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# Understanding processes on digital building permits – a case study in South Tyrol

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## ABSTRACT

Building permitting plays a significant role in life cycles of buildings because without a building permit a legal construction fails. However, digitalization in building permit, authorities is rare in a global context and issuing a building permit is primarily a manual and time-consuming process. In current research approaches on digital building permits, the focus lays on the digitalization of building-related regulation checks. Even if the approaches cover an important step in the building permit process, other significant steps such as administrative processes are neglected. In preliminary research, a building permit process model for structuring action-oriented elements was developed and transferred and applied to a Building Information Modelling (BIM)-oriented and process-based web application prototype, which serves as a basis. An empirical study – using qualitative expert interviews in a building permit authority in South Tyrol (Italy) – was conducted to simulate a BIM-oriented building permit review as well as to investigate the building permit processes thoroughly. The results show a classification of the information needed for digital tools supporting the building permit process, building permit processes of the case study authority, and the digital tools used. In the discussion, knowledge gained from a comparison between other building permit processes is presented alongside considerations for follow-up research.

## ARTICLE HISTORY

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building information  
modelling; process  
modelling; digital tools

## Introduction

According to the McKinsey Institute (Daub et al., 2020), digitizing services helps governments to meet public expectations and become more efficient and resilient. In an international survey, it was found that residents who are satisfied with a public service are nine times more likely to trust the government overall than those who are not. Moreover, digital interactions with the government and public administrations are less time-consuming for citizens, and reduce the administrative burden on companies, which can help support business as economies recover from the COVID-19 aftermath. Despite that – in a specific study on the Digital Transformation (DT) – the McKinsey Institute highlights that only large companies possess a high level of digital maturity.<sup>1</sup> Small-Medium Size Enterprises (SMEs) and the Architecture, Engineering and Construction (AEC) sector are the weakest actors, not benefiting from the DT (Bughin et al., 2016).

The AEC is looking at the DT as a new opportunity to overcome the lack in productivity by pushing

collaboration in an interdisciplinary environment. BIM, also known as Building Information Management, is a methodology for the digital managing of information along the whole lifecycle of a construction work. Handling 3D-geometry (such as technical models, blueprints, etc.) and alphanumeric data (costs, assembly, maintenance, etc.), it aims at implementing an integrated platform that spans project planning, design, execution, operations, and maintenance (Hamil, 2021; Sacks et al., 2018). Thus, BIM is pursuing the objective of driving the information management system towards an efficient DT. BIM is globally recognized as a standard methodology through the ISO 19650 standard – ‘Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling’ – and the EU countries are adopting BIM for public building commitments.

According to Aufa et al. (2022), a building permit is a permission given by a respective authority to a building owner to build a new structure, extend an existing

structure, maintain existing facilities, or reduce the size of existing buildings while complying with all relevant technical and administrative criteria (Aufa et al., 2022). Governments create built-environment laws, rules, and regulations to ensure citizen safety and health. Utility, energy economy, sustainability, and economic considerations have been important throughout the period. These disciplines have technical requirements and legislation for reviewing construction designs and providing building permits. Inspections during construction ensure that the building permit issued for the building is constructed according to design (Meijer et al., 2002). For this reason, a building permit is a cornerstone of each construction project and is essential for the issuance of a legal construction project.

Regarding the building permit processes, Noardo et al. (2020) provided an assessment of the present building permission procedures by summarizing the workflows of several distinct nations. It is feasible to separate the building permit workflow – which occurs after the commencement of construction – into subsequent phases by coordinating the various national procedures. Beginning with pre-consultation, the procedure involves further application submission, consultation with neighbours or other residents, application review and rule checks, planning decision, start of construction, site inspections while work is in progress, completion and notification to building authorities, final inspection, and issuance of a completion or utilization certificate. Meijer et al. (2002) summarized the building permit procedures in eight European countries as follows: consultation prior to application, submission of the building permit, preventive check of the technical requirements, inspection during execution, and completion.

In a global context, issuing a building permit is still an error-prone, time-consuming, and subjective process (Malsane et al., 2015). This is partly due to the fact that the legal foundation for prompt full automation in public administration is lacking, as is social acceptance (Etscheid, 2018). In addition, the clerks in the building permit authorities have fears of contact with digitalization and the use of BIM models (Fauth, 2021). There is a lack of suitable and user-friendly tools that enable the handling of BIM models in conventional reality.

The Autonomous Province of Bolzano – South Tyrol, located in northern Italy, has experienced consistently high demand for the number of building permits over the past five years. This corresponds to about 2000 building permits per year (ASTAT, 2021). Despite the increased workload for the building authorities, the optimization potential of DT is hardly adopted. In particular, the use of BIM has no significance on the local building approval authorities.

This paper delineates a research study aimed at testing and validating a building permit process model and a BIM-oriented and process-based web application prototype developed in a previous research study by the authors (Fauth, 2021). For this purpose, the results previously obtained in Germany were transferred to the South Tyrolean system. The research represents a case study of the GEOBIMM project, which investigates the integration potential between BIM and geographic information systems (GIS) for building permitting. The subject of this case study is a South Tyrolean municipality. The building officials of the considered municipality are employed as experts for qualitative interviews. During the interviews, the building officials are introduced to a simulation of the BIM-oriented building permit review in order to analyse the applicability and plausibility of the BIM-oriented and process-based web application prototype. Thus, a thorough analysis of the building permit process is conducted. Furthermore, the interviews will provide insights into the digital tools used and proposed as well as statements on opportunities and challenges.

## State of the art

### *Digital building permits*

In recent years, many efforts have been made in academia in the area of digitizing building permits. Eastman et al. (2009) outlined an initial approach by defining a rule review system that serves as a foundation for many other approaches. Guler and Yomralioglu, (2021) and Messaoudi and Nawari (2021) developed a framework for digitizing building permits in Turkey and Florida (US). Olsson et al. (2018) addresses the use of geospatial data in building permits. This is also the case for Noardo et al. (2020), whose approach also addresses digital workflows throughout the building permit processing process and concludes that BIM can support technical review. Korean researchers developed numerous approaches to digitizing and integrating a computer-interpretable Korean building code into their respective building permit systems (Kim et al., 2019). In Europe, researchers and practitioners established the European Network for Digital Building Permits (EUnet4DBP) in 2020. The EUnet4DBP formulates targets and requirements to promote digital building permits. One of the goals is to empower building authorities. In particular, the mentality of building authorities should be changed. The focus is on the direct involvement of building authorities in the process of digitalization. Another goal is to use interoperable, scalable systems that can be used at different levels and in

different countries (Noardo et al., 2022a). In addition, Ullah et al. (2020) defined eight necessary steps that a municipality must take in the initial phase of BIM adoption. The first step is to review the current situation and practices of the organization.

The interoperability of BIM data and GIS data environments allows architects and planners to easily achieve development standards during the architectural design process prior to submission for approval to building permit authorities, resulting in faster approval processes with more accurate results and less manual labour (Altıntaş & Ilal, 2022). Noardo et al. (2022b) developed specific features of Industry Foundation Classes (IFC) models to extract the necessary information to verify representative regulations. The case study is specific to models, regulations, and input models, but the problems encountered are generally applicable to automated compliance checking. Ciotta et al. (2021) proposed a model-based approach that implements openBIM standards such as IFC, Model View Definitions (MVD), and Information Delivery Manual (IDM) to improve traditional building agency practices, particularly for building permitting related to structural and seismic requirements.

Ullah et al. (2022) proposes a thematic analysis of interview data on the implementation of the BIM-based construction permitting process in public agencies, revealing ten factors that influence the overall process. Semi-structured interviews were conducted in Estonia at the Tallinn Municipality, at the Ministry of Economy and Communications (MoEAC), and at a software development organization to explore the factors influencing the adoption of BIM for building permits. Some of the influencing factors are complexity of the process, existing approval process, management support, advantages and disadvantages of the process, BIM awareness, external pressure, legal context, etc. Respondents indicated that the BIM-based approval process is new, and a desk study was conducted prior to a proof of concept to look at the real world. The BIM-based permit process should be simple because there are knowledge differences between professionals in design offices and approval authorities. The difficulty of converting to machine-readable automated controls of rules and regulations is not clear and includes vague and subjective expressions. Furthermore, it is necessary to ensure that uploaded BIM models comply with the standards. They may be missing certain features that are mandatory for the approval process. In the context of BIM awareness, respondents noted that the BIM-based approval process is different from the actual use of BIM, as 2D drawings are always required for construction approval instead of 3D models. Special

attention should be paid to the development phase of BIM-based building approval processes to reduce the impact of the technology's complexity on end users. The steps of BIM adoption by professionals in the AEC industry in general are important for authorities' understanding of the opportunities and challenges of BIM-based building approval processes (Ullah et al., 2022).

### ***Administrative and legislative situation considering digitalization in Italy with focus on South Tyrol***

In Italy, two sources regulate the building permit procedure: the 'Testo Unico delle Norme per l'Edilizia', which regulates the private construction sector (dPR 380/2001; Italian Government, 2001) and the Public Procurement Law (Dlgs. 50/2016; Italian Government, 2016), which regulates public works contracts. Legislation at the South Tyrolean level is based on two relevant laws: the Local Law for Urban Planning (LP. 9/2018, Autonomous Province of Bolzano, 2018) and the Local Law for Public Procurement (LP. 16/2015, Autonomous Province of Bolzano, 2015). At the municipal level, each municipality has its own building code and land use plan. A building code regulates the interior of a building, while a land use plan regulates the relationship between the building and its surroundings. Two main obstacles that limit the digitization of the current process are: (1) the complexity of the legal framework, which requires a multitude of procedures and (2) the lack of templates and standardized forms, which prevent the collection of high-quality data to monitor the process and assist building authorities in conducting assessments. Although the use of an online portal for managing construction procedures has been recommended since the publication of dPR 380/2001 (Italian Government, 2001), it is only since 2016 that the Italian Ministry of Economic Development has been pushing the digitization of the process through a national online portal denominated SUE/SUAP, through which applicants can submit building permit applications. Accordingly, all building applications are to be processed in digital form through the online portal. Based on this development at the national level, in 2018, LP. 9/2018 (PA dB, 2018) introduced for the first time in South Tyrol the concept of a standardized form for a building application, which was further implemented with the Municipal Council Bill No. 404/2020 (Autonomous Province of Bolzano, 2020). This provides a route to a standardization of the entire procedure in all 116 South Tyrolean municipalities and represents the first step towards the adoption of the

national online portal by the South Tyrolean municipalities. However, the back-end processing of the submitted building applications is still done through the municipal administration program G-Office. G-Office is a back-office software application used by the technical offices of the South Tyrolean municipalities for the management of administrative information. Data from the building application are furthermore manually entered into the G-Office software.

## Research methodology

### Previous studies

In previous research, the authors have developed a web application prototype to translate a theoretical decision model into a practical solution (Fauth, 2021). One subsystem of the theoretical decision model is a building permit process model. The building permit process model is used as a basis for a web application prototype and is schematically illustrated in Figure 1. According to Figure 1, the building permit process follows a process hierarchy and is subdivided into different levels and subprocesses. Five main processes (level 1) are identified: formal

review, assignment, participation, content review, and issuance. The building permit process model is limited to the internal process steps of building permit authorities starting with the reception of a building application until the issuance of the notification letter.

The prototype of the web application is based on decision making, which aims to support the decision maker by providing the required information. According to Laux et al. (2012), the required information includes legislative objectives, alternative actions, and influencing factors. The web application prototype is a process-based system that guides the user through a building permit process. In addition, the web application prototype provides information and links to external data sources that support the review. For example, a linked BIM model is provided as a source for further details. The authors tested the BIM-oriented and process-based web application prototype exemplarily in a German building permit authority (Fauth, 2021).

The proposed study is part of the GEOBIMM project. The main objective of the GEOBIMM project is to develop a link between BIM and GIS domains with the aim of supporting building officials to take faster

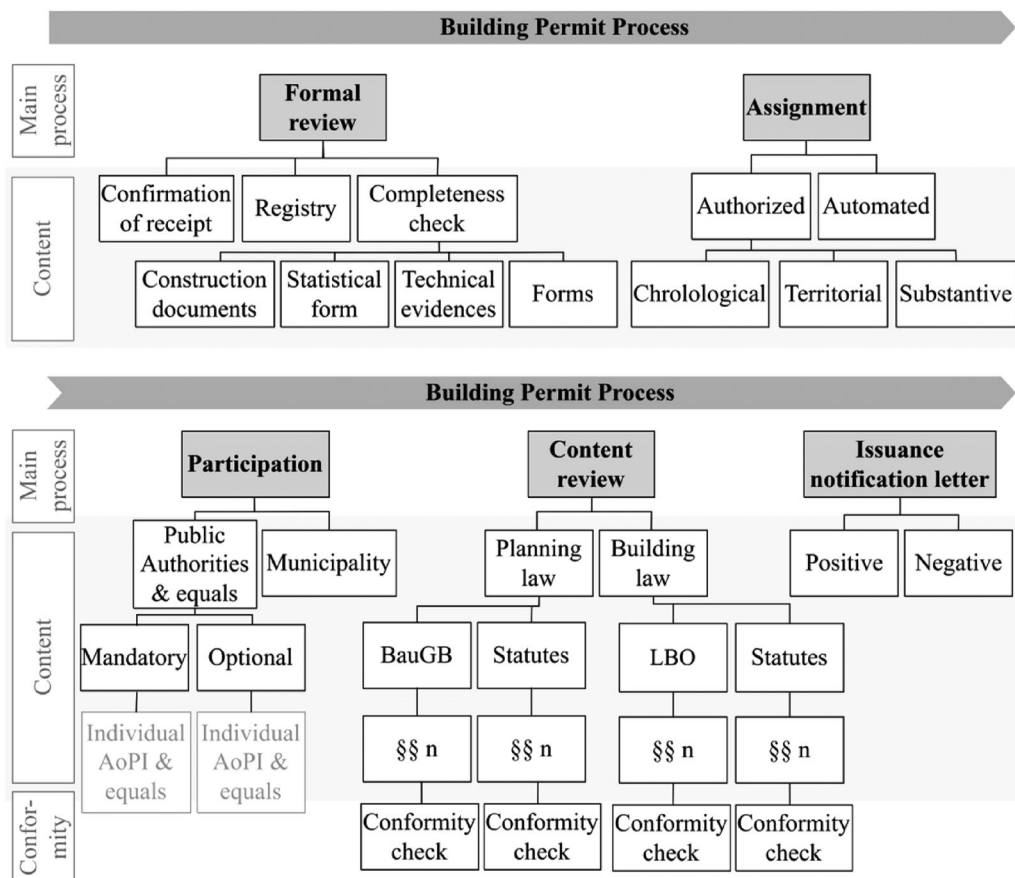
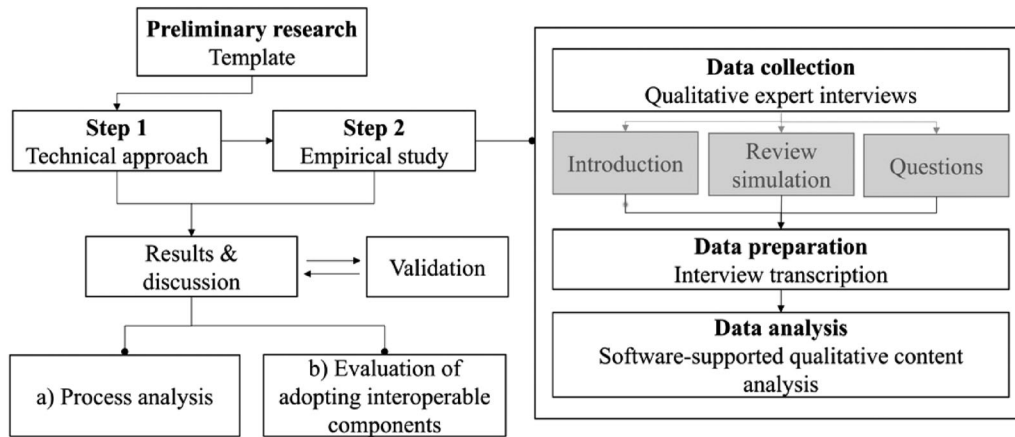


Figure 1. Schematic overview of the building permit process model (based on Fauth (2021)).





**Figure 2.** Research design concept.

and more effective decisions during the lifecycle of buildings. One of the expected outcomes of GEOBIMM is GEOBIMM4BP. GEOBIMM4BP has two main perspectives: (1) a process-based perspective through a digital process supported by BIM models and (2) a rule-checking perspective through automated BIM-GIS checks of building permit requirements. The early phase of the project focused on analysing qualitative data on the two perspectives to outline some general observations that were important to develop an approach for moving forward in subsequent phases of the research.

### Research design

The research design was conducted in two distinct steps and is depicted schematically in Figure 2. Step 1, the technical approach, refers to technical and content adjustments to the web application prototype before the interviews are conducted. Thus, the existing prototype is used as a template, and is revised and adapted to the laws and regulations of the case study each time the reference environment changes (e.g. different countries, different region, or even a different municipality). Moreover, the sample BIM model and various files related to the project and local laws (e.g. the urban land use plan) were implemented in the web application prototype. Step 2, the empirical study, includes data collection, data preparation, and data analysis and is described in section *Empirical study (Step 2)*.

#### Technical approach (Step 1)

The technical approach (Step 1) acts as a preliminary step. The technical approach includes an assessment of the web application prototype with regard to the

South Tyrolean context. This includes the selection of sample information such as regulations from the building code of the reference municipality, as well as the implementation of the web application prototype. For this study, three exemplary regulations are implemented in the web application prototype. Furthermore, a BIM model selected by the GEOBIMM project needs to be implemented in the web application prototype. The process steps of the case study municipality are not yet scientifically documented. Therefore, the original process steps remain for Step 2. Within the empirical study, the detailed process steps will be investigated thoroughly (see subsection *The building permit process in South Tyrol*).

#### Empirical study (Step 2)

The data collection (see Figure 1) consists of three parts: introduction, review simulation and questions and is implemented as a qualitative expert interview. First, the interviewers introduce the project to the interviewees. Then, the review simulation is realized using the example building selected in the GEOBIMM project. In the simulation, the interviewer guides the interviewees processing the review while using the web application prototype and the BIM model. Finally, the interviewees have to provide comments on the simulation and discuss the results. The main issues raised by the interviewers affect the functionality of the web application prototype and the BIM model for the daily work of the interviewees. For data preparation, the recorded interviews are transcribed and anonymized. The qualitative content analysis is conducted according to Gläser and Laudel (2010).

The characteristics of the interviews are explained as follows. The case study covers a geographical area composed mainly of small municipalities. In the proposed

case study, the building permit authority consists of four building officials who participated in the interviews. Accordingly, four expert interviews are performed and documented with 249 minutes of audio material. All interviewees are building officials and responsible for reviewing building applications. The result of the study is a comprehensive overview of the building permit review by this authority. The interviews were held in person in July and August 2021.

## Validation

After the data analysis, the results were prepared in the form of presentation slides for a validation workshop with all four participants of the interviews. The slides included a reminder of the interview structure and the interview guidelines as well as the simulation part (BIM model used and documented steps). Moreover, the methodology used for data preparation and data analysis was introduced. In the workshop presentation, the summarized interpreted answers of the interviewees regarding the use of the BIM model and the prototype of the web application were presented. The main part of the workshop slides was devoted to the processes. All process maps were modelled with BPMN 2.0. During the workshop, the interviewer went through each process step identified in the data collected. During the presentation, the interviewees were asked to confirm each step and to raise potential concerns or questions. A very few unclarities were discussed during as well as after the presentation. The unclarities laid on the one hand on the importance and usage of regulations at national level in the building permit process. On the other hand, some additional information on the building commission meeting was given and discussed, even the parts outside of the scope of the interviewees (because commission members are in charge of some review parts, not the plan review team as the interviewees). In case of additional information, the processes are enriched and updated accordingly. The final validation workshop took place in April 2022 as an online session (75 minutes long).

## Results

### Results from the technical approach

The technical approach is used to adapt and transfer information of the web application prototype from the context of one country (Germany) to another (Italy), respectively to the context of a municipality in South Tyrol. During the adaptation and transfer of the information into the web application prototype, it was

**Table 1.** Information types be provided for a digital building permit review.

Process-based information	Regulation-based information	Project-based information
<ul style="list-style-type: none"> <li>• Hierarchization of processes</li> <li>• Stakeholders involved</li> <li>• Business rules (implicit knowledge of interorganizational actions)</li> </ul>	<ul style="list-style-type: none"> <li>• Law texts and regulations</li> <li>• Objectives of the regulations</li> <li>• Information on the checkability of the BIM model (IFC entities) (based on Fauth (2021))</li> </ul>	<ul style="list-style-type: none"> <li>• Information specific to the building and its surroundings</li> </ul>

possible to derive different types of information needed to support an efficient workflow for digital building permit reviews as listed in Table 1.

The data sources of the information types are different, and are elucidated as follows:

#### (a) Process-based information

Processes in the case study municipality are not detailed and scientifically described yet. Previously declared building permit processes in South Tyrol provided an overview but they do not reach the thoroughness needed for the proposed process-based web application prototype.

Therefore, the processes are investigated within the empirical study (Step 2) and proposed in subsection *The building permit process in South Tyrol*. Therefore, the processes were not previously implemented in the web application prototype such as regulation-based and project-based information. Additionally, process hierarchy, stakeholders, and business rules are considered in the investigation.

#### (b) Regulation-based information

The web application prototype requires regulation checking under different considerations. First, the text of the law is provided itself. For the web application prototype, three exemplary regulations from the local building code are selected to simulate different technical checks within the building permit process. In this case, distances, wall heights, and closed staircases are selected. Second, the objectives of the regulations are implemented in the prototype. The law objectives provided in the web application prototype were adopted from the original approach, as it is assumed that the law objectives are comparable within European countries (Fauth, 2021; Sheridan et al., 2003). Third, depending on the regulation, the web application prototype provides information on the checkability of the entities of the BIM model.

### (c) Project-based information

Every construction project is unique. Specific insights related to the project cannot be easily generalized and need to be provided specifically. Project-based information is, for instance, location of the project, building-related entities and its properties, or formal details such as names and contact details. This type of information can be managed, stored, and transferred in different ways. For example, BIM models (including the modelling of the surroundings) of the project, or documents and plans requested by the municipality can be taken into account for project-based information.

### Results from the empirical study

The first results of the empirical study represent the as-is building permit process in the case study authority described in detail (subsection *The building permit process in South Tyrol*). Afterwards, the results of the interpretation of the statements by the interviewees are summarized and used for identification and evaluation of supportive digital tools in the building permit process (subsection *Identification and evaluation of digital tools in the building permit process*).

### The building permit process in South Tyrol

The structure of the building permit department within the case study municipality and stakeholders within the organization is a significant fact to be considered to understand the building permit processes. The department dedicated to building permits in the case study municipality has four employees (building officials). One employee represents the front office, while three employees (plan reviewers) operate in the plan review team. One of the plan reviewers represents the head of the plan reviewer team (plan review team leader).

The as-is building permit process in the case study municipality in South Tyrol is presented in Figure 3. Following the structure of previous studies by the authors, five main processes – formal review, assignment, participation, content review, and issuance of the notification letter – are explained.

### Formal review

Initially, applicants submit building applications through the online platform SUE/SUAP (using PDF files). The front office staff receives the documents. Afterwards, the formal review starts. The formal review consists of the proof of all administrative and formal

requirements. If documents or information are missing or unclear, applicants are notified of this. The communication is proceeded via the SUE/SUAP platform. The applicants can revise their documents and information missing within a given timeframe. All information received by the SUE/SUAP platform needs to be transferred to the back-office software G-office manually. Due to the bilingualism in South Tyrol, G-office is performing its functions in both German and Italian, depending on the language used by the applicant for the submission of the building application.

### Assignment

The plan review team leader assigns a building application to a plan reviewer. In advance, the front office staff suggested a suitable plan reviewer based on the previous communications and former responsibilities, while sending the review file with all information to the plan review team leader. The decision of the assignment is based on experience of the plan reviewer (e.g. less experienced plan reviewers deal with simpler building applications), duty of rotating the plan reviewers regarding contacts to applicants and designers (to avoid corruption), and prior knowledge of the area of construction or preliminary discussions on the project. After the decision is made, the SUE/SUAP platform provides a status update to the applicant, for direct communication.

### Participation

Other agencies or authorities need to be consulted to give statements regarding their responsibility on specific ancillary construction laws (e.g. nature protection authority, water company, fire department). The responsible plan reviewer participates the necessary agencies depending on the conditions of the project. The participation subprocess can be divided in two steps:

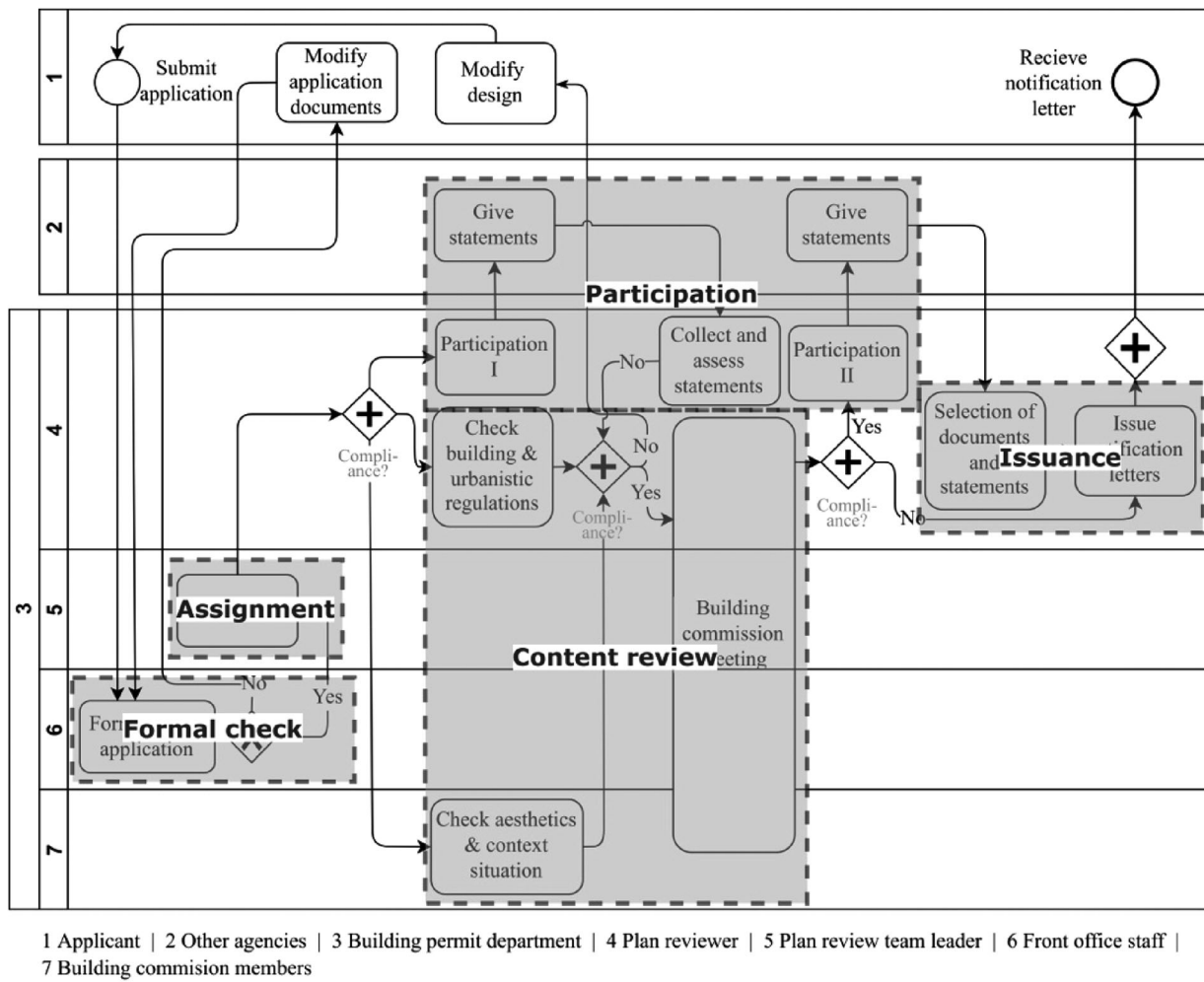
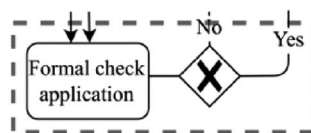
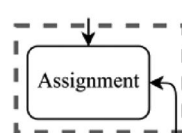
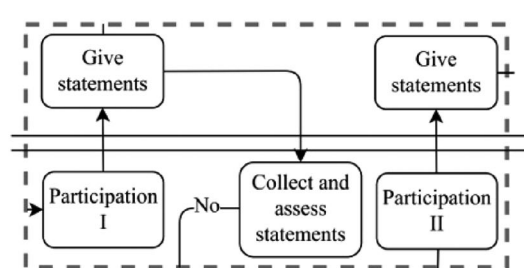
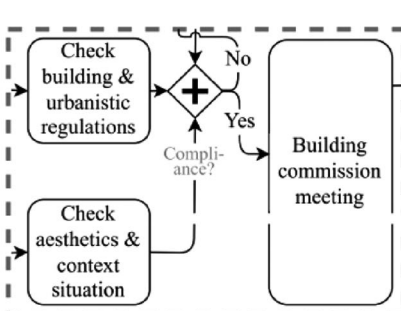
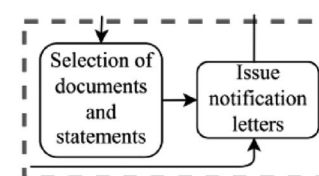
- (1) statements needed for the content review and
- (2) statements and documents needed for the final issuance of the notification letter.

Applicants are informed via SUE/SUAP about which agencies are selected for participation.

### Content review

The content review implies the review of conformity with substantive law. In the South Tyrolean context, the content review is separated in three stages:

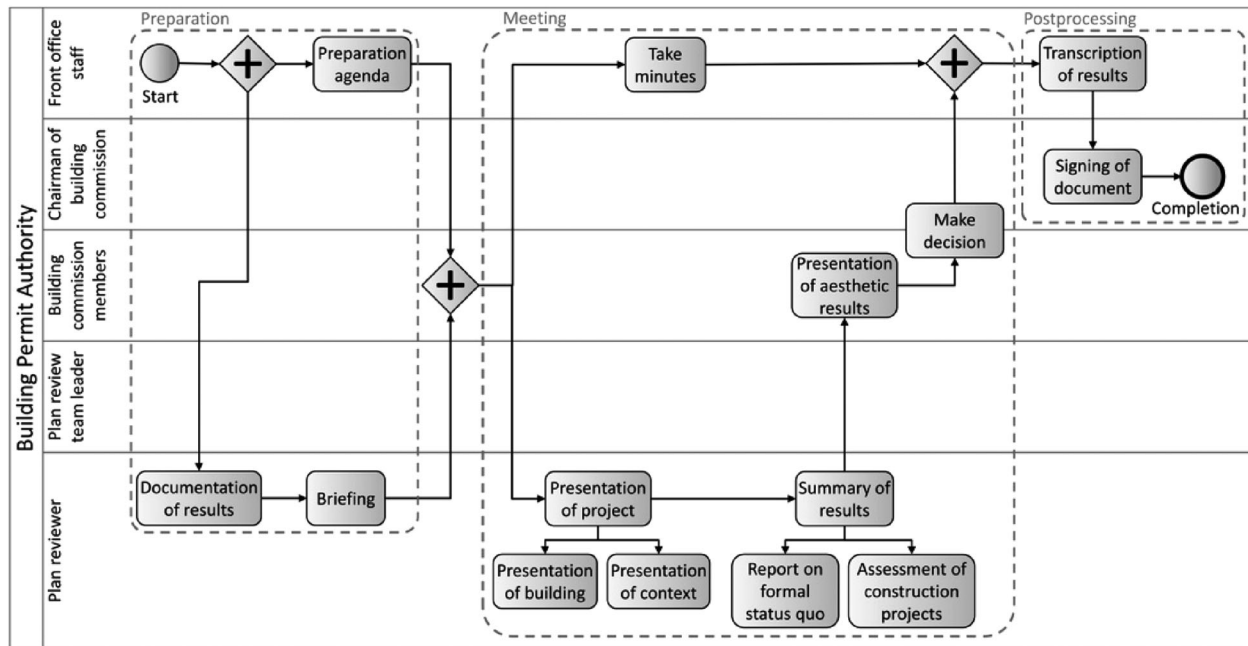


**Formal check****Assignment****Participation****Content review****Issuance**

**Figure 3.** Building permit process in the case study municipality in South Tyrol.

- (a) review of urbanistic and engineering manners,
- (b) review of contextual and aesthetical manners, and
- (c) building commission meeting (depicted in Figure 4).

The assigned and responsible plan reviewers provide the review of urbanistic and engineering manners (a). The plan reviewers prepare suggestions based on their review for the building commission. Difficult and



**Figure 4.** Detailed building commission meeting process presentation.

complex projects are discussed in an informal meeting before the building commission meeting. The members of the building commission are responsible to review contextual and aesthetical manners of the project (b). The information file of the project will be handed over to the members in advance for their own preparation and evaluation. The building commission meeting (c) is a non-public, official meeting of the building commission members and the plan reviewers as well as front office staff to make a decision on building applications. The building commission takes place frequently. There is a specific deadline by which a building application must be considered by the next building commission. The plan reviewers must review all building applications until the building commission meeting insofar as the information needed is complete. During the building commission meeting, a final decision on the project is made. Therefore, the respective plan reviewer introduces the project and the conditions and provides a suggestion. In some cases, additional material such as a physical building model and photo documentation are used for better illustration of the project. Afterwards, the results are discussed and evaluated before all members of the building commission vote. Formally, the building commission meeting is prepared, documented, and followed up by the front office staff.

### **Issuance of notification letter**

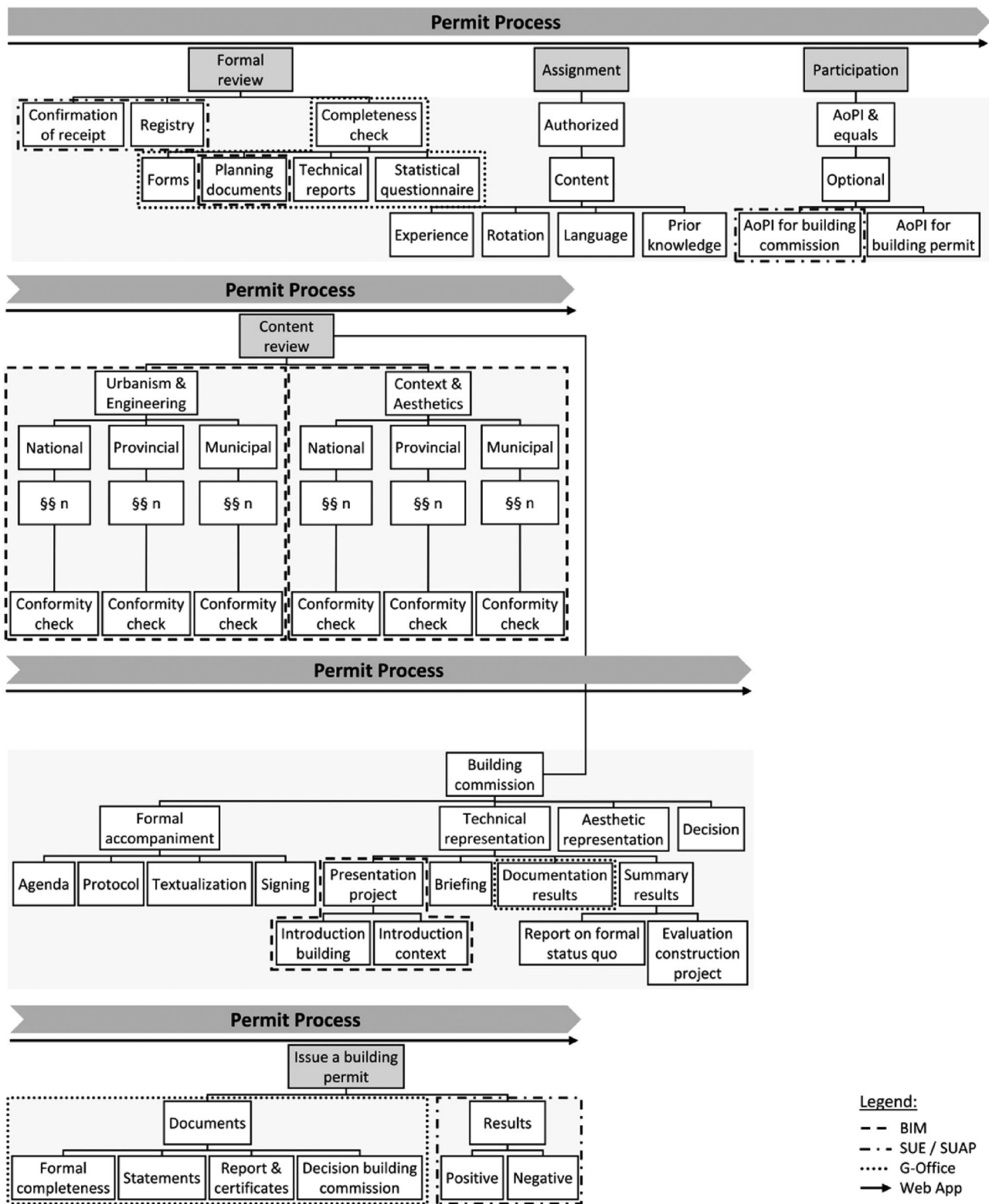
In the last step of the building permit review, a notification letter is transferred to the applicant via SUE/SUAP.

Before and to close the building permit review, the plan reviewer collects all necessary documents and information (formal completeness including fees paid, all statements of the participants, evidence and other expert opinions, decision from the building commission). The decision reported in the notification letter can be either positive or negative. A negative decision needs to be well defined and declared. A positive decision can come along with conditions, either by the building commission or the participated agencies.

The illustrated building permit process is limited to a regular building application and its review. Other existing procedures such as simplified reviews for smaller projects, or projects affecting landscape issues are out of the scope of this study.

### **Identification and evaluation of digital tools in the building permit process**

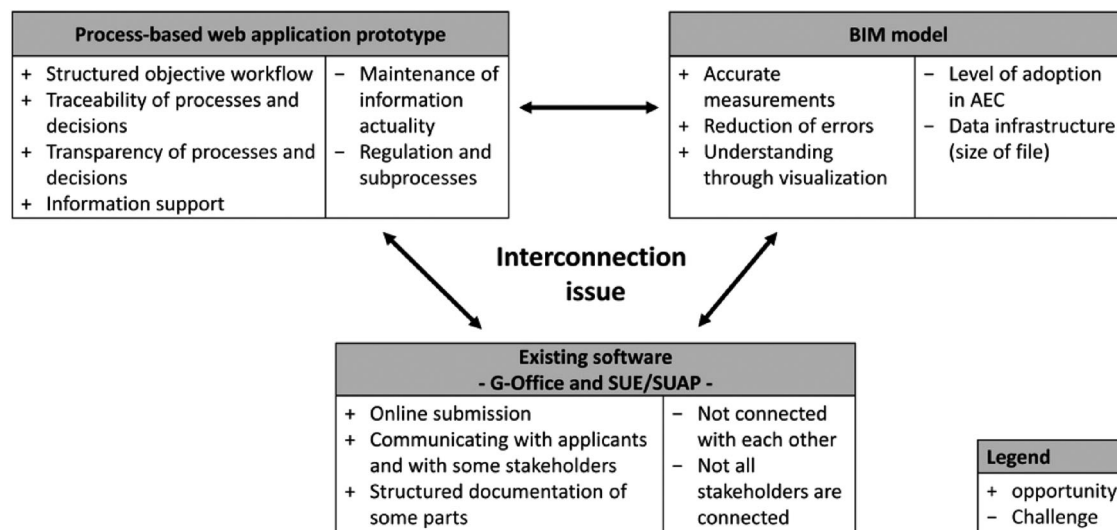
Figure 5 shows a schematic overview of the building permit process (based on the German overview represented in Figure 1). Four supportive digital tools play a role in the case study municipality: G-Office and SUE/SUAP (existing tools) as well as the web application prototype and a BIM model (proposed tools). The administrative back-office software tool G-Office focusses on the documentation of the information, particular the formal project-based information requested during the formal review, but also during the formal accompany of the building commission meeting. SUE/SUAP – as online portal – manages the submission process (including



**Figure 5.** Digital tools and their use along the building permit process.

automated registration and submission notification) and communication. It should be noted that the communication via SUE/SUAP is limited to correspondence with the applicant and within the municipality (employees from the building permit authority and other

departments in the same municipality). The web application prototype aims to be used during the entire procedure and supports the processes and the workflow. In consequence, process-based information is essential. The BIM model assists mainly with building-related



**Figure 6.** Opportunities and challenges of digital tools.

information of the project. For this purpose, the BIM model is applied for the content review including the urbanistic and engineering review as well as the contextual and aesthetical review. Furthermore, the BIM model is supportive in the building commission meeting, because it replaces or supports planning documents, photo documentations, or physical building models. The types of information (section Results) are present in the overall building permit process.

Figure 6 illustrates a summary of the collected and analysed statements given by the interviewees. The digital tools form the centre of Figure 6, while the opportunities and challenges are assigned to each.

Surprisingly, the interviewees do not expect to save time when checking content with BIM models, but instead emphasize accuracy and error reduction as advantages. Nevertheless, time savings are obviously identified in regard to formal and administrative tasks, such as copying and pasting information from one software tool to another.

## Discussion

### *Lessons-learned from the building permit processes in South Tyrol*

In order to gain insights into similarities and differences of building permit processes, the South Tyrolean building permit process is compared to other existing scientifically documented building permit processes. Similar data sets from Germany and the US collected in previous research exist and are used for comparison.

The five main processes are the same in all compared countries. The differences lay in the sublevels of the

processes. Figures 1 and 4 show the differences on a schematic manner.

The formal review – including all subprocesses – is largely the same. The missing interconnection of the existing tools (SUE/SUAP and G-Office) demands the manual transfer from one to another.

The assignment process in South Tyrol is handled in two steps. A preselection based on quantitative facts (e.g. previous consultations about the same project) is a support for the plan review team leader. The assignment is clearly based on a substantive decision and well considered even with just a few employees in the review team. An obligation in regard to rotation is investigated the first time.

Laws are structured differently in South Tyrol than in Germany or the US, which means a subdivision of building law and planning law does not work in the same sense. The contents are different or assigned differently. Even if they use the same name of the building code (like in this case the German word ‘Bauordnung’), the content differs. In the South Tyrolean context, urbanistic and engineering manners are separated from aesthetics and contextual manners. Even though the Italian governmental structure is not federal like in Germany and the US, there are still different levels of regulations to be considered (municipal, regional, national).

A building commission meeting, which is always group decisions, implies a robust decision by experienced commission members. The frequency of the meetings puts the plan reviewer under pressure of time to guarantee a review on time.

Some documents have to be handed in prior to the building commission meeting, while other documents

need to be submitted only after the decision is made, but before the notification letter can be issued. This differentiation is considered as a classification of documents. Some of these documents are statements from involved agencies of public interest. Therefore, is it obvious that the selection of other parties involved and the period when they participate is distinct.

In general, the processes in South Tyrol are much more regulated in the law than the compared countries such as detailed requirements of persons to be involved and deadlines to be met. Those regulations are at municipal level under reference to provincial laws. Moreover, formal and technical tasks are strictly separated from each other.

There is a strong connection and communication with the applicants required. Communication is proceeded via SUE/SUAP (e.g. the information about the involved parties to the applicant).

### **Methodological discussion**

Conducting qualitative expert interviews to conduct the research can be considered a suitable methodological approach. Since the interviewees have no BIM experience, it was necessary to guide them through the interview and explain the audit simulation in detail. A quantitative approach to the audit simulation with construction officials without BIM experience would not lead to satisfactory results. Ullah et al. (2022) underlines the valuable, in-depth, and multifaceted view gained from interviews in the research field of BIM-based building permits.

Although only four interviewees participated in the interviews, the results are representative of the building permit authority studied. While it can be assumed that the results are transferable to other building permit authorities, this cannot be proven at this point and only represents an exemplary sample. It needs to be noted that previous mappings represent generalized processes (data from different authorities) while this case study represents one municipality only. This is important to be considered because it does not represent interorganizational processes and action alternatives from a data set of a broader population. Nevertheless, the study serves as a starting point for researchers exploring other regions and parts of the world with the same methodology. The availability of similar data sets with the same quality and focus of data allows for a valuable comparison of a wider population to identify best practices among others.

It must also be taken into account that the proposed web application is still a prototype. Therefore, the prototype does not include all existing regulations or

possible sub-processes. Additionally, the web application prototype is limited to subprocesses with building permit authorities (from reception of the building application to the issuance of the notification letter) while the building permit process consists other subprocesses before (e.g. pre-consultations with applicants) or after (e.g. inspection of the execution of the construction project).

Nevertheless, the results of the interviews confirm the adaptability of the web application prototype to another country and its legal and administrative scope. This could be elicited through the interview dialogs. Furthermore, the building permit process model could be validated and shows the significance and demand of the hierarchization of the processes. The results underline the high variety in an international context, and that a generalization of building permit processes is only possible to a certain level of detail (depending on local, regional, and national circumstances). The level of detail differs again between the individual sub-processes. For example, the assignment sub-process can be broken down and generalized in a different way than the content review. More in-depth research is needed to gain a detailed understanding of the various interdependencies and interactions.

In conclusion, the adaptability of the research can be subdivided into context-dependent and non-context-dependent aspects. Context-dependent aspects certainly refer to the building permit process model and, alongside the web application, mainly depend on the local circumstances. By comparison, the used methodology itself in terms of qualitative expert interviews, including simulating a BIM-based building permit review, is seen as non-context-dependent. Notwithstanding, the fusion of the building permit process model along with the respective web application prototype and the methodology appeared as a suitable method to investigate the digitalization of building permit processes.

### **Considerations and suggestions**

The testing and validation of the building permit process model and the prototype of the BIM-oriented and process-based web application prototype was successfully carried out using a building permit authority in a municipality in South Tyrol (Italy) as a case study. The interviewees recognized the familiar structures, and the main processes were the same. Identification with the existing structure was the goal of adapting the web application prototype (step 1). The building permit process model and the prototype of the BIM-oriented and process-based web application prototype



is supportive and plausible for the building authorities and can be adopted by different countries. Compared to Ullah et al. (2022) whose research focuses on BIM implementation in building permit authorities and using expert interviews as research methodology, the results face commonalities with the Estonian context. Compared to previous studies (e.g. Meijer et al., 2002; Noardo et al., 2020), the investigation resulted in a very detailed documentation of the building permit process. A detailed documentation is necessary for thorough implementation and understanding. The study shows that generalization of processes, especially along with digital tools, is limited to a certain level. As mentioned by Noardo et al. (2022a), the mindsets of public officers need to be taken seriously into account towards a successful digitalization process. The proposed study focusses exactly on their commitment and sensitivities. Previous studies also show that already a few concepts for digitalizing the building permit process exist while the practice is still lacking. The proposed study focusses on understanding the importance of the process and a step-by-step approach and therefore introduces a more prudent approach.

Even though the benefits and challenges of introducing BIM and digital tools in building permit authorities are increasingly discussed, they have hardly been scientifically proven so far. The proposed study (Figure 6) makes a contribution in this direction.

The most concerning issue is the interconnection between the different digital tools. For this purpose, attention should be paid to connective platforms and software that can link the BIM-oriented and process-based web application prototype, BIM software, administrative software (such as G-Office), and online portals (e.g. SUE/SUAP). The case study authority interviewees expressed readiness and acceptance of supportive digital tools, even if accompanied by efforts (e.g. in the form of personal support for construction officials regarding new techniques, implementation of technical innovations in the authority environment, and linking new and existing information and software). The study shows that the mindset of building officials can be inspired and stimulated by the systematic introduction of new processes and tools. Furthermore, the study underlines the importance of the need to understand the building permit process itself to support the issuance of building permits with a continuous digital solution instead of providing decentralized stand-alone solutions.

The study particularly provides potential impacts on future research in the field of building permitting rather than municipalities, agencies of public interest, architects, engineers, as well as landowners, financial

institutes, and software developers. The municipality of the case study acknowledged especially the workshop in which their daily processes have been presented. Many process steps or decisions are sometimes not perceived as such. The results of the study will certainly be included in the considerations of restructuring the authority.

## Conclusions and future research

The study raised awareness of the significance of the process in digital building permits. Even if digital solutions exist, the solutions focus on a specific subprocess only and are not connected to each other. If the building permit process is really to be digitized, all subprocesses – no matter how small – must be considered, evaluated and digitized. This paper serves as a foundation for improvements in the digitization of building permit reviews, which begins with understanding the current situation.

Considering a global scale, the study shows that a thorough analysis and awareness of the building permit system (including processes, regulations, and digital tools used) in the specific country is needed for digitalization and improvement. Further comparisons of building permit systems will support understanding the procedural situation and will bring the ability for harmonization. Even if the study is limited to a case study region, potential aspects towards reflections for other countries are given.

In future work, testing and validating the building permit process model and the BIM-oriented and process-based web application prototype should be extended to a broader population and to other countries. Furthermore, interconnecting solutions for a continuous building permit process should receive more attention in research. Moreover, the study underlines the demand for a glossary regarding the interdisciplinary terms for common understanding of researchers and stakeholders in the field of building permitting. In addition, quantitatively measured parameters like time saving and satisfaction would be a great contribution to future research for the scientific community. Moreover, the development of the process-based web application prototype should be considered in pre and post-permitting processes.

## Note

1. Through a Digital Quotient™ index to quantitatively measure a company's digital maturity, based on specific management practices most correlated with positive digital and financial performance.

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