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## BIM for public authorities: Basic research for the standardized implementation of BIM in the building permit process

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# BIM for public authorities: Basic research for the standardized implementation of BIM in the building permit process

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**Abstract.** The building permit is an indispensable connection between the approval authority and the executive client within the construction process. Moreover, sustainability criteria do not have sufficient regard in the building permit process in the area of research. To lay the foundation for a state-of-the-art digitalization of the building permit process, the study identifies the information requirements relevant to implement the BIM methodology taking into consideration the available sustainability aspects relevant to the process. A detailed evaluation of the building permit process and the analysis of projects that have gained building permission in the last five years in the area of study of South Tyrol (Italy) gives us a better understanding of the organizational structure and responsibilities in the process. The authors use the data of in-depth process analysis to assess a defined catalogue of basic requirements for BIM methodology in the building permit process. As a result, the analysed BIM-integrated approach enables an early-stage identification of approval compliance, which can be evaluated in the building permit process. A good understanding of the current process must be considered a key factor of a successful introduction of BIM for the building permit procedure.

## 1. Introduction

Dealing with building permits is regarded to be one of the main business regulations indicators in a country's business environment [1]. The building permit is, therefore, an indispensable link between the approval authority and the executing client. At the same time, the inclusion of sustainability criteria is one of the most important steps in the promotion of sustainable housing [2].

The current state of the art on the building permit process shows that the successful use of digital information systems contributes to the increased efficiency of the building permit handling process [3]. A notable example is CORENET, CONstruction and Real Estate NETwork, which is used in Singapore and has significantly shortened the processing time since the introduction in 1995 [4]. As predicted by Michael Hammer in 1990, the use of the power of modern information technology to radically redesign business processes has contributed dramatically to improvements in their efficiency [5].



In Italy, the DM 560/2017 [6] regulates the gradual implementation and mandatory use of BIM in public procurement from January 1, 2019. While the majority of the stakeholders of the construction industry expects BIM to be a priority in the next 5 years [7], BIM in the public administration of the research area suffers from a relatively low level of awareness. Considering the fact that local provincial and municipal governments play a fundamental role in the implementation of the EU and national policies [8], the Italian Autonomous Province of Bozen (South Tyrol) was selected as research region for the purposes of this research.

This study aims to define the basis for a standardized procedure for the implementation of BIM in the building permit process. Studying the building permit procedure in the area of study is important for three main reasons: 1) The insufficiently investigated requirements represent a barrier to the standardized implementation of BIM in the building permit process; 2) The gap in informational knowledge on the building permit procedure in the area is a potential loss of efficiency in the construction process; 3) It is consequently intentional to enhance the information that is already available in the current process, by furthermore highlighting redundant information requirements, and make it available as a future BIM-based process. Therefore, it is fundamental to investigate, whether BIM would partly help to resolve the data handling issues [9]. Although many new buildings have sustainability ratings, they comprise a minute amount of the total impact of the built environment [9]. The consideration of sustainability criteria in the early design stage of the building permit planning stage is therefore essential for the support of sustainability in the construction industry.

## **2. Methodology**

The methodology is structured in three investigation sections: The introductory section covers a comprehensive building permit research of the current as-is process. It is followed by the statistical evaluation of past building permit applications and then an information requirements analysis is performed.

### *2.1. Building permit process research*

To define the legal framework of the building permit process, the authors analysed the regulations and laws in the area of investigation. In this research, the authors divided regulations and laws into two groups of primary and secondary sources. The primary sources are defined as documents of the direct legislation such as the National Legislation and the legislation at the provincial and municipal levels. Secondary sources are documents that have been deduced from them, such as relevant documents for the energy certification of buildings in South Tyrol. These are provided, for example, by the KlimaHaus Agency, a subsidiary corporation of the Autonomous Province of Bolzano. The agency was founded for the energy certification of buildings in South Tyrol.

The energy certification class directly influences the building permit approval in relation to the maximal permissible building volume. In fact, if the applicant declares that the new building – he/she wants to build – will achieve an energy certification class higher than the minimum prescribed by the legislation, a larger building volume can be built.

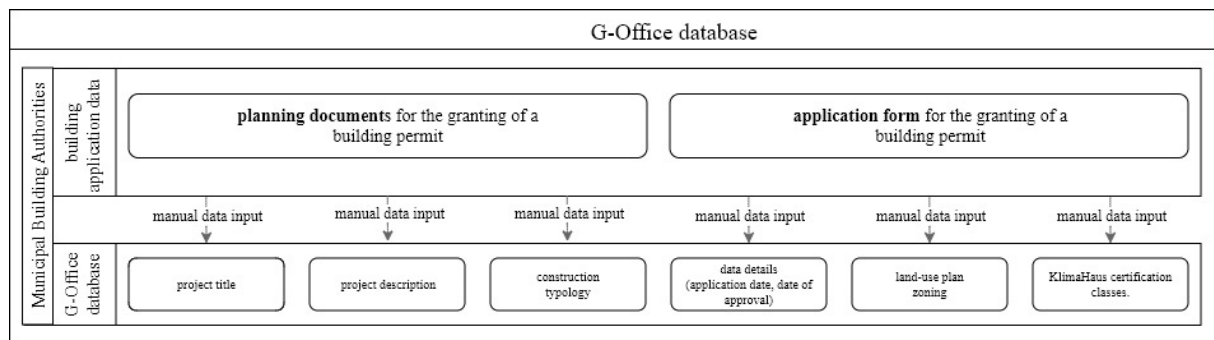
For each of these sources, the relevant content for the building permit has been identified and referenced in a data sheet.

Based on the legal basis, the authors determined the triggers of the building permit process, the individual process steps, the key individuals involved in the execution of the process steps and recorded the corresponding process in diagrams.

### *2.2. Statistical evaluation of past building permit applications*

For the statistical evaluation of the submitted building permit applications in the area of study, the authors asked the association of municipalities in South Tyrol (Consorzio dei Comuni della Provincia di Bolzano) for insight into the database of the software G-Office. G-Office is a back-office software solution used by the technical offices of the South Tyrolean Municipalities, for the management of the administrative procedure documents, including the building permit procedure. The data from the

building permit application is inserted manually into the G-Office software as shown in figure 1. For the scope of this research, the association has granted access to the following G-Office data: project title, project description, construction typology, data details (application date, date of approval), land-use plan zoning and the KlimaHaus certification classes. In consultation with the municipal authorities, the authors have studied the data of the building permits of the last 5 years (2014 – 2018). The analysis of the data has been performed using SPSS, a software package for statistical analysis.



**Figure 1.** The figure shows the data information flow of the data analyzed in G-Office.

In order to be able to better allocate and compare the data sets, municipalities have been sorted according to their geographical size and population.

From the data set, the authors determined the number of building permit applications submitted per year. This information was supplemented by the duration of the building permit procedure (i. d. from the application to issuing of the building permit). The authors continued the investigations by determining the distribution of the building typology, the distribution of the applications per land-use plan and the present frequency of the KlimaHaus certification. In conclusion of the analysis, the authors determined the number of applications submitted as a variant.

### 2.3. Information requirement definition

The requirements for the implementation of BIM in the building permit procedure were derived from the laws and regulations investigated in 2.1. In more detail, the technical specifications based on the legal requirements and the specifications defined by the process were analysed by the authors. The following six source documents were analysed: the application form for the granting of a building permit, the municipal building code (regolamento comunale edilizio) [10], a questionnaire of the National Statistics Institute (ISTAT) on building permits [11], the “Decreto del Presidente della Provincia 9 novembre 2009 , n. 541” (the Regulation concerning the Removal and Overcoming of Architectural Barriers) [12], the “Decreto del Presidente della Giunta provinciale 23 maggio 1977, n. 22” (the Regulation on Hygiene and Health Standards) [13] and the KlimaHaus technical guideline for new constructions [14]. The requirements were listed individually in a data set and grouped into information categories. This analysis highlighted all the redundant information and the duplicates information currently requested by the applicant. Moreover, the authors determined whether the individual requirements are directly objectifiable and quantifiable and if a unit of measurement can be assigned to the values.

## 3. Results

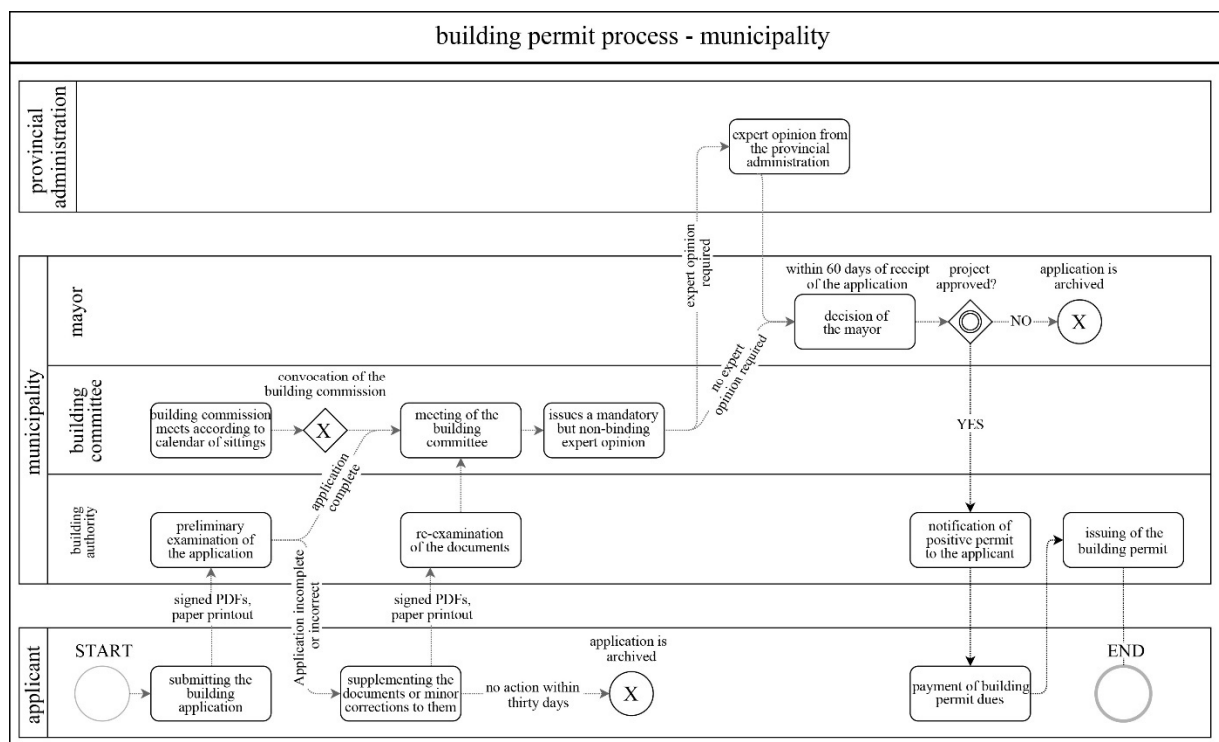
### 3.1. Building permit process research - As-is Analysis

At the national level, two sources regulate the building permit process: the "Testo Unico delle Norme per l'Edilizia", the Italian consolidated building law (Decree of the President of the Republic no. 380/2001) [15] and the Public Procurement Code (Decree-Law no. 50/2016) [16].

Legislation at the provincial level is based on two relevant laws: the valid Regional Planning Law No. 13/1997 [17] and the Regional Law of 17 December 2015, no. 16 [18], which regulates public procurement. At the municipal level, the municipal building code [10] regulates essential parts of the building permit procedure. The principles that are decisive for the building permit procedure are defined in the municipal land-use plan.

The authors identified the following entities as key figures for the process:

- Applicant: the client who submits the application for a building permit to the building authority of the relevant municipality.
- Municipality: the authority is mainly responsible for the processing of the building permit application.
- Within the municipality, the building authority, the mayor and the building commission: they are responsible for the execution of the building permit approval.
- Provincial administration: issues expert opinions and permits in special cases.
- Planner: a qualified person authorized to submit building documents and drawings.



**Figure 2.** This figure shows the as-is building permit process analysis.

The process for obtaining a building permit, as illustrated in figure 2, starts with the submission of the building permit application. In the next step, the submitted documents are pre-checked by the building authority. At this stage, if required by the building typology, the applicant will submit a self-declaration for the KlimaHaus class. However, this document is not checked for technical content or otherwise analysed. All further steps of the sustainability certification process take place at a later stage after the building permit has been issued. This reflects the weak role of sustainability aspects in building permit process. If the building permit application is incomplete, the staff of the municipal administration will ask the applicant to complete the documents within 30 days. Once this deadline has passed, the application will be archived without further notice. Upon the complete submission and the successful examination, the building committee reviews the application and delivers a non-binding expert opinion on the building permit application. The composition of the members of the building committee is defined in Art. 115 of the Regional Planning Law No. 13/1997. If reports from the

provincial administration are required, the mayor may not grant any authorisation before the final report has been received. The mayor's decision on the application for authorisation will be sent to the applicant within 60 days after receipt of the application or after submission of additional documents requested.

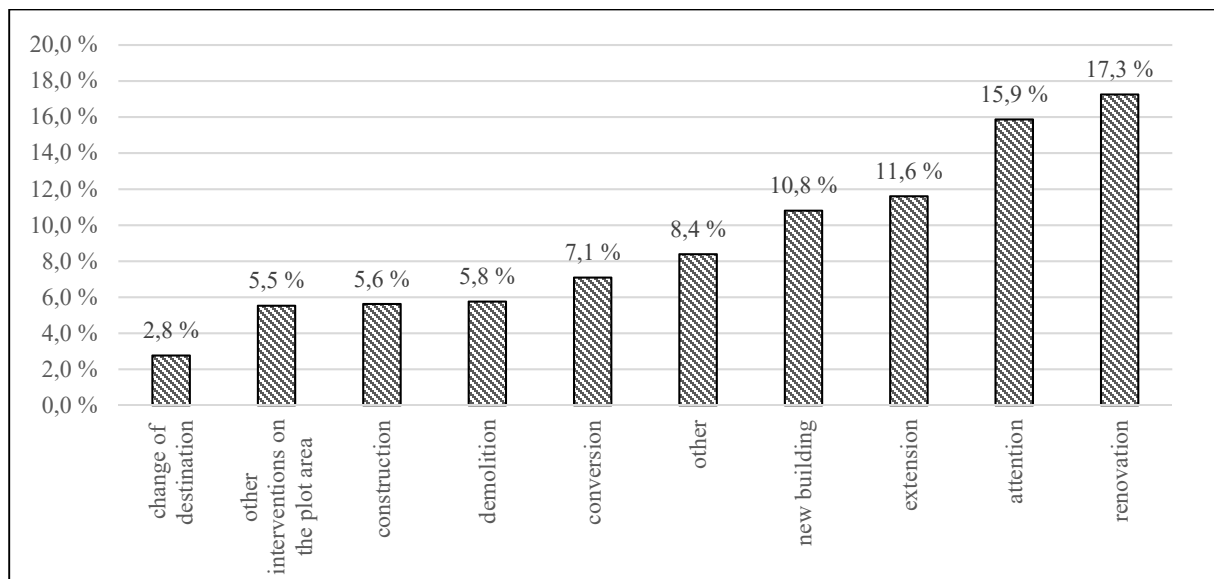
This process shows that the review of the project documents takes place at an early stage in the process for obtaining a building permit and concentrates on the authorities within the municipality. This fact facilitates a possible implementation as there is a limited number of parties involved.

### 3.2. Results of the statistical evaluation of past building permit applications

**Categorization:** The municipality category is allocated based on the population size. Municipalities with less than 3000 inhabitants are classified as small municipalities in the study area (3 units), municipalities with 3000 - 10000 inhabitants as medium-sized municipalities (3 units) and municipalities with more than 10000 inhabitants as large municipalities (2 units).

**Typology:** Since the building typology is not predefined in G-Office, the number of typologies found is high, reaching 287 different records. The evaluation of figure 3 shows the top 10 of the evaluated building typologies. The evaluation of the percentage distribution of the submitted building permit procedures shows that the typologies "renovation" 17.3%, "attention" 15.9%, "extension" 11.6% and "new building" 10.8% were most frequently found.

The "attention" entry suggests that the building typology was not accurately specified, and a placeholder was used instead.



**Figure 3.** The graphic shows the top 10 distribution of the building typologies of the past building permit applications.

**Duration of the building permit process:** A cross-comparison of the different municipalities shows that the distribution varies from municipality to municipality. The average duration of the procedure is 90 days. In large municipalities, the duration of the proceedings is the shortest, 77.93 days and 81,15 days respectively. In the small and medium-sized municipalities, by contrast to the large municipalities, there is no clear difference in the average process duration.

**KlimaHaus classes:** Only 3,3% of the building procedures analysed provides the KlimaHaus class. The 30 %, of the KlimaHaus classes recorded, are Class A, the second-highest climate house. This class corresponds to the nearly zero-energy building – NZEP class according to the EU Directive 31/2010/EU, Art. 2, Para. 2.

*Variant:* The data set shows that 16.8% of the building permit procedures involve subsequent changes to the building application that has already been approved. This procedure is necessary, if for example, changes are to be made to the planning prior to the start of construction or if changes to the project are necessary during the construction phase.

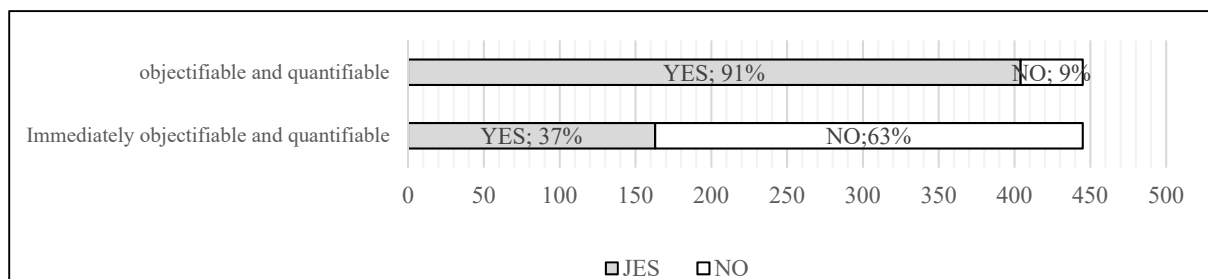
### 3.3. Results of the information requirement definition

The subsequent analysis of the source documents revealed that there are nearly 450 specifications requirements by the building permit. These include technical specifications, legal requirements as well as specifications required by the building permit procedure itself.

*Requirement categories:* The authors classified the information specifications, detected from the six source documents listed in 2.3, into the following requirement categories: specifications of the building (60.0%), building services systems (9.4%), surroundings (4.9%), urbanistic specifications, (3.8%) owner of the property (3.8%), location of the building (3.8%), energetic specifications (3.8%), planner (3.8%), applicant (2.9%), other (1.6%), materials (0.7%), infrastructures (0.4%), description of the work (0.4%) legal specifications (0.2%).

*Redundant information requirements:* In the categories, the authors found that 20.2% of the information requirements are redundant. Two different types of duplicates can be detected. Information requirements can be found multiple times in the same source document (8.9%), or multiple times in different source documents (11.3%).

*Objectifiable and quantifiable information requirements:* As illustrated in figure 4, the evaluation shows that 91% of the requirements are objectifiable and quantifiable. Only 9% of the requirements are neither objective nor quantifiable. These requests are, for example, reports, descriptions or undefined specification. 37% of the requirements are immediately objectifiable and quantifiable. 63% of the requirements must be calculated or derived and are therefore not directly derivable from the requirement.



**Figure 4.** The graphic shows a representation of the objectifiable and quantifiable entries of the information requirement definition

*Unit of measurement of the information requirements:* To each information requirement, the authors assigned a unit of measurement. In total, 37 different units of measurement were assigned. The most frequent units in the data set are meters (26%), followed by text entries (23%), true-false entries (11%), drawings (8%) and 7% both for generic number entries and square meters.

## 4. Discussion

All three methodical investigation sections unanimously reveal weaknesses points for general procedures of the building permit process as well as for the application of the sustainable criteria. The currently partially digitalized information flow can be supplemented by the BIM methodology without far-reaching adjustments to the approval process. The results show that the current process is BIM adaptable in a fundamental way without major changes to the processes currently in use. It is reasonable to assume that a considerable shortening of the duration of the building permit processing

time can be achieved. However, the complex legal frame and the resulting high number of necessary procedures are expected to limit the overall efficiency of the building permit procedure.

The low data quality of the examined G-Office database indicates that at present the building authorities are feeding the database in a partially negligent way. Since the information-technical complexity increases further with BIM-based procedures, it is necessary to assess which measures can support the acceptance by the users and the required careful handling of the data.

A further explanation for the low data quality can be traced back to the lack of preselection datasheets. So, for example, to describe the same information requirement, often different terms were chosen.

This shows that the use of templates and standards is essential when managing information requirements.

Based on the evaluated data, the authors determined that the detail level of the information requested by the approval process is noticeably high. In addition, a sufficient set of sustainability aspects can be found in the analysed documents. In fact, in many cases the data required for an early-stage assessment and/or consideration for the approval compliances is available. Due to the current processing procedures for the building permit documents, a significant part of this data cannot be directly retrieved and is therefore not accessible to public administrations. The unification of the requirement catalogue is necessary in order to avoid duplicate data.

It can be assumed that the immediately objectifiable and quantifiable information requirements can be seamlessly integrated into a BIM-based workflow. Since the information requirements are mostly clearly objectifiable and quantifiable, a considerable degree of semi-automated verification of today's information requirements is possible.

The research is to be understood as proof of concept to define the information requirements for a building permit process in the area of research.

## **5. Conclusion**

The paper represents a starting point for the technical implementation of a BIM-based building permit process in the area of study and provides the basis for the first use cases. The determined process-based requirements show that sustainability aspects are not taken into consideration sufficiently.

Without much additional effort, existing information requirements can be used for the early design stage implementation of basic sustainability aspects. The very complex approval structures and requirement profiles need to be adapted and streamlined to enable a smooth implementation. There were notable positional differences between the municipalities, with the consequence that the implementation in a first step will be limited to individual building typologies. The results show, however, that significant performance optimization is to be expected in the investigated area. The investigation is the first step towards a broad application of digitised information systems in the approval process.

## **6. Acknowledgements**

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