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# Understanding and conceptualizing inspections in the context of building permits

Smart and Sustainable Built Environment

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## Abstract

**Purpose** – This study addresses the current knowledge gap in planning and executing building permit-related inspections, which are essential for ensuring safety, legality and compliance with building regulations. The complexity of these inspections arises from their multidisciplinary nature and the variability of inspection processes across different jurisdictions.

**Design/methodology/approach** – The research employs a systematic approach that combines desk research, literature review and expert interviews conducted across different countries. This mixed-methods approach enables the development of a conceptual framework that organizes the inspection processes into clear categories of responsibilities, processes and characteristics.

**Findings** – The study identifies and formalizes key elements of building permit-related inspections, including diverse national or jurisdictional contexts, processes, inspector management and inspection categorization, before synthesizing them into a comprehensive conceptual framework. This framework illustrates the complex relationships between the different aspects of inspections, providing a structured method to effectively manage these complexities.

**Originality/value** – This research contributes to the fields of construction management and building permitting by bridging theoretical knowledge and practical applications in the realm of construction inspections. By synthesizing dispersed knowledge into one coherent framework, the study establishes a theoretical foundation that enhances the efficiency and transparency of building inspections globally. The research also provides significant insights that will aid in the digital transformation of the building inspection processes that are crucial for compliance and quality assurance in the construction industry.

**Keywords** Construction, Inspection planning, Building permit, Inspections, Conceptual framework, Knowledge

**Paper type** Research paper

## 1. Introduction

Inspections in the context of building permits are essential for ensuring the safety, legality, and quality of construction projects by serving as a compliance check throughout the construction



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process (Linß, 2018; Meijer *et al.*, 2002). Unlike other types of inspections, they specifically focus on compliance with the legal and regulatory requirements established in the building permit process. These on-site evaluations mandated by authorities, typically conducted during critical construction stages and upon completion, verify that construction aligns with approved permits, building codes, local zoning laws, and safety standards.

Proper planning of these inspections is crucial for ensuring a smooth, efficient, and transparent building permit process. Typically, the planning and execution of inspections in the construction domain involve various stakeholders and rely on manual processes. However, manual inspection planning is error-prone, non-transparent, and requires inspection planners to possess high levels of knowledge and expend corresponding levels of effort (Seiß, 2022; Xu *et al.*, 2021). Inspection planning for building permits encounters other challenges owing to the complexity of the knowledge and the diversity of the stipulated quality requirements (Olzem *et al.*, 2023). For instance, inspection knowledge is distributed over different norms and regulations related to various trades (Boukamp and Akinci, 2007; Zhong *et al.*, 2022). An additional challenge is the coordination of inspections between the building permit authority and other stakeholders (Ma *et al.*, 2018; Mirshokraei *et al.*, 2019). Furthermore, inspection planning must be flexible enough to accommodate changes that arise during the construction process, ensuring that any necessary adjustments are promptly incorporated into the inspection plan. Coordinating inspections between the building permit authority and other stakeholders, as well as any changes to construction or inspection planning, are particularly demanding (Bernards, 2005; Jung *et al.*, 2021). Both require prompt synchronization with concrete information concerning the construction execution phase and the capability of adaptive inspection planning (Ding *et al.*, 2017). For example, changes in the construction, delays in the execution of tasks, or detected failures result in adaptive changes in the inspection plan. Hence, the information required for on-site inspections is spread over heterogeneous information streams that are defined in different software environments, such as building information models, organizational data, and construction schedules (Gordon *et al.*, 2008).

In addition, with the increasing complexities introduced by Construction 4.0—a paradigm that leverages digital technologies such as automation, informatics, and AI to enhance construction processes—van der Heijden (2023, 2024) underscores the pressing need for effective public governance frameworks to address challenges in policy, data governance, and collaboration. This highlights a significant gap between theoretical discourse and practical implementation.

It is also evident that public administration faces technical challenges with regard to digital transformation, which have not been addressed in the literature, and a theoretical understanding of these challenges is correspondingly absent (Andrew, 2019). In addition, the architecture, engineering, and construction industry faces challenges due to new and more complex legislation, but scientific investigations that focus on specific aspects within the building permit domain are still lacking (Noardo *et al.*, 2022). In particular, a significant gap in knowledge exists with regard to building permit-related inspections. To date, research has primarily focused on compliance checking in the building permit review phase and its possible automation (Amor and Dimyadi, 2021; Peng and Liu, 2023). However, while Fauth (2021) has extended the administrative steps in the building permit review process beyond compliance checks, the process steps following permit issue have rarely been studied. Although previous technical efforts have provided insights into inspection systems and technologies, they fail to address the unique challenges of building permit-related inspections. For example, Bortolini and Forcada (2018) developed an inspection system for evaluating the technical performance of existing buildings, focusing on systematic evaluation methodologies rather than the integration of inspections with permit processes. Similarly, Rakha and Gorodetsky (2018) reviewed the potential of unmanned aerial systems for the automation of building inspections, demonstrating their utility in enhancing inspection efficiency. Other technologies such as VR and AR are also important for training and conducting inspections, but they are not utilized for the regulatory complexities of permit-related inspections (Eiris *et al.*, 2021; Oke and Arowoiya, 2022).

Consequently, limited research exists concerning the planning, executing, and evaluating on-site inspections. Few studies have systematically analyzed the role of building permit-related inspections in ensuring ongoing compliance with approved designs and regulations. These inspections are further complicated by diverse regulatory frameworks, the distributed nature of responsibilities, and the need for adaptive planning to accommodate construction changes. In summary, there is a knowledge gap regarding the systematic study of how building authorities conduct on-site inspections, including their planning, execution, and role in ensuring compliance with regulations. In addition, a generic process model of building permit inspection planning, which formalizes inspection planning knowledge and supports further digital applications, remains unaddressed.

In response to the identified research gaps, this paper aims to acquire explicit knowledge on building permit-related inspections. The focus of this research is guided by two key questions:

*RQ1.* What are inspections in the context of building permits?

*RQ2.* How can the key elements of building permit-related inspections be conceptualized?

This study seeks to answer these questions by formalizing explicit knowledge concerning building permit-related inspections into a conceptual framework. A three-step research approach is applied in which we first analyze different literature sources and authority-specific documents. In the second step, an empirical study is conducted using expert interviews and qualitative content analysis. Finally, the results are integrated into a conceptual framework that provides the generic knowledge of building permit-related inspection. The proposed framework serves as a foundation for future software development and empirical research aimed at improving the planning and execution of building permit-related inspections. It provides a theoretical basis for advancing research on and practical applications of inspection processes, particularly with regard to digital transformation and automation.

The remainder of this article is organized as follows. Section 2 presents a brief background description of general inspections and site inspections by building permit authorities. Section 3 explains the research methodology, while Section 4 investigates knowledge required to classify building permit-related inspections and processes. The findings of Section 4 are then transferred into a conceptual framework, which is illustrated in Section 5. Following this, the study results are discussed in Section 6. Finally, Section 7 summarizes the study and presents the conclusions.

## 2. Background and literature review

### *2.1 Inspections and inspection planning*

According to the ISO 9000 standard, the term "on-site inspection" is defined as the "determination of conformity to specified requirements" (DIN EN ISO 9000, 2015). The process for planning inspections is defined as "inspection planning" (DIN 55350, 2021). The result of inspection planning is the inspection plan, which details the specifications of one or more inspections (DIN 55350, 2021). An inspection plan outlines the comprehensive strategy designed for conducting inspections. It is essential to develop this plan (Brüggemann and Bremer, 2020), adapted to the specific inspection requirements, before inspections commence. In the construction industry, this involves stakeholders creating their inspection plans and coordinating these plans with one another.

The inspection planning process is structured into four tasks (see the bottom section of Figure 1). Before commencing inspection planning, it is necessary to undertake quality planning, which outlines quality characteristics and requirements of the planned building and corresponding manufacturing processes (Martínez-Pellitero *et al.*, 2011). Inspection planning is closely integrated with key documents such as schedules, contracts, plans, and procedures (Toteva and Vasivela, 2013). Inspection planning lays the groundwork for carrying out inspections and assessing quality, thus, it ties directly into the overall plan and progress of the

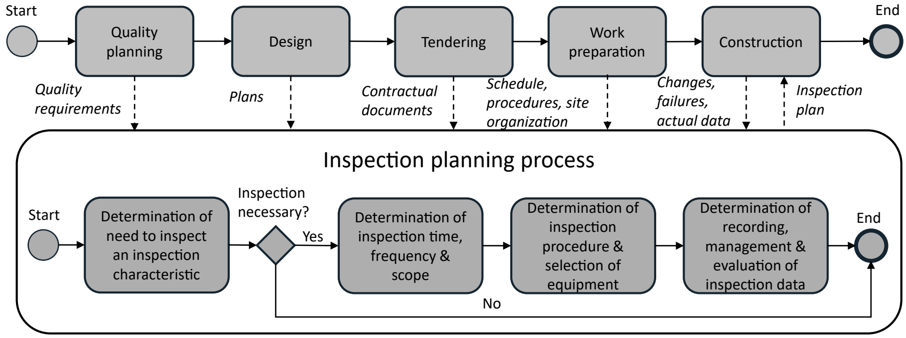


**Figure 1.** Process of inspection planning in lower section according to (Linß, 2018; Toteva and Vasivela, 2013), with inspection planning in the project life cycle and required information sources in upper section according to (Bernards, 2005; Pfeifer and Schmitt, 2011). Source: Authors' own work

construction project (Toteva and Vasivela, 2013). However, the inspection planning process is often complex and must be adaptive to reflect the dynamic and ever-changing nature of construction activities.

As outlined in Figure 1, the inspection planning process involves answering several key questions concerning inspection planning. First, the necessity of inspecting a particular characteristic is determined, and the associated inspection objects are defined. Next, the inspection time, frequency, and scope are determined. In the third step, the inspection procedure and equipment are defined, as they are interdependent. This step also includes defining the inspection location and the inspector. Finally, the fourth task involves determining how the collected inspection data will be recorded, managed, and evaluated (Linß, 2018; Toteva and Vasivela, 2013).

To perform inspection planning, all information related to the inspection object and its characteristics must be considered, as depicted in the upper section of Figure 1. Therefore, the inspection planner has to collect the required inspection planning information contained in several documents and specifications to begin the planning (Xu *et al.*, 2021). This information is critical not just for planning the inspection but also for describing the inspections by referencing and interconnecting this information. Therefore, inspection planning is usually undertaken after the work preparation phase, and different information concerning preliminary process steps is considered. In addition, changes and quality results during the construction phase should be integrated into adaptive inspection planning to reflect the dynamic nature of construction projects. Therefore, the inspection planning should not be regarded as a single step in the project life cycle; rather, it functions as a parallel process to the ongoing project, which begins with the quality planning step and ends with the completion of the construction (Bernards, 2005; Pfeifer and Schmitt, 2011).

### *2.2 Building permit process*

The building permit processes of building authorities consist of several steps, including both administrative- and content-related processes (Fauth *et al.*, 2024a). Administrative processes focus on verifying the completeness of relevant regulations, determining which building official will be assigned to the building application, and identifying whether other agencies and authorities need to be involved to provide statements about permits. In addition, a content review is conducted, in which substantive building information is checked for conformity (Bloch and Fauth, 2023; Fauth, 2021). Figure 2 schematically illustrates the position of the inspection within the building permit process.

Several studies (Bloch and Fauth, 2023; Meijer *et al.*, 2002; Pedro *et al.*, 2011) demonstrate that significant variation exists in building permit processes, including (1) whether a process

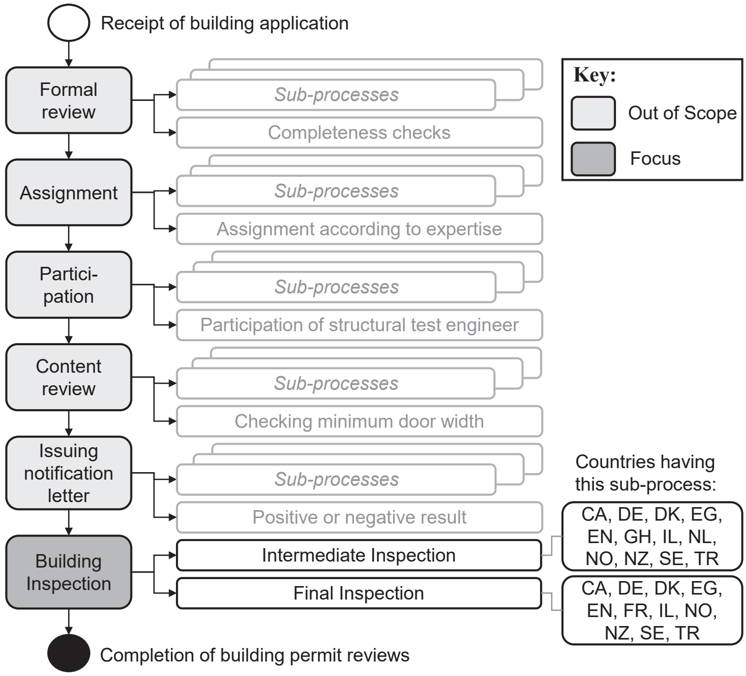


**Figure 2.** Building permit process adapted from (Fauth, 2021). Source: Authors' own work

step is present and (2) the sequence in which each step occurs. Fauth *et al.* (2024b) investigated this variation across European countries and found that construction site inspections conducted by or on behalf of building authorities vary in terms of defining inspections and whether they are considered a part of the building permit process. In some countries (e.g. the UK), the inspections and their certificates form part of the building permit, while other countries (e.g. Germany, Belgium) consider the inspections to be a separate (sometimes optional) step after the building permits (and the right to start the construction works) are granted. Their study also highlights that different types and responsibilities of inspections exist (Fauth *et al.*, 2024b; Meijer *et al.*, 2002).

Several cases highlight the importance of site inspections as a result of construction non-compliance with approved design (Comiskey *et al.*, 2018), such as the devastating consequences of the earthquake in Turkey in 2023 (Inanc, 2023). Hence, inspection aims to ensure the compliance of the actual construction work with regulations, safety standards, building permit information, and approved plans throughout the construction phase. The processing of inspections pertinent to building permits varies by country, building type, and authority expertise. Inspections are processed directly by the authority, or external inspectors, or a combination of the two. Inspectors of building authorities have the right to access the complete construction site, request construction documentation, and suspend the ongoing construction work in cases of non-compliance with requirements or missing building permits (Pedro *et al.*, 2011). To ensure accurate and transparent control of the construction in accordance with the requirements of the building authorities, inspections must be planned in advance (with or without the knowledge of the construction companies). Due to changes in the design and construction process, inspections must also be formulated to adapt to changes on site (Seiß, 2022).

In North Macedonia and Estonia, inspections by building permit authorities are not mandatory. Inspections are also not mandatory in Denmark, the Czech Republic, France, and

Germany. In Sweden, building inspections are handled by building permit authorities, although the process is slightly different, and overseen by an additional building inspector. Once the building permit is approved, a building inspector conducts inspections during and after the building work. In Estonia, inspections take place as part of the certificate of occupancy process and not as part of the building permit process (Fauth *et al.*, 2024a).

Meijer *et al.* (2002) examined building permit procedures in eight European countries, revealing significant variations in inspection practices. In Belgium and France, construction can commence once a permit is granted, with no mandatory inspections during or after the process; France allows construction to begin within three years of permit issuance and may issue a completion certificate up to two years after completion. Denmark requires a declaration of construction commencement post-permit and mandates inspections during construction along with a post-completion check. Germany imposes strict controls on certain buildings, demanding inspections during construction and requires official approval before the building can be used. In the UK and the Netherlands, construction can begin shortly after submitting a permit application, with regular inspections at defined stages and a completion certificate required before use. Norway conducts inspections based on a predefined plan, with an obligatory completion certificate. In Sweden, work can start three weeks after notifying authorities, with supervision following an inspection plan and inspection responsibilities outsourced to local authorities.

The Consortium of European Building Control published a report with results from a survey about building control systems in 18 different countries (Mjakuškina *et al.*, 2024). The participants underline the diversity between countries in regard to the requirements and responsibilities of inspections during the construction phase and at completion as well as fees encompassing inspections and completion certificates.

Fawzy and Magdi (2020) describe a detailed inspection procedure in Egypt, which includes several steps executed by the municipality or third parties. With regard to Ghana, Tengan *et al.* (2017) indicate that if an on-site inspection is required, the inspection date is announced during the submission of the application. The findings of Kpamma and Adjei-Kumi (2013) concretize the process in Ghana: After the submission of the building application documents, the confirmation of land title from the Lands Commission is obtained. This is followed by a site inspection by a technical officer of the Town and Country Planning Department and the submission of a report on site.

In their developments designed for digital permit systems, Yaakup *et al.* (2007) and Eirinaki *et al.* (2016) show that there are also inspections in Malaysia and the US that must be considered in end-to-end digitization as one part of the building permit process. In addition, Nisbet *et al.* (2024) explore adapting the RASE methodology for real-time health and safety compliance on live construction sites, shifting from static building information model (BIM) checks to dynamic, process-driven monitoring. Using semantic markup enables continuous, automated compliance assessment. This contributes to improving building permit inspections by facilitating real-time alerts and interventions without manual coding.

Nonetheless, despite the critical role of inspections in ensuring compliance and construction quality, building permit-related inspections remain an underexplored area of research. Existing research on building permit processes has primarily focused on compliance checking during the permit review phase, with limited attention to inspections conducted after permits are issued. Studies have also explored the potential of automated compliance checking using BIM-based rule verification (Amor and Dimyadi, 2021; Peng and Liu, 2023), yet these approaches remain largely theoretical and are rarely implemented in practice due to legal and procedural complexities. While digitalization has advanced in areas such as automated plan reviews and virtual permitting (Fauth *et al.*, 2024a), its application to post-permit inspections remains underdeveloped.

Several studies have examined technological advancements for inspections, including the use of drones (Rakha and Gorodetsky, 2018), AR for inspector training (Eiris *et al.*, 2021), and AI-driven data analysis for quality assessment (Nisbet *et al.*, 2024). However, these innovations have been investigated in isolation rather than as part of an integrated regulatory framework. The practical challenges of incorporating such technologies into inspections relevant to building permits, including legal acceptance, data interoperability, and regulatory enforcement, remain largely unaddressed.

A major gap in the literature can also be observed in the absence of a standardized framework for building permit-related inspections. Research has shown that inspection practices vary significantly across jurisdictions (Meijer *et al.*, 2002; Pedro *et al.*, 2011), with some countries treating inspections as an integral part of the permit process, while others view them as separate compliance checks with minimal oversight. These inconsistencies create barriers to developing a harmonized approach that supports digital solutions in inspection planning and execution. Moreover, studies on construction quality management emphasize the need for adaptive inspection planning (Ding *et al.*, 2017), yet little research has been conducted on how inspections should be structured to accommodate ongoing changes in construction projects.

In response to these gaps, this study seeks to bridge the divide between theoretical advancements and practical implementation by formalizing knowledge on building permit-related inspections. It provides a structured classification of inspection characteristics, analyzes variations in regulatory practices, and proposes a conceptual framework to support digital transformation. The aforementioned studies are limited on one or two research methods as a source of knowledge by using questionnaires, literature research, expert interviews, own experience, and analysis of legal documents. By combining all of these methods and adding desk research, this research contributes to a more comprehensive understanding of how building permit-related inspections can be improved through standardization and technological adaptation.

## 3. Methodology

The methodology used in this study follows a systematic and comprehensive three-step approach, integrating a literature review and desk research, an empirical study, and the development of a conceptual framework (see Figure 3).

The approach begins with Step 1: A literature review in combination with desk research, in which three sources of information and knowledge are reviewed. The first source focuses on literature related to inspection planning. The second source examines research on permit-relevant inspections (see also Section 2.2). The third source, involving desk research, provides factual information about processes and regulations published by the building permit authorities. As this research depends on governmental knowledge and processes, we reviewed governmental web pages and used reports related to inspections in the context of building permits. This set of information sources is no older than 10 years and was provided by official government sources. In total, international research results from 27 countries were used in Step 1.

Reviewing these three distinct sources provides a theoretical foundation and context for the study. This step aims to provide a theoretical analysis of the state-of-the-art building permit inspection process, including the current paradigms used in different countries, the key processes in these paradigms, and the essential inspection characteristics involved in building permit-related inspections.

Following the literature review and desk research, the research proceeds to Step 2, which consists of the empirical study comprised of three phases. The first phase, data selection, involves selecting expert interviews conducted by the authors in previous related studies. These interviews serve as the primary method for gathering qualitative insights from professionals who have direct experience or expertise in the area of building permit processes and how such processes (including the inspections) are managed in the interviewees' countries and organizations. Table 1 represents an overview of the interviewees in this study. In the second phase, data preparation, the collected interviews are transcribed to ensure the

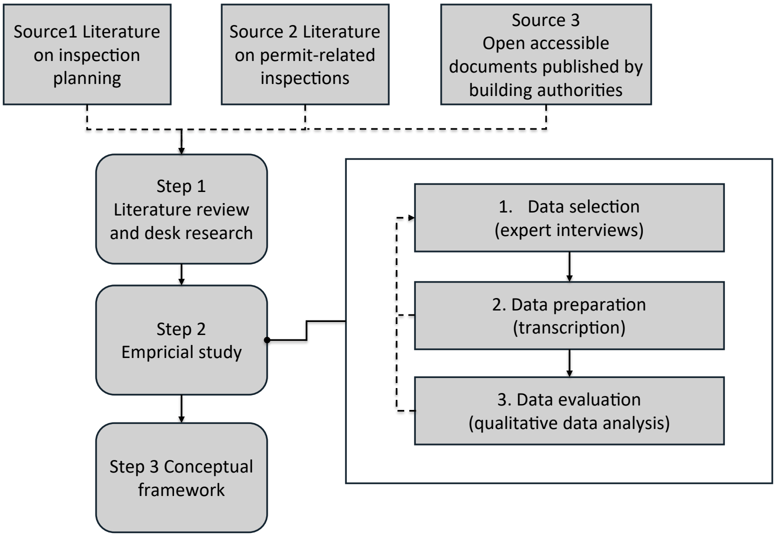


**Figure 3.** Methodology of knowledge acquisition. Source: Authors' own work

**Table 1.** Experts for interviews by institution, country, size of authority, role, and experience in years

| Interviewees | Institution type | Country | Size of authority | Role | Experience in years |
|---|---|---|---|---|---|
| ID1 | Building authority | New Zealand (NZ) | Large | Head of department | 18 |
| ID2 | Consulting company | New Zealand (NZ) | – | Senior building technical specialist | 14 |
| ID3 | Private checking agency | Israel (IL) | – | Building control officer | More than 5 |
| ID4 | Building authority | Germany (DE) | Large | Building official | More than 10 |
| ID5 | Building authority | Israel (IL) | Medium | Regulator | 9 |
| ID6 | Building authority | Australia (AU) | Medium | Building surveyor | 4 |
| ID7 | Developer | Israel (IL) | – | Head engineer | 13 |
| ID8 | Building authority | Israel (IL) | Medium | | More than 10 |
| ID9 | Building authority | Canada (CA) | Medium | Director of building services | 24 |

**Note(s):** [a](Country codes according to ISO 3166–1)
[b]Authority size per number of residents: Large >500,000; Medium 50,000–500,000; Small <50,000
**Source(s):** Authors' own work

qualitative data is systematically documented and ready for textual analysis. The final phase of the empirical study, data evaluation, involves the application of qualitative content analysis techniques.

The qualitative content analysis employed in this study followed a systematic approach to ensure the rigorous and structured interpretation of the data gathered through expert interviews. The analysis aimed to identify patterns, themes, and insights relevant to building permit-related inspections. A coding framework was developed based on both the study's research questions and existing literature (Gläser and Laudel, 2010) specifically drawing on established classifications of inspections in the manufacturing domain (e.g. Linß, 2018). The process began with the transcription of the interview data to ensure accuracy and completeness. A preliminary coding phase was conducted to identify recurring themes, which informed the refinement of the coding framework. The final framework included categories such as inspection processes, responsibilities, regulatory variations, and challenges. To ensure reliability, coding was conducted iteratively and discussed by multiple researchers to resolve discrepancies and achieve inter-coder agreement.

The qualitative content analysis also integrated a comparative dimension, examining similarities and differences across the five countries represented in the sample and the literature. This approach highlighted contextual factors influencing building permit-related inspections while also allowing for the identification of overarching patterns.

As illustrated in Table 1, the data is based on nine interviews conducted in five countries with stakeholders ranging from employees in building authorities to consultants. The interviews were conducted between June 2022 and August 2024. Each interview is assigned an identification number (ID) to track specifications by country and role.

In this study, an "expert" is defined as an individual with specialized knowledge and practical experience of at least three years in the domain of building permit processes and inspections. This includes professionals who are actively engaged in the planning, execution, or oversight of building permit-related inspections, such as building authority officials, consultants, and private building control officers. Experts were selected based on their demonstrated expertise and familiarity with the regulatory, technical, and procedural aspects of such inspections in their respective countries or jurisdictions.

A purposive sampling strategy was employed to ensure diverse and representative expert insights, considering geographic distribution, institutional roles, operating jurisdictions, and a minimum of five years of experience. This approach captured variations in regulatory frameworks and building permit processes across five countries, balancing depth and breadth in the sample. The final group of nine respondents, representing both public and private sectors, provided a comprehensive understanding of permit inspections. The interviews, complemented by a literature review (Section 2.2, Step 1), contribute to the study's broader dataset, incorporating insights from 29 countries and at least nine professionals. Saturation was achieved once we ensured we had covered the full scope of inspection relevance, ranging from highly integral to the permit process to minimally relevant, along with multiple intermediate cases.

The final stage, Step 3: Conceptual Framework, involved synthesizing the findings from the literature review and the empirical study. The insights gained from those findings are integrated into a conceptual framework that addresses the research question. In this way, the framework combines theoretical perspectives with empirical evidence to offer a comprehensive model and understanding of the research subject.

In summary, this study adopted a qualitative research orientation, grounded in an interpretivist epistemology and a constructionist ontology. These philosophical foundations are well-suited to the study's objective of uncovering tacit and under-researched knowledge concerning building permit-related inspections. The interpretivist epistemology acknowledges that knowledge is socially constructed and context-dependent, allowing for the exploration of diverse perspectives among stakeholders in the building permit process. The constructionist ontology further emphasizes that the realities of building permit inspections are co-created through the experiences, practices, and interactions of the various actors involved.

The chosen qualitative approach reflects the complexity of the subject matter, in which standardization and generalization are less applicable than a nuanced understanding of processes and practices. Through the integration of expert interviews and qualitative content analysis, this study seeks to interpret the meaning and significance of inspection practices, responsibilities, and characteristics, as perceived and enacted by practitioners.

By employing this orientation, the research aims to move beyond merely descriptive accounts by offering an interpretive synthesis that informs both theoretical advancements and practical applications in inspection planning and execution. This philosophical framing ensures alignment between the study's aims, methods, and the inherently interpretive nature of the data collected.

## 4. Investigation of inspections in the context of building permits

Building upon the insights obtained from the literature review, desk research, and expert interviews, we have developed a comprehensive classification for building permit-related inspections, along with a detailed process model for inspection planning and execution by building authorities.

### *4.1 Classification of inspections in the context of building permits*

The classification serves as a structured approach to categorize and understand the diverse types of inspections that occur in the context of building permits. The classification is based on the identification of key inspection characteristics using a qualitative content analysis of the interviews and literature. Table 2 illustrates the characteristics and the related classifications, which enable a systematic differentiation of inspection types, providing a clear overview of how inspections vary across different countries. Hence, the classification does not aim to compare national inspection practices in each country but rather to illustrate the heterogeneous varieties of building permit-related inspections and highlight commonalities and distinctions. The following sections describe the inspection characteristics and related classifications in more detail.

*4.1.1 Objective of building permit-related site inspection.* The major goal of building permit-related site inspections is to ensure buildings and their components are compliant with building regulations and other relevant legislation and guidance (Guler and Yomralioglu, 2021; Mjakuškina *et al.*, 2024). The regulations cover, for example, mechanical resistance and stability, fire safety, energy efficiency, and territorial planning. These requirements should be considered at the design stage and checked during the permit process.

*4.1.2 Selection of inspection characteristics.* The emerging building is compared with the requirements contained in permit documents and plans during on-site inspections. These site inspections generally focus on the quality characteristics of buildings, building components, and temporary site equipment (ID1; ID2; Meijer *et al.*, 2002; Mjakuškina *et al.*, 2024). For example, in Switzerland, inspections are also carried out to ensure construction safety, therefore, construction site equipment such as scaffolding and construction hoists are inspected (Baubewilligungen and Zürich, 2010; Hochbaudepartment Stadt Zürich, 2024).

To select inspection characteristics and begin the planning and execution of inspections, detailed information, such as approved design plans (ID1; ID9), zoning plans, infrastructure data, and geographical restrictions (ID8), is crucial. When planning what to inspect, historical inspection results by the building authority, such as those related to a specific building contractor, are not considered. The building permit authority conducts its checks on a case-by-case basis (ID1).

Actual construction information is also essential to conduct site inspections promptly. To date, none of the interviewed authorities have direct access to actual building construction data. However, this information gap can be resolved by a request by the inspector to the client or company on site (ID9). Legal regulations in Germany allow authorities to inspect construction logbooks, test certificates, and other prescribed records at any time as part of construction supervision (Hessische Bauordnung, 2011).

*4.1.3 Determination of inspection necessity.* Generally, the building component characteristics being inspected are directly based on legal regulations (e.g. manifested in the respective building code). These mandatory inspections can generally be classified as an objective decision for inspection. However, in practice, the necessity to inspect a particular building component and relevant characteristics is optional and depends on the subjective

**Table 2.** Criteria-based classification of building permit-related inspections

<table>
<tr><th>Inspection characteristics</th><th colspan="12">Classification of each characteristic</th></tr>
<tr><td rowspan="2">Objective of the inspections (Why?)</td><td colspan="12">Compliance with legal regulations</td></tr>
<tr><td colspan="12">DE, FI, FR, IE, LV, NL, GB, LT, RO, SI ,CY, DK, EE, IL, NO, ES (Mjakuškina *et al.*, 2024), TR (Guler and Yomralioglu, 2021), EN **(Local Government Association, 2017)**</td></tr>
<tr><td rowspan="2">Selection of inspection characteristics (What?)</td><td colspan="12">Characteristics of building, spatial & building components, and site equipment</td></tr>
<tr><td colspan="12">NZ (*ID1 and ID2)*; BE, DE, DK, FR, NL, NO, SE (Meijer *et al.*, 2002; Mjakuškina *et al.*, 2024), CH **(Amt für Baubewilligungen, Stadt Zürich, 2010; Hochbaudepartment Stadt Zürich, 2024),** CA *(ID9)*</td></tr>
<tr><td rowspan="2">Determination of inspection necessity</td><td colspan="6">Mandatory inspection (Usage of predefined inspections using checklists)</td><td colspan="6">Optional inspection based on inspector judgment and the individual responsible for processing the inspection (Planning of project-individual inspections)</td></tr>
<tr><td colspan="6">CA (*ID9*; **(City of Toronto, 2024)**), NZ (*ID1; ID2*), NO, SE (Fauth *et al.*, 2024a; Meijer *et al.*, 2002)</td><td colspan="6">NZ (*ID1; ID2*), MK, EE, DK, CZ, FR, DE(Fauth *et al.*, 2024b)</td></tr>
<tr><td rowspan="2">Inspection responsibility and competencies (Who?)</td><td colspan="4">Inspections by the building permit authority</td><td colspan="4">Third party inspections</td><td colspan="4">Hybrid</td></tr>
<tr><td colspan="4">NZ (*ID1; ID2*), CA (*ID9;* **City of Toronto, 2024)**, SE (Meijer *et al.*, 2002), EG (Fawzy and Magdi, 2020), GH (Tengan *et al.*, 2017), TR (Guler and Yomralioglu, 2021)</td><td colspan="4">FI, DE, SE (Bloch and Fauth, 2023) ; *ID4*), NZ (*ID1*), IL (*ID3*)</td><td colspan="4">EN **(Bristol City Council, 2024; GOV.UK, 2024; Local Government Association, 2017)**</td></tr>
<tr><td rowspan="2">Inspection time and frequency (When? and How many?)</td><td colspan="6">Inspections during construction (Based on period, predefined construction stages, request for inspection or construction schedule)</td><td colspan="6">Inspection on completion</td></tr>
<tr><td colspan="6">DK, EN, DE, NL, NO, SE (Meijer *et al.*, 2002; Meijer and Visscher, 2006); EN**(Building Control Partnership, 2024; Manchester City Council, 2024)**, NZ (*ID2*); IL (*ID3*); EG (Fawzy and Magdi, 2020), GH (Tengan *et al.*, 2017), TR (Guler and Yomralioglu, 2021), CA (*ID9*)</td><td colspan="6">DK, EN, FR, DE, NO, SE (Meijer *et al.*, 2002); NZ (ID2), IL (ID3), EG (Fawzy and Magdi, 2020), TR (Guler and Yomralioglu, 2021), CA (*ID9*)</td></tr>
<tr><td rowspan="2">Number and scope of inspection related to building components (How much?)</td><td colspan="4">100%-Inspection</td><td colspan="4">Random inspection</td><td colspan="4">X%-Inspection</td></tr>
<tr><td colspan="12">NZ (*ID1*; *ID2*)</td></tr>
<tr><td rowspan="2">Communication of inspections</td><td colspan="4">Inspection with announcement</td><td colspan="4">Inspection without announcement</td><td colspan="4">Inspection is requested</td></tr>
<tr><td colspan="4">GH (Tengan *et al.*, 2017)</td><td colspan="4">EN (Meijer *et al.*, 2002)</td><td colspan="4">CA (*ID9*; **City of Toronto, 2024**), AU (*ID6*), EN**(Bristol City Council, 2024)**</td></tr>
<tr><td rowspan="2">Documentation and certification</td><td colspan="3">Co-compliance certificate</td><td colspan="3">Amendment to the consent</td><td colspan="3">Code Compliance Certificate or completion certificate</td><td colspan="3">Notice to fix</td></tr>
<tr><td colspan="3">NZ (*ID1*)</td><td colspan="3">NZ (*ID2*)</td><td colspan="3">NZ (*ID2*); EN (Building Control, 2023); EG (Fawzy and Magdi, 2020)</td><td colspan="3">NZ (*ID2*), IS (*ID3*), CA (*ID9*)</td></tr>
<tr><td rowspan="2">Inspection cost</td><td colspan="6">Fixed fees</td><td colspan="6">Project-related fees</td></tr>
<tr><td colspan="6">CH (Amt für Baubewilligungen, Stadt Zürich, 2010)</td><td colspan="6">EN (Merton Council, 2023)</td></tr>
</table>

**Note(s):** Country codes according to ISO 3166-1: Australia (AU); Belgium (BE); Canada (CA); Switzerland (CH); Cyprus (CY); Czech Republic (CZ); Germany (DE); Denmark (DK); Estonia (EE); Egypt (EG); England (EN); Spain (ES); Finland (FI); France (FR); United Kingdom (GB); Ghana (GH); Israel (IL); Iceland (IS); Ireland (IE); Latvia (LV); Lithuania (LT); North Macedonia (MK); Netherlands (NL); Norway (NO); New Zealand (NZ); Romania (RO); Sweden (SE); Slovenia (SI); Turkey (TR).

Coding of fonts to distinguish different sources in Table 2: regular = literature, ***bold*** = grey-literature, *italic* = interviews

**Source(s):** Authors' own work

decision of the individual inspector (ID2). The decision to inspect is often project-related due to complexity and risks and relies on the discretionary scope of the inspector. Interviewee ID2 stated this concisely, *"But the inspections will be decided by whoever processed the building consent."* Decisions to inspect a specific component characteristic are made not only in advance but also during the on-site inspection (ID2). Additionally, the frequency and scope of inspections may also be influenced by the individual responsible for processing the building permit review (ID2). To improve the inspection planning process, the inspections are often predefined and summarized in templates or checklists (ID2). These templates are supplemented with project-specific actual values derived from plans and regulations, enabling inspections to be conducted based on this information (ID2). However, as previously mentioned, decisions to process inspections can be based on an individual project and are subject to the inspector's discretion. However, proper inspection planning requires a project-specific inspection plan.

*4.1.4 Inspection responsibilities and competencies.* Inspection responsibilities vary among building authorities. In many countries, construction companies are responsible for permanent self-inspections of their work. These self-inspections are usually performed by the architect on behalf of the building owner. In some cases, inspections are outsourced to third parties (Meijer *et al.*, 2002). In other countries, inspections may be directly carried out by building authorities with specialized inspectors or the same personnel who conducted the building permit review (ID2; ID3; ID 7; Kpamma and Adjei-Kumi, 2013; Mjakuškina *et al.*, 2024). In Canada, for example, interviewee ID9 summarized the responsibilities for his municipality in the following way: *"Building inspectors do both reviews of building permit application plans and inspections in the field. But many municipalities will have specialists that will sit at the desk all day and do plan reviews only, and they'll have field inspectors that only do inspections."*

Inspections conducted by building permit authorities require specific skills, necessitating training programs to ensure a comprehensive understanding of the code of practice for effective building inspections (ID1; ID3; Local Authority Building Control, 2024). Consequently, specialized construction inspection departments are often established within building permit authorities (ID1; ID3; ID4; ID9; Fawzy and Magdi, 2020). Additionally, specialized authorities (Guler and Yomralioglu, 2021) or external agencies (third parties) are sometimes involved in the inspection process, thus, providing the necessary qualifications or sovereign competence (ID3; ID5; Mjakuškina *et al.*, 2024). In the UK, applicants can choose whether site inspections are conducted by either building authorities or approved inspectors (Pedro *et al.*, 2011; Local Government Association, 2017). In Germany, there is a mixed division: some of the inspections are carried out by the building authorities, such as compliance with public law regulations, while other parts, such as compliance with structural analysis or fire protection, are performed by external experts (Hessische Bauordnung, 2011). In Israel, interviewee ID7 stated that "*control companies are now just trying to get into the business."*

*4.1.5 Inspection time and frequency.* The scheduling of inspections in relation to the construction execution is quite important for building authorities. Building authorities' inspections can be divided into two time-related types: (1) inspections during construction and (2) inspections after completion.

For inspections during construction, the allocation of responsibilities during execution aligns with the responsibilities assigned during the preventive check phase of construction. The Canadian interviewee ID9 stated that *"different stages of construction are looked at before the work continues."* In Germany, inspections are conducted by local authority building control or by recognized private control organizations on their behalf. In other countries such as the UK, the applicant or constructor notifies local authority building control to perform inspections at specific stages (e.g. after the foundation, ground floor, etc.), and construction can only proceed after these inspections (Building Control Partnership, 2024; Meijer *et al.*, 2002).

Inspections during construction can also be temporally categorized into commencement, intermediate, or completion inspections of specific components and related construction works, such as reinforcement acceptance, and final inspections of those components, such as the completed slab (ID2; ID3; ID9; Manchester City Council, 2024). Interviewee ID2 summarized these kinds of inspections as *"the idea is that you get to the end of the job and you have a whole lot of past inspections that have all been good."*

Upon successful completion of these sequential inspections, a final inspection or inspections after completion may be conducted to attest to the compliance of the building with the permitted building design (ID1; Pedro *et al.*, 2011). Different countries have adopted various procedures to verify the completion of construction work. As part of the occupancy permit in Turkey, the completed construction is inspected to ensure that the building has been constructed in accordance with the building permit (Guler and Yomralioglu, 2021). In the UK, local authority building control inspects the completed building upon the applicant's request and issues a completion certificate if the inspection is positive. Similarly, in Israel, interviewee ID7 described completion as an *"inspection on site when you need to authorize the building is ready for population."* In Canada, several inspections are performed up to the final inspection for occupancy (ID9). In New Zealand, final inspections have to be performed within 20 statutory days and are critical. Interviewee ID1 noted that *"final inspections usually have one of the highest fail rates . . . probably 40%, 35% of all final inspections will fail."* In Germany, a building can only be used if the local authority's building control deems it safe, and this can occur even before the building is fully completed. French local authorities have the right to inspect construction within two years of completion and issue a certificate if all is in order. In Denmark, a completion certificate is issued when the applicant signs a declaration confirming the construction complies with regulations. Similarly, in Norway, a final certificate is issued by local authority building control that declares all checks and inspections have been satisfactory. In Sweden, end inspections are contracted out to independent inspection organizations by local authority building control. However, the implications and rights derived from these end inspections and certificates are not entirely clear. In most countries, a building cannot be used until the end certificate is issued or the final inspection is completed, ensuring compliance with regulations throughout the project (Meijer *et al.*, 2002; Meijer and Visscher, 2006).

*4.1.6 Number and scope of inspections.* The number and scope of inspections vary significantly between countries due to differing regulatory frameworks and enforcement practices (ID1). In particular, due to the country-specific differences in inspections during construction and after completion, the scope and frequency of inspections vary. For instance, Germany conducts relatively few on-site inspections, whereas New Zealand performs highly detailed on-site compliance checks (ID1; Meijer *et al.*, 2002). In contrast, the U.K. building control bodies carry out inspections at predefined stages of construction, such as foundation excavation (GOV.UK, 2024). In addition, inspections are conducted by U.K. building authorities once every 28 days for active construction sites (Department for Communities and Local Government, 2017). In some jurisdictions, a minimum number of inspections is mandated by law. These inspections are aligned with critical process steps in construction and must be adjusted according to the complexity or size of the building. This planning process also relies on the subjective expert judgment of the inspection planner (ID3). Interviewee ID8 described this subjective inspection in the following words: "*Building control officers are just checking samples, just things that they are picking for from the plan . . . Building control officers are not checking everything . . . So, they have a checklist, and they are sampling the plans*" (ID8).

*4.1.7 Communication of inspection.* Building authorities process inspections with or without announcements. In Ghana, the date for the inspection of the construction site is determined during the submission (Tengan *et al.*, 2017). Due to the missing information regarding the actual construction status in some countries such as the UK and Canada, inspections have to be requested by the applicant (Bristol City Council, 2024; City of Toronto, 2024), but building authorities may also visit unannounced at other times (Meijer *et al.*, 2002). For example, the Austrian Building Act states that the authorities are authorized to check whether the execution complies with the requirements at any time. For this purpose, the authority and external agencies must be granted access to the construction site (Vorarlberger Baugesetz, 2008). In Switzerland, there are fixed construction stages (such as the completion of the shell) that must be communicated to the authorities, who then have three working days to inspect the relevant construction parts (Planungs-und Baugesetz, 2021). In Canada, interviewee ID9 stated that "The builder has to request their inspection before I think it's six in the morning," so his team will be able to arrange all the inspections for that day in the morning (ID9). As building authorities are responsible for large areas, the inspection planning requires that several inspections similar area are coordinated to occur in one trip (ID9).

It is important that the inspections are carried out without delay so that construction work can continue. Authorities must, therefore, anticipate the need for inspections to be able to keep capacities available. Otherwise, staff shortages or vacation periods can cause inspections to become scarce (Hillingdon London, 2024). One again, this demonstrates how useful inspection planning is for the authorities.

*4.1.8 Documentation and certification.* The inspection results are documented through photographs, and the evaluation of these results is recorded, including the rationale for each decision (ID1). Records of inspections should provide detailed information about work inspected as well as non-compliance (Department for Communities and Local Government, 2017; Kpamma and Adjei-Kumi, 2013). Different stages in the inspection process yield various certificates. Each compliance inspection (sub-process) results in a co-compliance certificate (ID1), which is subsequently used to apply for a Code Compliance Certificate or completion certificate (ID2). In cases of non-compliance, the building permit authority has to communicate contraventions and measures to the relevant person (Department for Communities and Local Government, 2017; Guler and Yomralioglu, 2021). An inspection may result in the issuance of a notice to fix, which halts work on the construction site until the issue is rectified and a subsequent inspection is conducted (ID2; ID3). If non-compliance arises due to the use of different materials, an amendment to the consent may be required to bring the construction into compliance (ID2).

Inspections are conducted within specific time frames, such as a period "*limited to 35 working days*," as stated by interviewee ID5, which are allotted for inspections by building control companies following a committee decision. Decisions made by the committee – whether to reject, approve, or conditionally approve – must be documented, potentially leading to certification or the issuance of notices to fix (ID5).

*4.1.9 Inspection cost.* Inspections carried out by building authorities often incur fees. These inspection fees are project-related fees, fixed fees, or combinations of both (Baubewilligungen and Zürich, 2010; Woking Borough Council, 2024; Merton Council, 2023). The authorities determine project-related fees based on complexity and project size. In addition, the inspection fees also apply for missed inspections or required re-inspections due to defective work (Town of Newmarket, 2024).

### *4.2 Planning and execution process of building permit-related inspections*

Following the insights into the derived classifications, a comprehensive Business Process Modeling and Notation (BPMN) diagram was developed to illustrate the stages of planning and inspections by building authorities. This process outlines the decision-making flow, integration with permit reviews, and on-site inspection procedures. Figure 4 presents a BPMN diagram that outlines the generalized stages of inspection planning and execution by building authorities. According to the interviews, the planning of inspections can already commence during the building permit review process. This leads to the conclusion that inspection planning is not just a sequential step following the building permit review but rather a parallel process that begins simultaneously with the review of the building permit or building consent (ID2). The presented process diagram captures the sequential and parallel activities involved, beginning with the integration of inspection planning during the building permit review and extending the inspection planning task through to the final on-site inspections. The intermediate inspections are executed after the notification letter is issued. In cases of

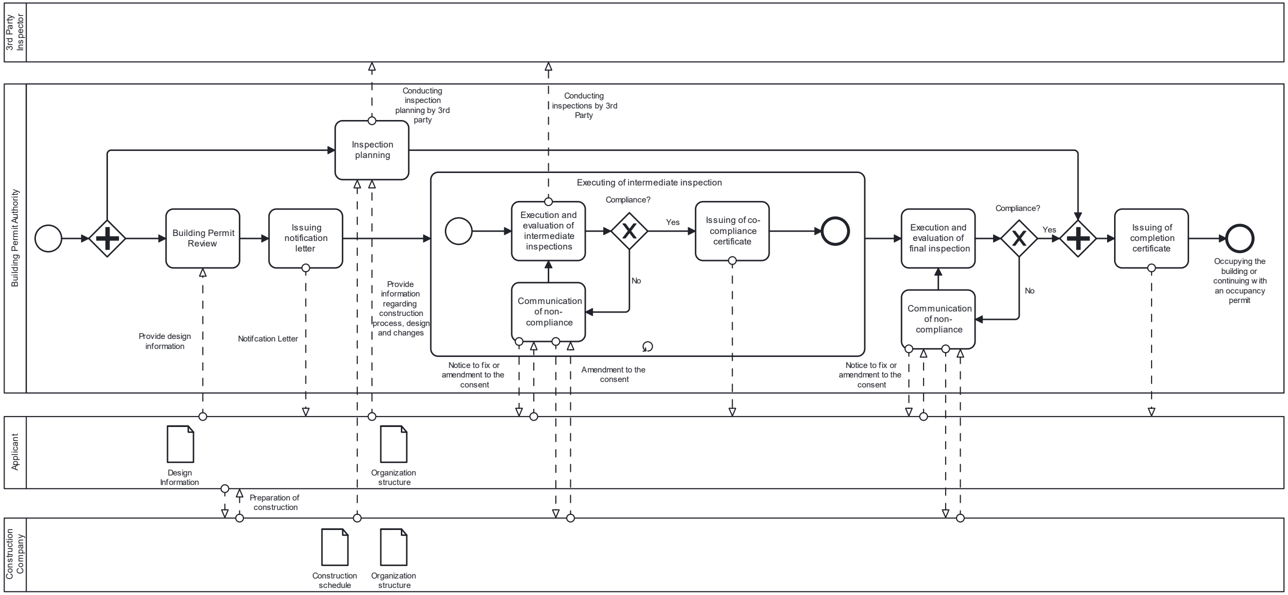


**Figure 4.** BPMN diagram outlining the planning and execution stages of building permit-related inspections. Source: Authors' own work

non-compliance, the building permit authority communicates with the applicant via a notice to fix, or the applicant requests an amendment to the consent form. For compliant construction works, a compliance certificate is issued. These intermediate inspections are conducted until the construction is finished. After the construction is finished, a final inspection of the building is performed. In this step, the non-compliance of the building is also communicated with the applicant and the construction company. Upon passing the final building inspection, a completion certificate is issued. This certificate signifies the end of the process used for planning and executing building permit-related inspections.

## 5. Framework development

The knowledge-based conceptual framework synthesizes and summarizes the identified findings. The knowledge for the framework was obtained from literature review (see Section 2), desk research, and empirical study (see Section 4) and consists of four key elements: 1) diverse national or jurisdictional contexts, 2) processes, 3) inspector management, and 4) inspection categorization (see Figure 5). The processes, inspection management, and inspection categorization are arranged in a triangular shape due to the direct influence that occurs between the components.

The corresponding diverse national or jurisdictional contexts are placed in the center of the triangle. They directly influence the other three components but are not influenced by them. Therefore, the country-specific regulations require different inspections, which can be classified according to the proposed inspection classification system. Similarly, the national regulations define processes and require inspectors to have different qualifications and capabilities due to the number of inspections.

The processes take into account the statutory and organizational procedures relevant to the planning and execution of inspections relevant to building permits. However, they also influence inspector management by describing responsibilities and the inspection categorization by declaring the number, frequency, and timing of inspections.

Inspector management represents the persons and organization responsible for planning and processing inspections. Inspector management consists of jurisdictional and third-party

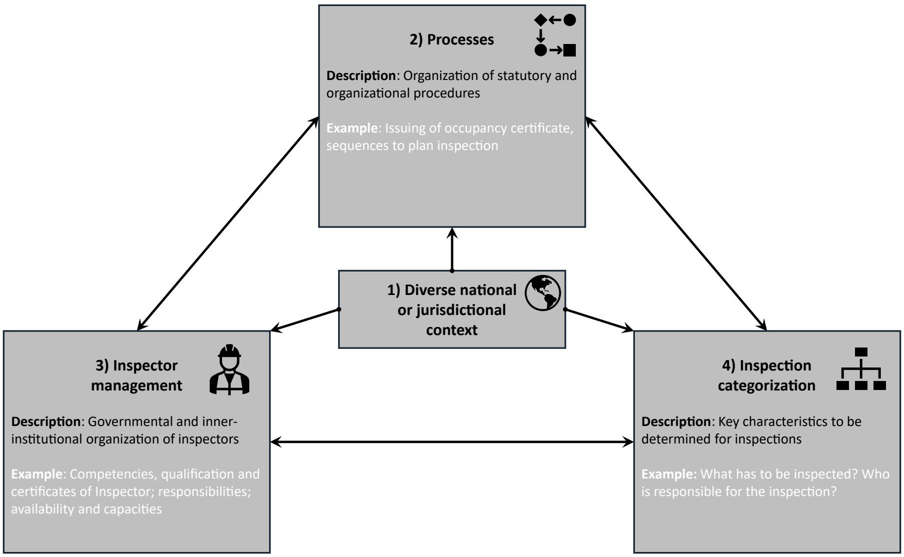


**Figure 5.** Conceptual framework for building permit-related inspections. Source: Authors' own work

inspectors. Hybrid models are also common for permit-related inspection processes. Inspection management varies in terms of qualifications, responsibilities, and competencies between countries according to the specifications defined in the regulations. Naturally, the authorities themselves are responsible for the management of the inspectors, including, for instance, the planning of workloads and the qualifications and ongoing education of employees. It becomes clear that inspection management also influences the process conducted by the authority as a result of the internal organization and structure of an authority or the digital management tools used for the requisition of inspections.

Finally, the framework has to consider the different inspection categories. The categories are derived from the different characteristics identified in Section 2. The characteristics enable a standardized pattern for categorizing and comparing inspections over multiple countries and authorities. The categories are, therefore, driven by inner institutional organizations and their corresponding processes. For this reason, the categorization of inspections is highly variable and diverse. Nevertheless, if inspection characteristics are changed, the processes and inspector management must also cover these changes.

## 6. Discussion

Building authorities are required to process an enormous number of on-site inspections per year, depending on the size and country-specific regulations. For example, a jurisdiction in New Zealand with around 60,000 inhabitants processes approximately 220,000 building inspections annually, corresponding to approximately 20,000 building applications (ID1). Consequently, authorities have begun utilizing digital applications to schedule inspections and document instances of non-compliance (ID1; ID9). This highlights the need for further scientific investigations to improve the understanding of permit-related inspections and to support the development of applications by providing explicit knowledge about such inspections.

Previous research has been limited to providing inspection knowledge by investigating regulations. In particular, comparisons have been made between European countries that describe these regulations in detail (Comiskey *et al.*, 2018; Meijer *et al.*, 2002) or state that inspections are part of the authorization process (Bloch and Fauth, 2023; Pedro *et al.*, 2011). Other international papers focus on individual building permit process descriptions, which include inspections (Eirinaki *et al.*, 2016; Fauth and Soibelman, 2022; Fawzy and Magdi, 2020; Kpamma and Adjei-Kumi, 2013; Tengan *et al.*, 2017; Yaakup *et al.*, 2007). However, these analyses do not address the practical knowledge needed by building authorities to conduct inspections.

In response to this gap, our research introduces a novel conceptual framework that formalizes and integrates distributed inspection knowledge in the context of building permits. Our major contributions are twofold: First, we provided a comprehensive classification of inspection types and characteristics based on qualitative content analysis and developed a structured process model for inspection planning and execution. We investigated and classified inspections according to key characteristics derived from literature, desk research, and expert interviews. Unlike previous studies, this classification does not merely compare national inspection practices but systematically identifies commonalities and distinctions across different jurisdictions. In addition, the classification is orchestrated in a decision-making process to illustrate the stages of planning and processing of building permit-related inspections. ComparingSecond, by synthesizing the results of the investigation, we developed the knowledge-based conceptual framework of building permit-related inspection with four key elements, including 1) diverse national or jurisdictional contexts, 2) processes, 3) inspector management, and 4) inspection categorization. Existing studies often focus on isolated aspects of the inspection process without offering a holistic perspective that connects these elements. Our framework serves as a foundational model to indicate the interconnection between different key elements and the dependencies of all elements to country regulations. By systematically integrating these elements, the framework provides generic knowledge to represent and manage building permit-related inspections in the context of building authorities.

Other findings can be derived by comparing the building permit-related inspections with on-site inspections and inspections in the manufacturing industry. First, our investigation shows that building permit authorities do not conduct process- or personnel-related inspections. On the contrary, the inspections by building authorities are limited to checking the quality of the building and its components. Second, building permit-related inspections possess unique aspects compared to construction inspections by other stakeholders. Inspections by a building authority are statutory tasks and significantly impact the construction process. These inspections check minimum requirements defined by law and not requirements agreed between clients and contractors. Third, building authorities do not conduct past inspection memories due to the objective processing and evaluation of inspections. These concluded inspections contrast with those of private companies that adapt inspections based on past project failure rates. Fourth, stakeholders of the construction process request or apply for inspections and related certificates directly from authorities or third parties. Fifth, inspections by building authorities must be executed in a specific time range required by regulations and do not depend on the actual construction schedule. At last, fee estimations are based on standardized catalogs rather than direct calculations of labor, equipment, and travel costs.

The proposed framework can benefit the practitioners and researchers from theoretical, societal, and practical aspects. In terms of theoretical aspects, it will be possible for practitioners and researchers to remodel the identified key elements of building permit-related inspections for their respective countries or authorities. Especially, the identified process, characteristics, and terminology of this paper can be used to remodel an authority's specific processes for internal process management or for transparent communication with other stakeholders. In addition, the categorization can be used for transparent classification of inspections according to the characteristics provided. The categorization can help to better understand, teach, and structure inspections that are relevant to the building authority or country. The proposed framework can also be used for comparisons or to identify best practices in planning and processing permit inspections on a global level to enable practitioners and researchers to obtain a broader understanding of building permit-related inspections. International practitioners, in particular, can profit from this framework by obtaining a quicker understanding of country- or authority-specific building permit-related inspections. From a societal perspective, the framework will promote more transparent planning and processing of inspections related to building permits for all stakeholders. For the practical aspect, the framework provides researchers and software developers with structured knowledge about inspections in the context of building permits, supporting the future development of software solutions. The software development process can be directly reused in the investigated classification stakeholder and process as specification. Especially the process provided in BPMN serves as explicit instruction and covers decision-making of building permitting processes for non-specialists.

This study has several limitations, which require future research. First, to reflect on the methodology, alternative approaches and additional sources could be applied to enhance the research result. For example, more in-depth research on the regulations (e.g. building codes) may have provided more insights. However, this was avoided due to the complexity of legal contexts in the international setting of the study, and it is the subject of a legal rather than a technical research question. Second, the small sample size of expert interviews may limit the generalizability of findings. While efforts were made to include diverse geographical and professional perspectives, some regional variations may not be fully captured. Third, the research relies on qualitative methods, which, while suitable for exploring complex processes, lack statistical generalizability. So far, quantitative investigations would not have been expedient because no uniform terminology exists, and the tests are too diverse to be carried out in a standardized survey. However, quantitative surveys could be executed based on the findings and framework presented here. Future studies could incorporate quantitative approaches to validate these insights based on the terminology provided in this paper. Fourth, inspections relevant to building permits are highly context-dependent and influenced by evolving regulations and digital transformations. As policies and technologies advance, some findings may require updates by ongoing research.

## 7. Conclusion

This study aimed to acquire and formalize explicit knowledge concerning building permit-related inspections to address the existing knowledge gap in planning and execution processes after building permits are issued. The study provides a comprehensive overview of the diversity and individual characteristics of permit-related inspections by different countries and provides a conceptual framework based on identified key elements of processes, stakeholders, and inspection characteristics. The framework helps to understand and improve inspection planning and execution for building permit authorities.

The study employs a literature review and desk research complemented by expert interviews conducted across several countries to provide a diverse assessment of current practices in building permit-related inspections. The findings of this research address two research questions. First, inspection categories relevant to building permits have been structured based on the characteristics derived from the general inspection planning process, enabling a transparent and extensive overview of inspection categories (as defined by RQ1). Second, the key elements for planning and processing inspections in building authorities have been identified, comprehensively described, and manifested in a conceptual framework (as defined by RQ2). The framework helps to understand and improve inspection planning and its execution for building permit authorities.

The study findings are important for decision-making in inspection planning and execution. The framework could serve to support the development of software solutions for the planning and processing of building permit-related inspections. The framework can serve as a theoretical foundation for the digital transformation of building permit-related inspections for building authorities and relevant stakeholders. Future work should focus on integrating the conceptual framework and its components into software applications to support a more efficient, transparent, and objective planning and execution of building permit-related inspections. Therefore, in future research, the framework can be used to create a comprehensive ontology to support building authorities with the knowledge to plan and execute inspections in the context of building permits.

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