2025 European Conference on Computing in Construction

CIB W78 Conference on IT in Construction

Porto, Portugal
July 14-17, 2025

LOST IN REGULATIONS: DIGITALIZATION AS THE KEY TO TRANSPARENT AND EFFICIENT BUILDING PERMIT EVALUATION IN ESTONIA

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Abstract

While the Estonian building permit process has evolved from paper to digital systems, it remains document-centric and fragmented. This study focuses on the problem identification phase of the Design Science Research (DSR) approach to identify key problems in the Estonian building permit process. Using a combination of secondary data analysis, semi-structured interviews, and theoretical analysis, the research reveals four primary challenges: inconsistencies and subjectivity in decision-making, lack of procedural transparency, a generally worded legal framework, and fragmented and non-standardized requirements. This study proposes introducing an artefact as a general solution for establishing a well-informed building permitting pre-consultation phase.

Introduction

Estonia, like many countries, has transitioned from physical paper-based processes to workflows reliant on digital documents (e.g., PDFs, DWGs, IFCs). However, underlying issues persist: time-consuming processes, lack of transparency for citizens, redundant workflows, and duplicate or inaccurate database records (e.g., about existing building stock data) (Elisa Iliste et al., 2024). This study examines these issues through the Estonian Building Registry (EBR).

The Estonian Building Code regulates building design, construction, use, and maintenance for supporting sustainable evolution of built environment while also ensuring safety, functionality, and usability (Riigikogu, 2015). National supervision is enforced through local authorities, ensuring that buildings and construction activities align with the Code and related legislation (Riigikogu, 2015). This is done via building permits/notifications, which authorize design solutions, and use permits/notifications, which legalize occupancy.

However, while a nationwide legal framework establishes unified principles, its implementation relies on local authorities to interpret and apply requirements. This creates variability in how specialists assess compliance, leading to misalignment between policy objectives and differences in operational practices. Additionally, compliance criteria are described not only in legislation but also in industry best practices (e.g., standards and technical guidelines). The fragmented and distilled nature of regulations creates difficulties for stakeholders, who need clarity on what regulations must be applied, when, and how. A structured pre-consultation phase could help clarify requirements early, but due to limited resources across municipalities, offering such guidance consistently is difficult. This study, therefore, proposes developing a scalable digital artefact to support this early-stage need.

This research is the first phase of an ongoing Design Science Research project that investigates decision-making challenges in the building permit process. It focuses on the pre-consultation phase, where applicable requirements must be determined in a case-specific manner.

The research questions are:

1. What are the key challenges and their significance in the building permit process?
2. What goals should an artifact (e.g., a framework or tool) meet to address these challenges effectively?

Research Design and Methodology

This study focuses on the first stage of the Design Science Research methodology (DSR) (Peffers, Tuunanen and Rothenberger, 2024). The research is conducted in four

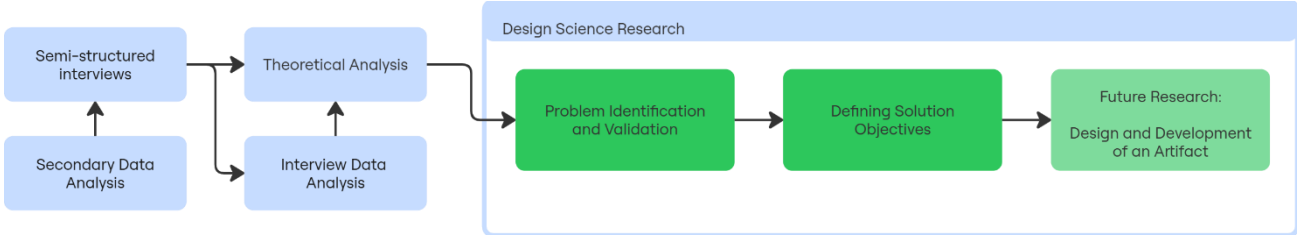

Figure 1: Schematic view of research methodology

steps: secondary data analysis, validation through semi-structured interviews, theoretical analysis of identified issues, and problem structuring, which form the basis for defining the artefact's objectives (Figure 1).

Secondary Data Analysis

The first step was to identify issues in the Estonian building permit process using secondary data. The reviewed public documentation focused on existing workflows, regulatory bottlenecks, and data exchange standards in Estonia. This included analyzing the process maps describing workflows in EBR, various studies on the Estonian e-construction platform, national legislation, and relevant policy frameworks.

Semi-Structured Interviews

To validate the findings from secondary data and to uncover additional challenges or recent developments, semi-structured interviews were conducted with 10 construction specialists from municipalities of various sizes (see Table 1). Respondents received a list of topic areas to guide the conversation and explore their experiences, practices, and perceptions of regulatory compliance checks (Richard Fellows and Anita Liu, 2015). These interviews were conducted online, recorded with the participants' permission, and typically lasted an hour. All recordings were transcribed and analyzed.

Theoretical Analysis

A targeted literature review was conducted to understand how similar challenges are discussed in the academic domain and to uncover additional problem dimensions. The review focused on peer-reviewed journal articles, conference proceedings, and papers from Scopus, Web of Science, ResearchGate, and Google Scholar. Keywords used included building permit digitalization, BIM-based compliance checking, an ontology for a building permit, and building regulations. From there on, a citation chain was used to find connected studies. The selection criteria prioritized studies published within the last ten years (2015–2025) to ensure relevance to recent advancements in BIM, building permit processes, and automatic compliance verification. However, older, highly cited references were included to provide foundational context.

Problem Structuring

The final step involved structuring the identified and validated problems into a comprehensive table, which presents each main problem category alongside its related sub-problems and the sources these issues were described. This structured overview serves as a foundation for defining objectives and requirements for a future artifact. The discussion section further reflects on these objectives and explores potential technologies that could support the development of a solution tailored to the Estonian context.

Estonian Building Registry

The Estonian Building Register (EBR) established in 2003, is a national database designed to track buildings and manage construction-related permits and applications (Majandus- ja Kommunikatsiooniministeerium, 2016). Its primary goal is to improve transparency and efficiency in construction by providing a centralized platform for storing and sharing relevant data. The system has undergone several updates to enhance its functionality, including a major redesign in 2014 that introduced a more user-friendly interface and technical upgrades. In 2021, the system transitioned to a microservice-based IT architecture as part of the broader e-construction platform (Majandus- ja Kommunikatsiooniministeerium, 2021).

Table 1: Table of interview participants

Position	Experi-ence in the sector	Size of the Municipality (inhabitants)	Permit applications in a year
Construction Specialist	3 years	< 20,000	< 1000
Head Construction Specialist	20 years	< 20,000	< 1000
Construction Specialist	14 years	< 20,000	< 1000
Construction Supervision Specialist	33 years	< 20,000	< 1000
Construction Specialist		< 20,000	< 1000
Chief Construction Specialist in the Construction and Communal Department	46 years	< 20,000	1000 – 2000
Building Permit Specialist	22 years	20,000 – 100,000	< 1000
Head of the Department of Architecture and Construction	17 years	20,000 – 100,000	1000 – 2000
Head of the Department of Architecture and Construction	14 years	20,000 – 100,000	1000 – 2000
Head of the Construction Department	12 years	> 100,000	> 2000

Today, the EHR serves as a central platform for managing building permits, allowing applicants to submit applications, municipalities to conduct reviews, and maintain detailed records of buildings, including technical specifications, legal status, and ownership. However, despite its digitalization, the system still relies on document-centric workflows, such as PDFs, limiting its full potential. This has led to inefficiencies, technical issues, and delays in the building permit process (Arrak et al., 2024). Ongoing efforts aim to transition to machine-readable, standardized data formats to better support

automation, improve data quality, and support more efficient construction planning.

Estonian Building Permitting Process and Challenges

This chapter is divided into two parts: a secondary data analysis based on public sector reports and a validation of the identified issues through interviews with different municipality building specialists.

Secondary Data Analysis

The Estonian construction sector is undergoing a strategic transformation, driven by two main goals : the creation of high-quality built environments and the improvement of productivity (Ehituse pikk vaade 2035, 2021). Digitalization plays a central, horizontal role in achieving these goals, both from the public and private sectors' perspectives.

The public sector has taken the lead in innovation development in the Estonian construction sector, intending to shift towards long-term, data-driven decision-making that balances ecological and economic objectives throughout the building lifecycle (Ehituse pikk vaade 2035, 2021). To achieve this, seven long-term strategic goals have been set for the sector to meet by 2035, one of which is digitalization. An integral part of this goal involves advancing digital construction by standardizing building data, enabling open data environments, creating BIM model platforms, and mandating BIM usage in public sector building design through initiatives like the e-construction platform combined with the Estonian Building Registry (EBR) (Arrak et al., 2024). This also includes enhancing the EBR to support permit processing based on BIM. The outputs encompass IT solution development, digital construction environments, and updated standards, all led by the Ministry of Economic Affairs and Communications in cooperation with public and private stakeholders (Ehituse pikk vaade 2035, 2021). However, the vision document fails to address that merely digitizing problematic processes won't achieve our goals. There is a need to reassess and redesign current processes with data-centric approaches at their core.

Despite these ambitions, the current building permit process continues to suffer from structural and procedural issues. Most notably, the process lacks transparency, which leads to miscommunication between stakeholders, prolonged processing times, and inconsistent application of regulations (Malsane et al., 2015; Ehituse pikk vaade 2035, 2021; Arrak et al., 2024). In this context, transparency refers to the clear, consistent, and accessible articulation of procedural steps, decision-making criteria, and regulatory requirements throughout the permitting process. Despite nationwide regulations and guidelines, specialists in different municipalities review and process applications inconsistently, resulting in variable processing times and correction requests across municipalities (Arrak et al., 2024). This creates a paradoxical situation where standardized national regulations result in non-standardized outcomes. These problems may lead engineers to design projects based on local practices rather than national standards, resulting in projects that may deviate from national regulations while still receiving approval.

An analysis conducted in 2019 revealed inconsistencies in building permit processes across municipalities and even between individual reviewers, despite all municipalities being required to operate under the same national legal framework (AS PricewaterhouseCoopers Advisors, 2019). Applicants describe this inconsistency as “noise” in decision making, forcing them to engage in informal pre-consultations to familiarize themselves with the personal or local preferences of permit reviewers (AS PricewaterhouseCoopers Advisors, 2019). These findings are supported by a 2024 study on the digitalization situation in the Estonian construction sector, where 37.3% of respondents indicated a need for simplifying state procedures such as planning and building permit applications (Arrak et al., 2024). However, the pre-consultation phase remains outside the formal building permit process. This situation is deepened by the ambiguity in legislation, which gives local authorities considerable discretion in procedural implementation. The result is excessive subjectivity, inconsistency, and confusion for applicants regarding which requirements must be met in their specific case.

The current (AS-IS) building permit process lacks detailed documentation, particularly regarding stages where project requirements are determined and compliance is assessed. This transparency gap creates procedural inconsistencies, resulting in inequalities and inefficiencies across municipalities. The proposed (TO-BE) process improvements include an address-based early view of applicable restrictions and BIM building permit functionalities. However, this proposed functionality fails to address the issue that the nature of each building permit application is dependent on the planned building technical solutions and construction activities.

Implementing BIM for permit applications would allow applicants to refine designs before submission, using partial validity checks before formal review, thereby reducing revision needs and accelerating the overall process. While the BIM model check added to the Estonian Building Registry (EBR) does, in some ways, function as a pre-consultation, it is applicable at the stage right before application submission, when the applicant already has a model. Moreover, the rules it checks are not filtered according to the specifics of the planned building project. As a result, applicants must already know which regulations apply and under what conditions, making it less of a guidance tool and more of a pre-check function.

In 2024, a BIM-based building permit applications module was added to the EBR, allowing applicants to pre-check models against select requirements (Ministry of Economic Affairs & Communications, 2021). As of April 2025, the BIM is in the beta-testing phase. The module incorporates numerous rule-based checks that must be resolved before an application is submitted for review. However, despite these improvements, it remains unclear

which regulations can be automated, requiring clarification to ensure consistency and credibility (Ministry of Economic Affairs & Communications, 2021). Furthermore, a fundamental issue remains unresolved: determining which regulations apply to specific cases as early in the design process as possible.

A building permit guarantees the lawfulness of the building and its construction (compliance with the basic requirements of the building, the requirements for construction, and the design of the construction project and allows for its subsequent inspection and use (Sorainen and TalTech, 2024). The Estonian Building Code aims to ensure the safety, proper functionality, and usability of the built environment, while supporting sustainable development (Riigikogu, 2015). The Code generally states that buildings must be designed, constructed, and maintained following good practice, which must also be followed in other regulated activities.

Yet a gap in current understanding of the building permitting lies not in the decision-making itself, but in the foundations of those decisions. Specifically, what must be checked, when, why, and how. A key challenge is that construction laws primarily define obligations and general principles, and only a few detailed, verifiable provisions. However, most objective compliance criteria are found in industry standards, guidelines, and best practices rather than in legislation itself. These documents are scattered, making comprehensive consideration difficult.

Compounding the issue is a fragmented legal framework. There are different sub-legislative acts for general construction and private buildings, which contain extensive exemptions and also vary widely in the level of detail of the rules laid down. It is not a question of imposing requirements specific to the building, but of different definitions of the concept of a building project and the repetition of general requirements for the preparation of a building project in different pieces of legislation (Sorainen and TalTech, 2024).

Interviews

The interviewees identified several critical challenges in the building permit process. Respondents emphasized that generically worded building regulations frequently result in miscommunication and procedural delays. The inconsistent interpretations across different municipalities and specialists were confirmed by multiple interviewees, with one of them stating that submitting identical projects to two different municipalities would result in substantially different outcomes. This highlights the presence of inconsistency in building permit decision-making processes.

This variance in review procedures and lack of transparency create a high level of unpredictability, often resulting in prolonged exchanges between applicants and authorities. Official documents give little detail on how applicable regulations are determined, and do not address how workflows differ by application type (building permit or building notification). Consequently, reviewers' decision-making relies substantially on professional expertise, which varies significantly across specialists in different municipalities. Although one municipality employs an in-house guide outlining the review process and required specialist approvals, it is not widely utilized. Most interviewees rely on personal checklists or tools to ensure thoroughness, while acknowledging that human error occasionally leads to oversights.

Although pre-consultation is not mentioned in national regulations, this practice is common in municipalities where most applications concern single-family houses. In these areas, property owners typically contact local building specialists before beginning construction and submitting permit applications. It is less common in larger municipalities, where heavier workloads limit specialists' availability for early-stage consultation. In this case, some applicants proactively contact authorities to prevent unexpected obstacles later in the process.

All interviewees confirmed that engaging in pre-consultation during the early project design stages significantly enhances the permit process by improving transparency and reducing delays. To support this, the Estonian ministry developed a building guide website, intended to inform about legal requirements and serve as an informative service or informal pre-consultation aid by providing detailed information about building regulations in simple language for both professionals and the public. However, interviewees acknowledged that while helpful, the guide alone doesn't resolve all sources of confusion.

All interviewees expressed concerns about the centralized EBR. While designed to support the permit processes and related communication between stakeholders, the system lacks intuitive design and user-friendliness, failing to evolve with changing processes and user needs. This results in technical issues, delays, and miscommunication, particularly for users who lack expertise. The mandatory nature of the EBR leaves applicants with no alternative but to navigate its complexities. Also paper-based applications (now rare) must be scanned and uploaded to the system by municipal staff for processing, as required by law. Most municipalities lack resources for tailor-made solutions and must rely entirely on the EBR. This situation shows that unifying building permit processes requires implementing changes directly through the EBR system.

Summary of Identified Challenges

The significant and persistent problems found in the current building permit process:

- Inconsistencies and subjectivity in decision-making
- Lack of procedural transparency
- Fragmented and non-standardized requirements
- Generally worded legal framework
- Technical shortcomings in the EBR system

In the following section, these findings are analyzed based on academic literature. The EBR system shortcomings will not be examined further, as they fall within the scope of future research. The issue of fragmented and non-standardized requirements in the Estonian construction

legislative framework is context-specific and therefore not discussed through the lens of academic literature.

Theoretical Analysis of Defined Issues

Inconsistencies and subjectivity in decision-making

While the construction industry has traditionally been resistant to change, there has been a notable shift towards digitalization, with Building Information Modeling (BIM) becoming standard practice (Eastman, 2011). However, fragmented data, a lack of integrated platforms, insufficient data standardization, time-consuming processes, and misalignment between local governments and industry professionals continue to hinder progress. Addressing these challenges requires a fundamental shift toward improved data interoperability to ensure seamless, accurate, and efficient data exchange across stakeholders (Wimmer, 2021). This shift also supports more consistent and objective regulatory interpretation, by making decisions based on structured, comparable data rather than personal judgement.

The industry must move beyond traditional paper-based and electronic document exchanges to focus on data access, sharing, and processing (Konstantinidis et al., 2024). This shift will support the harmonization of building permit processes across jurisdictions while ensuring efficiency, transparency, and compliance with public needs (Fauth et al., 2024).

Much like the transition from Computer-Aided Design (CAD) to BIM, adopting a data-centric governance model represents more than just a technological change—it constitutes a paradigm shift in public governance, emphasizing direct data access and improved transparency while reducing redundant efforts within public administration (Konstantinidis et al., 2024).

The transition to data-based digital permitting faces significant technical hurdles, particularly regarding the format of existing building regulations. Most building regulations currently exist in unstructured textual formats, such as PDFs or legal documents. This presents a significant challenge as regulations must be translated into machine-readable formats to enable structured rule interpretation and decision-making assistance. Advancements in Natural Language Processing (NLP) and Large Language Models (LLMs) offer promising solutions to this challenge (Li, Jiang and Xu, 2025). These technologies demonstrate potential for extracting, structuring, and translating regulatory information into formats compatible with BIM-based compliance models. (Li, Jiang and Xu, 2025). By enabling structured rule interpretation, these technologies reduce reliance on individual reviewers' experience and support more consistent decision-making.

For digital permitting solutions to be fully effective, it is vital to consider mandating machine-readable regulation writing alongside natural language regulations in future lawmaking processes (Konstantinidis et al., 2024). This requires a collaborative effort from legislative bodies, regulatory agencies, and industry stakeholders to establish unified policies, interoperable platforms, and standardized methods for rule representation.

Lack of procedural transparency

The building permit application phase impacts the construction project schedules and costs (Bloch and Fauth, 2023). One major obstacle to its digitalization is the lack of detailed analysis of sub-processes within the permitting workflow (Noardo et al., 2022; Bloch and Fauth, 2023). This study focuses in particular on the pre-consultation phase, which is currently formally implemented only in six of the 17 European countries, e.g., Belgium, Finland, Hungary, Portugal, Romania, and Sweden (Fauth et al., 2024).

To improve the quality and consistency of permit reviews, a standardized and centralized database of permitting workflows is essential. Without it, transparency is lost due to undocumented steps and inconsistent procedures. Current approaches tend to treat permit digitalization as a purely technological problem, neglecting the importance of integrating regulatory, organizational, and technological perspectives. Since permitting primarily involves public-sector stakeholders, research must start with understanding and improving governmental procedures before adapting them for the private sector (Eleni Papadonikolaki, Ilias Krystallis, and Bethan Morgan, 2020; Bloch and Fauth, 2023).

While efforts have been made to automate individual sub-steps, a lack of end-to-end integration continues to cause inefficiencies. Streamlining the process requires integrating the building permit review workflow with building data and automated code compliance checking (Zentgraf et al., 2023).

Moreover, there is no publicly accessible information on how regulations should be interpreted and applied. Although some municipalities have internal guidelines, their non-public and inconsistent nature demonstrates the lack of shared regulation interpretation, supporting the case for improved transparency. Furthermore, the process for determining which requirements should and could be automatically checked in digital systems remains undocumented. While some research has examined this issue from a project management perspective (Fauth and Seiß, 2022), government-driven innovation has proven more effective in addressing challenges in the dynamic construction sector (Li, Jiang and Xu, 2025).

Recognizing the necessity of collaborative, cross-border digital permitting solutions, the building permit digitalization community has emphasized the importance of joint efforts among stakeholders. As a result, EUnet4DBP was established, bringing together researchers, public authorities, private sector stakeholders, and other experts to develop a scalable, cross-jurisdictional approach. Because development varies across Europe, a unified strategy for interoperability and regulatory standardization is essential (Noardo et al., 2022; Fauth et al., 2024).

Generally worded legal framework

Many efforts have attempted to automate the building permit process (Noardo et al., 2022; Ataide, Braholli and Siegele, 2023; Bloch and Fauth, 2023; Chen et al., 2024), but no satisfactory solution has emerged. One reason is that building legislation primarily defines obligations and general principles, rather than detailed, verifiable requirements for specific solutions or components.

A significant challenge to automation is that building regulations are often written in general terms, creating "fuzzy rules" that contribute to inconsistent interpretation and miscommunication (Wimmer, 2021). At the core of the issue lies the interpretation of legislation, which shapes all sub-processes of the building permit review. For effective rule interpretation, regulations must be clearly defined and understood uniformly by all stakeholders, minimizing subjective interpretation (Li, Jiang and Xu, 2025). However, studies show that non-expert users find legislation difficult to understand, worsening the problem. While some flexibility in interpretation is necessary, this often extends even to clearly stated rules.

The lack of standardized rule representation in the AEC industry leads to inaccuracies and scalability challenges (Wimmer, 2021). Many current approaches borrow representation methods from other fields but fail to capture the complexities of construction regulations. Additionally, logic-based rule representations often conflict with object-oriented BIM standards, causing mismatches between rules and the models. These issues are further complicated by semantic differences across languages, hindering international collaboration and leading to redundant research (Li, Jiang and Xu, 2025).

Regulatory automation also faces obstacles due to building regulations often containing complex preconditions scattered across multiple sections, which traditional rule-based approaches struggle to capture. A hybrid approach that combines rule-based and statistical machine learning models, is needed to address this challenge (Abdullah et al., 2023). NLP can extract preconditions and conditional requirements from regulations, while LLMs use the Chain-of-Thought prompting techniques, which help break down complex regulatory scenarios into smaller, structured components, improving reasoning accuracy and formalizing preconditions (Konstantinidis et al., 2024).

In Estonia, the scalability of these tools remains a question, as current language comprehension models are not fully developed. While evidence for these technologies is based on widely spoken languages like English, adapting them to Estonian's unique intricacies presents additional challenges.

For long-term system interoperability, ontology-based approaches offer advantages. Their class structures and properties naturally align with rule logic, more accurate compliance verification than syntax-based approaches (Zhong et al., 2019). Semantic Web technologies allow for parallel compliance checks, where multiple stakeholders can review different building codes simultaneously, with results consolidated into a unified report. This approach enhances objectivity, transparency, and decision-making efficiency allowing for scalability across borders (Zentgraf et al., 2023).

Table 2: Building permitting issues in Estonia

Main issue	Sub-Issue	Reference
Inconsistencies and subjectivity in decision-making	Subjective interpretation of building regulations across municipalities	Secondary Data, Interviews, Theoretical Analysis
	Varying application of national standards by different specialists	Secondary Data, Interviews, Theoretical Analysis
	Lack of early requirements identification in the design process	Secondary Data, Interviews
	Unpredictable application of regulations to specific building projects	Secondary Data, Interviews
Lack of procedural transparency	Insufficient documentation of permit review procedures	Secondary Data, Interviews, Theoretical Analysis
	Informal pre-consultation phase not officially recognized	Secondary Data, Interviews, Theoretical Analysis
	Unclear methods for assessing regulatory compliance	Secondary Data, Interviews
	Limited explanation of decision rationale to applicants	Secondary Data, Theoretical Analysis
Generally worded legal framework	Building regulations are written in general terms	Secondary Data, Interviews, Theoretical Analysis
	"Fuzzy Rules" leading to inconsistent interpretation	Secondary Data, Interviews, Theoretical Analysis
	Technical language barriers for non-expert users	Secondary Data, Interviews, Theoretical Analysis
	Conflicting interpretations among different stakeholders	Secondary Data, Interviews, Theoretical Analysis
Fragmented and non-standardized requirements	Building requirements are scattered across multiple documents and sources	Secondary data
	Exemptions complicating regulatory understanding	Secondary data
	Inconsistent definitions of building project concepts	Secondary data
	Difficulty identifying all applicable regulations for specific projects	Secondary data, Interviews
	Compliance criteria are located in industry standards rather than laws	Secondary data

Discussion: Solution Objectives

The analysis reveals significant issues with the building permit processes in Estonia, which are summarized in Table 2. These problem categories form the basis for defining the objectives of a digital artefact that could address them.

The findings highlight the need for a solution that reduces subjectivity, improves transparency, and provides early, case-specific guidance for applicants. As the Estonian Building Registry (EBR) is the central platform for permitting, the artefact must be integrated into it to ensure procedural consistency across municipalities. It should help standardize procedures while accommodating local context, identify applicable requirements early, streamline review tasks, and reduce revision cycles by clarifying expectations for both applicants and reviewers. These objectives define the expected functionality of the artefact to be developed in subsequent phases of the research.

Designing such an artefact will require a hybrid automation system that combines a human-in-the-loop method with automated rule checking. While subjective decisions, particularly in cases of cultural heritage sites or for determining whether the design fits within the context, still require human interpretation, objective criteria such as the length of an evacuation route or building height limits could and should be automated within a structured framework. This would limit subjectivity while ensuring all objective compliance checks adhere to predefined criteria.

To support this, the artefact must enable integration with BIM workflows while ensuring a human-in-the-loop approach for critical decision-making stages (Konstantinidis et al., 2024; Li, Jiang and Xu, 2025). It should also be capable of translating legal and regulatory into computable logic. This depends on having regulations that are machine-readable and aligned with BIM structures, which in turn requires unified rule representation methods and the application of natural language processing (NLP) technologies (Li, Jiang and Xu, 2025).

Advancements in NLP-driven text analysis, ontologies, and AI-driven compliance verification enable the extraction and structuring of regulatory content while maintaining human oversight for context-dependent evaluations. A promising example is the integration of BMC with NLP, which has been shown to outperform manual methods in processing and interpreting large volumes of complex textual information (Li, Jiang and Xu, 2025).

Conclusion

In a small and digitally advanced country like Estonia, the building permit process is expected to be coherent and transparent. However, in practice, this is often not the case. There are considerable inconsistencies between municipalities in how building regulations are interpreted and enforced, with stakeholders experiencing inefficiencies rooted in technical constraints, fragmented communication, and opaque decision-making (AS PricewaterhouseCoopers Advisors, 2019; Arrak et al., 2024).

Addressing our first research question on key challenges in the building permit process, we identified four critical areas: inconsistencies and subjectivity in decision-making, lack of procedural transparency, a generally worded legal framework, and fragmented requirements. These challenges create regulatory inconsistencies across municipalities, extend processing times, and undermine the effectiveness of the entire system.

Drawing on findings from the previous sections, the artefact should standardize procedures while accommodating municipal variations, provide transparent pre-consultation tools, serve as both validation and reference tools, reduce review cycles, and support more informed decision-making through a hybrid automation approach.

This research emphasizes the importance of clear, structured, and standardized processes for building permit compliance. Municipalities and regulatory bodies should prioritize interoperability and data standardization over fragmented, tailor-made approaches. While technology offers solutions to persistent inefficiencies, the findings show that achieving a data-centric permitting system also requires a structured regulatory framework, clear process definitions, and collaborative efforts between policymakers, industry professionals, and researchers.

From an academic perspective, this study highlights a gap in the detailed analysis of the regulatory decision-making processes involved in building permitting workflows. Existing research often takes either a top-down approach, focusing on policy-level transformations, or a bottom-up approach, concentrating on isolated automation solutions without a comprehensive integration framework (Bloch and Fauth, 2023).

The next step in this research is to create a detailed map of the regulatory decision-making process involved in building permitting workflows. This map will serve as a foundation for developing an artifact aimed at making the process more efficient, transparent, and clear for all stakeholders. Addressing these challenges will ensure that building permit processes evolve into transparent, efficient, and reliable digital workflows, ultimately supporting sustainable urban development and regulatory compliance.

Acknowledgments

This work has been supported by the Estonian Research Council grant (PSG963). I would also like to thank Christopher-Robin Raitviir for providing access to interview transcripts he conducted in 2021, which informed the background understanding for this study.

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