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BOOK OF ABSTRACTS

Editors:

Harald Urban, Simon Fischer, Christian Schranz, Francesca Noardo, Jaan Saar, Judith Fauth

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Overview

Digitalisation of building permits was detected as the critical knot to be solved, in order to pave the way towards massive digitalisation in the construction industry, and to enable the potential of automation and optimisation in the management of building and city data.

The topic has been developing for a couple of years and now some mature solutions start to be available. Moreover, some important cross-border (e.g. European) projects as well as other local initiatives are currently running and can present their results.

Therefore, the EUnet4DBP, together with several relevant organisations, is organising the "Digital Building Permit conference" to dive into the current status of research, developments and implementations, and to provide the opportunity for several digital building permit actors to meet and discuss.

Multidisciplinarity and inter-sectoral collaboration are key to solve the multifaceted and complex challenge of building permit digitalisation. Therefore, the conference will be structured to host several different kinds of contributions and activities, from research to implementations, with a relevant part reserved to users and stakeholders, in order to investigate the challenges of the solutions' uptake.

Objectives

- Share progress all over Europe and the World
- Engage policy developers and regulators
- Show benefits and the value of building permit digitalisation through concrete examples
- Share solutions and components from several developers
- Encourage municipalities to bring their points of view and expertise
- Tackling the remaining outstanding problems and challenges
- Legal aspects discussion
- Share developments and experiences about data and technology for digital building permits

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Conference Topics

The conference focused on, but will not be limited to, the following topics.

Legislative system

- Capturing regulatory content
- Ambiguity and subjectivity in regulations
- Public policy, mapping, archive and records
- Sustainability and environmental checks supported by digital building permits
- Energy performance contracts and use cases related to retrofitting of existing buildings

Procedural system

- Quality of applicant submissions
- Implementation steps for transition
- Privacy in digital building permit
- Digital compliance

Organizational system

- Social, environmental and business case for digital permitting
- Legal, credibility and ethical challenges
- Training and education for digital building permit
- Applications of digital building permit in municipalities
- Advantages and benefits of digital building permit

Technological system

- Technologies for supported and automated compliance checking
- Current implementations
- Checking software demos
- Interoperability and software architectures and components for digital building permits
- Data, standards and ontologies in digital building permit
- GeoBIM

Scientific Committee

All research papers presented in this Book of Abstracts have been subjected to a peer-review process conducted by the members of the Scientific Committee. Each contribution was evaluated with regard to its scientific merit, methodological soundness, and relevance to the conference themes, thereby ensuring the academic quality and integrity of the published work. The research full papers will be published in an official Springer proceedings volume.

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Contents

Part I

Research-Track

A Hybrid BERT–LLM Approach for Regulation Graph Generation & Visualization from Fire Safety Documents

Jorge, Tomás [1]; Ribeiro, Diogo [1]; Reis, Jéssica [2]; Gavina, Rui [2]; Donkers, Alex [3]; Petrova, Ekaterina [3]; Canito, Alda [4]; Driesen, Cedric [5]

[1] iBuilt, School of Engineering, Polytechnic of Porto, Porto, Portugal;
[2] VN2R-Engineering Innovation Consulting LDA, Porto, Portugal;
[3] Information Systems in the Built Environment, Eindhoven University of Technology, De Groene Loper 6, Eindhoven, The Netherlands;
[4] GECAD/LASI, ISEP, Polytechnic of Porto, Porto, Portugal;
[5] Buildwise, Kleine Kloosterstraat 23, 1932 Zaventem, Belgium

The efficient application of fire safety regulations in the early stages of a project is often hindered by their unstructured language and dispersion across multiple legal documents. This fragmentation poses challenges for automatic interpreta-tion and hinders the digitalization of compliance verification processes. In this context, the paper introduces an innovative hybrid methodology that integrates pre-trained neural models (BERT) with large language models (LLMs), specifi-cally Gemini Flash 2.5. The main objective is to automatically transform natu-ral language regulations into a machine-readable format 'representing regulatory requirements as knowledge graphs, using a pre-defined regulation ontology. The proposed methodology was validated using Portuguese fire safety regula-tions and demonstrated strong adaptability across different regulatory docu-ments. The results reveal a significant reduction in manual effort and human er-ror traditionally associated with compliance tasks, while incorporating a Hu-man-in-the-Loop strategy to ensure expert validation at critical stages of the process. Overall, this work makes a substantial contribution to intelligent regu-latory automation and provides a solid foundation for automated compliance checking.

A Procedural Prototype for BIM-based Fire Safety Review in Building Permitting

Jost, Evelyne; Marcinkeviciute, Daiva

University of Applied Sciences and Arts Northwestern, Switzerland

Building permit authorities face increasing workloads due to inconsistent or incomplete submissions and the rising complexity of fire safety requirements. While Building Information Modelling (BIM) has been partially adopted in fire protection – mainly during design and construction phases – its application in early permitting stages remains largely unexplored, particularly in Switzerland, where BIM-based submissions are not yet practiced. This study investigates the feasibility of integrating BIM into the fire safety review process through a procedural prototype developed within a permitting case study. The study contributes a modular structure for information requirements, a proposed extension of the IFC schema, and conceptual visualization elements to enhance human–machine interaction in regulatory checking. The prototype implements automated rule sets for formal and technical compliance and defines structured information requirements aligned with Swiss fire protection standards. During testing, the initially comprehensive information model proved overly demanding, reflecting the ambition for automation across all possible fire safety concepts. In response, a modular structure was developed to balance automation potential with practical applicability, representing a transferable contribution that could be adopted by other permitting authorities seeking to advance digital review processes. Findings indicate that, under current conditions, visual and software-assisted checking offers a more applicable approach than automated checking. The study demonstrates the procedural feasibility of BIM-based fire safety review in a permitting context, while acknowledging that its conclusions are based on a single case and therefore limited in generalizability. Nonetheless, the results represent a novel step toward advancing BIM-based permitting prac-tices in Switzerland beyond fire protection.

A scalable AI enabled framework for digital building permit compliance verifications

Crisan, Andrei-Nicolae [1]; Pepe, Massimiliano [2]; Fenyo, Andrei-Ladislau [3]; Deac-Kaiser, Stefanie-Brigitte [1]

[1] Politehnica Univeristy of Timisoara, Romania;
[2] "G. d'Annunzio" University of Chieti-Pescara in Geomatics;
[3] Filiala Teritorială București a Ordinului Arhitecților din România

Digital building permitting (DBP) remains constrained by fragmented workflows, document-based exchanges, and the limited ability of existing standards to represent complex spatial and contextual regulatory rules. Although openBIM standards such as IFC, IDS and bSDD provide a foundation for model-based workflows, they are less suited for handling dynamic scene composition and geometry-dependent compliance checks. The paper addresses this gap by proposing a conceptual hybrid framework for DBP that combines openBIM standards with openUSD, a scene-graph-based and AI-ready data environment. The study follows a conceptual design methodology that integrates insights from literature review on automated code-compliance approaches with a case-based analysis of the Romanian Urban Planning Certificate as a representative example of multi-layered building permitting (BP) constraints. The framework distinguishes between property-based rules, which can be encoded and checked via IDS, and spatial or context-dependent rules, which benefit from openUSD's hierarchical and geometric representation combined with AI-assisted reasoning. The resulting hybrid BP pipeline illustrates how regulatory data, design models and automated checking routines can be federated within a single interoperable environment. While still conceptual, the framework defines a structured pathway for future prototyping, regulatory sandboxing and cross-border harmonization, contributing to the digital transformation of BP processes in Europe.

AI-Powered Compliance Checking for Construction Permits: A Case Study in accessibility regulations

Garcia, Oihana; Fernandez, Cristina; Aceta, Cristina; Díez, Francisco Javier; Romero, Ricardo

Fundacion Tekniker, Spain

Verifying projects against applicable regulations is essential in various fields such as construction, finance, and environment. This process, also termed compliance checking, is crucial for organizations to ensure that legal obligations are fulfilled when handling official documentation. As human verification of projects is time-consuming and prone to errors, developing an automated system to perform this task is of great importance. Taking advantage of the reasoning, understanding, and natural language generation capabilities of Large Language Models (LLMs), this work presents a system that assists users in verifying that projects comply with their corrresponding regulations in a more automated way. This system, based on a Retrieval-Augmented Generation (RAG) architecture, allows, in a real-world use case related to Bilbao's city council, to reduce the time spent and increase the accuracy obtained when verifying major construction projects against accessibility regulations. Its evaluation has proven to be a useful system to simplify this task, with good accuracy and a useful compliance analysis for the user, although there is still room for improvement to make the task 100% automatable.

Aligning Multi-Domain Ontologies to Automate Builidng Permit Review Processes

Fauth, Judith [1,2]; Yin, Mengtian [2]; Brilakis, Ioannis [2]

[1] Technical University of Munich, Germany; [2] University of Cambridge, United Kingdom

The building permit reviews require coordination between multiple agencies, particularly when road infrastructure is involved. This study integrates the National Highway Ontology and the Ontology for Building Permit Authorities (OBPA) to automate decision-making in permit reviews. By aligning these ontologies, the framework ensures relevant road agencies are involved based on predefined rules, enhancing cross-domain collaboration and regulatory compliance. A real-world case study validates the approach, demonstrating its potential to streamline inter-agency workflows. The findings highlight how interconnected ontologies can improve digital governance, reduce inefficiencies, and integrate infrastructure planning with urban development.

An Integrated LLM-BIM Semantic-Geometric Framework for Automated Building Code Compliance

Mirhosseini, Nikoo; Shojaei, Davood; Sabri, Soheil

Melbourne University, Australia

Building regulations are becoming increasingly complex, ambiguous, and multi-modal, posing substantial challenges for automated compliance checking in the Architecture, Engineering, and Construction (AEC) domain. While Building Information Modeling (BIM) provides rich, structured geometric data, aligning regulatory semantics with BIM geometry remains a significant challenge. This study presents a novel, fully integrated LLM–BIM semantic–geometric framework that combines large language model (LLM)-enabled multi-modal regulatory parsing, IFC-based BIM geometric data extraction, a semantic–geometric fusion layer, explainable question-answering (QA) modules, scalable orchestration via a Multi-Agent System (MAS), and comprehensive regulatory traceability through a Model Context Protocol (MCP). The framework demonstrates feasibility through detailed theoretical analysis and structured conceptual validation, showing how semantic interpretation and geometric reasoning can be dynamically unified to deliver explainable, jurisdictionally adaptive compliance assessments and actionable, data-driven remediation guidance. The proposed architecture establishes a scalable, transparent, and methodologically robust foundation for the next generation of AI-powered regulatory intelligence systems.

Application of an automated, LLM-based methodology for interpreting normative texts: from information requirement identification to data standardisation in IFC

Siegele, Dietmar [1]; Braholli, Orjola [1]; Ataide, Mariana [1]; Mastrolembo Ventura, Silvia [2]; Comai, Sara [2]; Raj, Kavita [2]; Ciribini, Angelo Luigi Camillo [2]

[1] Fraunhofer Italia; [2] University of Brescia

Interpreting building regulations manually, particularly accessibility requirements, is labour-intensive, subjective, and prone to inconsistency. This paper proposes a hybrid human-AI workflow leveraging a Large Language Model (LLM) to automate the transformation of regulatory text into structured, machine-readable terminology aligned with the Industry Foundation Classes (IFC) schema. Initially, accessibility clauses from regulations of four European municipalities were subjected to manual semantic analysis, creating examples to guide the LLM. Through structured prompts, the LLM systematically translates regulatory text, identifies relevant building objects and properties, maps these accurately to IFC entities, and generates standardized tables outlining compliance criteria. Deployed via a chat-based interface, our approach significantly reduced clause interpretation time compared to traditional manual methods. Evaluation against expert-established examples indicated a good interpretation performance, including language translation, IFC mapping, and structured output completeness, requiring minimal human post-processing. These findings confirm the practical feasibility of LLM-assisted regulatory interpretation, underscoring its potential to optimize compliance processes, improve consistency, and reduce human cognitive load within digital building-permit workflows.

Automating Building Model Preparation: A Comparison of LLM Performance on IFC-4x and IFC-5x

Iversen, Odin [1]; Hjelseth, Eilif [1]; Fauth, Judith [2]; Huang, Lizhen [1]

[1] Norwegian University of Science and Technology, Norway;
[2] Technical University of Munich, Germany

A key part of digital building permitting (DBP) is automatic compliance checking (ACC), which can be divided into four classes of functionality: 1) rule interpretation; 2) building model preparation; 3) rule execution; and 4) reporting checking results. Despite the goal of creating ACC artifacts being automation, building model preparation is still mostly manual work. Additionally, the ACC artifact often introduces additional information requirements, resulting in increased manual labor in preparing the building models. A key part of information extraction is the understanding of requirements, related terms, and definitions, which are language-based challenges. Thus, large language models (LLMs) have the potential to facilitate automation of information extraction and to assist in building model preparation. Building models are often in the form of building information modelling (BIM) models using the Industry Foundation Classes (IFC) format. While IFC-4.x and earlier versions are based on open standards, they rely on isolated geometric representations. The emerging IFC-5 format, however, adopts linked data principles, enabling richer semantic context and more interconnected information structures. This richer context may significantly improve an LLM's ability to interpret and process model data. This study presents a comparison of an LLM-based information extraction system's performance on building models represented in IFC4.x versus IFC5, revealing that the JSON-based IFC5 format enables significantly more accurate and reliable data extraction. This finding represents a critical step toward automating building model preparation in ACC artifacts.

Automating the assignment step in the building permit process – Empirical insights and ontology extensions

Pötz, Aurica [1,2]; Fauth, Judith [3]; Seiß, Sebastian [4]; Díaz, Joaquín [1,2]

[1] 5D Institut GmbH, Germany;
[2] Technische Hochschule Mittelhessen University of Applied Sciences, Germany;
[3] Technical University of Munich, Germany;
[4] Bauhaus-Universität Weimar, Germany

The building permit process is often slow and criticized, particularly in light of the global housing shortage. While digitalization and automation have been applied to several stages of the planning and building process, the assignment in the building permit process remains underrated. The selection of the building official can be critical to the efficiency and quality of the application review process. This two-stage study investigates the assignment process in an international context and extends the existing Ontology for Building Permit Authorities (OBPA) to support automation. A mixed-research-method approach combining interviews in 13 European countries and a survey in Australia was employed. Findings indicate the types of assignments and diverse decision criteria across all authorities. The results were used to extend the OBPA with internationally applicable rules and to enable automated machine-decided assignments. The ontology's modularity ensures adaptability to different legal and administrative systems. By formalizing assignment logic through machine-readable rules, the decision-making process can be conducted transparently, objectively, and traceably.

Automation of Processes for Building Permit Validation: A Case Study on Buildability Index in Spanish Construction Sector

Pérez-García, Ana [1]; Muniz, Bruno [2]; Granja, José [2]; Azenha, Miguel [2]; Martín-Dorta, Norena [1]

[1] Departamento de Técnicas y Proyectos en Ingeniería y Arquitectura, Universidad de La Laguna (ULL), Avenida Ángel Guimerá Jorge, s/n, 38204, La Laguna, (Tenerife), Spain;
[2] Department of Civil Engineering, ISISE, ARISE, University of Minho, Guimarães, Portugal

The process of obtaining building permits is fundamental in regulating and overseeing construction projects, ensuring their safety and compliance with local urban planning regulations. Traditionally, this procedure has been manual, involving the management of extensive physical documentation, inter-institutional coordination, and prolonged waiting times, which can delay projects and significantly increase costs. The digitization of these processes, driven by recent technological advances and European directives for sector modernization, represents a strategic opportunity to improve efficiency, transparency, and traceability in the granting of permits. In this context, this work develops and validates an open-source digital tool focused on automating the calculation of the buildability index from BIM models in IFC format, exemplifying the potential of digitization in building permits. The solution, implemented in Python, integrates modules for automatic retrieval of cadastral data, geometric processing of BIM models, and regulatory validation according to urban planning parameters. The automated workflow allows extraction of built areas per floor, distinction of specific elements such as balconies (adjusting their contribution to buildability according to regulations), and comparison of results against established legal limits, thus facilitating compliance in the permitting process. Its effectiveness is demonstrated through a residential case study, emphasizing the importance of digitization to advance toward smarter and more sustainable cities.

Best practices for geospatial technologies enabling Digital Building Permits

Noardo, Francesca; Toscano, Mayte; Atkinson, Rob; Villar, Alejandro; Zaborowski, Piotr

Open Geospatial Consortium, Belgium

The digitalisation of building permitting processes represents a critical step for modernising urban governance. This article highlights the results of the CHEK project towards such transformation through the development of open standards-based integration of geospatial data (GIS) and Building Information Models (BIM) within Digital Building Permit workflows. Building on its long-standing expertise in geospatial interoperability, the OGC provides a robust framework of standards (CityGML, GeoJSON, OGC API family) that enable consistent georeferencing, semantic alignment, and machine-readable compliance across domains. These are complementary to the buildingSMART standards (IFC, IDS, bSDD) and underpin the implementation of traceable, auditable and modular processes that can be integrated within public sector digital infrastructures. Scientific and technical contributions, including those developed within the CHEK project, demonstrate how standard-based workflows can be applied in real-world scenarios to bridge geometric, syntactic and semantic gaps between city representation and construction data. Through the use of semantic technologies, rule-based validation mechanisms, and geospatially enabled digital twins, OGC-led approaches show how automated permitting can be realised in practice. This work supports ongoing standardisation efforts across the built environment and geospatial communities, offering a reproducible and scalable path towards data integration and interoperability.

Beyond Binary Compliance: Mapping Hybrid Rule Logics for Logic-Aware Digitalisation of Building Codes

Nørkjær Gade, Peter [1]; Fauth, Judith [2]; Muneeb, Muhammad [2]; Holmberg Lauritzen, Dorthe [1]

[1] University College Nordjylland, Denmark; [2] Technical University of Munich, Germany

This paper investigates how building regulations embed multiple types of logic and how these logics are altered or erased in the process of digitalization. While current efforts to formalize building rules into computer-executable formats promise greater efficiency, they often treat regulations as discrete, technically neutral constraints. This reductive view risks flattening the interpretive, contextual, and normative dimensions that underpin rule application in practice. To address this problem, the paper introduces the concept of the rule space, a bounded interpretive domain shaped by language, regulatory intent, and disciplinary conventions. Drawing on a qualitative analysis of 143 normative clauses from the Danish building code, the study identifies four dominant types of regulatory logic: formal-legal, technical-functional, interpretive-practical, and fuzzy logic. These logics frequently coexist in hybrid structures, shaping how compliance is understood and how professional discretion is exercised. The paper demonstrates that digitalizing regulations without accounting for this hybridity leads to epistemic distortions, reduced design flexibility, and potential regulatory drift. By mapping how logics are distributed and interwoven in actual rules, the study offers both a theoretical framework and practical recommendations for developing logic-aware compliance technologies that preserve regulatory intent, support professional judgment, and maintain contextual responsiveness.

BIM-AI Permitting Framework for the Construction Industry in North Africa: Case Study of Algeria

Messaoudi, Mouloud; Nawari, Nawari

University of Florida, United States of America

The Algerian construction sector is one of the most promising markets in North Africa and is considered one of the fastest-growing sectors in the economy, alongside the industry and hydrocarbon sectors. According to the African Development Bank, the Algerian economy's growth rate increased to 4.2% in 2023, up from 3.6% in 2022. However, the complex matrix of laws and decrees required to obtain construction permits in Algeria has negatively impacted the issuance process of permits. Furthermore, the adoption of new laws to regulate existing constructions, such as Law 08-15 (2008), and the government's plans to increase the residential market by building new units across Algeria have put pressure on the authorities responsible for permitting, including municipalities and wilayas. As a result, the government has taken steps to streamline the construction permitting process by issuing Decree 15-19 (2015), which limits the timeline for issuing construction permits to 20 days. Additionally, the Guichet Unique system, a one-stop location for submitting permits, and Bawbetic, an e-permit portal for document submission, are being developed. However, these efforts have not yet leveraged cutting-edge technologies, such as BIM and AI. This study will highlight the gaps in the current system and introduce a BIM-AI-based framework to expedite the construction permitting process in Algeria, based on the Algerian National Code Standard. Advantages and limitations of the proposed system are discussed.

Classification of the degree of automation for compliance checking in standards

Hjelseth, Eilif

Norwegian University of Science and Technology, Norway

This study aims to investigate the level of readiness of requirements for implementation in solutions in a trustworthy manner. Following ISO standards are used as cases: ISO 15686-5:2008, including updated version ISO 15686-5:2017, ISO 15686-4:2014, including updated versions ISO/DIS 15686-3, and ISO 16745:2015, including updated version ISO 16745-1:2017. The standards were selected based on sustainability as scope, and included previous and current versions to identify trends in readiness for the digital processing of requirements. The technology for developing ACC solutions has been advancing rapidly. However, practical use is limited when implementing formal requirements from laws, codes, standards, contracts, best practices, and other written requirements. Clash detection, with simple rules processed without interpretation, is the dominant approach. The use of legal reasoning to clarify how requirements are transformed into computable rules for ACC solutions is generally lacking in ACC-related research. This study employs the Tx3 classification framework, Transcribe, Transform, and Transfer, to categorize the degree of automation for compliance checking in standards. The results indicate that the requirements in the standards are only partially prepared for direct implementation in ACC solutions. Newer versions of the standards are less prepared for ACC than the old standards. This finding is paradoxical because one would expect that preparing for digital processing would be improved. Increased share of performance-based requirements and the extension of scope to cover more complex situations are discussed. Offering two versions of each standard: a conventional text-based version and a digitally oriented version, is proposed as a solution.

Concept for modeling uncertainty in regulations in the context of BIM-based building permits

Exner, Hannah; König, Markus

Ruhr-Universität Bochum, Germany

The planning and approval of building projects are subject to diverse and evolving regulatory conditions. Before implementation, design proposals must be reviewed for compliance with a wide range of legal and technical requirements. In recent years, Building Information Modeling (BIM) has emerged as a promising method to support this process by providing structured, reusable building data. While progress has been made in translating deterministic rules into machine-readable formats, a major challenge remains: many regulatory texts include vague or discretionary terms that are difficult to formalize. This paper addresses that gap by proposing a structured approach to handling regulatory uncertainty within BIM-based building permit procedures. We introduce a rule categorization model (C1–C5) based on the State Building Code of North Rhine-Westphalia (LBO NRW), which distinguishes between deterministic, semantically enrichable, vague, discretionary, and non-operationalizable requirements. For vague terms (C3), fuzzy logic is applied to model gradual compliance. For discretionary provisions (C4–C5), structured decision logic and documentation techniques are proposed to ensure transparent, explainable assessments. The presented approach contributes to a more robust digital permitting architecture by extending existing rule-checking frameworks with mechanisms for uncertainty handling and traceability.

Definition of information requirements for the (semi-)automation of building height compliance checking in Italian municipality

Comai, Sara [1]; El Yamani, Siham [2]; Noardo, Francesca [3]; Stoter, Jantien [2]; Mastrolembo Ventura, Silvia [1]

[1] Department of Civil, Environmental, Architectural Engineering and Mathematics, University of Brescia, Italy;
[2] Section Urban Data Science, Delft University of Technology, Faculty of Architecture and the Built Environment-Urbanism, The Netherlands;
[3] Open Geospatial Consortium, Belgium

Recent research has focused on the digitalization of building permits, particularly the compliance checking of design compliance with legal constraints. Compliance checks are currently performed manually and involves an expense of time and possible subjective errors. Currently, research is investigating processes for the (semi-)automation of check compliance. In order to automate this step, it is essential to define Information Requirements (IRs) that the building and context models must have. The IRs, consisting of GeoBIM objects and properties, are included in the legal documents, so through the interpretation of the normative articles the level of information need can be established. The present work focuses on automating the compliance check of the building height in the Municipality of Ascoli Piceno, Italy. The IRs identified after the legal documents interpretation were the basis for further reasoning, such as IRs accuracy and completeness, to automated the compliance checking of building heights. The research highlighted the need to implement both designs and legal documents with additional elements for the accurate identification of the objects under check. For instance, the specification of the main building façade has been identified as a main feature to be implemented for the automation of the building height measurement process. Specifying base and end points of the main façade was essential for the proper height computation. Altogether, this research points out the need to revise building designs and normative articles, to promote the digital transition.

From property lists to checking rules: The evolution of information requirements

Fischer, Simon; Urban, Harald; Schranz, Christian

Research Unit Digital Building Process, TU Wien, Karlsplatz 13/E235-03, 1040 Vienna, Austria

Building authorities are increasingly influenced by digitalisation and are gradually adopting BIM. While the information content of 2D plans is well established and has been refined over decades, the information requirements for BIM models for digital building permits need to be defined. These information requirements need to be aligned with the objective of automatically checking the code compliance of the models and integrating the data into existing building authority information systems. Typically, information requirements concern the existence of properties and property sets for defined elements. With the new open format Information Delivery Specification (IDS) there are new possibilities to extend them and include more complex dependencies. Therefore, this paper examines the different levels of information requirements in the context of digital building permits. We analyse the current state of information requirements and then focus on how IDS can be used to enhance these information requirements. IDS allows information requirements to be refined and applied to very specific items, reducing unnecessary information. By this, logical and code compliance dependencies can be incorporated into the information requirements. Finally, we consider existing extensions to the IDS schema and their impact on the scope of the information requirements. As a result, we present a layered model for the development of information requirements for digital building permits, from text-based property lists to IDS-based logical and code compliance dependencies. This layered model can help building authorities to categorise the current state of their information requirements and develop them further.

Information Delivery Specification (IDS) for code compliance checking in context of the City of Vienna

Loibl, Patrick; Fischer, Simon; Pfeiffer, Daniel; Urban, Harald; Schranz, Christian

Research Unit Digital Building Process, TU Wien, Karlsplatz 13/E235-03, 1040 Vienna, Austria

Building authorities have started using BIM methods for automated code compliance checking (ACC) in the building permit process. As public authorities, they have additional requirements, particularly with regard to the use of open standards instead of proprietary formats. The open standard Industry Foundation Classes (IFC) is already in place for processed BIM models. However, the checking process itself is still based on proprietary systems. This paper therefore discusses the potential of using the open standard Information Delivery Specification (IDS) for ACC. Although IDS is initially intended for checking information requirements, it has the potential to be used for ACC as well. The City of Vienna already uses IDS to deliver its information requirements for the openBIM building permit process. ACC runs in Solibri Office in the current pilot phase. Using IDS for some checking rules would provide a more software-independent approach. We have explored the possibility of recreating the checking rules implemented in Solibri Office using IDS. Additionally, we considered an existing extension to the IDS schema to improve its functionality. The results show that standard IDS can perform several simple code compliance checks. The extension to the schema allows the implementation of further checking rules based on relations between elements, but limitations remain. IDS cannot cover a complete code compliance checking system. Nevertheless, it could facilitate software-independent pre-checking or establish a standard checking core that can be extended by any software with proprietary rules.

Integration of BIM and AI for Digital Code Compliance in North American Context

Hosseini Gourabpasi, Arash; Jalaei, Farzad

National Research Council Canada, Canada

This research analyzes the integration of Building Information Modeling (BIM) and Artificial Intelligence (AI) concepts by examining enabling technologies such as openBIM, AI, and semantic web technologies to facilitate the transition from traditional code compliance to automated digital code compliance. In this study, recent advances and successful implementation of compliance procedures in the literature are investigated and adapted to move towards digitalization and transformation of building code compliance in North America. The main issues identified are the complexities of building codes, stakeholder diversity, jurisdictional variability, and the need for semantic interoperability with current schemas like IFC (Industry Foundation Classes), which cause the problem. Some of these challenges are partly due to the nature of existing building codes, as they were not originally designed and authored to be machine-readable. However, leveraging existing technologies can automate and digitalize compliance processes. This study investigates best practices in the industry to understand how such solutions can be adapted for North American codes. The aim of the research is to enable a seamless transition to AI-assisted code compliance to reduce errors, increase productivity and encourage creativity in terms of innovative building designs. However, this transition is expected to have several challenges that need to be addressed, such as the need for identifying rulesets, rule formalization, code checking mechanisms, change management, and full automation before achieving digital code compliance in North America. This paper focuses on the National Building Code of Canada (NBC) to show the practical application of the proposed methodology.

Interpreting performance-based requirements by use of legal reasoning

Hjelseth, Eilif

Norwegian University of Science and Technology, Norway

Despite significant advancements in Automatic Compliance Checking (ACC), widespread practical implementation remains limited, particularly for qualitative and performance-based requirements, due to interpretative ambiguities. This study addresses this challenge by integrating legal reasoning methods and legal informatics principles into the interpretation process, with a particular focus on Fairness, Accountability, and Transparency (FAT) principles to bridge the technical-legal gap in interpreting requirements into computable rules. Utilizing a combination of literature review and case studies, the research examines three ISO standards (ISO/DIS 15686-3 [7], ISO 15686-5 [8], ISO 16745-1 [9]), analyzing their computability through the application of FAT principles. This includes emphasizing unbiased assessment as "Fairness", clear "Accountability" structures, and "Transparent" decision-making processes. Studies by use of the Transcribe–Transform–Transfer (Tx3) framework and the Test Indicator Objective (TIO) methodology indicate a notable reduction in non-computable requirements, exemplified by an increase from 57% to 83% of automated processing of requirements in the ISO 21542:2011 standard. Findings underscore the effectiveness of the Tx3 framework, TIO methodology, and FAT principles in addressing critical interpretative challenges, significantly enhancing the reliability, transparency, and acceptability of computational compliance checks. Integrating legal reasoning and informatics principles has the capability to significantly influence the critical early phases in the development of ACC solutions.

LLM-based Translation of Tables to Support Automated Compliance Checking

Zhang, Yuxian [1,2]*; Ren, Xuhua* [1]*; Amor, Robert* [2]

[1] Hohai University; [2] The University of Auckland

The implementation of Digital Building Permit (DBP) systems necessitates the adoption of Automated Compliance Checking (ACC). According to the ACC framework proposed by Eastman et al., regulatory codes must be translated into a computer-readable format to enable automated reasoning and validation. While considerable progress has been made in translating textual provisions, research on converting table data within these codes into a structured, machine-interpretable format remains largely unexplored. Based on Large Language Models (LLMs), this study proposed a prompt engineering workflow for translating table data into an XML format. The workflow consists of table data extraction, preprocessing, and prompt-driven transformation. During implementation, the LLM was guided through structured parsing steps and carefully designed instructions to output the corresponding XML representation. The proposed workflow was validated on a dataset of 200 tables extracted from structural design codes in the field of hydraulic engineering, using four state-of-the-art LLMs for table translation. The results demonstrated high similarity between the predicted outputs and the ground truth, thereby confirming the effectiveness of the proposed approach. All data and code are available at (https://github.com/zhangyu-xian/Table-data-translation/tree/main).

Personalized workflows for building permit applications

Nuyts, Emma [1]; Haesendonck, Gerald [1]; Werbrouck, Jeroen [2]; Van Hoecke, Sofie [1]; De Meester, Ben [1]; Verstraeten, Ruben [2]; Ongenae, Femke [1]

[1] IDLab, Ghent University – imec, Belgium;
[2] Department of Architecture and Urban Planning, Ghent University, Belgium

Architects and permit officers are familiar with the building permit process, but applicants often find it confusing, as they rarely deal with this complex procedure. Moreover, the steps and timelines involved in permit applications are highly context-dependent, influenced by factors such as the building's location and intended use, making it difficult for them to understand the application's progress. To enhance transparency and clarify their position and next steps, this paper proposes a method to dynamically generate workflows based on the application's context. To achieve this, we (i) enable stakeholders to model the permit process using the user-friendly Mermaid charting tool; (ii) use MerWeb to automatically translate this process to a semantic workflow by using the Function Ontology (FnO) to model steps (FnO-Steps) and the DigiChecks ontology to annotate domain-specific information; and (iii) generate a context-dependent journey based on these descriptions by using the FnO-Steps composer, an automatic semantic workflow composition tool, starting from user context and using FnO-Steps to reach a target state. Our approach is demonstrated through a building permit application use case in Flanders, evaluating scenarios from a historic city centre and rural area. The use of the Mermaid charting language enabled clear visualisation of the building permit process, enhancing transparency. By leveraging the DigiChecks and FnO-Steps ontologies, the process was described in a standardised, machine-readable format. The FnO-Steps composer used this representation to generate workflows tailored to the application's context. This way, the proposed method provides applicants a clear overview of the current progress, improving comprehensibility.

Proposing a Standardized Approach for Efficient Broadband Expansion with BIM

Napps, Daniel [1]; Theiler, Michael [2]; Aziz, Angelina [1]; Ali, Sherief [1]; König, Markus [1]

[1] Ruhr University Bochum, Germany; [2] planen-bauen 4.0 GmbH

The expansion of broadband infrastructure is a key driver of economic and social development. However, current planning and approval processes are fragmented, time-intensive, and inefficient due to the involvement of multiple stakeholders, heterogeneous data formats, and varying regulatory requirements. Different modeling approaches (2D plans, 3D models, GIS, and documents) lack standardized integration, leading to inconsistencies and delays, particularly in planning and approval. The absence of a structured digital workflow further complicates coordination and slows decision-making. A core challenge is the lack of automated validation. Regulatory and technical compliance must be manually checked, making the process error-prone and inconsistent. This extends project timelines and increases the administrative burden, especially for approving authorities. This paper proposes a structured approach to optimize broadband planning and approvals through a Building Information Modeling (BIM)-based workflow. By integrating 3D models with Geographic Information System (GIS) data and regulatory rules, we present a standardized method that supports authorities in streamlining approvals and offers planners a clear framework for execution. Automated compliance checks reduce manual work, minimize errors, and increase transparency. Applying this workflow to broadband deployment in Germany shows clear benefits. A real-world case study indicates reduced approval times, automated model checks, and more efficient decisions. This structured, scalable process offers a concrete solution for accelerating broadband expansion effectively and transparently.

Requirements and challenges for the application of process mining in the building permit review

Hagedorn, Philipp [1]; Fauth, Judith [2]; Weinkauf, Ronny [3]

[1] Ruhr-Universität Bochum, Germany;
[2] Technical University of Munich, Germany;
[3] Hochschule Merseburg, Germany

The building permit process is inherently complex and time-consuming due to its multifaceted nature, involving numerous stakeholders, intricate regulatory requirements, and diverse approval criteria. The research problem arises from the complexities inherent in the multi-stakeholder and multi-system environment commonly found in authority permit processes. As a possible solution for improving processes, process mining is a data-driven methodology that utilises event log analysis to discover, monitor, and optimise business processes for enhanced efficiency and compliance. This research examines the possible application of process mining in the building permit review, focusing on the three basic types: process discovery, process conformance checking, and process enhancement. However, requirements must first be defined and fulfilled to use process mining for the building permit review. For this purpose, the approaches from the requirements analysis, the building permit review, and the input data for the process mining procedure must be combined, resulting in a Requirements Traceability Matrix (RTM). We further discuss the challenges of varying event log maturity and the need for harmonising data sources. These challenges are demonstrated in a case study of process mining realised using anonymised event logs. The output of the article is an overview of how process mining can be applied to the building permit review.

Retrieval of Digital Regulations using Neuro-Symbolic AI with GraphRAG

Donkers, Alex; Petrova, Ekaterina

Eindhoven University of Technology, The Netherlands

The interpretation and application of digital building codes remains a significant challenge in the Architecture, Engineering, and Construction (AEC) industry, especially across national borders. This paper presents a method to structure building codes as knowledge graphs and thematically enrich them using Large Language Models (LLMs) to improve information retrieval. Dutch building codes were converted into an RDF-graph with thematic metadata tags added using a zero-shot text classification approach. To bridge the gap between complex SPARQL queries and end-user accessibility, the paper introduces a Graph Retrieval Augmented Generation (GraphRAG) approach that dynamically translates natural language queries into SPARQL. The methods were implemented in the FireBIM Chatbot, which enables end-users to query relevant building codes and definitions of relevant terms using natural language. The chatbot was evaluated with fire safety experts from multiple countries. Results show that the method effectively enables retrieval of relevant digital building codes; however, trust and transparency remain critical concerns for adoption in legal contexts. Future research should explore hierarchical metadata propagation, richer conversational capabilities, and ensuring trust and transparency of the neuro-symbolic AI methods.

Structuring the Financial Dimensions of Building Permits: A Taxonomy Extension

Fauth, Judith [1]; Deac-Kaiser, Stefanie-Brigitte [2]; Kwan Chan, Anson Tsz [3]; Tekavec, Jernej [4]

[1] Technical University of Munich, Germany;
[2] Politehnica Univeristy of Timisoara, Romania;
[3] University of Cambridge, Cambridge, UK;
[4] University of Ljubljana, Faculty of Civil and Geodetic Engineering, Ljubljana, Slovenia

Building permits (BPs) are a critical regulatory tool shaping urban development, yet their economic implications remain insufficiently understood, particularly in relation to cost structures, delays, and sustainability impacts. While environmental and social aspects of BP are widely discussed, economic dimensions are often overlooked despite their direct influence on project feasibility and housing affordability. This study addresses this research gap by extending a previously developed taxonomy of BP systems to systematically capture financial aspects. Drawing from literature review, expert input, and open data sources, we identify and structure economic elements such as direct fees, indirect costs, and value-added implications. The taxonomy extension is presented through a hierarchical visual framework to ensure conceptual clarity and practical usability. We validate the extended taxonomy through case studies in Romania, demonstrating its applicability across diverse regulatory environments. Findings confirm that financial elements are dispersed, inconsistently understood, and often hidden in BP processes, leading to increased risks and inefficiencies. Our contribution offers a structured vocabulary for future research and policy evaluation, laying the groundwork for quantifying BP costs and integrating the economic pillar of sustainability in permitting reform. Ultimately, the results support better-informed decisions in both administrative and investment contexts.

The DigiChecks Ontology: a Top-Level Ontology for Managing the Building Permit Process

van Gruijthuijsen, Coen [1]; Werbrouck, Jeroen [2]; Verstraeten, Ruben [2]

[1] Semmtech, The Netherlands; [2] University of Ghent, Belgium

The building permit process involves complex regulatory requirements and stakeholder interactions. Digitizing this process requires the integration of data from divergent sources, such as Building Information Models (BIM) and documents from applicants, but also machine-readable translations of regulations. In this paper, we present the DigiChecks ontology, which structures and supports the permit application process by formalising compliance checks required for permit issuance. It addresses the connection between the data of the applicant and the authority. The DigiChecks Ontology provides a structured top-level data model that allows to describe projects, permits, actors and requirements. The ontology builds upon existing ontologies in the model-based systems engineering domain, extending them with concepts specific to regulatory compliance. We validate the added value of the DigiChecks ontology by demonstrating automated compliance checks for permitting across Europe. By addressing the most risk-intensive aspects of the permitting process, our approach enhances efficiency, reduces errors, and minimizes the need for rework. As a result, the DigiChecks ontology alleviates time constraints and labour costs for both permit issuers and applicants through digital traceability and automation.

Translating Building Regulations into IDS for Automated Compliance Checking: A Comparative Study of Manual and AI-Driven Approaches

Karn, Anshika [1]*; Tekavec, Jernej* [2]

[1] Blends Design Private Limited; [2] University of Ljubljana

With the potential to enhance efficiency, transparency and compliance in the construction industry, the Digital Building Permit (DBP) process has one major challenge for this transformation which is automation in the compliance checking process. With recent developments in the Information Delivery Specification (IDS) schema, many authorities have already started the use of IDS for automated compliance checks. However, to facilitate the integration of IDS into the checking process for DBP, a critical step in this approach is the translation of building codes from the legislation into IDS files. A lot of work has been done on rule extraction for Automated Compliance Checking (ACC) but not in relation to rule extraction for IDS. In this paper, we focused on the methodology for this rule translation process which involves some critical steps for preparing the rules including rule extraction, categorization, structuring them into machine readable formats, specifically IDS. For this, we explored both manual process and AI-driven approaches and analysed them on the basis of structure, validity and applicability. With an aim to contribute to the ongoing efforts and research regarding the automated compliance checking and digitalization of the building permit. This paper aims to provide optimized solutions for translation of rules to ensure a smooth integration of IDS into the DBP framework.

Uncertainty and Risk Assessment for the Use Case BIM-based building permit process

Koller, Valentin [1]; Wolf, Gertraud [2]; Wogan, Martin [3,4]; Meins-Becker, Anica [5]

[1] Hochschule Bremen;
[2] Universität der Bundeswehr München;
[3] Institute of Construction Informatics, TU Dresden;
[4] B/M Consult, Braunschweig;
[5] Institut für digitales Planen, Bauen und Betreiben, Bergische Universität Wuppertal

This study investigates the relationship between subjective knowledge and risk assessment in the context of BIM implementation, using the BIM-based building permit process as an illustrative use case. Despite existing standards such as DIN ISO 19650 and the use case definitions by buildingSMART, companies and authorities face significant uncertainties and risks during the adoption of BIM. A multi-phase mixed-methods approach was used to identify risks, categorize them into uncertainty domains, and assess participants' subjective knowledge. The findings show a systematic overestimation of certainty relative to actual knowledge among both experts and non-experts, confirming the well-known phenomenon of overconfidence. This misalignment highlights the importance of explicitly incorporating knowledge levels into ISO 31000-compliant risk assessments. The study demonstrates that subjective uncertainty, particularly in categories with low knowledge and high confidence, should be addressed through targeted knowledge-building measures before initiating risk treatment. The developed framework provides a methodological basis for identifying and managing uncertainties in BIM use cases. Ultimately, the study contributes to a better understanding of adoption barriers and supports the development of knowledge-based strategies for informed decision-making in digital transformation processes.

When Digital Building Permits, Digital Building Logbooks and Renovation Passports meet

Fauth, Judith [1]; Mêda, Pedro [2]; Visscher, Henk J [3]

[1] TUM – Technical University of Munich, Bavaria, DE;
[2] CONSTRUCT – ICS/Porto University, Faculty of Engineering, Porto, PT;
[3] TU Delft, Delft, Nederland

The construction sector is undergoing a dual transformation driven by digitalisation and sustainability goals. Central to this shift in the EU are three emerging instruments: the Digital Building Logbook (DBL), the Digital Building Permit (DBP), and the Building Renovation Passport (BRP). While each instrument has been developed independently, their integration holds significant potential for improving information flows, regulatory efficiency, and lifecycle sustainability. This study presents an empirical analysis of data overlaps across these three concepts, using five official data sources from the Portuguese construction context. The results show that the DBL consistently acts as a central data hub, with all shared data points between DBP and BRP also appearing in the DBL. Key sources such as the Energy Performance Certificate (EPC) and the Technical Housing Data Sheet revealed high degrees of cross-concept integration. However, notable asymmetries and differences in data granularity were also observed. These findings highlight both the technical feasibility and the design challenges of integrated digital workflows. The study contributes to the understanding of how DBL, DBP, and BRP are related and can be harmonised. In addition, outlines future directions for reducing redundancies, improving interoperability, exploring the single sources from which the data originates, and supporting the Once-Only principle in the built environment.

Part II

Practice-Track

6 steps to successfull establishment of DBPs with real-life implementation examples in governmental and private sector

Ajrulovski, Gazmend

Intelligent Network Solutions, North Macedonia

Throughout the course of developing our NexusTwin platform, our team has been deploying the solution as a core element of digital building permit workflows for both private and governmental entities. Out of numerous implementations, we will consider three success stories as straightforward examples of how NexusTwin achieves real results in practical applications:

- Implementation of the BIM e-submission platform in Dubai (in production since 01.01.2024, used by Dubai authorities to issue building permits automatically).
- Establishment of automated code-compliance checking workflows with IMKAN, one of the largest real estate developers in the UAE (www.imkan.ae).
- Ongoing development and deployment of a state-wide BIM-centric DBP platform for the Kingdom of Bahrain, where we are working on a state-level definition of a BIM mandate as well as establishing the digital building permit platform. This platform covers automated checks of rules and regulations ranging from urban parameters and architectural design rules to water and electrical utility requirements.

What is common across all these implementations is our unique approach, which we call the "6 Steps to Success." This methodology represents six phases of project implementation that ensure clients can successfully move from their current level of digital readiness (whatever that may be) towards a fully established, automated BIM-based digital building permit workflow. These six steps have been refined over time and are based on our team's extensive experience. They describe milestone activities such as: defining the BIM development roadmap (outlining where the client should be in five years in terms of BIM adoption), preparing a BIM mandate (specifying how BIM models should be created so that automated compliance checks can be properly executed), and developing BIM and other data templates used in DBP applications. While the complexity of these steps may vary depending on the client's objectives and the desired level of implementation, following this structured framework ensures that the journey from the client's current digital ecosystem to a future state, where digital building permits can be issued automatically with minimal manual effort, is both clear and achievable. In this session, we will discuss these six steps in detail and share our concrete experiences from implementing the three highlighted projects.

Automating Accessibility Compliance in Building Design: A Proof-of-Concept Model Checking Service for Singapore's ePermitting Workflow

Mikkonen, Sami; Nitz, Pia

Solibri, Finland

In collaboration with AcePLP and the Building and Construction Authority (BCA) of Singapore, Solibri has developed and deployed a Proof-of-Concept (PoC) model checking service to support automated compliance verification against the 2025 Code on Accessibility in the Built Environment. This initiative responds to the increasing demand for scalable, transparent, and standards-based validation of Building Information Models (BIM) within regulatory workflows.The PoC introduces a dual-tool architecture: a desktop-based Solibri Office extension for regulatory officers and a cloud-based Web Model Checker for industry users. The system is designed to validate a substantial portion of accessibility-related requirements using rule templates developed in Solibri's Checking Engine. These rules address geometric and parametric aspects of building design and leverage OpenBIM standards such as IFC and IDS. The Web Model Checker enables Qualified Persons (QPs) to pre-check their models before submission, reducing feedback loops and improving model quality. Results are delivered in both JSON and BCF formats, supporting transparency and traceability.

The rule development process involved analysing the structure and intent of the accessibility code, identifying which requirements could be reasonably interpreted and automated, and testing rule logic against representative models. Rather than aiming for exhaustive coverage, the focus was on demonstrating feasibility and establishing a foundation for future expansion. A test version of the Web Checker containing the latest rule logic will be handed over to BCA by 20 October 2025. The service is hosted on Cloud environment in Singapore and secured via ISO27001-certified procedures including HTTPS encryption, and token-authenticated APIs. Models are discarded post-checking, and result data is stored with configurable retention policies.

Three post-PoC deployment scenarios are:

1. Manual verification using Solibri Office.
2. Hybrid checking via Web Model Checker and Solibri Office.
3. Full automation through integration with the Corenet X permitting portal via Solibri's Checking API.

This initiative demonstrates how BIM-based rule checking can be embedded into national permitting workflows, improving throughput, reducing manual effort, and enhancing regulatory compliance. The modular architecture allows future expansion to other disciplines such as fire safety and supports scalable rule maintenance via service packages. The Solibri Model Checking Service exemplifies how digital innovation can transform regulatory processes in the built environment. It offers a replicable model for other jurisdictions seeking to modernise their permitting systems while maintaining high standards of accessibility and design quality.

BIM challenges in the urban licensing in Vila Nova de Gaia

Carvalho, Marco Lima; Baptista, Ana Patricia; Pires, Carla

Gaiurb / Municipality of Gaia, Portugal

In 2012, the municipality of Vila Nova de Gaia, through the municipal company Gaiurb EM, began digitising private construction processes, an advance that has provided significant added value by optimising the entire workflow associated with issuing building permits. In 2018, benefiting from the strategy previously adopted, the focus shifted to implementing the BIM methodology in urban licensing. The first step was to adapt the digital platform so that it could receive files in IFC format. In the absence of technical standards at national or municipal level, the implementation of this complex process made it possible to carry out a diagnosis of the current state of the art, particularly with regard to the technical knowledge of design offices on the development of architectural projects in digital models in IFC format. Analysing more than six dozen models submitted in BIM format made it possible to identify recurring patterns of errors in the structure of IFC files. This survey was fundamental in outlining a clear and well-founded direction for the future definition of good practices and appropriate methodologies, thus promoting the widespread adoption of the BIM-IFC format to replace the traditional PDF or DWFx formats. During this process it became clear that urban licensing is not just about submitting the architectural model. It is essential to ensure compliance with land management instruments and the integration and relationship of the project with its urban surroundings. In this context, assessing the impacts and challenges associated with verifying these criteria in a BIM environment is crucial. Participation in the CHEKdbp project consortium also made it possible to see that although automatic project verification is feasible, it requires an adaptation of urban planning rules and a paradigm shift right from the planning stage. Only in this way will it be possible to achieve efficient automated verification, an essential condition for speeding up and modernising the construction licensing process.

BIM-based building permit in Estonia: gains and pains

Raitviir, Christopher-Robin [1,2]

[1] Head of Digital Construction, Tallinn Strategic Management Office, Tallinn, Estonia;
[2] Early-Stage Researcher, Tallinn University of Technology, Tallinn, Estonia

The Estonian Ministry of Climate launched Europe's first nationwide BIM-based building permitting system in February 2024. The service is fully embedded in the national Building Registry (EHR). It allows permit applications through IFC models and semi-automated compliance checking. The roll-out marked a shift from pilot projects to a live national service covering all 79 municipalities. The system brings clear gains. Core regulatory data such as floor counts, heated area, and apartment numbers can be extracted automatically from IFC models in seconds. This reduces manual entry and clerical work. The rule engine currently performs 47 checks on housing requirements, fire safety, and accessibility. These checks speed up the review and create a more transparent process. The system is built on national BIM data requirements (ÜBN), ensuring consistency in submissions. Its modular design and open APIs support scalability and integration with other services. A web-based interface lowers the threshold for use, especially for municipalities with limited technical capacity. Somewhat neutral aspect is control over the software. Estonia chose a custom solution rather than relying fully on commercial platforms. Although this reduces vendor lock-in and allows adaptation to national legal and technical needs, it comes with costs. Maintenance and further development require stable political support and ongoing funding. Without this, the system risks stagnation. The pains highlight the limits of automation and adoption. Rule checking depends on the quality and completeness of submitted models. False negatives occur when the system flags errors that are not real, often due to rigid logic applied to complex legal texts. False positives arise when violations are missed because data is incomplete or misclassified. Both problems underline the need for human oversight. Reviewers must interpret results and balance automation with accountability.

Adoption challenges are even greater. The service is not mandatory, and awareness is low. Many designers, clients, and municipalities are unaware of the option to use BIM-based permitting. Gains are not sufficiently communicated, and training has not been widely provided. Without a government-led communication and training plan, uptake will remain limited. The experience shows that technical readiness alone is not enough. Institutional support and user capacity are essential. There are also structural limits. Many rules require interpretation and are not clearly measurable. This makes it difficult to translate them into precise digital checks. Expansion of the system will therefore depend on identifying which rules can be formalised and how exceptions can be handled. Future work will need to consider IDS-based requirements and ontology-driven rule encoding to move beyond the current 47 checks.

In conclusion, Estonia's BIM-based permit demonstrates both progress and fragility. The gains include faster data extraction, more transparent checks, interoperability, and stronger control over national systems. The pains include errors in automated checking, high maintenance costs, political dependence, low adoption, and legal complexity. The case shows that digital permitting reform is not only a technical challenge. It is equally a matter of governance, communication, and institutional design. Success will depend on combining robust infrastructure with clear rules, political continuity, and active training and outreach.

Data continuity between BIM and GIS for seamless integration of outdoor spaces into digital twins: A case study in Austria

Pfeiffer, Daniel [1]; Loës, Jan Morten [2]; Schranz, Christian [1]; Urban, Harald [1]

[1] Research Unit Digital Building Process, TU Wien, Vienna, Austria; [2] VIE Build GmbH

Urban areas are increasingly affected by the consequences of climate change, including rising temperatures and the intensification of the urban heat island effect. While many municipalities have introduced regulations to protect and promote urban green and unsealed areas, authorities often lack the digital tools needed to verify compliance between permitted and built environments. This gap results in limited monitoring capabilities and inconsistent implementation of sustainable land use policies. Addressing this challenge, the Austrian research project AMAzE 2.0 aims to develop an integrated digital workflow that supports the automated verification and monitoring of outdoor and green spaces by linking Building Information Modeling (BIM) and Geographic Information Systems (GIS) within an interoperable data ecosystem.

In the early stages, the key stakeholders across the construction and permitting ecosystem were identified and the overall process and data interface challenges were determined. Workshops with these stakeholders were used to collect and structure requirements into concrete use cases, forming the foundation for the project roadmap. Building on these insights a prototype is under development and iteratively evaluated as a real-world solution for Austrian building and land administration authorities. This ensures that the developed tools are both technically feasible and administratively applicable within existing legal frameworks. As project-members the administration of the city of Klagenfurt and the VIE Build GmbH provided both legal and technical advise as well as exemplary datasets.

Within AMAzE 2.0, the “outdoor space” of the built environment is defined and digitally represented using multiple geospatial datasets provided by authorities. These datasets cover both legal and infrastructural aspects of the property and contain among others aerial and satellite imagery and a high-resolution terrain model derived from ALS data and terrain breaklines, as well as the Land Use and Green Space Cadastres. The latter two provide detailed raster and vector representations to quantify the sealed and green space volumes for every parcel within the city of Klagenfurt. These datasets together form the geospatial backbone for BIM–GIS integration in the project. The integration of GIS and BIM data in AMAzE 2.0 is structured around three main components:

- GIS–BIM data fusion: The project leverages new data sources obtained through laser scanning and high-resolution aerial surveys, combined with classical geospatial processing techniques, to ensure up-to-date and consistent GIS data.
- Semantic annotation: Artificial intelligence methods are applied to enrich the high-resolution but unstructured imagery and point clouds with semantic labels, identifying sealed and green surface classes as well as damage to ground coverings.
- Differential analysis: Temporal analysis of GIS data enables the automated detection of discrepancies between the planned BIM and actual as-built states of outdoor spaces, supporting data-driven monitoring and enforcement.

Through the AMAzE 2.0 framework, seamless BIM–GIS integration is demonstrated as a practical enabler for data continuity, transparent permitting, and automated environmental monitoring. By combining AI-enhanced geospatial data with openBIM processes, cities can more effectively manage green infrastructure, verify the compliance to issued permits and respond to the challenges of climate change.

Defining and Validating BIM Information Requirements with IFC, IDS and bSDD: A Practical openBIM® Workflow

De Stefano, Sara

ACCA Software, Italy

This presentation will show how to effectively define and manage an information request for a BIM model using openBIM® standards such as IFC, IDS, and bSDD. Through a practical workflow, it will illustrate how to specify information requirements based on the model's purpose and lifecycle stages and how to distribute these requirements in IDS format to different project stakeholders. Finally, it will demonstrate how to check the accuracy and consistency of the delivered information during model handover, combining automated and semi-automated validation procedures that ensure data reliability and compliance across the openBIM® process.

Digital Building Permits in Ukraine: The Path to an Automated Verification of Project and Cost Documentation and Beyond

Poddubny, André

Civitta, Ukraine

Like many countries, Ukraine is introducing digital tools to modernize the issuance of building permits. With the Unified State Electronic System in the Field of Construction (USESCS) a level 1 national permit system is already in operation, allowing applicants to fill-in forms and submit project documentation in PDF format. Since November 2024, cost documentation must be submitted in a machine-readable format, establishing a unique foundation for further digital transformation.

In preparation is the submission of machine-readable project documentation in IFC format to the system and the development of an IT tool to verify project design and cost information automatically, thereby ensuring that quantities declared in these files align to reduce errors and, thereby, inefficient spending. What makes the Ukrainian case distinctive is that the first public use of BIM occurs via digital permitting and that it will not initially focus on compliance checks against building codes, but rather on ensuring consistency between project design and cost documentation. This orientation reflects the country's reconstruction priorities: with large volumes of donor funding expected for its restoration from the war, cost transparency and accountability are paramount.

Implementation will proceed step-by-step, beginning with housing projects, followed by civil buildings and, at a later stage, infrastructure. Through this process, Ukraine demonstrates how BIM and digital permitting can serve not only as a regulatory instrument but also as a mechanism to strengthen trust in the effective use of international funds. At the DBP 2025, I would like to present Ukraine's unique approach for expert compliance reviews as well as the role of the Unified State Electronic System in the Construction Sector (USESCS, e-construction.gov.ua) in issuing building permits online. I intend to further highlight the next steps in the digitalisation of building permit issuances, highlighting technological and methodological milestones.

Digital Interfaces as Accelerators for Building Permits – BIM-Automation and GIS-Integration in the "Bauportal Hessen" (Hessian Building Permit Portal) – a case study

Pötz, Aurica [1]*; Sauerbier, Simon* [2]

[1] 5D Institut GmbH [2] ekom21 KGRZ Hessen, Germany;

The Hessian Building Permit Portal "Bauportal Hessen (DigiBauG)" is the state's central platform for paperless building permit procedures, based on nationwide communication standards. It provides a user-friendly end-to-end solution for digital submission, online participation, and electronic approval. In parallel, innovations such as Building Information Modelling (BIM), Geographic Information Systems (GIS) and Artificial Intelligence are being integrated to support collaboration. The project aims to establish technological foundations in line with recognised standards, highlight interpretative requirements, and test interoperability. A focus is linking BIM and GIS to unlock cross-cutting potentials. Interoperable, continuously available data enable digital transformation of planning, permitting, and operational processes, improving transparency, saving resources, and supporting knowledge management across stakeholders and throughout building lifecycle.

Despite acknowledged importance of digitalisation, challenges remain. Municipal geodata infrastructures are only partially accessible, leaving their potential for decision-making, planning, and approval processes underused. Clear guidelines for georeferenced BIM-models in permitting contexts are missing. Concepts and a common understanding are lacking on how model content can be reduced to permit-relevant information and visualised in GIS-context. The potential of BIM-GIS-collaboration has not been systematically and comprehensively exploited. Model-based pre-checks require new professional and operational concepts, including the definition of suitable BIM-artefacts, modelling guidelines, and checking rules, together with approaches to ensuring data quality and currentness, particularly in response to legal changes. These shortcomings underline the need for practice-oriented solutions.

The approach centers on developing a state-wide BIM-interface within DigiBauG. Based on this, a GIS-integration-concept is developed, including a procedure for georeferencing BIM-files via coordinates and rotation. Selected BIM-baseline-information are integrated into GIS to enable professional assessment of projects in their geographical context. This combines BIM-floor-plans with municipal GIS-information such as development and land-use plans, flood protection zones, and digital terrain models. The approach also opens perspectives for extended BIM-GIS-collaboration, for example through measurement tools or differentiated role- and rights-based models. Another focus is automated pre-checking. Fire safety aspects are examined as a case study using defined BIM-attributes. In addition, the technical, legal, and organisational prerequisites for state-wide implementation are analysed.

Implementation:

1. State-wide BIM-interface*
2. GIS-integration via map window**
3. Pilot of a BIM-based GIS-visualisation / fire safety pre-check**

* Validation by application in productive / ** development environment.

The core technologies for digital model transfer have been tested successfully in DigiBauG. Roll-out is scheduled in autumn 2025, laying the foundation for future collaboration between applicants and authorities based on BIM. Unresolved challenges continue: Framework conditions for state-wide deployment and the adaptation of modelling guidelines and checking rules to legislative changes, need to be clarified. In practice, the perceived value of BIM often does not yet overperform the additional effort for architects. Demonstrating efficiency gains through GIS-integration and BIM-automation could significantly increase acceptance. An accessible geoinfrastructure with georeferenced BIM-data accelerates site assessment and decision-making. The combined use of BIM and GIS through the integration of platforms such as DigiBauG can unlock cross-cutting potential, creates overviews, saves time and resources, and optimises the entire value chain.

Embracing the Digital Shift: BIM4Gov and the Future of Building Permits in Public Administrations

Vergés Vega, Paula; Cantero Caldito, Natalia; Pruñonosa Bengochea, Cristina

Office of Business Management, Catalonia, Spain

BIM4Gov is an Interreg Europe project that aims to facilitate the exchange of experience, knowledge, and good practices in the use of Building Information Model (BIM) to obtain permits for urban works and other activities for those cases that have the most economic impact, arraying from the standardization of common data models for each of the regulatory fields. The partnership is composed by: Office of Business Management (Spain) as Lead Partner, City of Tallin (Estonia), Rzeszow Regional Development Agency (Poland), EDA – Enterprise Development Agency Eda (Bosnia and Herzegovina), University of Limerick (Ireland) and Vas County Government Office (Hungary). BIM4Gov strives to improve the policy instruments that work towards increase eGovernment in the efficiency of procedures and permits, making business-administration relationship more effective, efficient, digital and compromised with the 2030 Digital Agenda. The focus is to support digital transformation for more efficient and data oriented administration, harnessing the potential of building information models, automated administrative action and big data.

Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. BIM represents a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life cycle; defined as existing from earliest conception to demolition. The BIM4Gov specific challenge is to use the BIM methodology as a basis for managing construction and activity permits in a digital and more efficient way. The conceptualization of BIM in eGoverment is inspired by the recent trends of digitalization of Europe's administration, as well as its developmental goals for Europe 2030. An expected practical result, amongst others, is the definition of a technological and methodological scope governed by BIM in regards to obtain public building permits. In all, the innovative factor is driven by inserting the design in projects that tackle high complex revision and authorization processes from different organizational and administration scopes. This will ultimately facilitate data management to engineers and architects elaborating the project and administrations automating such permits. This digitalization process will facilitate Business-Government relations and, at the same time, reduce management time. There has been some BIM-related projects, but the focus of BIM4Gov is much different: a new perspective into the administration permits much rather than the building itself. The Office of Business Management for the Government of Catalonia represents the lead partner for the project. In this scope, the Government is tackling the processing of the environmental permits, which represents a heavy load in terms of complex permitting. Initially, the process for this permit was upon a form-free PDF, which made the authorization of thus slow-pathed and with bureaucratically burdensome. Including BIM in permits like this will enable the Government to respond faster to the necessities of the businesses, while also reducing administrative tasks and facilitating interdepartmental cooperation. This initial change will set the initial change to eventually have a complete catalogue of BIM-based permits for all digital permits and other economic procedures.

Evaluation of Checking Software for use in the openBIM Building Permit Process

Gaishofer, Leo; Pfeiffer, Daniel; Urban, Harald; Schranz, Christian

Research Unit Digital Building Process, TU Wien, Vienna, Austria

The construction industry continues to lag behind other sectors in terms of digitalisation, despite ongoing efforts to improve productivity and data integration across project phases. Building Information Modeling (BIM) has emerged as a transformative method for addressing this digital gap, offering a comprehensive framework to enhance efficiency, coordination, and quality assurance in construction projects. While the private sector has successfully adopted BIM-based workflows to optimise planning and execution, public authorities are only beginning to explore its potential for the digital building permission process.

One of the main problems with the digital building submission workflow is checking the models automatically. This makes sure that the models follow the rules and building codes. Various commercial BIM checking tools have been developed to support quality control in design and construction. But these tools are mainly made for private companies and don't fully meet the requirements and processes of public building authorities. Therefore in collaboration with the City of Vienna, we determined the criteria for selecting and evaluating BIM checking software suitable for an openBIM-based building permit process.

The main aim of the project was to find out which checking applications best meet the requirements of a building authority in the context of an openBIM approval process. This included three main steps:

- *Requirements Analysis*: We worked closely with the City of Vienna's building authority to do a full analysis of what was needed. It was particularly important to make sure that the checking applications could be easily maintained, made available and expanded, as these aspects are critical for ensuring that they can be used for a long time in a public-sector context.
- *Evaluation Framework Development*: A step-by-step evaluation system was created to evaluate BIM checking applications against the set criteria. This framework includes things such as interoperability with openBIM standards (e.g., IFC), regulatory rule implementation, user accessibility, and integration with existing administrative workflows.
- *Application Testing and Comparison*: Several BIM checking tools available on the market were tested and compared using representative digital building models. The evaluation focused on their capacity to verify legal compliance, their flexibility in accommodating evolving regulations, and their technical robustness within the openBIM environment.

The results show that no BIM checking application currently available can fully meet the requirements of a public building authority for an automated approval process. While some tools are very good at checking rules and interoperability, there are still major problems with legal code mapping, adapting to local rules, and keeping the system working in the long term. This study provides a foundation for future collaboration between municipalities (local government), software developers, and standardisation bodies (organisations that set and agree on standards) to improve digital building permission processes (the process of obtaining official permission to start construction) across Europe.

Feasibility study towards the realisation of BIM-based permit reviews in the German state North-Rhine-Westfalia

Vonthron, André

VSK Software GmbH, Germany

The transfer of the Building Information Modelling (BIM) methodology into digital building permitting is still at the very beginning. After national and international research projects show much potential to increase quality and efficiency using BIM methodology in combination with automated code compliance checking (ACC), practical experience of actual BIM-based permitting is very rare. To change this, a feasibility study is undertaken in the German federal state of North-Rhine-Westfalia (NRW). The study includes construction projects being reviewed using BIM incorporating automated checking procedures. It is based on preliminary research projects undertaken by the City of Hamburg in 2017–2022, digitalizing the German template building code into machine-readable requirements and rules, code as well as subsequent developments by the City of Bochum in 2021–2023, who adapted this research to support building permits based on the federal building code.

In 2024, the results convinced the building ministry of NRW to fund a 2-year feasibility study to test the field applicability on the federal state level. The study includes the mobilisation of review staff, the evaluation of predefined open-source checking rules and the development of a long-term strategy to the production and maintenance of BIM-based reviews. It is been tested on 9 different construction projects in 8 cities across the NRW, namely Herford, Münster, Herne, Dortmund, Bochum, Essen, Cologne, Düsseldorf. The projects cover different construction types, such as residential buildings, office building or school buildings. A BIM-based review is undertaken by the permitting departments of each city. Some of projects are replays, while others allow to draw direct comparison to a parallel (officially needed) 2D application review. A special case in Dortmund represents a BIM-based review, exclusively, and will be granted as such.

The presentation will show the current results, including the feedback of the reviewers, which regulations can be reviewed with BIM and where automatically proposed results help in accuracy and efficiency. It also shows the challenges that arise to allow a productive application. In cooperation with the architects, the information requirements were compressed to reduce effort on the applicant's side. Both are aspects of the overall goal to find the course of action how to organize a structured, effective and long-term integration of BIM and automation into digital building permits.

From Pilots to Practice: Implementing BIM-Based Building Permitting under Finland's New Building Act

Mattila, Ilkka; Poutanen, Olli

Cloudpermit Oy, Finland

Digital permitting platforms have been in use for over a decade, and technology for applying Building Information Modeling (BIM) in permitting has also been available for many years. Despite early proof-of-concept projects and Finland issuing its first BIM-based building permits almost five years ago, large-scale adoption remains limited globally. On 1st January 2026 new Building Act makes BIM as a compulsory part of the building permitting in Finland, which makes Finland an interesting case study of a nation-wide systemic adoption.

Key factors influencing the adoption of BIM in permitting relate to speed, cost, and easiness. Authorities and applicants typically pursue different benefits: authorities seek cost savings through automation and improved data quality, while applicants value faster processing and better feedback mechanisms. The broader societal benefits—improved data availability, accuracy, and interoperability—are also well recognized. These aspects to add value to different stakeholders have been incorporated into the Finnish regulation and related technical development. However, technology and potential benefits alone do not enable BIM-based permitting. Regulatory frameworks must explicitly allow and support digital BIM–based submissions. In Finland, the new Building Act (coming into effect in 2026) introduces the legal basis for using BIM in permitting processes when a project's design has been developed in BIM. This legislative change represents a paradigm shift in the regulatory domain, requiring clear definitions, standardized data requirements, and updated workflows. At the same time, the process must avoid over-standardization, as excessive modeling requirements could increase applicants' costs and reduce adoption willingness.

Building permitting for large-scale projects is inherently complex, involving multiple authorities and applicants collaborating across organizational boundaries. Therefore, designing the new BIM-based process requires strong cooperation among all stakeholders—ministries, municipalities, designers, and software providers. In Finland, the Ministry of the Environment has led the legislative work, while standardization and implementation have been jointly developed in cross-organizational projects involving municipalities, the construction industry, and technology providers.

Following several earlier pilot projects, including Rava3Pro, a comprehensive multi-city BIM-based permitting project was carried out in early 2025 in Finland. Five advanced municipalities—Helsinki, Vantaa, Tuusula, Järvenpää, and Hyvinkää—collaborated to test BIM-based permitting and automated code compliance checking in real-world cases using the Lupapiste digital permitting platform. The main objective of the project was to validate that BIM-based permitting functions effectively in practice before the relevant sections of the new Building Act come into force in January 2026. The project focused on testing and improving the new BIM functionalities within Lupapiste, training municipal staff, gathering feedback from applicants and designers, and defining the remaining development steps required for full-scale national rollout.

This presentation summarizes the results and lessons learned from this multi-city implementation. It highlights key enablers and challenges encountered in translating legislation and standards into operational permitting practices, offering insights for other countries preparing for similar BIM-based regulatory transformations. The project was carried out using the Lupapiste digital permitting platform developed by Cloudpermit, providing a practical example of how an existing e-permitting service can evolve to support model-based regulatory processes.

Geometry Validation for BIM

Diakite, Abdoulaye

CityGeometrix, Australia

A Digital Building Permit (DBP) process can only be as reliable as the data it consumes. While numerous tools exist to validate semantics, classifications, and format compliance in BIM (IFC) models, a fundamental layer has been largely overlooked: the geometry itself. In contrast, the geospatial community has long recognized this need, with robust geometry validators such as val3dity ensuring the integrity of city models before any spatial or regulatory checks are applied. Our contribution introduces a geometry-first validation tool for BIM, designed to fill this critical gap. Built on top of the experience gained in the CHEKdbp project, where data validation pipelines were developed for automated permit checking, this new tool focuses exclusively on geometric integrity and reliability. It ensures that BIM submissions are free from invalid solids, non-manifold edges, self-intersections, or degenerate faces, problems that not only compromise downstream compliance checks but can completely prevent them from running.

By leveraging open-source foundations such as IfcOpenShell or web-ifc, and extending them with advanced geometry analysis methods, the tool provides municipalities and practitioners with the equivalent of a "val3dity for BIM." Checks include:

- validity of IfcSolidModel, IfcFacetedBrep, and tessellated representations,
- manifoldness and orientation of shells,
- detection of overlaps, slivers, and gaps beyond tolerance,
- clearance, connectivity, and adjacency derived directly from geometry

Positioned as a critical component of the DBP workflow, this validator acts as a safeguard: if the geometry is invalid, no reliable rule checking (whether semantic, legal, or AI-assisted) can proceed. By enforcing this baseline, municipalities can build trust in the digital permitting process, reduce costly iterations with applicants, and ensure smoother integration with higher-level compliance engines. By addressing the missing piece of geometry validation for BIM, this contribution demonstrates how DBP initiatives can become more robust, scalable, and globally transferable. It positions geometry-first validation not as a niche improvement, but as a foundational requirement, one that every future DBP implementation will need to rely on.

Madrid's journey towards Digital Building Permits

Parro Pérez, Marta; Herrera Rodriguez, Rebeca; Serena Gómez, María

Madrid Municipality (Ayuntamiento de Madrid), Spain

Madrid Municipality is developing MADRIDdbp, a pioneering platform for the automation of building permits, based on BIM methodology and open standards (IFC, BCF, IDS). This ambitious project responds to the need to streamline permitting procedures considering the expected urban growth (more than 170.000 new dwellings in the coming years) and is part of the "Madrid Capital Digital" strategy. The initiative began in 2020 with two collaboration agreements with ASPRIMA (Madrid's Real Estate Developers Association), which provided the first approach to BIM methodology. Real BIM models were tested in new urban developments (Mahou-Calderón and Los Berrocales), confirming that the self-validation of urban planning parameters within BIM models was both feasible and effective. In 2023, an Open Market Consultation was launched, attracting nine technological proposals. Based on its conclusions, Madrid municipality initiated a Public Procurement of Innovative Technology (PPI). The public tender was published on 30 June 2025, with a submission deadline of 15 September.The tender has a base budget of €9.2 million and a four-year duration (plus possible extension). It is organized into four main components:

1. Development of the MADRIDdbp platform as an integrated technological solution.
2. Continuous support and maintenance to ensure stability and operability.
3. Functional evolution, including progressive improvements and regulatory updates.
4. Support for implementation and outreach, including training for internal and external users, technical assistance, change management, and digital culture promotion.

This innovative project is promoted by the General Directorate for Building and supported by a multidisciplinary Technical Committee. The MADRIDdbp platform will feature a developer portal to self-validate BIM models against IDS requirements defined by Madrid Municipality, a rule engine with machine-readable urban regulations, a 3D viewer, GIS integration, and full connection with the municipal permitting system. Development will follow six-month Minimum Viable Products. Within one-year, automated validation of key urban planning parameters (coverage, buildability, position, volume, and stories of the building) will be available. This will enable the issuance of the Urban Viability Report (IVU), which allows developers to obtain the Basic License, the planning instrument in Madrid that authorizes the start of construction.

The contract also provides for the creation of a Platform Office responsible for training, technical support, communication, and user engagement. The strategy further includes enriching the city's digital twin with "as built" models and ensuring interoperability with the urban planning viewer and the Geoportal, in operation since 2019. With MADRIDdbp, Madrid positions itself among Europe's most advanced cities in digital permitting. As the first of its kind in Spain, the project is fully aligned with European recommendations on administrative efficiency, traceability, and transparency.

New Processes! New Services! New Fees?

Ziolkowski, Jörg

ASTOC Architects and Planners GmbH, Cologne, Germany

This presentation explores the current **pilot initiative** in North Rhine-Westphalia (NRW) that introduces a **model-based building permit process** as a central component of the region's digital transformation strategy in the construction sector. In the model-based building permit pilot project, architects take a **central, proactive role** in ensuring regulatory compliance before submission, while authorities focus on complex and non-automatable tasks. The talk provides insights from practical architectural involvement in this pilot program, indicates some technical issues and outlines both the procedural changes and the professional implications for architects.

At the core of the model-based building permit is the idea that a digital model can serve not merely as a visual representation of a building, but as a **structured information carrier** containing all geometrical, functional, and regulatory data necessary for automated verification. The architect submits a machine-readable BIM model, which the **certified software** analyses against the applicable building code provisions. The system performs rule-based checks on aspects such as setback distances, building heights, usage parameters, and selected fire-safety and accessibility requirements. The result is a formal inspection report that identifies compliant elements, highlights modeling errors or missing attributes, and specifies which regulatory aspects require manual review by the authorities – typically non-standard cases such as exemptions or discretionary assessments.

A central requirement for this automated procedure is strict adherence to a mandatory **modeling guideline**. This guideline, issued either by the permitting authority or by the software manufacturer, defines the modeling standards that architects must follow. It specifies how building elements must be structured, classified, and attributed; what level of information detail is required; and in which format the model must be delivered. The **effectiveness** of the automated checking process depends directly on the quality of the submitted model and the architect's ability to implement these modeling rules consistently.

While the model-based permit process promises **faster procedures**, **greater transparency**, and **earlier regulatory certainty**, it also introduces new responsibilities and additional services on the architectural side. These include:

- producing a fully compliant BIM model instead of traditional plans,
- managing classifications, attributes, and information levels,
- performing internal model checks and preparing the data for software analysis,
- interpreting and addressing software feedback,
- documenting the digital approval steps, and
- coordinating digitally with building authorities.

These tasks are not covered within the traditional service phases defined in the German **HOAI** (Official Scale of Fees for Services by Architects and Engineers). As a result, there is an increasing discrepancy between what architects must deliver in a digital approval workflow and what the HOAI currently compensates. The presentation argues for **expanding** the HOAI to include a dedicated service profile for digital building permit procedures and recommends temporary use of supplementary BIM agreements until such regulations are formalized.

Overall, the model-based building permit represents a significant shift in both regulatory practice and architectural service delivery. It enables more efficient and reliable approval processes, provided that modeling standards are met and the additional work required from architects is fully acknowledged—both procedurally and financially.

"One-for-All" – experiences and perspectives of the digital building permit in Germany

Fiedler, Andreas [1]; Weinkauf, Ronny [2]

[1] brain-SCC GmbH, Germany; [2] Hochschule Merseburg

The rollout of digital building permits

The digital building permit started production in the first municipalities in 2021. According to the "one-for-all" principle digital building permits are now used in 13 of the 16 German federal states. The online service is quickly adapted to the various state building regulations of the participating countries using configurations. Currently 220 building authorities use the solution in production. More than 50.000 applications have already been submitted online. Over 700 authorities will use the digital building permit in the future. Over 30 different online services along the entire value chain are offered here. The connection of the specialist software via the XBau standard takes place in close coordination with the software companies. The solution has a high political priority and is intended to simplify and significantly accelerate the approval processes.

The process room as collaboration platform

The so-called "process room" is at the center of the solution. It is a central collaboration and communication platform, which serves as both the front end for the applicants and the back end for the public officer and other parties involved. The process room is connected to external basic components such as identity providers or payment systems. The building applications can be automatically sent to the specialist software in the municipality using a public data standard (XBau). The building owners, its representative and the architect can collaboratively develop the online building application. Communication between the applicant and the building authority takes place completely digitally. The building authority can now address all parties involved digitally in parallel. Finally, the building permit is sent digitally to the building owner and he can pay his fees online.

Functional developments to strengthen the solution

The new German government puts high priority on acceleration of approvals and the effectiveness of digitalization. The development of the overall strategy and the detailed technical requirements take place in close coordination between the program office, the participating federal states, and the service providers. The main focus remains on user orientation and the business process view of the various stakeholders involved.

We consider business processes as a whole and use optimization methods such as process mining. Future technology development is focused on BIM-based building application, Automated code compliance checking, AI functions, register access including geodata register and building statistics digital twin and augmented reality. For these developments, prototypes are initially built. After practical testing, they are incorporated into the overall solution within an agile software development process. A particular strength is the combination of digital building permits within planning approval procedures. Acceleration applies not only to the building application but also to the planning of large-scale projects (example: Hydrogen Core Network Germany).

In centralized operations, requirements for the automation of operational processes are being strengthened. The foundation is a Kubernetes-based cloud infrastructure. With the growing productive use in building authorities, support requests also increase. Fast and high-quality support is therefore a crucial factor for the acceptance of the solution.

openBIM Building Procedure of the City of Vienna Building Authority

Schneider, Roman

City of Vienna, Austria

Digital transformation in the construction sector increasingly requires standardized, transparent, and efficient approval procedures. Based on EU-funded research and development project BRISE-Vienna, which defined the necessary prerequisites for a digital permitting process applying BIM methods, the City of Vienna is developing an openBIM-based building permit checking system. The subsequent conceptual project delivered a coordinated and reliable overall framework for productive deployment. This framework includes functional requirements, optimized process flows, system architecture, and cost and time indicators, serving as a blueprint for implementation. Together with the TU Wien, the Building Authority of the City of Vienna initiated the creation of a dedicated BIM-checking software for authorities. Since the development of automated openBIM-checking tools for public authorities is uncharted territory for the City of Vienna, risks regarding cost, time, and feasibility must be carefully assessed. The initial development phase provides practical insights, forming a reliable basis for implementation planning. This initial development phase focuses on prototyping selected rule checks relevant to building regulations. Examples include formal information delivery checks (LOI compliance), dimensional requirements such as minimum door widths and regulatory constraints on built-up area. These checks are implemented directly on IFC-based architectural models, ensuring software- and vendor-neutral applicability. By the end of 2025, an MVP (Minimum Viable Product) will enable low-code rule creation by the building authority and offer a pre-check website. This MVP will provide two essential capabilities: first, it will enable the building authority to define and manage its own regulatory rules; second, it will offer a pre-check website where external stakeholders ("friendly users") can upload their BIM models and receive automated feedback. This dual functionality ensures both internal efficiency gains and external transparency, supporting applicants in preparing compliant submissions. The resulting MVP marks a significant step toward fully digital, automated, and authority-ready building approval processes.

Practical experience with the openBIM building permit procedure of the City of Vienna

Böck, Thomas; Stadler, Matthias
A-NULL Bausoftware GmbH, Austria

A-NULL Bausoftware GmbH (www.a-null.com) is a software and service company focused on the construction industry. Our clients range from architects, civil engineers, and master builders to public companies and authorities. A-NULL has three business sectors. The first is software sales, where we are the market leader in Austria for Archicad, Solibri, and BIMcollab. The second is our training academy, where we teach software and BIM methods in over 40 courses. The third sector is consulting, where Thomas Böck and Matthias Stadler support architects and public clients with their expertise in projects. One of these projects was the research and development project BRISE of the City of Vienna, where we collaborated with four of our customers to support them in their digital building permit process. We, Thomas Böck and Matthias Stadler, are both certified trainers (openBIM experts) of buildingSMART Austria. Our experience with the openBIM building permit procedure of the City of Vienna As consultants, we have the unique opportunity to gain insights from various offices and their journey towards project submission.

Offices with little experience in BIM initially had to familiarize themselves with this topic. For example, understanding how to create properties in Archicad or export an IFC file. One of the biggest challenges was the amount of information that had to be stored in the model. Creating, managing, exporting, and checking this information often required significant manual effort. The Feedback of the Pre-Check provided by the City of Vienna was crucial for quality assurance. Another difference compared to a standard submission were certain Modelling-Guidelines and that additional volumes had to be created in the model, which were solely necessary for automated checks by the authority. We successfully assisted our clients with each of these challenges and are pleased that the submitted models were among the best.

Progress in Technology and Software: A lot has changed from today's point of view since the BRISE project. The buildingSMART international created a new openBIM Standard for Requirements "IDS Information delivery Specifications" which was released in June 2024 as Version 1.0. The goal of this open format is to have human- and machine-readable Specifications. This allows us to seamlessly transfer the requirements from the client into the planner's authoring tools and into the checking devices to assure the quality. Since the release of IDS all Software Vendors are implementing more and more functions to ensure a seamless workflow. Archicad for example has the IDS-import since AC28. This year Archicad improved its IDS-Importer in the AC29 version which now allows the Import of Properties and Classifications. Another example for the IDS-implementation is the Checking Software Solibri. This software allows to create an LOI-check with an IDS-File just per Drag and Drop.

Conclusion:

- Embrace openBIM formats to ensure software-neutral workflows.
- Prioritize standard IFC properties and minimize special properties to facilitate information reuse throughout the project.
- Leverage digital building permits to offer clients advantages, such as expedited approval processes.
- Ultimately, ensure that the added value is for the planned building.

Practical Lessons from Wingecarribee Shire Council's AI Assistant (DAISY) for Digital Building Permits

Masella, James; Rebkowski, Alex

ADAPTOVATE, Australia

Digitalisation of building permits is emerging as a critical lever for reforming planning systems worldwide. The case of Wingecarribee Shire Council in New South Wales, Australia, provides a concrete example of how local governments can adopt digital permit solutions to address persistent inefficiencies and rebuild community trust. In 2025, Wingecarribee faced the longest development application (DA) processing times in the state, averaging 238 days – more than double the state benchmark. Under pressure from regulators, the Council launched a modernization program combining workforce investment with digital innovation. A centrepiece of this effort was DAISY, an AI-powered assistant supporting residents and staff across the building-permit journey.DAISY (Development Application Information System), launched in May 2025 with NSW Government funding, demonstrates how AI can be harnessed to improve compliance, streamline submissions, and enhance public access to planning rules. Available 24/7 on Council's website, DAISY explains requirements in plain language, identifies relevant controls, pre-vets applications for completeness, and guides residents through the NSW Planning Portal. Importantly, DAISY is advisory only, complementing rather than replacing professional planners.

Early DAISY results show tangible benefits:

1. Channel shift and access: 24/7 availability drives adoption outside business hours – 44% of total enquiries now occur after hours.
2. Staff time returned: Front-of-house teams spend ∼30% less time answering basic enquiries better handled by a virtual assistant trained on address-specific policies, allowing planners to focus on substantive assessment.
3. Throughput uplift: Early operational data indicates an 11% improvement in assessment timeframes, with on-time determinations increasing from 29% to 47% relative to state-set benchmarks.

Wingecarribee's unique context – recovering from devastating 2019-20 bushfires and balancing heritage, environmental and housing pressures – provided a rigorous testbed. DAISY was configured to flag hazard-related requirements (e.g., bushfire standards, flood controls), ensuring faster approvals do not compromise safety or environmental due diligence.

The project had to overcome a number of challenges. Staff training and change management were essential to build internal capability and alleviate fears of job displacement. Process alignment required careful encoding of the Council's Local Environmental Plan (LEP), Development Control Plan (DCP), and state policies into DAISY's knowledge base, with governance protocols to ensure accuracy and accountability. On the data side, consolidating planning instruments, integrating spatial hazard layers (e.g. bushfire, floodplain), and updating policy information were critical to ensure reliable guidance.

The case demonstrates that digital permitting is as much organisational and cultural as it is technological. DAISY's rollout shows how municipalities can combine AI tools with governance, records management and stakeholder engagement to achieve practical, accountable and community-oriented progress – delivering clearer guidance for residents, reducing low-value work for staff, and improving determination performance while aligning with state and federal assurance expectations.

The Ups and Downs of BIM-based Permitting in Netherlands: Translating Aspiration into Implementation

Saar, Jaan

Future Insight, Netherlands, The

The Netherlands is a long-time leader in BIM use, but making the nation's digital plans translate into everyday BIM automation in cities and towns is proving to be a massive challenge. This presentation explores the significant gap between high-level digital aspirations and the struggle to achieve widespread implementation in regulatory work. The first part looks at the "Upside"—the powerful national ecosystem built to drive this transformation. Top-down efforts, including the DigiGO initiative and the wider DMI Ecosystem, successfully bring together every major player. These efforts produce strong official frameworks and standards like the DSGO (Digital Stelsel Gebouwde Omgeving), miniGIM, and miniBIM which, in theory, should make automated permitting simple and efficient.

The second part dives into the "Downside"—the deep, real-world obstacles that keep action stuck in pilots and workshops. Why, despite all this national alignment and tools like the Rotterdam BIM Compliance Checker, is widespread BIM automation still missing? The main challenge is consistently local: municipalities lack the motivation, budget and manpower required for the necessary organizational change. Digital solutions are often viewed as expensive investments rather than essential tools that generate efficiency and savings.

The Dutch experience forces a crucial discussion: How does one turn high-level consensus into practical results on the ground? What specific methods can overcome the perception that this progress is "only talking, not doing"? Finally, how can implementation and organizational change be achieved when staff have time to discuss new methods but no budget to put them into practice? The presentation will explore ways forward, demonstrating that effective change is possible when national strategy meets local, practical support. Join me to find out how the Netherlands can move from being a leader in BIM aspiration to a leader in BIM automation.

Towards a Nationwide Implementation of Digital Building Permits in Portugal: Targeting 2030

Azenha, Miguel [1]; Pires, Carla [2]; Espinho, André [3]; Mateus, Ricardo [4]; Granja, José [1]; Muniz, Bruno [1]; Baptista, Patrícia [2]; Lima Carvalho, Marco [2]; Frescata Pereira, João [3]

[1] University of Minho, Guimarães, Portugal;
[2] Gaiurb EM, Vila Nova de Gaia, Portugal;
[3] Lisbon Municipality, Portugal;
[4] Lusófona University, Lisbon, Portugal

In 2023, prior to any general Building Information Modelling (BIM) Mandate towards the widespread adoption of BIM in the country, the Portuguese Government enacted legislation determining the mandatory use of BIM for digital building permits (DBPs) by 2030, namely Law n.50/2023. Since then, the 'buzz' around BIM and digitalisation in the country has definitely increased. Leveraging the momentum of the EU-funded innovation and research project CHEK,and recent specific activities that have joined local efforts of municipalities, the authors have engaged in continued dialogue with the central government, municipalities, and various stakeholders. These interactions were particularly intense in the last couple of years and included meetings, local training courses, drafting of local guidelines, and mere informal conversations They have enabled the emergence of several insights that this communication aims to share, together with practical and anecdotal examples specific to Portugal (yet probably applicable to many other cases throughout Europe), covering key findings such as:

- DBPs are far from being solely a technological matter. Law, people, and processes likely play equally, if not more, critical roles.
- Implementing DBPs in the short term means that current law cannot be adapted to be machine-readable or at least unambiguous. The dispersion of different applicable laws for building permits along with several confusing jurisprudence do not help. Full or significant automation would not be expected in the short to medium term.
- GIS information in most municipalities (if not all) does not yet have the accuracy to support detailed building permit checks, such as façade alignment or the positioning of floors and windows.
- Even without specific information requirements, one of the co-authoring municipalities has been receiving IFCs in building permit applications on a voluntary basis since 2018. Even though the submitted IFCs fall short in many aspects of modelling and even adherence to standards, they have already proven very useful.
- There are many boring and repetitive tasks in the overall process of building permits. Most of them are well identified and could benefit from proper information requirements for BIM-GIS. With relatively small investments, significant benefits can be achieved in all municipalities (including smaller ones).
- Regardless of what the future holds, new laws tailored for easier automation are becoming a trend in the European Union. Municipal urban planning laws shall be no exception. It's only a matter of time.
- Whatever measures are taken, the involvement of all stakeholders in the process of urban planning is fundamental to ensure effective implementation.

Part III

Poster-Track

A Multi-level Approach to Integrating Sustainability into Digital Building Permitting

Deac-Kaiser, Stefanie-Brigitte; Zaharia, Raul; Crisan, Nicolae-Andrei

Department of Steel Structures and Structural Mechanics, Politehnica University of Timisoara, Timisoara, Romania

Introduction

This PhD study investigates the transition toward digital and sustainable construction, which requires rethinking the current role of building permitting (BP) in supporting climate goals, energy efficiency, and circular economy principles. While digitalization has improved BP efficiency, the integration of sustainability remains underdeveloped. Building permits often function as regulatory checks rather than tools to advance climate neutrality. The research explores how digital building permitting (DBP) can act as a sustainability enabler by linking BP processes with the United Nations Sustainability Development Goals (SDGs). Two guiding research questions were addressed: i) Which sustainability-dimensions and concepts intersect with BP?; ii) What data and processes within these concepts influence sustainability compliance?

Methodology

The research follows a four-stage methodology. The first stage establishes a foundation through a literature review examining how BIM-integrated BP relate to sustainability drivers. A matrix-based cluster analysis categorizes challenges and potentials, identifying solutions across education, research, standardization, policy incentives, and technology integration. The second stage consists of preliminary studies: i) a comparative study in 19 European countries capturing procedural diversity; ii) a taxonomy was developed to classify BP systems; iii) a KPI-based framework for BIM-integrated BP was validated through expert interviews from advanced countries. While this phase highlighted the digital inconsistencies, it did not explicitly address sustainability, which guided to the subsequent research focus. Stage 3 involved the core analysis: i) mapping relevant SDGs to DBP and DBL practices, showing fragmented but broad contributions; ii) sustainability matrix linked BP concepts to environmental, social and economic pillars, connecting them with policies and practices. The validation phase deepened the analysis: i) the taxonomy was extended with financial dimensions, capturing direct and indirect costs and value; ii) EPCs were studied as underused but valuable data sources with reuse potential for sustainability goals.

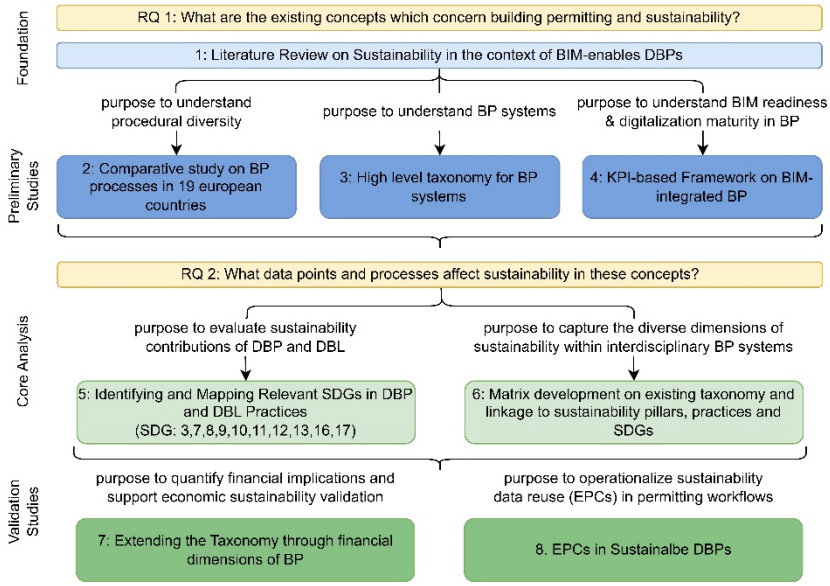

Fig. 1 Research Methodology

Key Findings

The research produced several contributions across four methodological stages. The foundation phase outlined the general challenges, opportunities, and solutions for integrating sustainability into DBPs. It provided a holistic overview of BIM in the context of BP, with a long-term sustainability perspective. Drawing on an extensive literature review and cluster analysis, it proposes a set of specific solutions for integration, including education, research, standard development, government incentives, and technology alignment.

A comparative study across 19 European countries revealed the procedural diversity of BP systems, underlining differences in compliance rules, risk management, and institutional roles. These differences demonstrate the difficulty of achieving standardization across regions, while also exposing limitations in data representation and potential biases.

To navigate this complexity, the next phase introduced a taxonomy to systematically classify BP systems into four interdependent subsystems: legislative, organizational, procedural, and technological. This framework formed the basis for evaluating sustainability links and digital maturity. A set of KPI was established to assess digital maturity and BIM-readiness across diverse contexts. Seven expert interviews from Europe and beyond validated the KPIs and offered multi-perspective insights into practical implementation. Building on this, the study mapped current DBP and DBL practices against SDGs. It found that BP already touches a broad range of sustainability targets (namely 3, 7, 8, 9, 10, 11, 12, 13, 16, and 17). However, these contributions remain fragmented and underrecognized.

To better structure these, a sustainability matrix was developed linking BP concepts to three sustainability pillars, and relevant policies and practices. While most connections fall within the environmental pillar, the research also identified significant contributions to the social and economic domains, offering a holistic and interdisciplinary integration model.

Extending the taxonomy to include financial dimensions further emphasized the economic relevance of BP, including direct and indirect costs as well as their broader systemic value, an area rarely addressed in sustainability discussions. In parallel, the focused study on EPCs revealed that, although commonly submitted, briefly checked and archived during BP, they

contain substantial untapped data with reuse potential. When systematically integrated into DBP workflows, EPCs can provide meaningful support for achieving sustainability goals.

Overall, the findings establish that BP are not merely administrative instruments, they can act as active enablers of sustainability. By linking DBPs with established frameworks such as SDGs and by tracing a clear compliance pathway, from concept mapping (Step 5), to sustainability indicators (Step 6), to financial assessment (Step 7), and EPC-based verification (Step 8), this research offers a structured, practical approach for tracking and validating sustainability outcomes across all pillars.

Conclusion and Future Work

This research contributes to integrating sustainability into DBP by identifying key sustainability-driven concepts, mapping their role in BP workflows, and analyzing the data points they generate. Through a structured, multi-stage approach, it establishes conceptual foundations, offered comparative insights across European systems, and developed methodological tools. Together, these results demonstrate how DBPs can connect directly to sustainability principles and policy frameworks such as SDGs and EPBD. The findings offer a bridge between data-rich sustainability instruments and BP systems, contributing to the development of compliance pathways that embed sustainability into digital workflows. Looking ahead, future research will explore advanced tools sucj as AI-powered compliance checking and Digital Twins for real-time sustainability assessments. Another key direction is developing unified frameworks that connect municipal practices, regulatory policies, and digital platforms. By advancing these efforts, this research supports policymakers, BP authorities, and technology developers in creating more efficient, transparent, and sustainability-driven BP systems.

Bridging the BIM-Immersion Gap: A Methodological Framework in Administrative Processes

Balin, Simone [1]; Bolognesi, Cecilia Maria [1]; Borin, Paolo [2]

[1] Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Milan, Italy; [2] Department of Civil Engineering, Architecture, Territory, Environment and Mathematics (DI-CATAM), Università degli Studi di Brescia, Brescia, Italy

As digital transformation progresses in public administration, particularly in the area of digital administrative procedures, advanced representation systems, such as extended realities (XR) and metaverses, offer opportunities to enrich collaborative and decision-making processes. However, a gap remains between their theoretical potential and practical adoption, as they are often relegated to the role of visualization tools rather than conceived and integrated as methodological innovation. The integration of information management and structured representation models is essential to transform experiential dimensions from unpredictable outcomes to controlled and intentional outputs in collaborative decision-making processes. This is particularly critical in administrative contexts, where data reliability, transparency, and legal validity are essential. This underestimation stems from the lack of structured approaches to guide their integration into established professional processes, such as BIM workflows. Consequently, their application in this context generates information ambiguities and procedural misalignments that compromise their reliability and hinder their use. This research seeks to overcome this gap by developing a methodological framework for the systematic integration of representation systems into collaborative and decision-making processes supported by BIM methodology, with particular reference to digital administrative procedures and extendable to the context of Digital Building Permits. Through a mixed-methods approach based on the Design Science Research Methodology (DSRM), which combines the rigor of a systematic literature review with the practical validation of two experimental case studies (a simulated application and a real application in the MIND project in Milan), the research presents an innovative solution (see Figure 1). The framework operationalizes the experiential dimensions (presence, immersion, usability, and engagement) within the framework of BIM standards such as ISO 19650, ISO 16739 and the level of information need, transforming them from random variables to systematically designed outputs. The framework follows a three-step workflow: (1) extraction of data compliant with IFC standards; (2) semantic alignment and quality checking based on ISO 19650 information management principles; and (3) generation of immersive environments for collaborative review and decision support. This operationalization ensures traceable, interoperable, and legally reliable data exchanges. This solution transcends the traditional object- and system-based approach to adopt a model that focuses on the entity (user, object, and environment), addressing not only the model's geometry and data in terms of an "information system," but also the usage scenario and the enduser's cognitive experience. In practical terms, the framework supports collaborative concept of a "irepresentation ecosystem". The framework represents a new taxonomy of prerequisites and requirements that, inspired by the structure of the ISO 7817-1 standard and aligned with Exchange Information Requirements (EIRs) and BIM Execution Plans (BEPs), enriches it with elements specific to experiential representation systems. This classification

harmonizes technical requirements (scalability, interoperability) with experiential factors (usability, immersion, presence), ensuring that experiential dimensions emerge not as unpredictable byproducts, but as intentional results of structured decision-making processes. In practical terms, the framework supports collaborative decision-making by structuring information to improve understanding and consensus among stakeholders with different expertise, such as technicians, public administrators, and citizens. Specifically, it facilitates administrative decisions such as compliance verification, approval of project variants, and stakeholder coordination in workflows for obtaining comments or decision-making opinions, where advanced representation improves shared spatial understanding and transparency. The case study results demonstrate that its application not only optimizes technological implementation but also transforms the collaborative process: it significantly improves the user experience, reduces the time required for effective collaboration, and increases the overall quality of decisions. At the same time, the research identifies significant trade-offs and limitations, including implementation costs, the need for frequent model updates, and ergonomic challenges associated with devices. The framework thus serves as a functional bridge between the accuracy and informational robustness of informational models and the intuitive under-standing of representation systems, making complex spatial issues accessible and facilitating informed consent in legally sensitive administrative procedural contexts. In the specific case of digital building permits, the framework provides a structured method for representing, verifying, and communicating project information between authorities and stakeholders, improving both efficiency and procedural transparency. The value of this research lies in its ability to connect information management with structured representation models, enabling transparent and collaborative decision-making processes, in which experiential dimensions are not a random outcome but the fruit of an intentional construction.

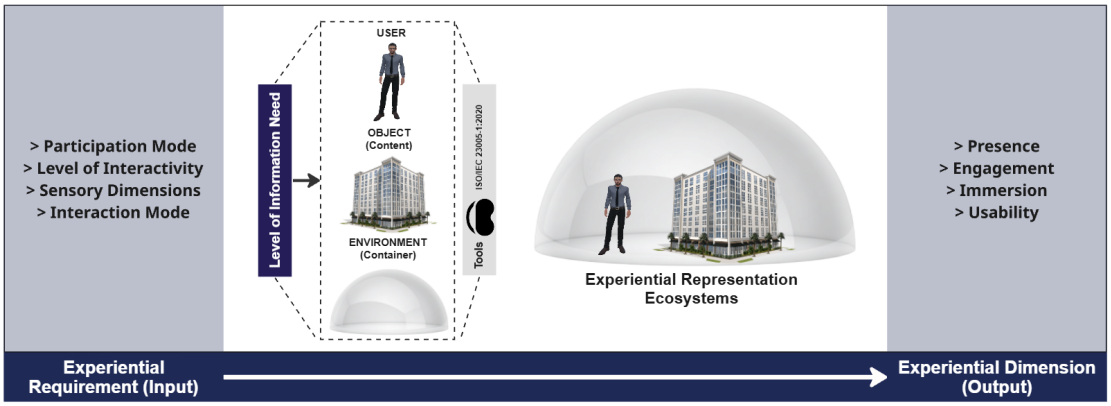

Fig. 1 Compositional scheme of the Experience Ecosystem

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Leveraging Game Technology for Interactive BIM-Based Building Permits

Muniz, Bruno; Granja, José; Azenha, Miguel

ISISE, Department of Civil Engineering, University of Minho, Guimarães, Portugal

Introduction

Automation of compliance checks (ACC) is fundamental to Digital Building Permits, due to its potential to reduce the permit issuing times, improve its transparency and make it less error-prone [1]. Yet, ACC still needs further research to be comprehensively implemented [2], and at the moment, not all the regulatory rules are suitable for automation, due to factors such as subjectivity and geometrical complexity.

Assisted compliance check approaches that make use of interactive tools to enable a smart inspection of the 3D information models might be a complementary solution to the automation, enabling an easier digitalisation of rules that are mostly based on geometrical aspects, such as planes, distances and alignments. Despite its potential, the research on the assisted approaches is scarce, which can be explained by the challenges of developing these interactive tools, which often demand a high degree of programming skills and 3D graphics knowledge.

Game engines are extensible and reusable software used to develop games [3]. It often incorporates subsystems specialised in graphics rendering, collision detection and other common features demanded to create interactive experiences. Commercially available engines are also focused on ease of use, being equipped with graphical user interfaces and integration with data formats for 3D assets. For these capabilities, they have been investigated as a way to promote visualisation, interaction and data exchange of construction models [4]. Ultimately, these engines have the potential to ease the development of heavily interactive experiences for the construction industry, not being limited to specific use-cases.

Objective

This study aims to verify the benefits of assisted compliance check in the permitting process compared to traditional two-dimensional project verification. In this study, assisted verification is developed through the integration of resources associated with BIM methodology and game engines, to provide an intuitive experience of verifying spatial elements that are difficult to implement in automatic verification. The main contribution of this study is to demonstrate the feasibility of the assisted compliance check as a complementary solution of the Automated Compliance Check (ACC) to enable the full digitalization of building permits.

Methodology

The activities involved in this work will follow the sequence: a) selection of representative rules within the Portuguese regulatory framework, where the rules will be chosen within the ones that are actually verified by municipalities due to the juridical regulation and that also incorporate geometrical aspects, such as planes, alignments and distances; b) determination of verification methods for the representative rules, where the toolset will be conceptualized based on game design concepts and current building permit concepts; c) development of toolset prototype and foundation tools, where the game engines will be adapted and heavily used to create interactive assisted compliance checking experiences; d) testing and evaluation of prototype with municipality, with sessions to compare traditional and assisted verification performance and e) reporting.

First results and next steps

To assess the feasibility of the proposed methodology, a sprint round of the activities a, b and c – that represent the heaviest technical activities – was executed:

a) The rule selected comes from article 59 in the Portuguese code for building and urbanisation, which determines limitations for the height based on 45-degree planes coming from the alignments of buildings across the street;
b) To correctly allow the verification of this rule, a tool to create 45-degree planes was conceptualised. It allows the selection of points of an existing building to define its alignment and, consequently, the plane. This tackles the challenge of alignment definition in buildings with complex facades, which can be hard to automate;
c) Godot was the game engine used to elaborate the prototype. Its open-source nature and large growing community provide a lot of flexibility and resources to facilitate its use. A simple BIM model (IFC) reader for Godot was created to obtain the geometry needed for this verification.

For testing purposes, an IFC file containing multiple sites was created. In Fig. 1 the executed verification is presented, in which the building on the left side is the proposed building and the one on the right side is the existing building. The created plane clearly demonstrates that the facade of the proposed building is non-compliant, being higher than the plane coming from the alignment of the existing building.

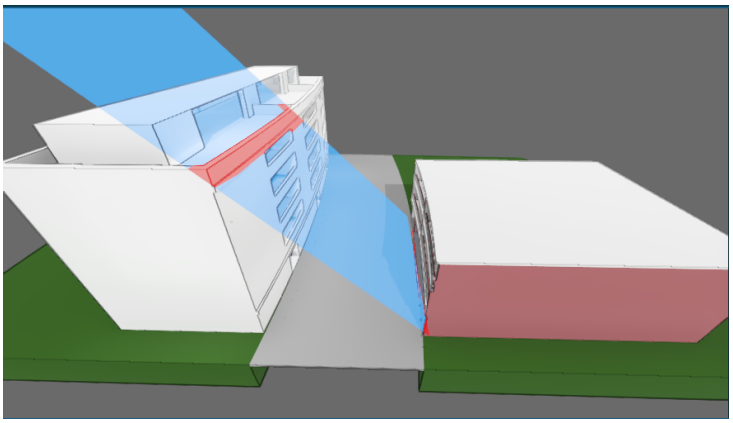

Fig. 1 Real-time capture of the first prototype developed

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Mitigating Construction Lending Risks through Digital Building Permits and BIM to Enable Streamlined Due Diligence and Enhanced Transparency

Mbabu, Alex [1]; Wildenauer, Adrian [2]

[1] University of Salford / School of Engineering and Environment, Salford, United Kingdom; [2] Bern University of Applied Science / Institute of digital Wood and Construction Industry, Biel, Switzerland

The construction lending sector faces significant risks due to information asymmetries, lengthy approval processes, and potential manipulation of traditional paper-based documentation systems. This research examines how digital building permits integrated with Building Information Modelling (BIM) can reduce lending risks by enabling streamlined due diligence processes while minimising opportunities for data manipulation. Through a thematic literature review analysing recent developments in digital permitting systems, this study identifies key mechanisms by which digitalisation transforms construction loan risk assessment. Digital permits facilitate paperless submission and review processes, enabling real-time access to project documentation, regulatory compliance status, and construction progress data. When integrated with BIM technology, these systems provide three-dimensional visualisation, automated clash detection, and continuous project monitoring capabilities that enhance lender confidence and decision-making accuracy.

The research reveals benefits for multiple stakeholders: lenders gain access to transparent, tamper-resistant project data that improves risk assessment accuracy; borrowers experience reduced approval times and lower transaction costs; regulatory authorities benefit from streamlined compliance monitoring; and construction professionals achieve better project coordination through enhanced communication platforms. Digital systems enable automated code-checking, real-time progress tracking, and integrated audit applications that collectively reduce the likelihood of cost overruns, schedule delays, and regulatory violations that traditionally threaten loan security. However, implementation faces notable limitations including substantial technology investment requirements, staff training needs, and potential resistance from stakeholders accustomed to traditional processes. Data security concerns and the need for standardised protocols across jurisdictions present additional challenges. Smaller market participants may face barriers to adoption due to resource constraints, potentially creating competitive disadvantages.

The literature demonstrates that successful digital permit implementations have reduced permit approval times while BIM integration has improved tampering detection accuracy across various validation mechanisms. Early adopters report enhanced project completion rates within budget and schedule parameters, suggesting risk mitigation potential for construction lenders.

This research contributes to understanding how digital transformation can address longstanding challenges in construction finance by providing empirical evidence of risk reduction mechanisms and identifying critical success factors for implementation. The findings support broader adoption of integrated digital permitting and BIM systems as strategic tools for construction lending risk management.

Modelling and Optimizing Stakeholder Interactions in Building Permit Processes

Motahar, Hossein

Bauhaus-Universität Weimar, Chair of Construction Engineering and Management, Weimar, Germany

Building permit processes across Europe exhibit significant complexity due to multi-stakeholder environments, regulatory heterogeneity, and coordination inefficiencies [2]. This research presents a comprehensive analysis of stakeholder management practices and process optimization strategies for European building permit systems through systematic empirical investigation and advanced computational modelling approaches.

The investigation employed a mixed-methods approach integrating qualitative analysis, social network analysis (SNA), agent-based modelling, system dynamics, and multi-objective genetic algorithm. Figure 1 illustrates the integrated empirical-computational workflow linking these methods.

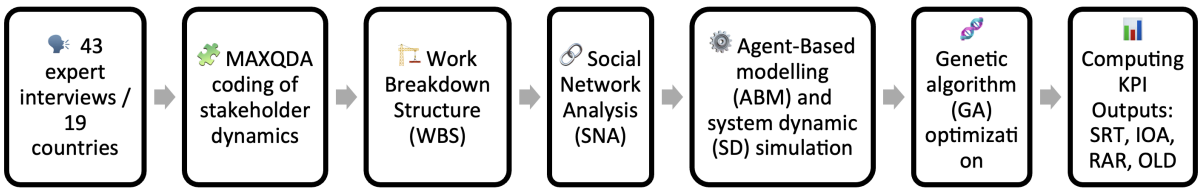

Fig. 1 Compositional scheme of the Experience Ecosystem

Primary data selection and adaption involved existing 43 semi-structured interviews with building permit experts across 19 European countries [2], generating comprehensive stakeholder interaction data. The interview transcripts were systematically analysed using MAXQDA software to code stakeholder management aspects, interaction patterns, and coordination mechanisms according to a structured coding framework [1, 2].

A four-level work breakdown structure (WBS) was developed: Stages → Processes → Activities → Stakeholders. This hierarchical framework enabled systematic mapping of stakeholder roles, responsibilities, and interdependencies throughout the building permit lifecycle. Social network analysis was conducted to quantify interaction patterns, identify communication bottlenecks, and measure stakeholder centrality metrics across different national regulatory contexts [3].

Agent-based simulation models were implemented using AnyLogic software, combining system dynamics and discrete-event simulation methodologies. The simulation environment replicated real-world building permit processes based on empirical data from the interview analysis, incorporating stakeholder behavioural patterns and process variations identified across the European sample. Four key performance indicators (KPIs) were operationalized and quantified based on stakeholder-specific requirements identified through qualitative analysis: Stakeholder Response Time (SRT), measuring individual entity processing efficiency; Inter-organizational Adherence (IOA), evaluating coordination effectiveness between stakeholders; Regulatory Adherence Rate (RAR), assessing compliance with established procedures; and Operational Load Distribution

(OLD), examining workload allocation across the stakeholder network. These metrics were integrated into the simulation framework to systematically measure process efficiency and stakeholder performance.

Genetic algorithm optimization was applied to enhance process performance through iterative fitness function evaluation. The algorithm evolved multiple generations of solutions to identify optimal stakeholder coordination patterns, resource allocation strategies, and process sequencing arrangements. Fitness functions incorporated the four KPIs to balance efficiency improvements with regulatory compliance maintenance.

Social network analysis revealed significant variation in stakeholder centrality and coordination patterns across European countries. Critical bottlenecks were consistently identified in inter-organizational communication channels, with regulatory authorities exhibiting high betweenness centrality but variable response efficiency across national contexts. Simulation results demonstrated that optimized stakeholder coordination could reduce total permit duration by 15–30% while maintaining regulatory compliance standards above 95%. The genetic algorithm optimization identified specific stakeholder interaction patterns that systematically minimize process bottlenecks while maximizing Regulatory Adherence Rate (RAR).

Load distribution optimization emerged as a critical factor, with balanced workload allocation reducing system congestion by up to 25%. Inter-organizational Adherence (IOA) was established as a key determinant influencing both process duration and quality outcomes across different regulatory environments. The research provides evidence-based insights for digital transformation initiatives in European building permit processes, offering a systematic methodology for mapping digital workflow requirements and identifying automation opportunities.

Optimization results indicate that strategic stakeholder coordination improvements can achieve substantial efficiency gains without compromising regulatory standards or procedural integrity. The methodology provides a replicable framework for evaluating and enhancing building permit processes across diverse European regulatory environments [4].

This research contributes empirically grounded methods for stakeholder analysis and process optimization in complex regulatory systems. The integration of social network analysis, agent-based simulation, and genetic algorithm optimization provides a comprehensive framework for understanding and systematically improving multi-stakeholder regulatory processes.

The methodology demonstrates practical applicability for digital building permit initiatives, offering quantitative metrics for evaluating process improvements and stakeholder coordination strategies. Results support evidence-based policy development and system optimization approaches in European building permit contexts, providing a foundation for systematic digital transformation planning. The framework supports local administrations in identifying coordination bottlenecks and testing digital workflow scenarios before implementation.

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Pre-Consultation as the Missing Link in the Estonian Digital Building Permitting

Peet, Pille-Riin [1]; Pikas, Ergo [2]; Ruus, Aime [1]

[1] Tartu College School of Engineering, Tallinn University of Technology, Puiestee 78, 51008, Tartu, Estonia; [2] Building Lifecycle Research Group: Department of Civil Engineering and Architecture, Tallinn University of Technology, Ehitajate tee 5, 19086, Tallinn, Estonia

Introduction

The digitalization of the building permit process is often seen as a solution to inefficiency, subjectivity, and lack of transparency. Current research, however, mainly focuses on automating compliance checks after a completed design is submitted and assume applicants know which regulations apply in their specific case.

Our earlier research identified four systemic problems in the Estonian permitting process: inconsistencies and subjectivity in decision-making, lack of procedural transparency, fragmented requirements, and generally worded legislation [1]. To address these, we proposed introducing a structured preconsultation phase.

This study revisits these findings considering a BIM-based building permit module was introduced in the Estonian Building Registry in 2024, as of October 2025, in beta testing. The module is an important step, but it is limited to BIM models, and has no case-specific rule filtering functionalities, leaving applicants to interpret the check results relevance themselves [2].

We distinguish between pre-checking and pre-consultation and argue that digitalisation alone cannot solve systemic problems without procedural redesign [4]. The study advances digital building permitting practice in Estonia by identifying how a structured pre-consultation phase could increase regulatory clarity, improve transparency, and support a more objective digital permitting system. Pre-checking refers to a rule-based BIM model check carried out before application submission to flag issues [2], whereas pre-consultation takes place early in the design phase, helping to determine which regulations apply and mitigate potential issues before they arise [3].

Based on the BIM module pilot and stakeholder feedback, we define objectives for a digital pre-consultation tool that can identify applicable requirements early from minimal project data (i.e., building type, use, location, and type of intended activity), reduce subjective interpretations across municipalities, and improve transparency for both applicants and authorities. We argue that early-stage identification of applicable regulations is the missing link for transparent and effective digital permitting systems, and that Estonian case offers internationally relevant lessons.

Methodology

This paper is part of a ongoing research project, which uses the Design Science Research (DSR) method. The DSR approach supports iterative development of digital tools grounded in real-world needs. The focus of this paper is on the problem identification phase of the overall research. This work was carried out in two steps:

1) a case study of the Estonian permitting process, including a secondary data analysis of policy documents and existing analysis of the overall process and the BIM module;
2) semi-structured interviews with municipality specialists and BIM module pilot participants to get a nuanced understanding of both processes.

Results and Discussion

The results show that inconsistent interpretation of regulations remain a central challenge in both traditional and BIM-based processes. The current BIM module offers a limited number of automatic checks and therefore has little impact on the process's subjectivity problem. Transparency gaps persist as applicants are not given detailed information about the process development and the rationale behind the decisions. Fragmented legal requirements hinder both human and machine interpretation of the legislation.

The Estonian BIM module does have some efficiency gains in isolated cases, but automation alone cannot solve the systematic problems. It supports pre-checking based on a completed BIM model but does not provide the early guidance of pre-consultation. As a result, applicants still face uncertainty about which regulations apply until late in the process. Early-stage regulatory identification is underexplored in research and practice. Integrating a structured pre-consultation phase into the process would establish a shared baseline for both authorities and applicants before a full design review, reducing costly delays and inconsistencies.

Conclusion

This study extends earlier findings by incorporating stakeholder experiences from Estonia's BIM module pilot. The results strengthen the case for a structured pre-consultation tool as a missing link in current digital permitting initiatives. It argues that early identification of applicable regulations, case-specific guidance, and compatibility with the BIM module represent the next step toward a more transparent, efficient, and inclusive permitting system. Future work will focus on designing such a digital pre-consultation tool and developing a prototype that would be integrated into the Estonian Building Registry.

This study is limited to the context of a single country, municipality, and building case. Future work will extend the findings by testing a prototype pre-consultation tool with multiple municipalities of different sizes and including non-BIM projects.

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The CHEK Project Approach to Reskilling and Upskilling in the context of BIM and GIS

Mantelatto, André; Muniz, Bruno; Gatto, Chiara; Sobral, Luciana; Granja, José; Azenha, Miguel

ISISE, Department of Civil Engineering, University of Minho, Guimarães, Portugal

Lack of digital skills remains one of the main barriers to the adoption of Digital Building Permits (DPBs); in addition, the digitalization of public officers' mindset is a goal of the European Network for Digital Building Permits (EUnet4DBP) [1]. Among other objectives, the CHEK Project addresses this gap by delivering a capacity-building training developed for key stakeholders in the building permitting workflow. With the rapid growth of Industry 4.0, many AECO (Architecture, Engineering, Construction, and Operations) professionals lack the technical knowledge to effectively apply digital technologies, such as Building Information Modelling (BIM) and Geographic Information Systems (GIS), in their daily work. Such techniques are essential for transitioning from a paper-based approach to a fully automated digital system [2]. However, traditional educational methodologies are typically rigid and struggle to stay updated with technological advancements [3]. The CHEK Project aims to streamline the building permit issuance process by introducing a new set of digital tools and training the pivotal actors involved in the building permit [4]. Built upon materials developed within Work Package 5 (WP5), a training program has been created that aligns emerging trends in reskilling and upskilling initiatives with modern information consumption habits. While reskilling is the process of acquiring new skills due to obsolescence—often necessary when technology changes job responsibilities and roles—upskilling is the process of improving and upgrading existing skills to adapt to new technologies, methodologies, or approaches. Both are indispensable in an era of rapid technological innovation and new working habits [5].

Unlike other BIM and GIS courses focused on model authoring, this training introduces the theoretical background for adopting DBPs and explains the CHEK toolkit through a practice-oriented approach. The program is structured as a self-paced set of fast-consumable, bite-sized learning materials, designed in both storytelling (Carousel) and video-based formats, with minimal text but visually engaging content. Tailored to three key target groups—municipalities technicians and inspectors, designers and applicants, and other stakeholders in the construction value chain (e.g., policymakers, construction firms, etc.)—the training addresses their distinct objectives and challenges through seven different Learning Objectives (LOs): (1) Understanding Digital Building Permits, (2) Key Technologies Behind DBPs, (3) Information Management, (4) GeoBIM for DBPs, (5) Digital Building Permit Workflows, (6) openBIM for DBPs in Practice, and (7) the CHEK Toolkit.

Three courses have been designed and launched for each target audience, following a subset of the same seven LOs adapted to their roles. Each LO is progressively unlocked in a prestructured content delivery order. Each lesson includes interactive Q and A sessions to reinforce learning and concludes with additional references from both academia and industry, providing an in-depth understanding through external links, videos, ISO standards, and scientific papers. Before completing the course, users are required to complete a short feedback survey evaluating the training's usability and their overall experience, consisting of 10 questions. The questionnaire analysis indicates a high overall user satisfaction rate. Upon successful completion of the training,

a Certificate is issued, attesting to the trainee's attendance. The training was created entirely in English to facilitate cross-border knowledge sharing and is provided through Moodle (Modular Object-Oriented Dynamic Learning Environment) due to its versatility and scalability. The courses are hosted on the CHEK e-learning platform: elearning.chekdbp.eu.

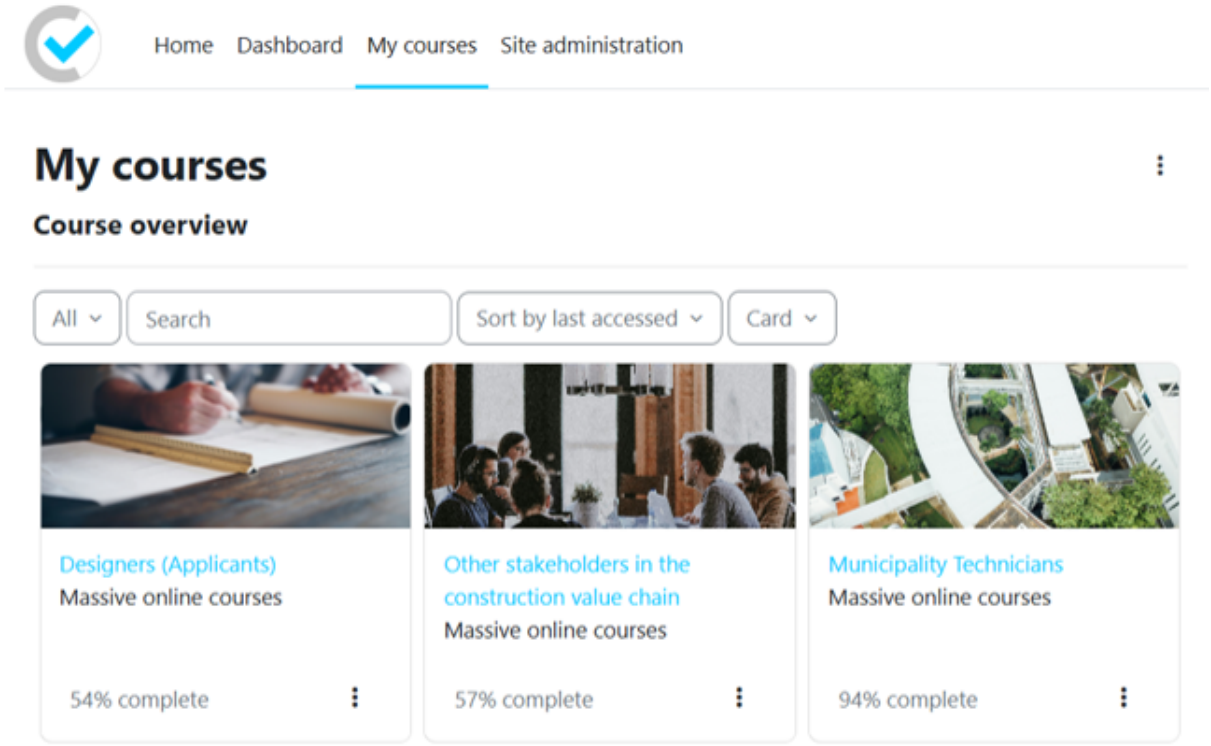

Fig. 1: The CHEK e-learning platform

It's therefore expected to encourage professionals to reskill and upskill their curricula with foundational knowledge across various digital domains, and to help them keep pace with the latest, cutting-edge technologies. Ultimately, it aims to empower municipalities, designers, and other stakeholders to actively participate in the digital transformation of building permitting, reinforcing collaboration, transparency, and efficiency over the construction value chain.

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