the municipality that has been stamped by the following authorities: WAJ, JEPCO, Department of Antiquities, and Jordan Telecom Group.	Except for the Department of Antiquities, which is now directly linked to the GAM system, these authorities are excluded and play no role in the e-permit process.	Except for the Department of Antiquities, there is no legally binding law requiring them to be kept.
2	The application was reviewed sequentially by JEA engineers.	The application is now reviewed concurrently by JEA engineers, except for architectural engineers.	The hard copy was difficult to review concurrently.
3	The application process went as follows: the JEA, then the CDD, and finally the GAM.	Following JEA approval, the application is routed to the GAM, where it is transferred to the CDD and then reviewed by the GAM.	The CDD does not want to be linked to a private entity directly.
4	There is no need for recertification; the applicant only needs to re-stamp the approved drawings at the end.	After each comment or rejection, the entire recertification process must be repeated.	By law, the CDD cannot review an application without first obtaining JEA approval; the same is true for the GAM.

Table 8. List of network abbreviations

Office		Office
Surveyor		SR
Soil Engineer		SL
JEA	Front desk	JEA/R
	Preventive security	JEA/PS
	Architecture	JEA/A
	Civil	JEA/C
	Mechanical	JEA/M
	Electrical	JEA/E
	Supervision	JEA/S
CDD	Front desk	CDD/R
	Engineers	CDD/A, CDD/C, CDD/M, CDD/E
	Bureau	CDD/B
	Head of department	CDD/HD
	Financial Department	CDD/F
GAM	Front desk	LM/R
	Urban planners	LM/U
	Supervision Department	LM/S
	Financial Department	LM/F
	District engineers	LM/E
	District head of engineers	LM/HE
	GAM main building	GAM
	Head of Permit Department	GAM/HE
	Engineers	GAM/E
	Head of engineers	GAM/HE
	Inspector	GAM/I
	GAM Committee	GAM/C
	District Committee	LM/LC
	Accounting Department	LM/AC
Department of Antiquities		DA
Supervision Office		SVO
Contractors Association		CA

The visual representation of the handover of work network allows for the depiction of collaborative behaviors among actors within the workflow. The size of the nodes indicates the betweenness centrality of the actors; for instance, the office (the applicant) has the highest betweenness centrality and serves as the primary gatekeeper and mediator in the network. This highlights the lack of communication channels between authorities and stakeholders, as indicated by the absence of links between them, while also emphasizing the central role of the applicants in the process. This is consistent with the findings on the frequency of resources from the JEA and the GAM, as the office was the second most frequently used resource in the process.

Additionally, the network provides insight into the organizational structure of the participating entities. For example, the frequent contact between JEA employees and the office and JEA/R, but not with each other, suggests a lack of internal communication within the JEA. Similarly, CDD employees primarily rely on the Applicant Office for the handover of work between departments and authorities.

The *information exchange network* was constructed based on interviews with experts and official staff. An adjacency matrix was created and input into UCINET, resulting in three networks: one representing the traditional system information exchange, the second representing the improvement in information exchange after the adoption of the e-permit system, and the third proposing potential improvements in information exchange based on interviews.

As illustrated in Figure 8, the traditional permit system involves a network of information exchange relationships, with the Applicant Office serving as a central mediator. This office plays a crucial role in the process and is the only significant connector in the network, indicating that the process cannot be completed without it. The network also reveals limited connections among other actors. Figure 8 displays colored nodes according to the actor group they belong to (green for JEA actors, blue for GAM actors, yellow for CDD actors, and grey for other involved stakeholders). The betweenness centrality measure is also depicted, providing insight into the relative importance of each node within the network.

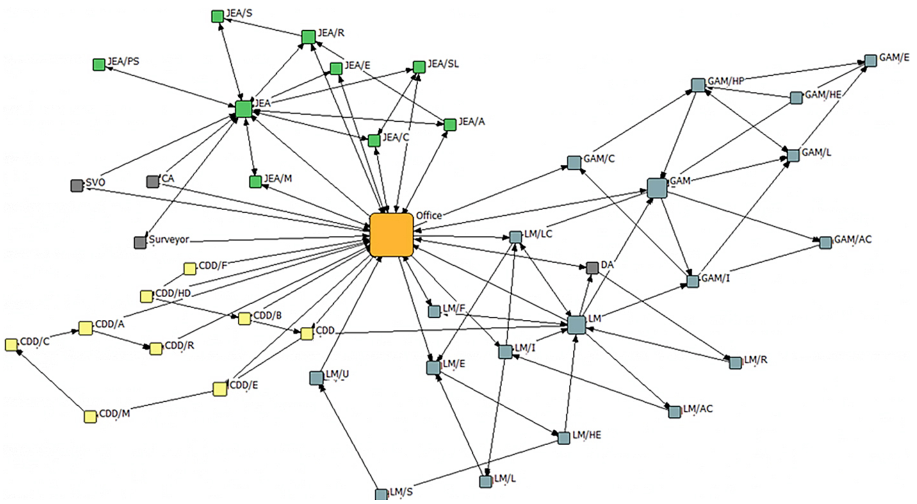

Figure 7. Handover of work network

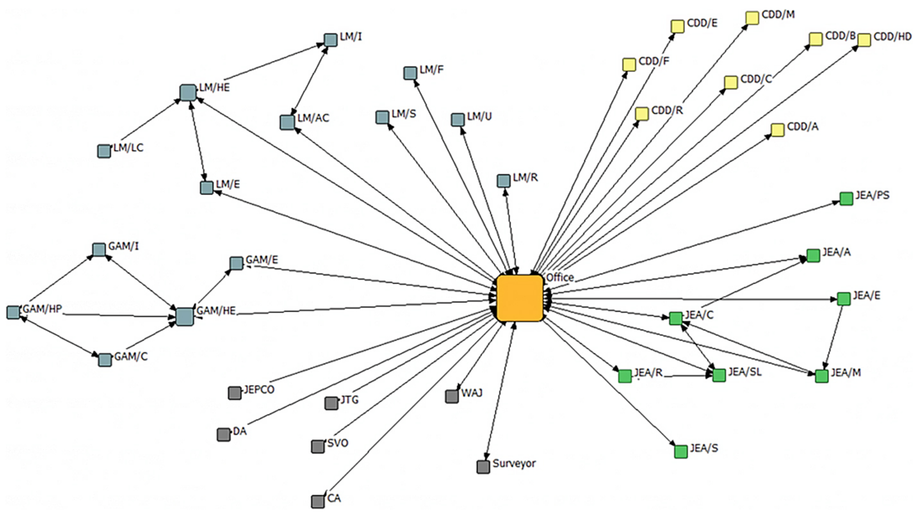

Figure 8. Information exchange network in the traditional permit system

In contrast, Figure 9 illustrates the network of information exchange relationships in the new e-permit system, which demonstrates significant improvements in terms of the number of links and the significance of the actors. The exception to this is the yellow nodes representing the CDD, which still rely heavily on the office due to their continued use of traditional systems rather than automation. However, the network still lacks connections between different authorities, indicating that while the information exchange relationships have improved within a single authority, they have not improved between authorities. Additionally, the utility services authorities are no longer a part of the process, and thus there are no nodes representing them.

This study proposes an alternative information exchange network, depicted in Figure 10. The information exchange network for the new e-permit system is shown with the betweenness centrality measure, with green nodes representing actors from the JEA, blue nodes representing actors from the GAM, yellow nodes representing actors from the CDD, and grey nodes representing other stakeholders.

This network suggests the inclusion of utility authorities in the process and the establishment of a one-stop shop, a single e-permit site integrating the JEA, the CDD, the GAM, and utility services (SRV). The circle-shaped nodes represent the suggested added nodes (e-permit, SRV, the WAJ, the JEPCO, JTG, and the CDD). SRV refers to the portal that will connect the various utility services (water, power, drainage, the Department of Antiquities, and communication). Kuwait enhanced its e-permit platform similarly, by incorporating additional authorities, which led to improved communication and cooperation among multiple agencies (The World Bank Group, 2019). In contrast, some nodes, such as the GAM nodes, were removed in

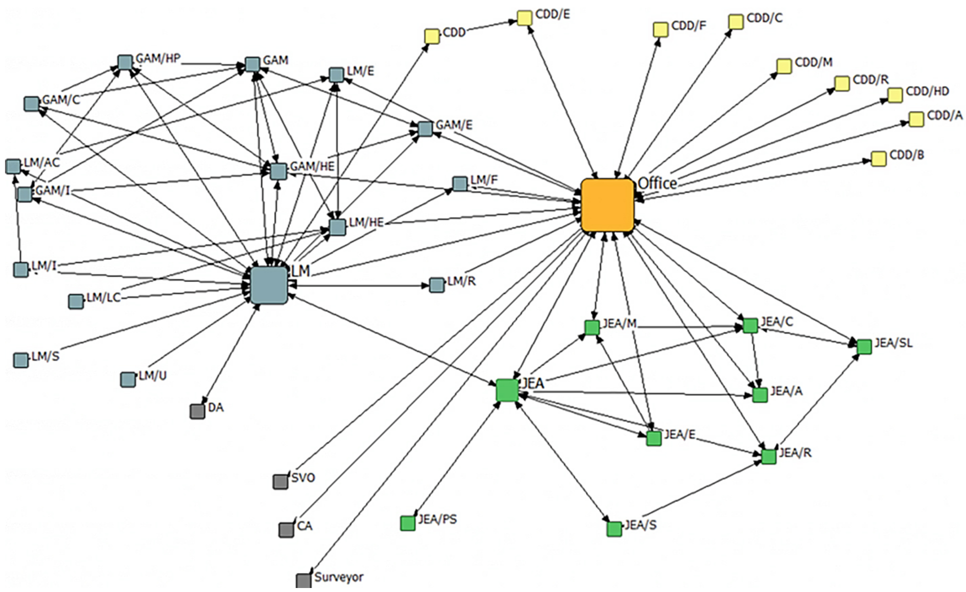

Figure 9. Information exchange network in the new e-permit system

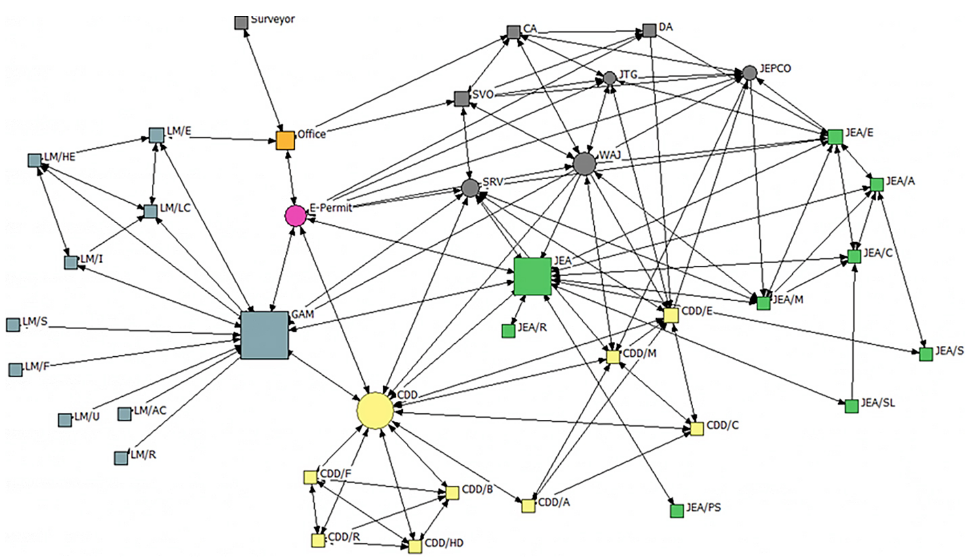

Figure 10. Alternative information exchange network

this network and replaced with local municipality nodes to streamline the network, as both stakeholders serve the same role and authority.

The proposed network aims to improve communication channels within and among authorities through the implementation of a one-stop-shop solution, which would enhance the overall process, coordinate activities, and promote internal coordination and communication (Hamad et al., 2017). It also aims to delegate certain tasks currently performed by the office to internal parties and reduce the office's role as the primary gatekeeper. The proposed network is more interconnected, with more links, and the office has a lower betweenness centrality compared to the main authorities of the JEA, the CDD, and the GAM. The increased centrality of these authorities is expected to lead to higher customer satisfaction by improving connections between stakeholders within and across authorities and reducing the effort required by the applicant to link all involved stakeholders.

The introduction of a one-stop-shop solution is likely to streamline the process and minimize the time needed for obtaining a permit. Each agency's role has been identified, and while all roles aim to ensure the health and safety of the building, they may overlap and operate simultaneously. Figure 11 illustrates a potential one-stop-shop workflow.

Many countries, such as Hong Kong (The World Bank Group, 2019), have implemented one-stop shops to facilitate interactions with agencies and enhance coordination. Interviewees in this study agreed that a one-stop shop would streamline the permit process, but successful implementation is critical.

By allowing all authorities to work concurrently and receive, modify, and re-upload comments at the same time, the delay time can be reduced, and by promoting communication and integration among authorities, the entire system can be improved and streamlined.

To evaluate the three networks, basic properties of Newman's network theory were applied (Newman, 2018). Comparing the three networks, we found that they differ in terms of the type and number of actors who play a major role in information exchange, as well as the number of communication channels among actors as shown in Table 9. The suggested network has a higher mean degree centrality, representing the average number of links that players maintain to share information, and a higher mean betweenness centrality, representing the average number of times players are placed on the shortest path between any two actors in the network. The mean eigenvector centrality, which describes an actor's average distance from all other actors in the network, is relatively similar across all networks. The mean closeness centrality, which may be viewed as a measure of the time needed to sequentially propagate information from one actor to all others, is also higher in the proposed network. Overall, the proposed network's information exchange is characterized by intensive interactions, making it cohesive and easier for actors to exchange information with each other.

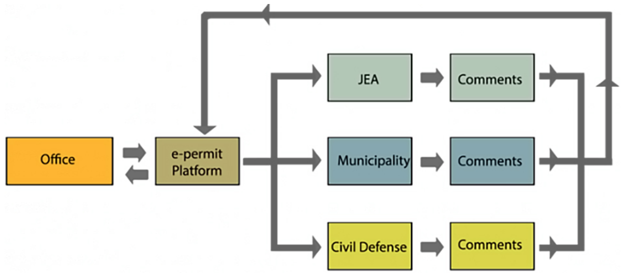

Figure 11. One-Stop-Shop platform

Improving information exchange among the various actors aims to reduce the effort required by the office to connect authorities and employees, resulting in improved service and increased customer satisfaction. Table 10 shows that, compared to the traditional network, the proposed network has a low degree of centrality, low betweenness centrality, high closeness centrality, and low eigenvector centrality for the office. This indicates that the proposed network's information exchange distributes links among other actors in addition to the office, reducing the effort required by applicants to obtain a construction permit.

To validate the proposed network, six interviews were conducted using subject matter experts, and the researcher

Table 9. Common properties of information exchange networks

Network Properties	Definition	Traditional Network	E-Permit Network	Proposed Network
Number of Ties	Total number of ties in the network that link actors together (Mok & Shen, 2016)	91	144	190
Number of Nodes	Total number of actors in the network (Mok & Shen, 2016)	38	39	38
Degree Centrality (Mean)	The structural significance of an actor who holds a prominent position in a social network (Zhang & Luo, 2017)	2.47	3.79	5.32
Betweenness Centrality (Mean)	Actor's position as a facilitator of information transmission within the network (Kourtellis et al., 2013)	21.5	23.33	25.60
Closeness Centrality (Mean)	Quantifies the sequential propagation time of information from a single actor to all other actors within the network (Kas et al., 2013)	80	84.60	88.20
Eigenvector Centrality (Mean)	Impact of a node in network, scores based on connections to high-scoring nodes affecting node score more than to low-scoring nodes (Parand et al., 2016)	0.12	0.13	0.13

Table 10. Properties of the office node across the three information exchange networks

Network Properties (Office)	Degree Centrality	Betweenness Centrality	Closeness Centrality	Eigenvector Centrality
Traditional Network	32	640.5	42	0.681
E-Permit Network	25	453.967	51	0.463
Proposed Network	5	42.483	91	0.086

explained the one-stop-shop solution and proposed relationships and connections. The experts expressed interest in the network and the one-stop-shop solution and emphasized the importance of discussing this topic. They also suggested that significant time savings would be achieved if the process started with the GAM acting as the main distributor of applications.

5. Conclusions and future directions

The aim of modernizing and automating the construction permit process is to improve efficiency, reduce waiting times, and increase customer satisfaction. However, the e-permit system implemented in Amman has been unsuccessful in achieving these intended goals.

To overcome this issue, it is necessary to understand the underlying causes and identify potential solutions. This study aimed to evaluate the existing building permit workflow, identify the causes of delays, and examine the social networks of integration, collaboration, and information-sharing among stakeholders involved in the building permit process in Jordan.

The study provided a detailed overview of the current e-permit process, including the workflow of the JEA and the GAM, as well as that of other participating stakeholders. It was found that the presence of not one but two portals for applicants to navigate and the requirement that some activities still be completed manually hindered the process and resulted in longer delays than with the traditional system. Additionally, despite being fully automated, the process continues to be reviewed sequentially rather than concurrently, and the sequence of activities is heavily reliant on legislation, which has proven to be a major obstacle to improving or assessing the process.

When comparing the traditional and electronic processes, it was found that implementation of the electronic system did not reduce the time needed to issue a building permit but rather increased it. Additionally, the activities and sequence of activities were not significantly altered, more precisely, the traditional process was simply automated without consideration of the needs of the new format. This suggests that simply automating a process without reengineering it to take advantage of technology's capabilities can be counterproductive.

The study also identified several factors that have determined the current building permit system's lack of success in Jordan. Technology-related deficiencies included the lack of an online platform connecting all stakeholders and a lack of interactive digital communication between applicants and employees. Process-related deficiencies included an outdated and burdensome process that was automated without any concern for its new format; the creation of unnecessary complexities through the adoption of the electronic system; and a lack of coordination among the agencies involved in the process. People-related deficiencies included insufficient staffing, resistance to technology among permit officials, and a lack of follow-up and feedback mechanisms.

To address these issues and improve the e-permit system in Amman, it will be necessary to reengineer the process to optimize it for the technology being used. This may involve establishing an online platform connecting all stakeholders, improving digital communication between applicants and employees, redesigning the process to be more efficient and effective, and addressing issues related to coordination among agencies, staffing, and resistance to technology. By addressing these issues, it may be possible to enhance the building permit process, reduce wait times, and increase customer satisfaction. Additionally, it will be important to regularly assess and evaluate the effectiveness of the revised process to identify and address any additional issues that may arise.

Overall, this study highlights the importance of considering both the process and the technology when implementing electronic systems and the need to continuously assess and improve these systems to achieve their intended goals. It also emphasizes the need for a holistic approach to process improvement, considering all relevant factors including technology, process, and people. By adopting this approach, the e-permit system in Amman can be successfully enhanced to meet the needs of all stakeholders.

This study makes a significant contribution to the body of knowledge in building engineering by providing a detailed analysis of the e-permit system in Jordan's capital city, Amman, and identifying the key factors contributing to its failure to achieve its intended goals. It offers valuable insights for other industries considering the implementation of similar systems, as well as for researchers studying the effectiveness of electronic processes in the construction industry. Practically, the study introduces a framework decision-makers can use to enact required adjustments to the current permit process by improving communication among stakeholders, which ultimately will streamline the permit process.

There are several limitations to this study. First, the data for this study were collected through interviews and surveys, which are subject to bias and may not accurately represent the experiences and perspectives of all stakeholders. Additionally, this study focused on the e-permit system in Amman and may not be generalizable to other municipalities or countries. Further research is needed to confirm the findings of this study and to examine the potential for success of e-permit systems in other contexts.

This study has identified several opportunities for future research to further elaborate on its findings:

- Empirically validating the study's findings through pilot implementation to further explore the effectiveness of the proposed workflow.
- Conducting additional studies on e-permit systems implemented around the world to investigate the success or failure of such systems in terms of people, process, and technology, and using SNA tools to better understand relationships and interactions among stakeholders.
- Examining the impact of occupancy permits on construction project delays, as well as how deferring electrical, water, and drainage connection clearance to the final stages of construction may result in additional labour.
- Examining the feasibility of developing a cloud-based platform with BIM-based submissions and automated review, as well as converting building and urban planning rules into a computer-readable format.

By addressing these areas of research, it will be possible to gain a deeper understanding of the challenges and opportunities associated with e-permit systems and to develop strategies for improving their effectiveness in the future.

Author contributions

LA and MT conceived the study and were responsible for the design and development of the data analysis. LA, MT and FS were responsible for data collection and analysis. LA and MT were responsible for data interpretation. MT and FS wrote the first draft of the article. NL was responsible in reviewing the paper, giving comments when needed, and modifying the transcript.

Disclosure statement

All Authors confirm there is no competing financial, professional, or personal interests from other parties.

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