

Article

Toward a Sustainable and Efficient Design Process: A BIM-Based Organisational Framework for Public Agencies—An Italian Case Study

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Abstract

The implementation of Building Information Modelling (BIM) in public design processes enhances efficiency, transparency, and sustainability. However, public agencies often encounter significant barriers, particularly regarding organisational and managerial readiness. This study develops a BIM implementation framework tailored to the specific needs of an Italian public agency. The research adopts a qualitative approach, combining 15 semi-structured interviews with process mapping Using (Business Process Modeling Notation) BPMN. The current *as-is* workflows were analysed and validated by internal stakeholders. Based on this analysis, strategic objectives were defined, relevant (Building Information Modelling) BIM uses were selected, and revised *to-be* processes were proposed, integrating new roles and responsibilities according to the standards. The framework addresses both technical and organisational dimensions of BIM adoption, highlighting the need for training, coordination, and stakeholder engagement. The main outcomes include a structured process model, a priority-based selection of BIM uses, and a role matrix supporting organisational transformation. The added value for researchers lies in the replicable methodology that combines empirical process mapping with implementation planning. For practitioners, especially consultants in sustainable design, the study offers a practical roadmap for aligning BIM adoption with project goals, regulatory compliance, and environmental performance targets in complex public sector contexts.

Keywords: BIM; implementation strategy; public agencies; public authorities; BPMN; process management



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1. Introduction

The adoption of BIM (Building Information Modelling) in public works varies from country to country [1,2], while several nations are encouraging or even requiring the mandatory use of BIM in the processes of public agencies to enhance efficiency, reduce costs, and improve the quality of constructions. In fact, the application of a BIM methodology not only provides and shares quantitative information regarding cost and materials but also enables data analysis and reduces evaluation times for decision-making [3,4]. Additionally, this facilitates efficient collaboration within a system composed of multiple stakeholders, considering several perspectives [5].

By enabling real-time data sharing and collaboration among stakeholders, BIM fosters transparency, and streamlined decision-making [6]. The adoption of BIM aligns seamlessly

with the twin transition, leveraging sustainable digital technologies to advance both environmental goals and digital innovation [7]. By integrating BIM within public procurement, stakeholders not only promote resource efficiency and sustainability but also contribute to the broader European agenda of achieving a carbon-neutral economy through the synergy of green and digital transitions [1]. Furthermore, it supports sustainability by optimising resource use, minimising waste, and aligning with Environmental, Social, and Governance (ESG) criteria [2]. In fact, unlike traditional methods, BIM integrates comprehensive data on building geometry, components, and processes, promoting a holistic approach to construction [3].

Specifically regarding BIM adoption in Europe, the European Commission published Directive 2014/24/EU, which encourages the use of digital tools, such as Building Information Modelling, in public procurement to enhance efficiency, transparency, and innovation in project delivery [4]. Article 22(4) explicitly encourages the use of tools such as electronic modelling systems for building (e.g., BIM) in the preparation of tenders. This legal provision has served as a strategic enabler for Member States to mandate or recommend BIM adoption in public works, thereby fostering digitalisation, transparency, and efficiency in procurement practices across the European Union. The implementation of BIM has increasingly been supported by international standards, particularly the ISO 19650 series, which provides a structured framework for information management throughout the asset lifecycle. These standards have become reference points for public authorities aiming to improve efficiency, coordination, and data reliability in construction projects [8]. The EU BIM Task Group highlights the strategic role of BIM in transforming public sector construction through improved information management, lifecycle thinking, and cross-disciplinary collaboration [9]. Its handbook provides a coordinated European approach for BIM adoption in public works, recommending not only the use of BIM for design and procurement, but also its integration across the entire asset lifecycle. This institutional effort has encouraged member states to align national strategies and develop guidelines, mandates, and training programmes to facilitate BIM implementation in public administration.

Many member countries of the EU have implemented this directive through specific legislations and guidelines [10]. In Italy, the integration of BIM in public works has been progressively mandated through Ministerial Decree No. 560/2017 [11], subsequently updated by Ministerial Decree No. 312/2021 [12]. These decrees, in alignment with Art. 23, paragraph 13 of the former Public Procurement Code (Legislative Decree No. 50/2016) [13], outlined for the first time the procedures and timelines for the phased implementation of Building Information Modelling tools and methodologies in public procurement processes. The 2016 Public Procurement Code incorporated the European Directive 2014/24/EU, which marked the first instance of advocating BIM usage in construction projects. The latest iteration of the Italian Public Procurement Code (Legislative Decree No. 36/2023 [14]) repealed the earlier ministerial decrees and introduced a definitive timeline for mandatory BIM adoption. According to Article 43, starting in 2025, public authorities acting as contracting and awarding entities must utilise BIM for the design and construction of new public works, as well as for interventions on existing assets, provided the tender value exceeds EUR 2 million [15].

The Italian government, in order to prevent public administrations without previous experience from approaching the BIM methodology, requires them to first establish an organisational document. This document must provide a structured and organised framework to guide the integration of management methods and building information modelling into the processes of public administration [12]. Planning for the implementation of BIM at an organisational level requires defining new roles and responsibilities combined with training and skills development [16].

Although BIM has seen widespread adoption in the AECO sector, current research offers limited insight into its effective organisational implementation within public agencies. Several studies have addressed specific aspects such as procurement processes, contract management, or technical compliance but tend to overlook the procedural integration and institutional restructuring required for long-term adoption [17,18]. As a result, the literature often fails to consider the complexity of internal workflows, the variability of administrative structures, and the human factors that influence digital transformation in the public sector. This highlights the need for frameworks that are not only technically robust but also responsive to the organisational realities of public administrations. This study sets out to investigate an Italian public agency with the objective of developing a strategic framework aligned with organisational needs and existing workflows. The framework is intended to support the future identification of BIM uses, roles, and responsibilities tailored to institutional goals. To achieve this, the research seeks to analyse current processes and define future ones, with the aim of enabling targeted adoption, efficient integration, and optimised value from BIM data and models in design and construction activities.

The paper is organised as follows: Section 2 discusses the literature review and the research gap against the research objectives; Section 3 introduces the methodology applied, while Section 4 shows the results of the method applied; Sections 5 and 6, respectively, address the discussions of the results obtained and the final conclusions.

2. Literature Review

In the existing literature, several studies focus on the implementation of BIM starting from the organisational structure; however, they predominantly concentrate on the private construction sector [19–21]. Regarding BIM adoption within public administrations, research primarily focuses on specific processes involving these entities, such as the tendering phase, the issuance of building permits, or particular applicative cases. These studies often do not address permanent revisions at the organisational level [22–24]. There is a noticeable lack of attention to BIM adoption at the organisational level, leaving a gap in understanding its broader institutional integration. Nevertheless, many governments across Europe are actively promoting, or even requiring, the permanent adoption of BIM within public administrations [25]. Consequently, research efforts are increasingly shifting towards examining BIM implementation within public agencies at the organisational level [26]. However, despite this growing interest, there remains a limited number of studies addressing this specific aspect, thereby highlighting a significant research gap.

Gurevich and Sacks, (2020) [27] followed the adoption of BIM in three large public bodies in the United Kingdom and Israel. They studied its impact by recording and monitoring the results over a three-year period. Their longitudinal study illustrates that public organisations can achieve significant progress by adopting a procedural framework to structure BIM adoption. However, their focus on large, centralised institutions in the UK and Israel limits the generalisability of their findings to smaller or more decentralised public agencies, such as those common in the Italian context.

Lindblad et al. (2021) [28] highlight the role of the public client as a promoter of change and innovation in the construction sector, aiming to foster a more sustainable and productive industry. The study explores BIM as a catalyst for organisational transformation in public agencies, offering useful insights into systemic change. Nonetheless, it remains largely conceptual, lacking an operationalised methodology to map and redesign actual workflows, a gap this paper aims to address through empirical process mapping.

Alwee et al. (2023) [18] present a case study involving the construction of a public complex based on BIM, adopting an approach that includes semi-structured interviews to investigate the process. The study explores current practices in the administration of

a public contract, aiming to understand the impact of BIM on achieving more efficient project management.

Marocco et al. (2023) [29] aiming to support public administrations in responding to governmental requirements, develop an operational framework for the implementation and digitalisation of workflow processes during the design phase. This framework is supported by an iterative process for evaluating performance based on key performance indicator (KPI) levels.

Pérez-García et al. (2024) [17] evaluate BIM implementation within Spanish public procurement using a mixed-methods approach, including surveys and expert interviews. Their mixed-methods study sheds light on market immaturity and its implications for BIM procurement in Spain. While their framework is useful for the pre-contractual phase, it does not extend to internal organisational procedures, which are the primary focus of this paper.

Matos et al. (2025) [30] aim to enhance public procurement procedures in order to promote the efficient use of BIM in construction projects. Their research specifically examines public procurement practices within the context of the Portuguese Public Contracts Code and provides practical recommendations for improvement.

Given the objectives of this study, the comparison with existing literature has focused on research examining the implementation of BIM within public administrations, particularly studies analysing the organisational and procedural changes resulting from its adoption. These investigations shed light on how BIM influences administrative workflows, decision-making processes, and structural adjustments within public institutions, offering critical insights into its impact on institutional practices and the transformation of traditional management frameworks.

However, recent studies highlight the absence of a systematic approach that identifies the needs of public administrations based on an analysis of the current organisational structure (the *as-is* condition). Since BIM adoption is intended to become a permanent element of public sector procedures, this initial analysis should serve as the foundation for a tailored implementation framework, derived from the identified needs and criticalities. Indeed, before introducing new procedures or methodologies, it is essential to understand the organisation's needs and existing processes, as this contributes to ensuring greater acceptance and adoption by the individuals involved in the change [31]. Table 1 summarises the critical issues identified in the literature regarding BIM implementation in public agencies, which informed the development of the present study's framework.

This study seeks to address the identified research gap by proposing an implementation framework that operationalises BIM adoption at the organisational level within a public agency. Unlike previous contributions that often remain at a conceptual level or focus on specific project phases, the framework developed herein is grounded in empirical data derived from detailed process mapping and stakeholder interviews. It refines existing models by integrating normative references, institutional workflows, and professional role definitions. Furthermore, the proposed framework introduces a replicable methodology that considers internal organisational heterogeneity, technological readiness, and institutional constraints, dimensions frequently underexplored in current literature. In doing so, it extends prevailing theoretical models by offering a procedural pathway for BIM integration that is both context-sensitive and aligned with public sector transformation goals.

Table 1. Summary of critical issues in BIM implementation highlighted in the literature.

Category	Description	Reference
Conceptual gaps	Fragmented or generic models that lack practical applicability in public agencies	Gurevich & Sacks (2020) [27]; Lindblad et al. (2021) [28]
Process limitations	Insufficient integration of BIM into organisational workflows	Lindblad et al. (2021) [28]
Public sector specificity	Lack of frameworks tailored to the regulatory and administrative context of public administrations	Alwee et al. (2023) [18]; Pérez-García et al. (2024) [17]
Skills and resources	Gaps in digital competence and resource allocation in public organisations	EU BIM Task Group (2017) [9]
Change management	Limited consideration of cultural, managerial and behavioural aspects in implementation	Gurevich & Sacks (2020) [27]; Pérez-García et al. (2024) [17]
Evaluation metrics	Scarcity of empirical studies measuring the impact of BIM at organisational level	Lindblad et al. (2021) [28]

Public administrations do not operate uniformly; they differ significantly in terms of human and financial resources, as well as in their levels of knowledge and technological expertise. These variations necessitate the development of implementation strategies that are both replicable and adaptable, taking into account such specificities to ensure that solutions are adopted and applied with greater organisational engagement.

Considering the case study of an Italian public agency, this research aims to develop a framework as a strategic approach to BIM implementation, taking into account the organisation's needs and expectations. The framework is intended to guide the public administration in identifying the strategic objectives it seeks to achieve through BIM adoption, based on an analysis of existing *as-is* processes and the definition of new *to-be* processes.

3. Methodology

A qualitative research approach was selected as the most appropriate method for this study, given its exploratory nature and its aim to investigate organisational processes, contextual practices, and stakeholder perspectives within a public agency. Qualitative methods are particularly well suited for examining complex social systems and uncovering latent structures, which are not easily accessible through standardised quantitative instruments [32]. In this case, understanding the *as-is* design workflows, institutional roles, and the internal logic behind BIM adoption required detailed, context-rich data that could only be obtained through semi-structured interviews and interpretive analysis. The use of qualitative inquiry also aligns with the objective of codeveloping a context-specific implementation framework that reflects the agency's operational reality.

A qualitative research methodology was adopted in the first part of the study (Figure 1). This approach involved data collection and analysis, followed by the development of a BIM implementation framework based on the data analysed [33]. Data were collected through semi-structured interviews, with the aim of revealing the *as-is* design processes currently performed by the public agency.

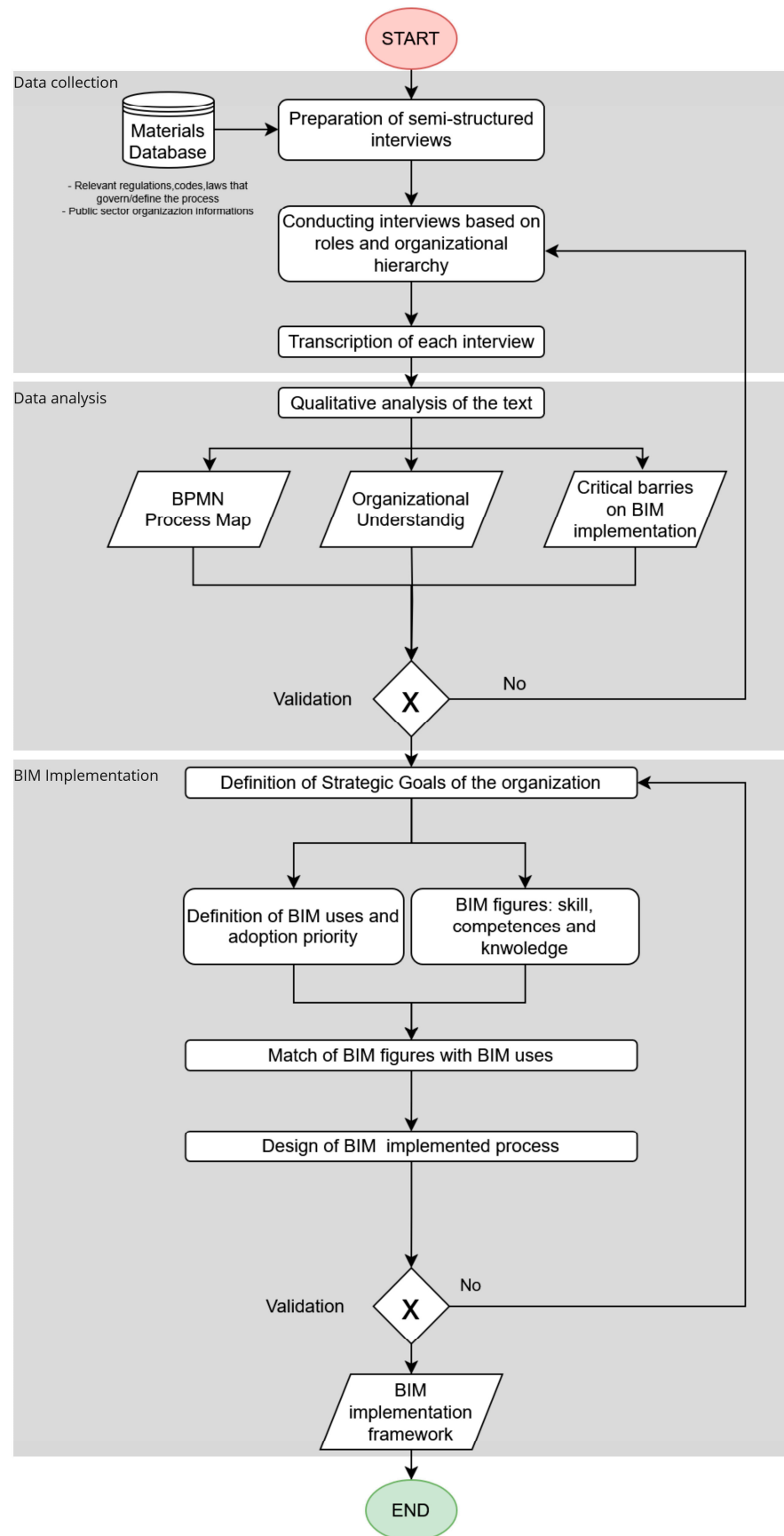


Figure 1. Steps of the methodology adopted.

The collected data were analysed using a qualitative methodology based on an inductive approach [34]. The analysis involved coding the interviews and highlighting emerging themes related to the investigated aspects, in order to understand (1) the process, (2) the organisation, and (3) the critical points concerning the management of the existing processes. To accomplish the research objectives, the inductive analysis enabled the design processes to be mapped according to the BPMN standard representation [35].

Subsequently, the methodology proceeded with the development of a BIM implementation plan tailored to the needs of the organisation. This phase first involved identifying the organisation's strategic goals, followed by the selection of BIM uses, based on the results obtained from the previous methodological steps [36]. In fact, according to Penn State University's BIM Project Execution Planning Guide, strategic goals are determined by the performance outcomes intended to be achieved through BIM implementation. The Penn State University's BIM Project Execution Planning Guide was selected due to its structured approach to defining strategic goals, identifying BIM uses, and aligning them with process activities, features that were particularly valuable in the early stages of framework development. Its detailed taxonomy and use-case orientation provide a flexible yet comprehensive foundation for linking organisational objectives with digital tools. However, it is important to acknowledge that this guide originates from a US-based context, which differs from the legal, procedural, and administrative frameworks of Italian public agencies. To mitigate this limitation, the selected BIM uses were critically reviewed and adapted in accordance with the requirements of the Italian Public Procurement Code and UNI 11337 standards [37]. The integration of these local norms ensured contextual alignment and practical applicability of the methodology within the Italian public sector.

Once the strategic goals were defined, it became possible to identify the BIM uses associated with the various process activities. The list of BIM uses was derived from Penn State University's Guide and the BIM Initiative list [38] and adapted to reflect the evolving needs of the new processes emerging within the public organisation. Subsequently, new roles and responsibilities were identified, associated with the activities and selected BIM uses, with the aim of supporting the achievement of the organisation's strategic goals [36]. These roles were defined in accordance with the Italian standard UNI 11337-7:2017 [37], which outlines four key profiles essential to BIM process management. Indeed, among the requirements established by the Italian Public Procurement Code is the obligation to implement a training plan aligned with the specifications of this standard.

The outputs of the adopted methodology are the newly implemented *to-be* processes, which incorporate the interaction of the newly defined profiles with the existing *as-is* design processes.

3.1. Qualitative Analysis Method

3.1.1. Data Collection

For the purpose of data collection, semi-structured interviews were employed to comprehensively capture the processes involved in the design stages. Although these processes are delineated by the relevant normative references, it is necessary to integrate them with the practical perspective of the public agency in order to obtain a representative and context-specific viewpoint. The aim of the data collection is to achieve a tailored solution [39] combining the requirements of normative documents with information specific to the agency's operational processes. A tailored solution enables the assessment of the applicability of particular standards and the adaptation of procedural protocols to the organisational context. It also allows results to be customised by selecting, modifying, or adding requirements according to the specific application context. Semi-structured

interviews allow the interviewer to use a pre-established list of questions as a guide during the conversation. This format provides the flexibility to lead the discussion in a semi-free manner, allowing additional relevant topics to emerge alongside the prepared questions [40,41]. The use of open-ended questions offered the opportunity to capture different perspectives and gain a more in-depth understanding of the topics discussed. Consequently, the application of semi-structured interviews enabled the collection of qualitative and reliable data [40].

In order to capture the design processes as actually conducted by the public agency, a structured interview framework was prepared. Table 2 presents the interview structure, designed to investigate the management of the design stages. Section A aims to profile the respondent. The questions in this section were developed following an initial study of the agency's organisational chart. The public agency's hierarchy places the General Directorate at the top, followed by several directorates, each subdivided into sectors based on their area of responsibility. Additionally, a question was included to ascertain whether the respondents possess theoretical or practical knowledge of BIM. The subsequent questions focus on mapping the design processes and were formulated according to the Italian normative references that define public sector design procedures works [13,42,43]. Each interview includes 30 questions. More in detail Section B focuses on surveying the actual process and is structured into sub-sections. Sub-section B.1 contains questions related to the recruitment and contracting procedures for stakeholders involved in design phase. Sub-sections B.3, B.4, and B.5 reflect the three steps of design project delivery as defined by the Italian normative framework: (1) Outline Design, (2) Definitive Design, and (3) Executive Design. (Although the Definitive Design phase was repealed under the 2023 Public Procurement Code, it is included in this research as the data collection encompassed this stage.) Sub-section B.7 investigates how the project is verified, validated and approved. Section B following the first two pilot interviews was expanded with sub-sections B.2 and B.6 in order to directly investigate critical issues during the design phase and the main documentation produced during workflows. Finally, Section C concludes the interview, inviting respondents to comment freely on the preceding questions and highlight any related topics they consider relevant.

Table 2. Interview structure (design stage).

Section A	Interviewee profile
Section B	Tracking process-management procedures during the three design stages
	B.1 Design commission
	B.2 Critical issues during the design process
	B.3 Outline Design stage
	B.4 Definitive Design stage
	B.5 Executive Design stage
	B.6 Documentation
	B.7 Checking and validation of the project
Section C	Conclusions

A total of 15 interviews were conducted, specifically for the design phase (Table 3). All the interviews were recorded and transcribed. The total of 15 interviews was considered sufficient for the scope and objectives of the study. This sample size aligns with established qualitative research practices, which suggest that data saturation can often be reached with 12–20 in-depth interviews when the sample is relatively homogeneous and the research questions are narrowly focused [44] In this case, saturation was observed when no sub-

stantially new themes emerged during the final interviews. Moreover, participants were selected to represent the key functional areas involved in the design process within the public agency, ensuring that the diversity of roles, responsibilities, and experiences was adequately captured. The inclusion of multiple sectors and directorates further enhanced the reliability and comprehensiveness of the collected data. Specifically, interviews of the design phase have a total time length of about 12 h. And the interview participants were anonymised with a code. The participants belong to the road sectors under the Directorate for Mobility, Infrastructure and Public Transport and sectors belonging the Directorate for Land Protection and Civil Protection. Also, to supplement the data collected, two open-ended interviews were conducted with the Contracts Sector. For the purposes of analysis, these open-ended interviews help to collect data of the contractual part of the process. Figure 2 illustrates this information visually, showing the proportion of interviews per duration range and the sectoral representation of participants across the public agency.

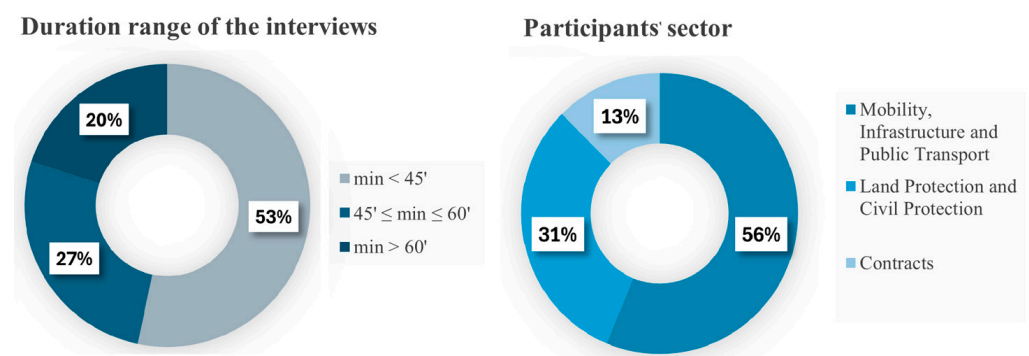


Figure 2. Interview duration ranges and sectoral distribution of participants. **Left:** Percentage of interviews by duration category. **Right:** Sectoral distribution of interviewees across the three main departments involved in the design process.

Table 3. Participants' directorate/sector and the duration of each interview.

Participants Involved			
Interview No.	Directorate/Sector	No. of Participants per Interview	Duration
1	Mobility, Infrastructure and Public Transport	1	1 h 35 min
2	Mobility, Infrastructure and Public Transport	1	45 min
3	Mobility, Infrastructure and Public Transport	1	31 min
4	Land Protection and Civil Protection	1	32 min
5	Land Protection and Civil Protection	1	15 min
6	Mobility, Infrastructure and Public Transport	2	1 h 49 min
7	Mobility, Infrastructure and Public Transport	1	49 min
8	Mobility, Infrastructure and Public Transport	1	26 min
9	Land Protection and Civil Protection	1	45 min
10	Contracts	1	20 min
11	Contracts	1	22 min

Table 3. *Cont.*

Participants Involved			
Interview No.	Directorate/Sector	No. of Participants per Interview	Duration
12	Land Protection and Civil Protection	1	1 h
13	Land Protection and Civil Protection	1	28 min
14	Mobility, Infrastructure and Public Transport	1	1 h 41 min
15	Mobility, Infrastructure and Public Transport	1	31 min
Total		16	11 h 49 min

3.1.2. Data Analysis

The substantial amount of data gathered from the interviews underwent transcription and analysis employing a quantitative methodology via an inductive approach [34]. Data analysis was carried out using the NVivo 14 software (QSR International, Burlington, MA, USA, 2022), which provides a dedicated environment for coding, organising, visualising, and querying qualitative data [45]. The used software is optimal for qualitative data analysis because it provides a workspace in which data can be coded, organised, visualised, and analysed. In addition, it is possible to query data by arranging them according to customised search criteria and create matrices.

The data analysis is aimed at understanding the design and construction processes as they are actually performed by the public agency. In this way, it is possible to proceed to identify new roles and responsibilities to highlight the domain for a BIM implementation that fits the needs of the organisation. Therefore, in parallel with the process mapping, critical issues as well as roles and responsibilities are analysed in order to have a detailed organisational chart.

In order to investigate in detail the amount of data collected, a primary coding scheme was set up in the NVivo software that reflects the interview structures (Table 4). Each interview has been coded compared to the themes of the main coding scheme by assigning the statements made by the interviewees within the inherent codes.

Table 4. Primary code scheme (design stage).

Name	Focus
0. Profile of the interviewee	Identify the respondent regarding the sector and area in which they carry out the work, their role within the public agency, years of service, and experience/knowledge with BIM methods and tools.
1. Design commission process	Investigate how the commissioning is formalised, when contracting is carried out internally in the public agency, and the management of any mixed contracting with externals. Also, how documents containing preliminary indications are drafted, the authorisation processes, and the third part authorities involved are investigated.
2. Design process (Internal/External)	To investigate the three phases of design as they are actually performed by the public agency. The investigation included both the design process performed internally and externally of the public organisation. Also, for each of the phases of design processes, the actors involved and the activities performed are coded.

Table 4. *Cont.*

Name	Focus
3. Checking and validation process	Topic investigated to understand aspects related to design-validation check procedures.
4. Critical Issues	The purpose of this survey is to capture critical issues of different types expressed and observed during the phases of design and during the checking and validation phase.
5. Organisational Features	The purpose of this code is to highlight if some sectors have their own internal work organisation, particularly for work coordination and data management.
6. Technological facilities	Collection of information related to technologies adopted by the agency, in particular working platforms and file-sharing facilities.

3.2. BIM Implementation Strategy

Based on the data framework obtained through qualitative analysis of interviews and a graphical representation, it is feasible to proceed to the final step of the methodology for implementing BIM in the processes of the public agency that align with its characteristics. The strategy employed for this phase refers to the guidelines provided by Penn State University and BIMe Initiative [36,38].

In accordance with Penn State University's BIM Project Execution Planning Guide, strategic goals depend on the performance desired to be achieved by implementing BIM in processes. These goals, e.g., may relate to reducing costs and time, improving coordination, or increasing productivity. Therefore, the organisation's strategic goals were defined based on an analysis of the previous methodology step, especially regarding the activities mapped in the design and construction process maps.

Once the strategic goals were defined, it became possible to proceed to identify the BIM uses associated with the mapped activities in the design and construction processes. More specifically, this leads to the development of a new process implemented by matching the processes with the BIM uses in reference to the list provided by Penn State University's BIM Project Execution Planning Guide and the list defined by the BIMe Initiative.

Once the uses of BIM associated with the objectives of the design and construction processes have been defined, the roles involved operationally within them must be specified. The Italian UNI 11337-7 2017 [37] standard indicates the four profiles which play key roles in BIM process management.

4. Results

4.1. Coding Scheme

The collected data were analysed using an inductive approach to qualitative inquiry, grounded in the thematic examination of transcribed interviews. Through this process, individual utterances were systematically assigned to corresponding primary codes. These codes were subsequently refined and structured into sub-codes, allowing for a more nuanced and granular categorisation of content in relation to the specific thematic domains emerging from the data.

In addition, some of the sub-codes were created based on themes that do not emerge directly from the interview structure, but are widely discussed by the interviewees and therefore are relevant to the analyses and objectives of the research. For example, during the coding of the interviews, it emerged how work is coordinated within individual sectors or how specific tasks are divided and assigned. Figure 3 presents the final coding

scheme, showing its hierarchical structure and the number of references for each code and subcode.



Figure 3. The final coding scheme (References represent the parts of text (occurrences) that have been coded for that topic).

4.2. As-Is Process Mapping and Analysis

In the initial phase of the research, a qualitative methodology with an inductive approach was employed for both data collection and analysis. The subsequent phase of analysis aimed to:

1. Map the design processes as effectively carried out by the public agency;
2. Identify the roles and responsibilities involved in these processes;
3. Uncover the critical issues emerging from the mapped procedures.

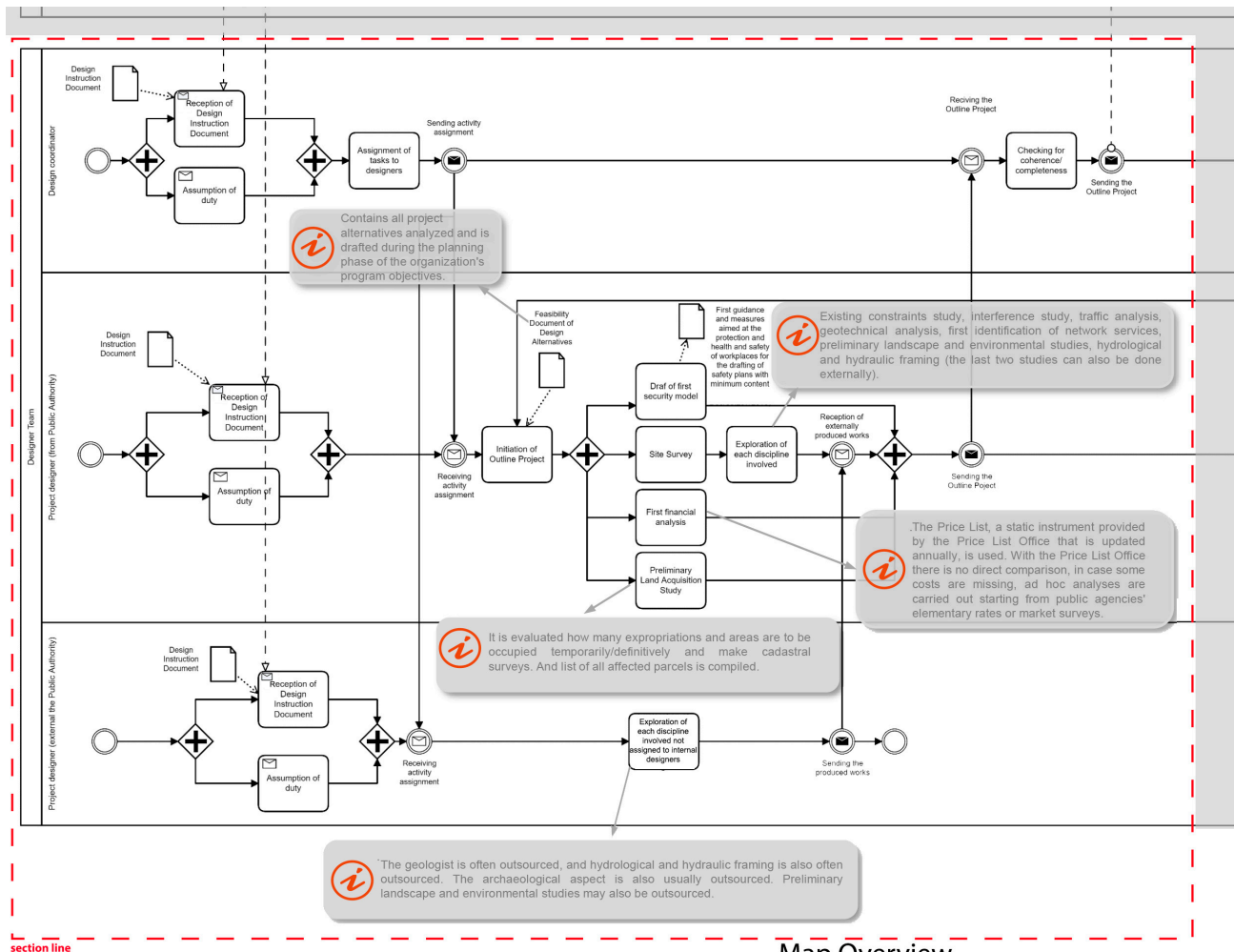
The above points make it possible to define a domain to study a plan to implement BIM, new roles, and responsibilities in the processes that suit the organisation.

Structuring the data into a coding scheme allowed them to be analysed systematically in order to outline the entire process through (1) maps. Business Process Model and Notation (BPMN) was used to produce the maps. The BPMN language represents an effective representation standard for understanding processes. In order to better communicate the maps to the public agency, additional notations and notes were introduced to support the BPMN symbols. The notes report some significant statements made by the interviewees or extracts from the normative references. In addition, moments of collaboration with other stakeholders or differences found in the ways of operating among the various sectors interviewed were highlighted with added icons.

To rebuild the entire design process, four BPMN maps have been produced:

1. Design commission;
2. Outline Design stage;
3. Definitive Design stage;
4. Executive Design stage.

The BPMN maps once produced were shared with some of the re-reference figures within the public agency who provided additional input to validate the maps in their final version. Figure 4 shows the *as-is* map of the Outline Design stage. A complete version of the BPMN diagrams representing the *as-is* processes across all design stages is provided in Appendix A, which includes notational details and sector-specific variations. The complexity of the process can be seen: the BPMN mapping highlights a dense network of activities, their sequence, and their dependencies. To facilitate interpretation, the diagrams adopt standard BPMN elements such as swim lanes to distinguish between actors, activity boxes for operational steps, and gateways to indicate decision points. Icons and annotation bubbles provide contextual information, such as regulatory references or interdepartmental differences. Readers unfamiliar with BPMN notation are advised to refer to Appendix A for a summary of the notation used. All the actors involved and which responsibilities each of them has and the dense network of communication between them also emerge. In fact, process mapping combined with the analysis of the data collected in the interviews makes it possible to highlight (2) organisational structure at a deeper level. It has been understood that each sector has a Director who has authorising and approving power over the final documents; below there is the figure of the Technical Officer and Coordinator who is responsible for coordinating a group of Technical Officers in charge of performing individual specialised functions. This hierarchy usually reflects that established during the process of design and construction. Indeed, the roles involved during the design and construction phases in Italy are specified by the legislative framework. Generally, the Director of the Sector performs the function of the Contract Manager or the Process Manager. The Technical Officer and Coordinator can assume several roles but mainly that of Design Coordinator or Director for Public Works. The matrix below (Table 5) provides the overall view of the responsibilities assumed by public agency employees during the design and construction processes.



Map Overview

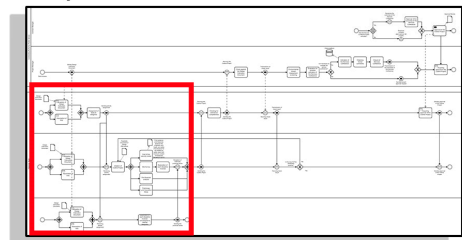


Figure 4. As-is BPMN map representing the Outline Design stage of the public agency’s workflow. The diagram visualises sequential activities, responsible actors, and interdependencies using standard BPMN symbols. Notes and visual markers are included to highlight critical comments from interviewees, process variations across departments, and collaboration points with external stakeholders. Full map in Appendix A.

Table 5. Role assumed during the design and construction phase by the public officers. (The dots represent the roles assumed by the three figures during the design and construction phase.)

Position Held in the Public Agency	Roles Assumed During the Design and Construction Phases						
	Contract Manager	Project Manager	Design Coordinator	Project Designer	Coordinator for Safety	Director of Public Works	Construction Inspector
Director of the Sector	•	•					
Technical Officer and Coordinator		•	•	•	•	•	•
Technical Officer				•	•	•	•

In the last step of the data analysis, (3) critical issues were highlighted as possible obstacles to the adoption of BIM in the organisation. In fact, interviewees were asked to explicate critical issues and problems they face during processes. Critical issues that may hinder successful implementation of BIM fall within the following three topics:

1. Processes;
2. Stakeholders;
3. Technology facilities.

The first type of critical issue concerns the heterogeneity of (1) processes. Different practices between sectors and directorates in performing design were highlighted by the interviews. Respondents made explicit that they have not been provided with standard protocols for operating and how this slows down the processes for designing and realising a project. Such freedom to operate according to different sensitivities of approach results in diversities. Therefore, respondents would like coordination among sectors when they cooperate with each other and standard procedures.

The next kind of difficulty reported concerns the lack of information sharing (2) among individuals and different sensitivities to accomplishing assigned tasks. Such aspects constrain collaboration and interaction between parties inside and outside the organisation. Moreover, this kind of criticality is an obstacle to the successful implementation of BIM. Indeed, one of the first choices to be made will involve the reorganisation of work and assignment of new responsibilities to employees.

The last type concerns technological equipment (3) which is also very heterogeneous within the organisation and in some cases obsolete. In particular, respondents pointed out that the inadequate information technology facilities lead to difficulties in sharing and visualising the data. In addition, some individuals prefer traditional methods of conducting activities (e.g., working on local files, or individual data sharing via e-mail), avoiding the utilisation of available sharing platforms. Indeed, through a thorough analysis of processes and issues, it is possible to implement corrective measures and adopt targeted approaches to address challenges related to the introduction of BIM, thus forwarding improved management of workflows. For this reason, based on the identified critical issues, the public agency conducted an internal survey to measure the perception of these issues within the organisation, administering a questionnaire not only to the individuals interviewed during data collection but to an extended number of employees. Specifically, out of the 75 critical issues identified concerning processes, stakeholders, and technologies, the public agency selected 45 as actual obstacles to BIM implementation.

4.3. BIM Implementation Action

The analysis and mapping of *as-is* processes is a preparatory step for the study of a BIM implementation plan that fits the needs of an organisation. It is inevitable that this transition will require a change at the workflow level, and the introduction of new roles and work practices. This change is also required by the Italian government, which is calling for public agencies to adopt BIM as part of their processes by 2025 for contract amounts exceeding EUR 2 million [15].

4.3.1. Strategic Goals and BIM Use Selection

In accordance with Penn State University's BIM Project Execution Planning Guide, strategic goals depend on the performance desired to be achieved by implementing BIM in processes. These goals, e.g., may relate to reducing costs and time, improving coordination, or increasing productivity. In fact, in the analysis of *as-is* processes, some critical issues also emerged such as long lead times or difficulties in coordinating work when many sectors are involved.

Therefore, the organisation's strategic goals were defined based on the critical issues identified with the public agency in the interviews, the *as-is* analysis, and the activities mapped in the design and construction process maps. The outlined strategic goals aspire to increase process efficiency, productivity, and quality while reducing costs and improving collaboration and safety. All the strategic goals of the public agency are detailed as follows:

- SG.1—Efficient design flows and improvement of multi-discipline coordination. These strategic goals are in both the function of the design verification for validation purposes and during the construction phase, by identifying in advance any conflicts or inconsistencies between different aspects of the design and resolving them in a prompt response.
- SG.2—Risk mitigation through early identification of potential problems at the design stage and before the start of any work during construction. This ensures that the process/project is not likely to be damaged or endanger people during its execution or during its entire life cycle.
- SG.3—Cost reduction through improved verification of the actual constructability of the project in order to reduce the risk of excessive extra costs during project construction. In addition, accurate planning of the construction site can reduce labour and material costs.
- SG.4—Improved communication and increased acceptability of the intervention starting with the design process and through information sharing. Increased transparency and collaboration between different sectors/departments/external parties for the reduction of communication errors.
- SG.5—Stakeholder engagement and authorisation acquisition support in favour of shared and consistent understanding, as well as more direct and timely participation in decision-making.
- SG.6—Support for the Works Direction Office and centralisation of collected data in order to achieve more consistency and accuracy of available information, simplifying the management of the activity control and ensuring better quality of work execution.

Once the strategic goals were defined, it became possible to proceed to identify the BIM uses associated with purpose cases that came out from the mapped activities in the design processes. More specifically, the activities captured in the *as-is* analysis were matched with the BIM uses in reference to the list provided by Penn State University's BIM Project Execution Planning Guide and the list defined by the BIM Initiative. Figure 5 combines the uses of BIM with the activities in the three phases of the design phase. In addition, adoption priorities have been associated with each case:

- High priority for BIM uses to be adopted early as they are highly urgent and useful for the associated activities.
- Medium priority for important but proportionately medium-urgent uses of BIM. Scheduling adoption of such uses can be scheduled later—both for reasons of the organisation's digital maturity and for reasons related to the time and cost associated with training and technological facility acquisition.
- Low priority for uses of BIM that are potentially useful to the organisation but not urgent because high digital skills and maturity are required.

The table showing the selected BIM uses with the purpose of each one was shared with public agency employees who validated the priorities by prioritising each BIM use themselves.





Nº	OBJECTIVE	BIM use	BIM uses (description)	BIM uses (ID)	Adoption priority
1	SITE ANALYSIS	Site Survey	Digital capture of existing conditions, including terrain, infrastructure, and utilities.	OB.1_Bu1	●
		Context Modelling	3D modelling of the existing environment, incorporating topography, vegetation, land use, and hydrogeology.	OB.1_Bu2	●
		Site Documentation	Graphical representation of site conditions for documentation purposes.	OB.1_Bu3	●
2	DESIGN	Disciplinary 3D Modelling	Development of discipline-specific BIM models (e.g., structures, roads, geotechnics, hydraulics, etc.).	OB.2_Bu1	●
		Design Comparison & Scenario Analysis	3D visualisation to evaluate design alternatives in relation to site conditions.	OB.2_Bu2	●
		Preliminary Quantity Takeoff	Extraction of quantities by discipline for early cost estimation.	OB.2_Bu3	●
		Integrated Design Review	3D-based review of coordinated design models and their relationship to existing site conditions	OB.2_Bu4	●
		Preliminary Metric Computation	Extraction of quantities for initial bill of quantities by discipline and component.	OB.2_Bu5	●
		Detailed Quantity Estimation	Detailed metric estimation by work type, element, and technical specification.	OB.2_Bu6	●
		Construction Detail Visualisation	3D visualisation of design details to support control and verification processes.	OB.2_Bu7	●
		Engineering Simulation & Impact Analysis	Simulations for environmental, infrastructural, and legal impact assessments (e.g., flooding, expropriation).	OB.2_Bu8	●
		Drawing Generation	Automatic generation of 2D drawings from 3D BIM models.	OB.2_Bu9	●
3	DESIGN OF THE CONSTRUCTION SITE SYSTEM	Site Planning & Safety Coordination	Meta-project modelling for construction site layout and safety planning.	OB.3_Bu1	●
		Construction Phasing Visualisation	3D visualisation of site phasing in relation to the site and construction sequence.	OB.3_Bu2	●
		Drawing Generation	Automatic generation of 2D drawings from 3D BIM models.	OB.3_Bu3	●
4	MAINTENANCE ORIENTED DESIGN	As-Built and Asset Management	Integration of as-built models for operation and maintenance of infrastructure.	OB.4_Bu1	●
5	MULTI DISCIPLINES COORDINATION	Federated Model Visualisation	3D-based integration and visualisation of specialist design models within the project context.	OB.5_Bu1	●
		Macro Clash Visual Inspection	Visual review of major design clashes to detect spatial coordination issues.	OB.5_Bu2	●
		Clash Detection and Resolution	Checking and management of interferences between specialised models.	OB.5_Bu3	●
		Multidisciplinary Coordination Support	Generation of graphical outputs to support clash resolution and team coordination.	OB.5_Bu4	●
6	SYNTHESIS AND SHARING OF DESIGN RESULTS FOR THIRD PARTY APPROVAL	Stakeholder Communication (3D/4D BIM)	Communication of design intent and project outcomes using 3D/4D BIM models for stakeholder engagement.	OB.6_Bu1	●
7	PLANNING OF SPACE AND TIME CONSTRUCTION SEQUENCES (WORK SCHEDULE)	Construction Phase Simulation (4D BIM)	Simulation of construction sequencing and site use through BIM–schedule integration.	OB.7_Bu1	●
		Traffic Impact Simulation	Evaluation of the project's impact on road systems and traffic performance.	OB.7_Bu2	●
		Environmental Impact Simulation	Simulation of effects on surrounding ecosystems, including hydrogeological risks and alterations.	OB.7_Bu3	●
8	DESIGN VERIFICATION FOR VALIDATION AND AUTHORIZATION PROCEDURES	Design Usability & End-User Simulation	3D simulation for assessing usability, functionality, and safety from the end-user perspective.	OB.8_Bu1	●
		Regulatory Code Compliance Checking	Semi-automated compliance verification using parametric rules and code-checking tools.	OB.8_Bu2	●
9	ANALYSIS OF INFORMATION INCONSISTENCIES	Model Content Verification – Basic	Check of model completeness and correctness (UNI 11337 V1).	OB.9_Bu1	●
		Model Content Verification – Advanced	Verification of readability, traceability, and data consistency (UNI 11337 V2).	OB.9_Bu2	●
		Model Content Verification – Integrated	Verification of federated models for global consistency and compliance (UNI 11337 V3).	OB.9_Bu3	●

Figure 5. The uses of BIM, accompanied by their descriptions, are categorised according to their priority level (green as high, yellow as medium, and red as low) and the procedural phase in which they offer the most value [37].

4.3.2. To-Be Processes: New ROLE and Responsibilities

Once the uses of BIM associated with the objectives of the design processes have been defined, the roles involved operationally within them must be specified. The Italian UNI 11337-7 2017 standard [37] indicates four profiles which play key roles in BIM process management (Table 6).

Table 6. BIM profile definition according to UNI 11337-7 [37].

	CDE Manager	Is the individual responsible for the management of the data-sharing environment procured by the organisation itself or contractually provided for a specific contract from another organisation.
	BIM Manager	Is the digitised process manager who primarily relates to the organisational level regarding digitisation of processes. The BIM Manager has overall supervision and eventually manages the coordination of the portfolio of ongoing orders. He is delegated by the top level of the organisation and defines the BIM instructions and how the digitisation process impacts the organisation itself and working equipment.
	BIM Coordinator	The coordinator of contract information workflows (BIM coordinator) operates at the level of the individual contract, in consultation with the top management of the organisation and at the recommendation of the BIM manager.
	BIM Specialist	The advanced operator in BIM management and modelling who usually acts within individual work contracts, collaborating on a stable or occasional basis with a specific organisation.

The Italian UNI 11337-7 standard defines three types of responsibilities, which are skills, competencies, and knowledge that the four BIM figures should acquire:

- Knowledge: *“Result of information acquisition through apprenticeship.”*
- Skill: *“Ability to apply knowledge to complete tasks and solve problems”,*
- Competence: *“Proven ability to use personal knowledge, skills and capacities in workplace situations, practiced with self autonomy and responsibility”,*





The reference standard provides a list of 32 types of knowledge, 52 skills, and 51 competencies which are distributed according to the four BIM profiles.

In order to associate the three types of responsibilities with the individual uses of BIM identified for public agency processes, each competency, knowledge, and skill was first coded with an ID. Table 7 shows an extract of the list of skills that are defined by the Italian normative and that are demanded of the four figures. The same steps were repeated for skills and knowledge.

The correlation between skills, competencies, and knowledge allows one, consequently, to define the features of BIM professional profiles for the purpose of programming the level of information needs, human capital recruitment, and preparing the relevant job profile specifications.

The next step was to proceed to associate the selected uses of BIM—for design and process activities—with the new BIM profile and the responsibilities they must possess [36].


Table 7. Extract of the coding of the list of skills defined by the Italian normative matched with the BIM profiles.

ID	Skills				
Sk-1	Using one or more platforms to manage a data-sharing environment	•			
	[...]				
Sk-30	Ability to master the requirements inherent in hardware and software in order to optimise their adoption and utilisation			•	
Sk-31	Ability to hold elementary elemental knowledge of the requirements pertaining to hardware and software			•	
Sk-32	General ability to use some of the applications of Space Programming, BIM Authoring, Code and Model Checking		•		
Sk-33	High ability to handle Code and Model Checking applications			•	
Sk-34	Advanced management of one or more BIM Authoring applications				•
Sk-35	General ability to master Geographic Information Systems and Point Cloud acquisition systems for digital surveying		•		
	[...]				
Sk-51	Ability to manage information-exchange protocols				•

It is specified that the roles assigned to the individual use of BIM reflect proportionately their greater responsibility; however, the other roles can always be involved in a complementary mode. In fact, on the basis of a building information modelling and management system there is cooperation between the different roles, which is essential to ensure a consistent and complete process. The knowledge, skills, and competencies assigned may vary according to the objectives and priorities set within the design and construction context, as well as according to the needs of the organisation and external stakeholders.

The schema in Figure 6 proposes an extract in detail. The example considers the design objective and associated use—with ID Ob2_u1—of 3D modelling for a single discipline involved as a specification. Depending on the objective and depending on the use, the profile of the BIM Specialist is associated. Also, the knowledge, skills and competencies—taken from the 11337-7 standard—that fit the selected use are matched. Since the research in this article focuses on the design phases, the roles of the BIM coordinator and BIM Specialist appear to be the prevalent ones.

N°	Use case	BIM uses (ID)
1	Gathering information on the state of places through topographic, morphological, and geological survey	Ob1_u1 Ob1_u2 Ob1_u3
2	Design	Ob2_u1 Ob2_u2 Ob2_u3 Ob2_u4 Ob2_u5 Ob2_u6 Ob2_u7 Ob2_u8 Ob2_u9
3	Design of the construction site system	Ob3_u1 Ob3_u2 Ob3_u3
4	Design for the sustainment	Ob4_u1
5	Multiple Disciplines Coordination	Ob5_u1 Ob5_u2 Ob5_u3 Ob5_u4
6	Synthesis and sharing of design results to support the interaction with stakeholders	Ob6_u1
7	Planning of space and time construction sequences (work schedule)	Ob7_u1 Ob7_u2 Ob7_u3
8	Design verification for validation and authorization procedures	Ob8_u1 Ob8_u2
9	Analysis of information inconsistencies	Ob9_u1 Ob9_u2 Ob9_u3

BIM uses (ID)	BIM profile	Description
Ob2_u1	BIM Modeller 	Information modeling (3D BIM) by subject specialist discipline (e.g., structures, road design, geotechnics, underground works, geology, hydraulics, facilities, interferences, environment) with possible specification of work, part of work and technical element.

UNI 11337-7 (skill, competence and knowledge association)

- | | |
|-------------------|--|
| Skill | <ul style="list-style-type: none"> • Sk-8 : Application of fundamental knowledge elements of project management; • Sk-19: Ability to analyze an BIM Execution Plan; • Sk-20: Ability to analyze an Employer's Information Requirement; • Sk-34: Advanced management of one or more BIM Authoring applications; • Sk-50: Ability to apply subject disciplinary knowledge to information modeling; • Sk-51: Ability to manage information exchange protocols; |
| Competence | <ul style="list-style-type: none"> • Cm-8: Management of information exchange protocols in complex, multidisciplinary design environments; • Cm-29: Analysis of an Employer's Information Requirement; • Cm-45: Verification of a disciplinary information model; • Cm-49: Use of BIM Authoring applications in complex, multidisciplinary design environments; • Cm-51: Integration of disciplinary knowledge in complex and multidisciplinary modeling contexts. |
| Knowledge | <ul style="list-style-type: none"> • Kn-4: Knowledge of information exchange protocols; • Kn-20: Elementary knowledge of the requirements inherent in hardware and software; • Kn-21: General knowledge of the logic and operational capabilities of Space Programming, BIM Authoring, Code & Model Checking, nD Modelling applications; • Kn-28: Knowledge of how to set up and test a discipline information model; • Kn-29: Knowledge of Employer's Information Requirement reading criteria; • Kn-32: Expert knowledge of at least one subject discipline. |

Figure 6. Example of one BIM use matched with the BIM profile and the list of skills, competencies, and knowledge [37].

This type of association was made for each BIM use. Then it was possible to operate on the *as-is* process maps. Process objectives and previously defined uses of BIM were associated with the activities of the map. This made it possible to be able to trace back to the BIM role and the responsibilities required depending on the activity and the BIM uses associated with them. The results of the qualitative data-analysis phase were shared with the public agency, which corrected and validated the current process maps. An example of the Outline Design process map is shown in Figure 7. The full set of redesigned *to-be* process maps, along with the integration of BIM uses and associated roles, can be found in Appendix B. These diagrams illustrate the proposed organisational adjustments based on the implementation strategy.

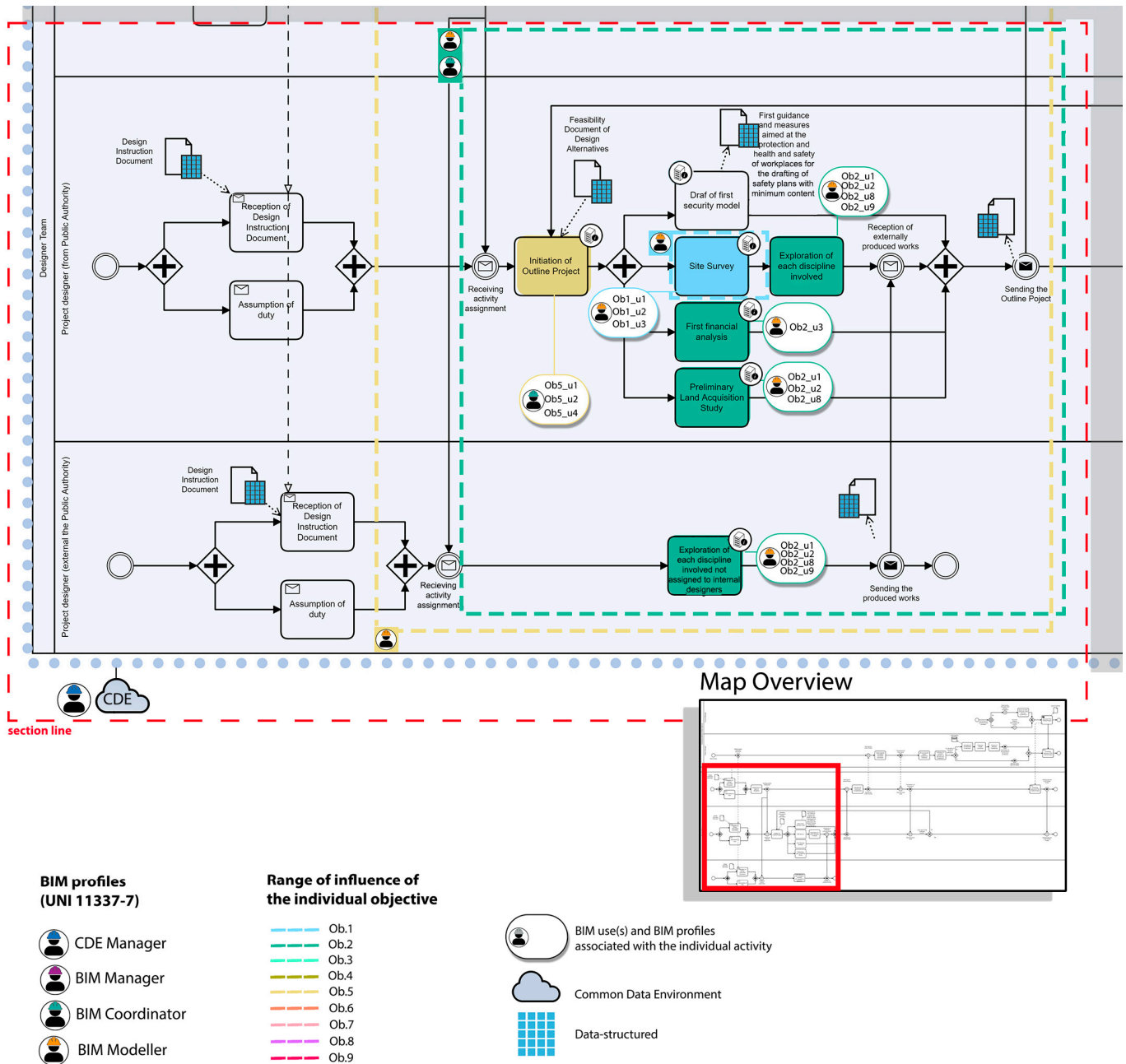


Figure 7. Extract from the *to-be* BPMN design map illustrating the interventions of BIM profiles in relation to specific BIM uses. New BIM roles are colour-coded and explained through visual markers. Key transformations from the *as-is* map are highlighted through callouts to support direct comparison and visual understanding of the proposed process improvements. Full map in Appendix B.

5. Discussion of the Results

The data-analysis phase enabled the identification of various organisational nuances, particularly with regard to three fundamental aspects of operational practices: (1) the BPMN-based representation of the design processes as carried out by the public agency; (2) the roles embedded within these processes and their corresponding responsibilities; and (3) the criticalities associated with the mapped procedures. Notably, the analysis was instrumental in uncovering certain issues that may act as barriers to the adoption of BIM and the digitisation of process management, such as individuals' reluctance or negative attitudes towards organisational change. Conversely, some of the identified challenges highlight areas where BIM could offer potential solutions, for instance by fostering greater collaboration and transparency, or by reducing time and costs. This is particularly relevant in the broader context of public sector digitalisation, where BIM is increasingly seen as a strategic enabler of efficiency, cost reduction, and improved decision-making. These findings reinforce the notion that digital transformation in the public sector is not solely a technological endeavour, but one that is deeply embedded in cultural and behavioural change. The insights that emerged from this *as-is* analysis phase constitute a foundational framework for defining the organisation's strategic objectives, subsequently informing the selection of appropriate BIM uses and the corresponding delineation of new professional roles. Such a framework not only supports strategic planning but also provides a diagnostic lens through which existing inefficiencies and bottlenecks can be critically assessed.

The definition of the organisation's strategic goals represents the objectives that the public agency aims to achieve through a correct and efficient implementation of BIM in their processes. These goals are aimed at increasing process efficiency in terms of productivity, process quality, collaboration, and work safety. Crucially, the alignment of these objectives with broader digitalisation strategies ensures that the BIM implementation is not carried out in isolation but rather integrated within a coherent institutional vision. The strategic goals are derived from both the analysis of the processes mapped in the current process maps *as-is* and from the criticalities identified during the interviews. Indeed, given the critical aspects emerged during the interviews, which may include difficulties in collaboration or communication, these organisational objectives aim to relieve the corresponding complexities that arise during the procedures. This reflects a proactive stance, whereby the organisation seeks not only to respond to existing inefficiencies but also to anticipate and mitigate future challenges through informed digital planning. In this light, BIM adoption can be understood as a key component of the digital and ecological transitions pursued across Europe, aligning with broader Environmental, Social, and Governance (ESG) objectives and supporting more sustainable, data-informed construction practices.

The definition of strategic goals subsequently, allows for the selection of BIM uses associated with activities mapped in the current process maps *as-is*, along with adoption priorities. These priorities result from a survey distributed to employees of the public administration, where they were asked to evaluate, for each BIM use, the adoption priority for their organisation. The priority depends not only on the urgency of introducing a particular use in the processes but also on its feasibility and the availability of professional skills and necessary technologies for implementation. This participatory approach enhances internal buy-in and supports the tailoring of technological solutions to the specific constraints and capacities of the organisation. Establishing these priorities plays a crucial role in providing clear and actionable guidance for organisations. By focusing on the most pressing needs and aligning resources accordingly, organisations can effectively orient their actions, streamline decision-making, and ensure a more strategic and impactful approach to implementing changes and improvements. Moreover, BIM's ability to integrate and communicate information in real time across stakeholders contributes directly to reducing

delays and fragmentation, thereby strengthening the transparency and accountability of public procurement processes. This contributes to reducing the risk of implementation failure by emphasising a realistic and context-sensitive deployment strategy.

Then, each BIM use was associated with the three types of responsibilities defined for the 4 BIM roles by the Italian regulatory framework UNI 11337-7, labelled first with a distinctive reference ID. Finally, it was possible to define a new *to-be* process that includes the implementation of BIM on the current BPMN maps *as-is*, identifying specifically which activities or parts of the workflow will be implemented while also associating the new professional roles required for these activities. The *to-be* process maps represent a framework within which the public organisation can navigate regarding the implementation of BIM in their processes, depending on the associated BIM uses, and have control over which steps require the contribution of new professional figures. This represents a key operational step in bridging the gap between strategic planning and practical implementation, ensuring the alignment of envisioned outcomes with day-to-day procedural realities. This result stems from the analysis process that begins with the objective of understanding the needs and expectations of the public agency through the investigation of the *as-is* processes, organisational structure, and analysis of criticalities to ensure greater adherence and acceptance of the solutions obtained. By grounding the digital transition in empirical evidence and organisational self-reflection, the proposed approach contributes to fostering a culture of continuous improvement and resilience in the face of evolving technological demands. By adopting this methodology that integrates technical, organisational, and strategic dimensions, the proposed approach illustrates how BIM can serve not merely as a design tool, but as a transformative driver for institutional innovation and sustainable public value creation.

Addressing the identified barriers to BIM adoption, such as fragmented workflows, limited technological infrastructure, and inconsistent stakeholder engagement, requires not only technical solutions but also deliberate organisational change strategies. In this regard, established change management theories offer a valuable lens to guide the transition. For instance, Kotter's 8-Step Change Model emphasises the need to create a sense of urgency, form a guiding coalition, and empower broad-based action, elements that resonate strongly with the need for cross-sectoral coordination and internal training identified in this study [46,47]. Likewise, Lewin's model highlights the importance of unfreezing existing habits and organisational routines before introducing new practices such as digital workflows [48]. These theoretical models underline that the successful implementation of BIM depends not solely on technological readiness, but on cultural adaptation, leadership commitment, and continuous engagement of stakeholders. Incorporating such principles into the BIM implementation strategy enhances its feasibility and sustainability within the dynamic environment of public administration.

Among the key contributions of this study is the development of an implementation roadmap that defines a sequenced set of actions to support the gradual adoption of BIM within the public agency. This includes targeted training programmes, the establishment of coordination mechanisms, and the need of the introduction of collaborative digital platforms, elements that are essential for translating strategic objectives into operational change. Table 8 summarises the main components and deliverables of the proposed implementation framework, highlighting both strategic planning and operational outputs derived from the case study.

Table 8. Main outputs of the BIM implementation framework.

Output Category	Output Category
Strategic objectives	Definition of six project-specific goals (SG1–SG6) to guide BIM adoption aligned with institutional priorities.
BIM use selection	Prioritisation of BIM uses based on project stage and internal capabilities, mapped to strategic goals.
<i>As-Is</i> process mapping	BPMN diagrams of current workflows, identifying inefficiencies, redundancies, and coordination gaps.
<i>To-Be</i> process design	Redesigned workflows integrating BIM uses, coordinated roles, and revised task sequences.
Role-definition matrix	Assignment of responsibilities according to UNI 11337-7, including new roles such as BIM Coordinator and CDE Manager.
Implementation roadmap	Sequence of actions for gradual adoption (training, coordination mechanisms, platform use).
Validation through stakeholder engagement	Participatory revision of the framework based on feedback from interviews and internal testing.

6. Conclusions

Following the widespread demand from several governments in Europe, including Italy, to implement BIM within the processes of public agencies, this research develops an implementation strategy tailored to the needs and requirements of a case study organisation. It highlights the growing recognition of BIM as an essential tool for enhancing efficiency and improving public sector project delivery, while aligning with broader digital and ecological transitions.

There is a lack of literature offering guidance to support public administrations in implementing BIM not only from a technical standpoint, but also from a procedural and organisational perspective. In fact, the implementation of BIM requires public developers to manage contractual documentation that clearly defines responsibilities, obligations, and requirements associated with its use. The proposed framework increases awareness in drafting such documents, which demands not only technical knowledge of the methodology but also the definition of new roles and responsibilities, leading to a restructured organisational asset within public administrations. This aspect is particularly crucial, as it embeds BIM within broader policy frameworks aimed at promoting sustainability, reducing costs, and increasing transparency.

The proposed methodology offers a context-specific solution that equips the organisation with the tools, knowledge, and structure needed to adopt BIM methods, tools, and procedures effectively. Providing a strategy that reflects the unique features and demands of the public organisation enhances the acceptability of the proposed changes and fosters a greater readiness for transformation. Accordingly, a qualitative data-analysis approach was employed, beginning with the collection of information through semi-structured interviews, allowing for the development of a bespoke solution. This approach not only enables the integration of diverse perspectives, but also fosters a culture of collaboration and transparency, both of which are essential to successful BIM implementation in the public sector.

The analysis led to the representation of current *as-is* processes using BPMN notation, and the identification of criticalities that may serve as barriers to full BIM adoption. These include resistance to change and the lack of adequately trained personnel, which must be addressed through targeted training initiatives and active stakeholder engagement. Recognising these critical issues made it possible to define strategic objectives for the organisation to achieve following BIM implementation. The final outcome comprises the definition of future *to-be* processes, which include the integration of BIM uses identified through the process analysis. These uses are prioritised across three levels, according to factors such as the perceived urgency by staff, the availability of professional expertise, and the presence of technological infrastructure. This prioritisation ensures that implementation is both pragmatic and impactful, responding directly to the organisation's most pressing needs.

Furthermore, the *to-be* process maps incorporate new professional roles aligned with the three categories of responsibility defined in the Italian regulatory framework, and associated with the selected BIM uses. These maps serve as strategic tools to guide the agency's gradual implementation of BIM and support interaction with external stakeholders involved in the workflows.

Although the results were consistently validated through ongoing interaction with the public agency, they are based on interviews with individuals reflecting their own roles and subjective viewpoints. Consequently, certain aspects may have been overlooked, especially those emerging from alternative organisational perspectives. This underlines the need for future studies to incorporate a broader range of stakeholders in order to capture a more comprehensive picture of the challenges and opportunities related to BIM adoption.

To make the proposed method replicable across other public administrations, the validity of results can be enhanced by selecting interviewees based on objective criteria such as role and years of experience. Further development of this research could involve testing the framework in additional case studies to assess its adaptability, monitor outcomes, and implement adjustments where necessary. This may include comparative analysis across jurisdictions to better understand the wider applicability of the framework.

The identification of necessary professional profiles also underscores the importance of defining the tools, both software and hardware, to be implemented, and of establishing acquisition and training plans for the individuals involved. The alignment of BIM adoption with sustainability objectives is equally critical, supporting the broader European goal of a carbon-neutral economy through the synergy of green and digital transitions.

Future research should also investigate the integration of automated workflows in BIM-enabled processes, particularly as public organisations progress towards greater digital maturity. The adoption of BPMN in this study was not only aimed at process clarity but was also a strategic choice, as it supports the potential development of automated, interoperable workflows across information systems. In this context, artificial intelligence (AI) offers promising opportunities for process optimisation, predictive analysis, and document automation. AI may enhance decision-making, mitigate risks, and improve resource allocation within BIM-driven public project, thereby advancing the digital transition in support of efficiency, sustainability, and transparency.

Future research could extend the findings of this study by conducting cross-case comparisons with other public agencies across the EU. Such comparative analysis would help identify contextual variables, institutional patterns, and transferable strategies for BIM implementation in diverse regulatory and organisational settings.

In conclusion, this research focused on the design phase to develop an implementation strategy; however, future studies should extend the analysis to include the planning, construction, and post-construction asset management phases. Exploring BIM's role across the entire lifecycle of public infrastructure may contribute significantly to long-term sustainability and value creation. This structured integration of BIM methodologies underscores the critical importance of organisational readiness, comprehensive training programs, and the meticulous delineation of roles and responsibilities to facilitate effective implementation and harmonisation with global best practices. Ultimately, by embracing BIM as a strategic tool, public agencies can enhance operational efficiency, reduce waste, and contribute to a more sustainable and transparent future for public sector projects.

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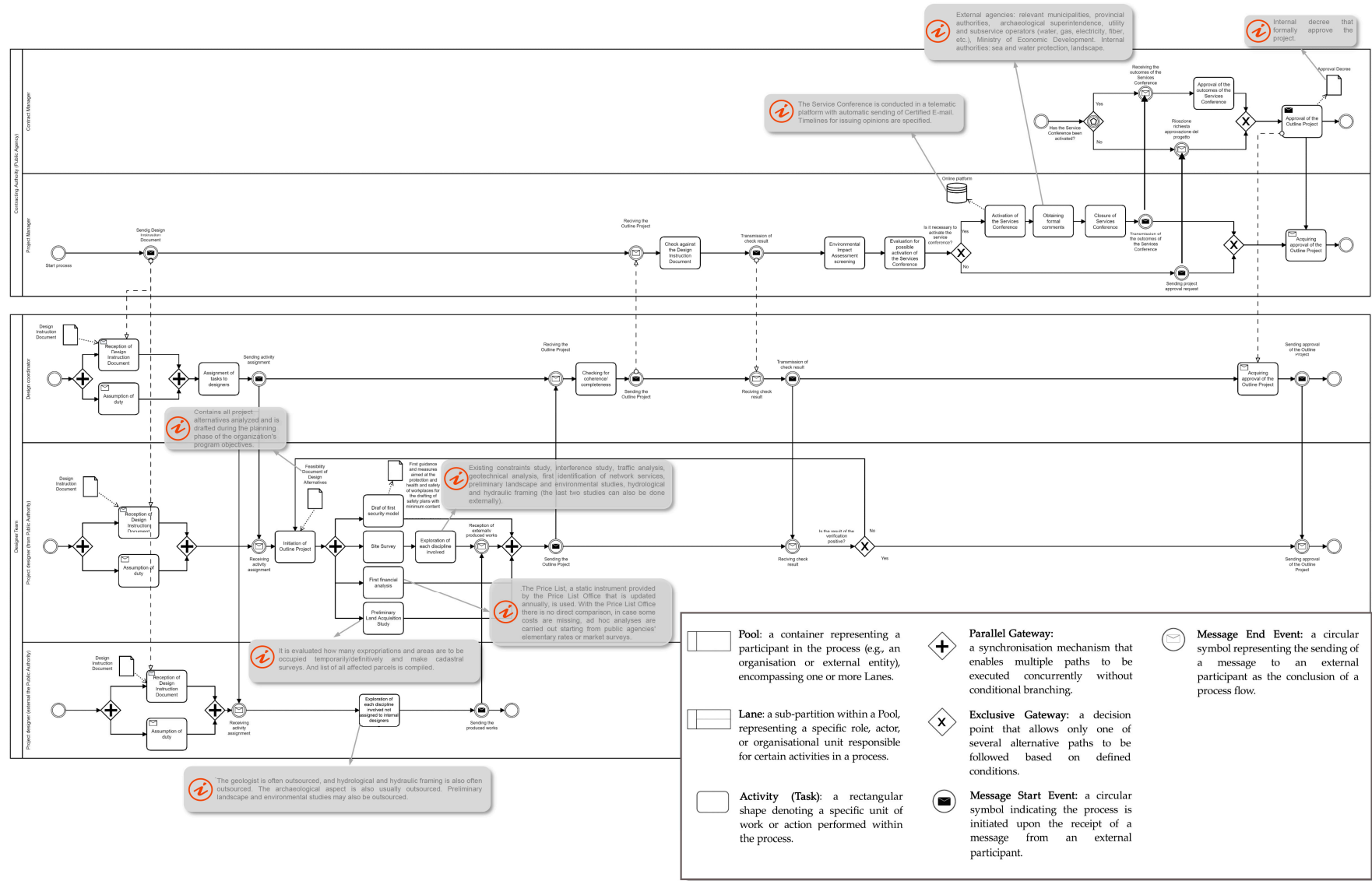
Institutional Review Board Statement: Ethical review and approval were waived for this study due to the collected data were based on interviews with employees of public administrations whose answers remained anonymous.

Informed Consent Statement: Informed consent was obtained from all subjects involved in this study.

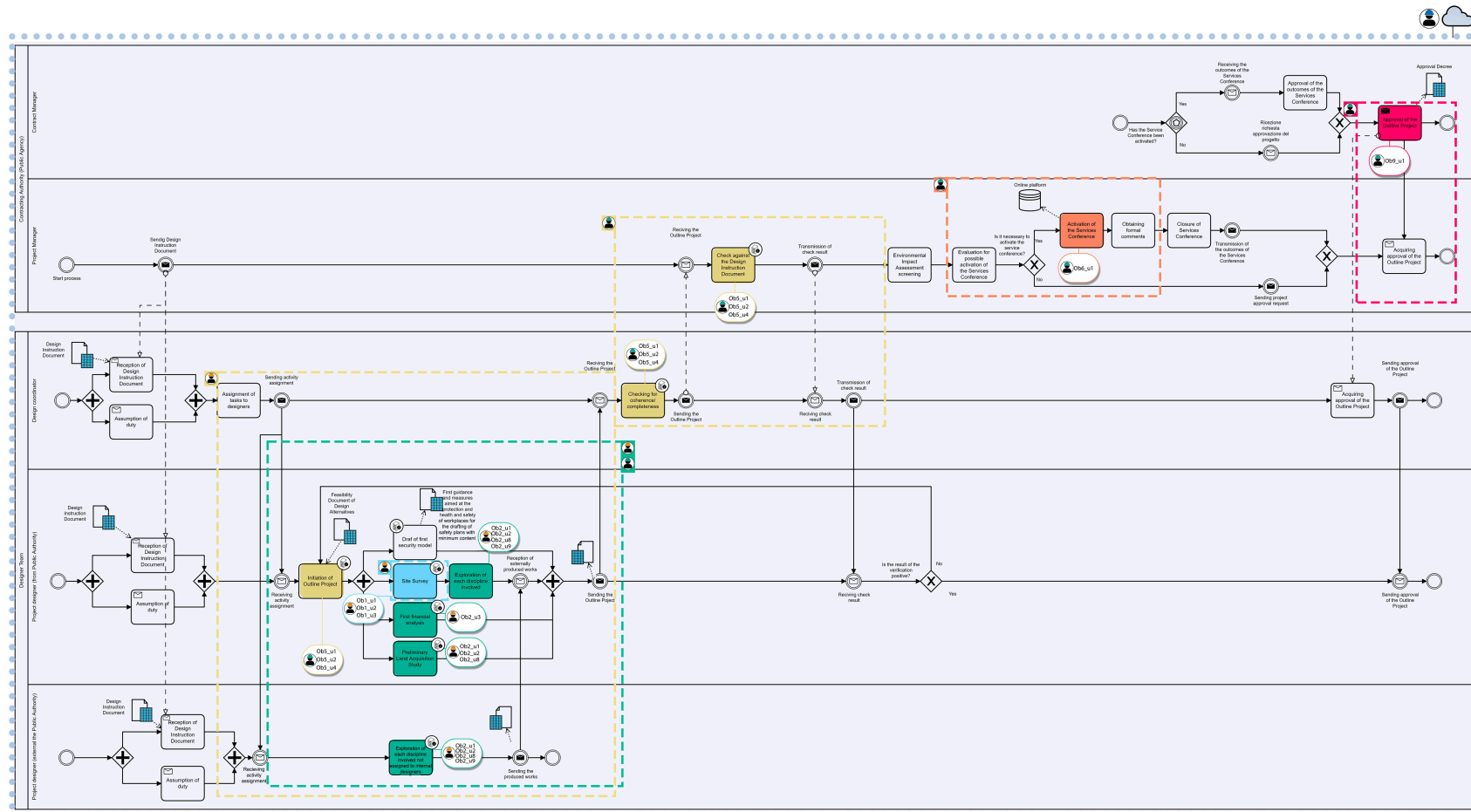
Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. As-Is BPMN Map of Outline Design Project Process



Appendix B. To-Be BPMN Map of Outline Design Project Process



BIM profiles (UNI 11337-7)

- CDE Manager
- BIM Manager
- BIM Coordinator
- BIM Modeller

Range of influence of the individual objective

- Ob.1
- Ob.2
- Ob.3
- Ob.4
- Ob.5
- Ob.6
- Ob.7
- Ob.8
- Ob.9

- BIM use(s) and BIM profiles associated with the individual activity
- Common Data Environment
- Data-structured

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