

**Applying the Business Process Management Lifecycle to  
Public Sector Digital Platforms: A Case Study approach in  
the Portuguese public sector**

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**Declaration**

I declare that this document is an original work of my own authorship and that it fulfills all the requirements of the Code of Conduct and Good Practices of the Universidade de Lisboa.

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# Abstract

Business Process Management, commonly known as BPM, has become an important methodology for analyzing, improving, and redesigning organizational processes. In the public sector, processes are often complex, involve multiple stakeholders, and are subject to legal restrictions, making BPM particularly relevant. BPM lifecycle was applied to the e-Avalia platform, a system that supports the issuance of prior opinions for ICT investments in the Portuguese public administration. The study followed all phases of the BPM approach: modeling the As-Is process, performing qualitative and quantitative analyses, conducting scenario-based simulations, and proposing redesign alternatives based on established BPM heuristics. Ten BPMN diagrams were created to represent both the overall workflow and detailed sub-processes capturing the interactions between internal and external stakeholders. The qualitative analysis identified four key inefficiencies related to rework loops, waiting times, and redundant clarifications. Scenario-based simulations quantified their impact on time, cost, and workload. Four To-Be models were designed and evaluated using the Devil's Quadrangle performance dimensions. The redesigned models showed tangible performance improvements, particularly in the Evaluation sub-process, where process time decreased by 35% and cost by 36%. Overall, the results demonstrate that combining analysis, simulation, and heuristic-based redesign provides an effective and evidence-driven approach to identify inefficiencies and guide process improvement in digital public administration.

## Keywords

Business Process Management; Process Simulation; Process Redesign; BPMN Modeling; Public Sector Digital Transformation; Process Performance Evaluation.



# Resumo

A Gestão de Processos de Negócios, conhecida como BPM, tornou-se uma metodologia essencial para analisar, melhorar e redesenhar processos organizacionais. No setor público, a sua relevância é ainda maior devido à complexidade dos processos, ao envolvimento de múltiplas partes interessadas e às restrições legais. O ciclo de vida BPM foi aplicado à plataforma e-Avalia, um sistema que apoia a emissão de pareceres prévios para investimentos em TIC na administração pública portuguesa. O estudo seguiu todas as fases da abordagem BPM: modelagem do processo atual, realização de análises qualitativas e quantitativas, realização de simulações baseadas em cenários e proposta de alternativas de redesenho com base em heurísticas BPM estabelecidas. Foram criados dez diagramas BPMN para representar tanto o fluxo de trabalho geral como sub-processos detalhados que captam as interações entre as participantes internos e externos. A análise qualitativa identificou quatro ineficiências principais relacionadas com ciclos de retrabalho, tempos de espera e esclarecimentos redundantes. Simulações baseadas em cenários quantificaram o seu impacto no tempo, custo e carga de trabalho. Quatro modelos To-be foram desenhados e avaliados usando as dimensões de desempenho do Devil's Quadrangle. Os modelos redesenhados mostraram melhorias tangíveis de desempenho, particularmente no sub-processo de Avaliação, onde o tempo do processo diminuiu em 35% e o custo em 36%. Os resultados mostram que a combinação de análise, simulação e redesenho é uma abordagem eficaz e baseada em evidências para identificar ineficiências e melhorar processos na administração pública digital.

## Palavras Chave

Gestão de processos de negócios; Simulação de processos; Redesenho de processos; Modelagem BPMN; Transformação digital do setor público; Avaliação do desempenho de processos.



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# Acronyms

<b>ARTE</b>	Agência para a Reforma Tecnológica do Estado
<b>AMA</b>	Agência para a Modernização Administrativa
<b>BPM</b>	Business Process Management
<b>BPMN</b>	Business Process Management Notation
<b>RE</b>	Requesting Entity
<b>ICT</b>	Information and Communication Technology
<b>VA</b>	Value Adding
<b>BVA</b>	Business Value Adding
<b>NVA</b>	Non-Value Adding
<b>WFM</b>	Workflow Management
<b>OMG</b>	Object Management Group
<b>KPI</b>	Key Performance Indicator
<b>EPCs</b>	Event-driven Process Chains
<b>BPR</b>	Business Process Reengineering
<b>DFSS</b>	Design for Six Sigma
<b>BPR</b>	Business Process Reengineering
<b>ERP</b>	Enterprise Resource Planning



# Glossary

## **ARTE (Agência para a Reforma Tecnológica do Estado)**

Public agency responsible for administrative modernization, digital transformation, and ICT governance in the Portuguese public sector ..... 1

## **As-Is Process Model**

Process model representing the current state of a process ..... 8

## **e-Avalia**

Digital platform developed by AMA to support the submission, analysis, and issuance of prior opinions on ICT acquisition requests in the Portuguese public sector ..... 1, 2

## **Prior Opinion**

A legally required document that assesses the compliance, strategic alignment, and financial justification of ICT acquisition requests from public entities ..... 23

## **To-Be Process Model**

Process model representing the redesigned and improved version of a process ..... 11

## **Triangular Distribution**

Probability distribution defined by minimum, most likely, and maximum values, often used to estimate task durations ..... 53



# 1

## Introduction

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Business Process Management (BPM) has emerged as a recognized approach for analyzing, improving, and monitoring organizational processes in the public and private sectors. In public administration, where processes are often complex, involve multiple stakeholders, and are subject to legal restrictions, the application of BPM is particularly relevant to guarantee transparency, efficiency, and compliance. This dissertation applies the BPM lifecycle to a real case in the Portuguese public sector, focusing on the e-Avalia platform managed by ARTE (Agência para a Reforma Tecnológica do Estado). The goal is to demonstrate how BPM methods can be used to analyze, evaluate, and redesign digital processes in government contexts, thus contributing to both academic knowledge and practical improvement.

## 1.1 Motivation and Background

Public sector organizations face constant pressure to deliver efficient services while operating under strict legal and budgetary constraints. BPM provides methods for modeling, analyzing, and improving processes, offering a systematic way to address these challenges [1]. Although its adoption has been more widespread in the private sector, BPM has shown significant potential in public administration, where it can support efficiency gains, improve resource allocation, and increase transparency [6]. At the same time, projects in this context must take into account institutional complexity and cultural resistance, which are critical factors influencing their success [7].

Business Process Management Notation (BPMN) is a standardized process modeling notation that allows for clear and uniform representation of business processes. It allows the structured description of activities, decisions, roles, and information flows through intuitive models that facilitate communication among stakeholders and create an understanding of how work is organized. BPMN models provide systematic analysis and continuous improvement by identifying inefficiencies and bottlenecks and evaluating redesign options using performance metrics and simulation. Complementary to this, Business Process Reengineering (BPR) is a systematic technique for rethinking and improving processes by concentrating on value creation and eliminating non-value-added tasks. In public administration, combining BPMN modeling with BPR principles gives a complete basis for identifying issues, improving workflows, and achieving measurable improvements.

In Portugal, issuing prior opinions on Information and Communication Technology (ICT) acquisitions is a legal requirement that ensures strategic alignment, financial justification, and compliance of public investments [8]. To support this process, the e-Avalia platform, managed by Agência para a Reforma Tecnológica do Estado (ARTE), was developed as a digital governance tool. Although it fulfills a critical legal and strategic role, the process involves complex interactions, decision points, and exception handling that can lead to inefficiencies and delays. These characteristics make e-Avalia a particularly relevant case for the application of BPM, both to identify bottlenecks and activities without added value, and to explore redesign alternatives that balance compliance, efficiency, and stakeholder satisfaction.

## 1.2 Research Problem and Objectives

The e-Avalia platform supports the legally required issuance of prior opinions on ICT acquisition requests in the Portuguese public sector. While essential for ensuring compliance and strategic alignment, the process it manages involves multiple stakeholders and complex decision points, that generate inefficiencies such as delays, rework, and coordination difficulties.

The objective of this study is to apply the BPM lifecycle to the e-Avalia process in order to evaluate its current performance and explore opportunities for redesign. More specifically, the study aims to identify

value-adding and non-value-adding activities, evaluate performance through qualitative and quantitative analyses, test alternative scenarios with simulation, and propose redesign options based on established BPM heuristics.

### 1.3 Structure of the dissertation

This section provides an overview of how the dissertation is organized. The document follows a logical progression from the motivation and theoretical foundations to the case study, analysis, and redesign of the process:

Chapter	Content
1. Introduction	Motivation, research problem, objectives, and structure.
2. Background	Fundamentals of BPM and the BPM lifecycle.
3. Related Work	BPM applications and tools in the public sector.
4. Case Study Context	Overview of ARTE and the e-Avalia platform.
5. Methodology	Research design and application of the BPM lifecycle.
6. As-Is Process Modeling	Scope and modeling of the current process.
7. Process Analysis	Qualitative and quantitative analysis of the process.
8. Simulation	Evaluation of scenarios through simulation experiments.
9. Process Redesign	Redesign proposals based on BPM heuristics.
10. Process Evaluation	Evaluating the improvement between As-Is and To-Be model.
11. Conclusion	Main findings, contributions, and future research.

**Table 1.1:** Overview of the dissertation structure.



# 2

## Background

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This chapter presents the theory behind BPM, covering its life cycle, modeling notations, analysis techniques, simulation approaches, and redesign heuristics that support the case study developed in this dissertation.

### 2.1 Business Process Management and the Lifecycle

The development of BPM was driven by growing reliance on Workflow Management (WFM) systems during the 1990s. While WFM is primarily concerned with process automation, BPM adopts a broader

perspective. BPM combines knowledge from information technology, management sciences, and industrial engineering to enhance and optimize business processes [9].

The focus of BPM is to analyze, design, execute, monitor, and improve business processes to achieve consistent, efficient, and value-driven outcomes [9, 10]. While early contributions in the field emphasized the redesign of individual processes, more recent perspectives frame BPM as a comprehensive organizational capability. This broader view integrates strategic alignment, governance, methodology, technology, people, and culture into a cohesive management approach. As such, BPM combines multiple disciplines to support the structured and iterative management of end-to-end business processes [10].

It supervises how work is performed within an organization to ensure consistent results and capitalize on improvement opportunities [1]. BPM is not solely about enhancing the performance of individual activities. Instead, it focuses on managing entire chains of events, activities, and decisions that collectively contribute value to the organization and its customers. These interconnected chains of events, activities, and decisions are what we refer to as processes. By adopting this comprehensive approach, organizations are better equipped to achieve their goals and maintain a competitive edge in their respective markets [1].

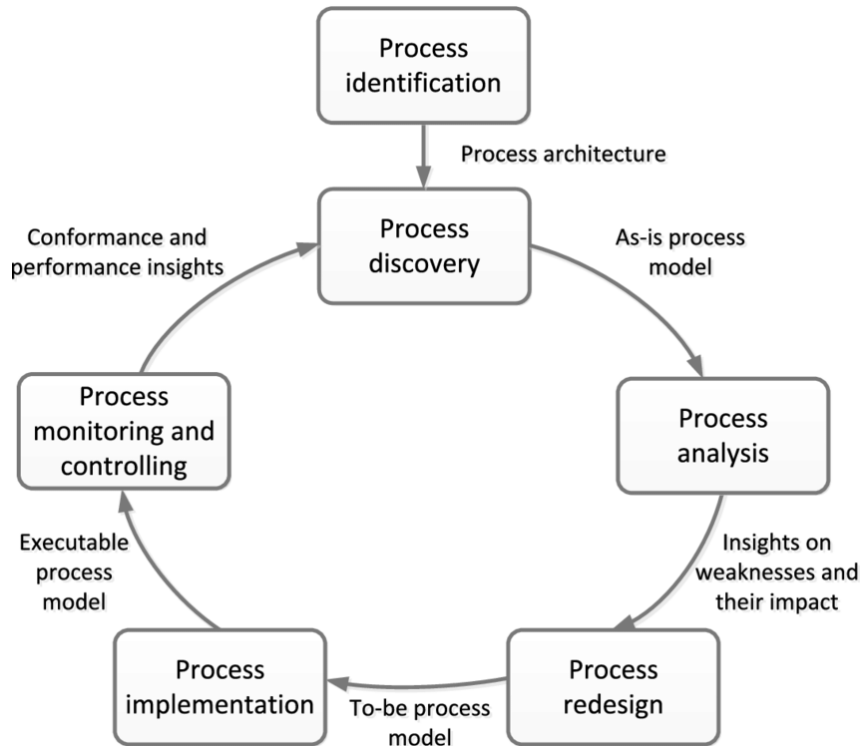
The BPM lifecycle, shown in figure 2.1, is a cyclic process that involves six key phases: Process identification, Process discovery, Process analysis, Process redesign, Process implementation and Process monitoring and controlling.

## 2.2 Process Identification

Process identification marks the starting point of the BPM lifecycle and is fundamental to its success. It involves defining the organization's existing business processes and selecting which ones should be prioritized for management and improvement. This phase results in a process architecture that maps out the core, support, and management processes, offering a strategic overview of the organization's operations [1]. Given that implementing BPM initiatives requires significant investment of time and resources, organizations are often unable to apply them universally. Therefore, they must evaluate which processes align best with their strategic goals and current challenges [11].

This phase consists of two key stages: the designation phase, which involves understanding the organization's business processes and their interrelationships by defining a coherent process architecture; and the evaluation phase, which focuses on developing prioritization criteria to select the most suitable processes for BPM initiatives [1].

The designation phase focuses on identifying all relevant processes, understanding their relationships, and structuring them into a coherent landscape. One widely used framework for categorizing



**Figure 2.1:** The BPM lifecycle [1]

processes is Porter’s Value Chain, which differentiates between: core, support, and management processes. Core processes generate direct value for customers. Support processes enable the execution of core activities. Management processes guide and coordinate both core and support functions through planning, control, and compliance. Some frameworks also include business network processes, which involve collaboration with external stakeholders [1, 12].

The resulting process architecture is typically modeled at three levels of detail: a high-level process landscape for general understanding, abstract process models that capture logical relationships, and detailed models that define specific flows and data. While a broad scope can yield greater impact, it may also introduce complexity and make implementation harder to manage. A narrower scope, on the other hand, offers a more practical starting point for organizations new to BPM [1].

The second step, the evaluation phase, aims to determine which processes should receive priority for redesign or automation. This decision is based on three criteria: strategic importance, process performance, and feasibility. The process is measured using performance dimensions such as time, cost, quality, and flexibility, which can be translated into Key Performance Indicator (KPI) for analysis [1].

Identifying key processes using a structured approach, aligning their outcomes to deliver the business goals, designing appropriate measures and allocating sufficient resources for their improvement is the key to the success of an organization. Identifying and prioritizing the right processes is crucial

to maximize the value of BPM efforts. A well-designed process architecture not only supports better decision-making but also increases the likelihood of project success [12]. .

## 2.3 Process Discovery

Process discovery represents the second phase of the BPM lifecycle and is essential for any improvement initiative. It involves identifying and documenting how a business process is currently executed, typically resulting in one *As-Is Process Model*. These models serve not only as a visual representation of process flows but also as tools to communicate understanding, validate operational knowledge with stakeholders, and identify inefficiencies or deviations early in the BPM cycle [1].

This phase involves defining the setting by establishing scope and responsibilities, gathering information through documentation, interviews, workshops, or system logs, conducting the modeling task using notations such as BPMN, and finally ensuring model quality by evaluating syntactic correctness, semantic accuracy, and usability for stakeholders.

The information gathering step is often the most effort-intensive. Discovery methods are classified in three main types: evidence-based such as documents or observations; interview-based; and workshop-based. Each method has different strengths—evidence-based approaches are more objective but less rich, while interviews and workshops provide deeper insights but are time-consuming. Table 2.1 summarizes the comparative strengths.

Aspect	Evidence-Based	Interviews	Workshops
Objectivity	High	Medium-High	Medium-High
Richness	Medium	High	High
Time Consumption	Low-Medium	Medium	Medium
Immediacy of Feedback	Low	High	High

**Table 2.1:** Strengths and Weaknesses of Process Discovery Methods [1]

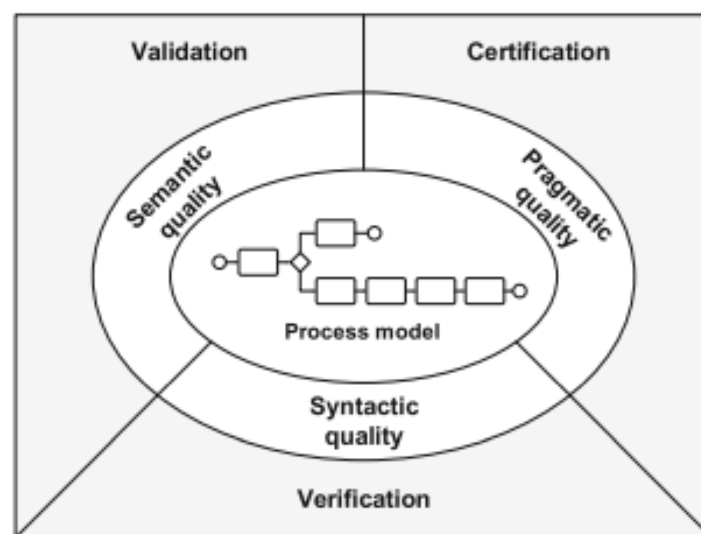
Effective process modeling requires a structured and methodical approach to ensure the resulting models are both accurate representations of operational reality and useful tools for analysis, redesign, and stakeholder alignment. Adopting a disciplined modeling method supports the development of process models that meet quality standards in terms of completeness, correctness, and relevance [1]. Clarifying the aim of modeling early on is crucial to avoid needless complexity and delays in the modeling process [13].

In this regard, five-step process modeling method has been proposed, designed to support analysts in systematically capturing and organizing process information [1]:

- Define the process boundaries, establishing the start and end points of the process and clarifying its inputs and outputs;

- Identify the activities and events that comprise the process, ensuring that all essential tasks and triggering events are recorded;
- Identify resources and handovers, mapping the roles, responsibilities, and interactions between process participants;
- Identify the control flow, specifying the logical sequence, decision points, and conditions that govern the process;
- Identify additional elements, including relevant data, business rules, supporting artifacts, and exceptions that provide further context and precision to the model.

Various modeling notations can be employed during process discovery, including UML Activity Diagrams, Event-driven Process Chains (EPCs), and simple flowcharts, BPMN has become the preferred standard due to its balance of expressiveness and accessibility for both technical and business audiences [1]. Given these advantages, BPMN will be adopted as the modeling notation throughout this study to document processes. The next section provides a detailed overview of BPMN, its core elements, and its applicability within the context of business process management.



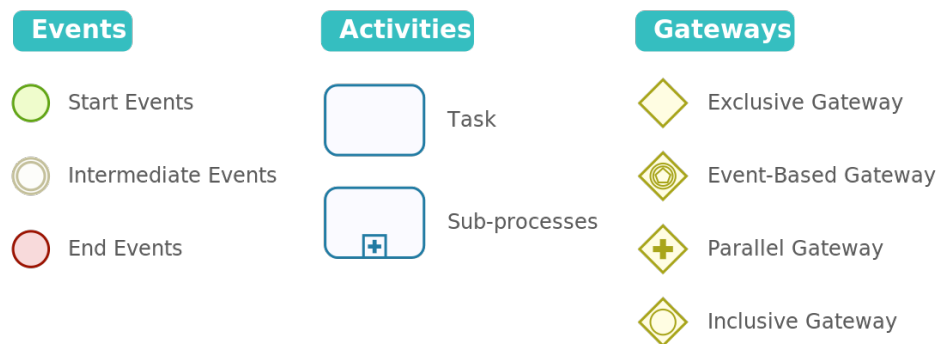
**Figure 2.2:** Process model quality aspects and assurance activities [1]

Lastly, assuring process model quality is essential to ensure that the resulting diagrams are both usable and accurate. As shown in figure 2.2, this involves evaluating syntactic quality, which refers to adherence to notation rules; semantic quality, which assesses how faithfully the model represents actual operations; and pragmatic quality, which focuses on ensuring the model is clear and understandable for stakeholders [1].

## 2.4 Process Modeling with BPMN

Business process modeling plays a central role in the BPM lifecycle, as it allows organizations to represent how their processes are structured and executed. Through visual and structured models, it becomes easier for stakeholders to understand, evaluate, and improve the way activities are carried out. Among the various notations developed for this purpose, BPMN has emerged as the most widely adopted standard, offering a balance between expressive detail and ease of use for both technical experts and business professionals [1].

was introduced by the Object Management Group (OMG) and continues to be maintained as part of its open specification framework. The current version offers a comprehensive set of graphical elements designed to describe business processes in a way that is intuitive for business users while still supporting the accuracy and formality required for system implementation [14].



**Figure 2.3:** Core BPMN Elements: Events, Activities, and Gateways [2]

At its core, a BPMN model consists of flow objects, connecting objects, and swimlanes. The primary flow objects include [1, 2]:

- **Events**, representing triggers such as process starts, ends, or messages;
- **Activities**, denoting units of work like tasks or sub-processes;
- **Gateways**, which define decision logic or process branching, where the flow diverges based on conditions or events.

The elements in a BPMN model, illustrated in figure 2.3 are connected through sequence flows, which define the order in which activities are carried out. To represent the organizational context, BPMN introduces the concepts of pools and lanes: pools typically represent participants or systems, while lanes are used to distinguish roles within those participants. When communication occurs between different pools, message flows are used to visualize these interactions, allowing BPMN to effectively model both internal workflows and collaborations that cross organizational boundaries [1].

Depending on the objective, BPMN supports multiple levels of abstraction. High-level models are used for communication and stakeholder alignment, while detailed models can support process analysis, automation, and simulation. In the context of this research, BPMN is applied to document the current as-is process, perform qualitative and quantitative analysis, and propose a redesigned To-Be Process Model [1].

## 2.5 Process Analysis Techniques

Process analysis constitutes a critical phase within the BPM lifecycle, providing the foundation for systematically identifying inefficiencies, process weaknesses, and opportunities for improvement [1]. By integrating both qualitative and quantitative approaches, this phase enables organizations to gain a comprehensive understanding of their current processes, supporting the development of structured issue registers and the prioritization of redesign initiatives based on evidence and strategic alignment [1, 13].

Among the widely used qualitative techniques, value-added analysis has become a standard approach for categorizing process steps based on their contribution to value creation from the end customer's perspective [1]. In this method, each step is critically assessed and classified into three categories: Value Adding (VA) steps, which directly transform inputs into outputs the customer is willing to pay for; Business Value Adding (BVA) activities, which do not directly contribute to customer value but are necessary for compliance, risk mitigation, or internal control; and Non-Value Adding (NVA) steps, which generate no tangible benefit and are candidates for elimination, automation, or simplification [1]. The importance of value-added analysis lies not only in its ability to highlight inefficiencies but also in fostering stakeholder dialogue regarding process relevance and necessity [15]. Studies have shown that the systematic application of this technique allows organizations to refocus their processes on activities that generate stakeholder value while questioning traditional controls and bureaucratic procedures that add overhead but little benefit [1].

Complementing value-added analysis, waste analysis provides a different perspective by focusing explicitly on uncovering inefficiencies that consume time, resources, or effort unnecessarily [1]. Waste analysis can be structured into three main types: move, hold, and over-do. The move category captures inefficiencies associated with unnecessary transportation of data, documents, or people, including redundant handoffs and system switching, which introduce delays and errors. Hold reflects idle times or bottlenecks due to waiting for approvals, clarifications, or the availability of critical resources, often leading to increased lead times and decreased process reliability. Finally, the over-do category refers to over-processing, over-production, and rework. These are common in bureaucratic and highly regulated environments, where steps are repeated, controls are duplicated, and unnecessary outputs are produced, frequently resulting in process fatigue and inefficiency [1].

Waste analysis and value-added analysis are inherently complementary. While the former focuses on the elimination of NVA steps by analyzing activities in isolation, the latter provides a broader critique of the overall process flow, highlighting inefficiencies that may be hidden between steps or within handovers. Furthermore, the combination of these techniques allows organizations not only to identify waste but also to understand its root causes, which is essential for effective process redesign [1]. Involving domain experts in these assessments is key to ensuring that the analysis reflects operational reality, as analysts alone may not fully capture the intricacies and exceptions present in daily activities [16].

Importantly, these qualitative techniques are complemented by quantitative analysis methods, which offer objective insights into process performance dimensions such as cycle time, cost, quality, and flexibility [1]. Quantitative techniques, such as time studies, cost analysis, and process mining, enable organizations to measure the current performance of the process and identify variations, bottlenecks, and resource inefficiencies based on actual data. Furthermore, simulation techniques are frequently employed as an advanced form of quantitative analysis, allowing analysts to model the as-is process in a dynamic environment and assess its behavior under varying conditions [1, 13].

Simulation plays a critical role in process redesign initiatives, serving as a key enabler for validating assumptions derived from qualitative assessments and supporting data-driven decision-making. It allows organizations to predict process performance in scenarios that are difficult or risky to test in real environments, enabling analysts to explore process redesign alternatives, quantify the impact of changes on throughput time, resource utilization, and costs, and identify potential unintended consequences of proposed interventions [1]. Modeling and simulation tools, including process simulation, scenario analysis, and what-if analysis, provide a structured framework to assess alternative configurations, allowing decision-makers to evaluate expected performance improvements, identify bottlenecks, and estimate the impact of resource reallocations without interfering with live operations [17, 18].

Taken together, these techniques offer a comprehensive and balanced approach for critically analyzing as-is processes and exploring redesign opportunities [1]. When combined with qualitative techniques such as value-added analysis and waste analysis, simulation enhances the robustness of process analysis by ensuring that redesign proposals are supported by both operational insights and empirical performance estimations [1]. This integration of qualitative and quantitative methods enables the identification of both systemic and localized process inefficiencies, thereby supporting evidence-based and risk-mitigated process redesign efforts [1].

Additionally, the systematic documentation of identified process issues through an issue register is essential for structuring problems and supporting their prioritization [1]. The issue register serves as a consolidated repository where detected problems—whether arising from qualitative methods like waste and value-added analysis, stakeholder interviews, or from quantitative approaches such as simulation and performance measurement—are recorded, classified, and evaluated based on their business impact

and feasibility for resolution [1]. This structured problem management approach not only enhances transparency but also ensures that redesign efforts remain focused on issues of highest organizational relevance.

Finally, simulation modeling plays an important role in strengthening managerial confidence by providing predictive insights into redesign scenarios, reducing uncertainty, and supporting informed decision-making through the quantification of variation and risk [18]. By grounding redesign decisions in data-driven insights and structured analysis, organizations can ensure a more rigorous assessment of the current process landscape while enhancing the credibility and reliability of process improvement initiatives [1, 18].

## 2.6 Process Redesign

Process redesign is a critical phase within the BPM lifecycle that aims to improve existing processes by addressing inefficiencies, reducing costs, enhancing quality, or increasing customer satisfaction [1]. This phase leverages the insights obtained from process analysis and translates them into actionable changes to the process model or its execution.

To support the decision-making process regarding the selection of redesign approaches, Dumas et al. [1] propose the Process Redesign Orbit, a conceptual model that illustrates the spectrum of redesign strategies based on their degree of disruptiveness and organizational impact. As shown in Figure 2.4, the orbit visually positions redesign heuristics closer to the center, representing lower risk and more evolutionary changes, while radical redesign options are placed in the outer layers, reflecting higher levels of innovation potential but also greater complexity and risk exposure. This model assists organizations in aligning their redesign efforts with their strategic priorities and risk tolerance, ensuring that the choice of redesign options considers both performance improvement ambitions and organizational capabilities.

Aligned with the Process Redesign Orbit, two predominant strategies are identified for process redesign: transactional and transformational approaches [1]. The transactional approach focuses on incremental and continuous improvement by applying redesign heuristics and process refinement techniques that optimize processes in a controlled and less disruptive manner. This strategy aims to enhance existing capabilities, often through the elimination of waste, automation of tasks, or reduction of handoffs, and is typically positioned in the inner orbits of the model, reflecting lower levels of risk and organizational disruption.

The transformational approach involves radical redesign initiatives that seek to fundamentally rethink and reinvent processes in order to achieve significant improvements in performance. These initiatives often involve significant changes to organizational structures, functions, and enabling technologies, requiring high levels of change management and presenting greater risks due to their disruptive nature.

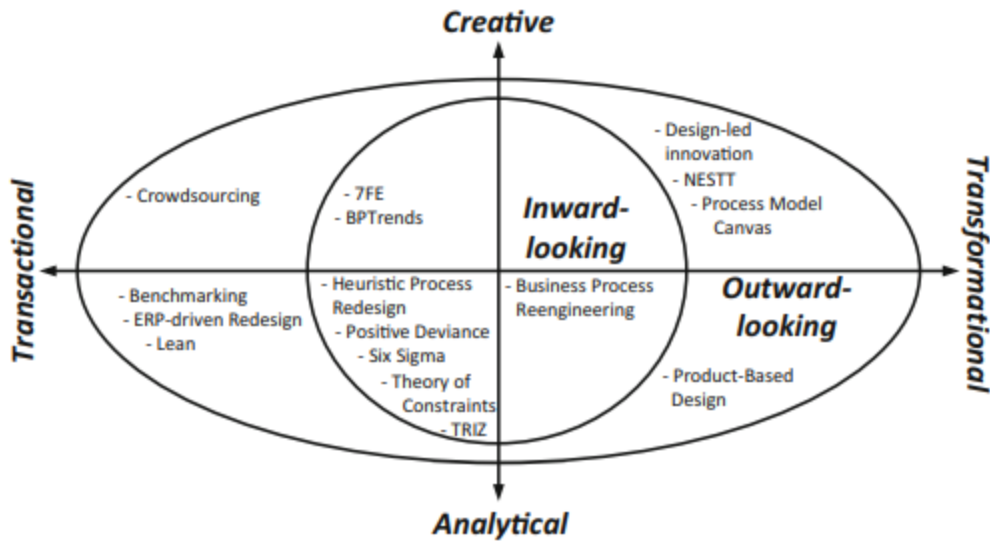


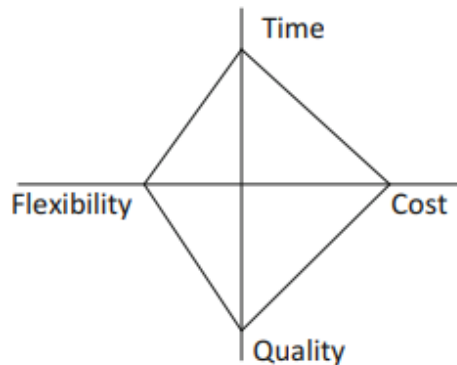
Figure 2.4: The Process Redesign Orbit [1]

Transformational redesign is usually associated with the outer orbits of the model, representing high impact but also high risk interventions [1].

Heuristics have been widely recognized as a practical approach to support process redesign initiatives, providing a structured set of best practices aimed at improving performance dimensions such as time, cost, quality, and flexibility [19]. Reijers and Mansar offer a comprehensive catalog of redesign heuristics, including task elimination, task composition, resequencing, parallelism, and triage, enabling organizations to systematically identify improvement opportunities. These heuristics help organizations navigate the inherent trade-offs in the devil's quadrangle by balancing competing objectives across multiple performance dimensions, as shown in figure 2.5 [1, 19]. However, as Tsakalidis and Vergidis [20] emphasize, despite the widespread application of these heuristics in BPR practice, there is a significant gap in the literature concerning systematic methods for evaluating the applicability and effectiveness of redesign heuristics prior to implementation [20]. Most existing approaches rely on runtime performance evaluation, neglecting the assessment of redesign capacity and heuristic applicability at design time.

According to the BPM lifecycle, heuristics play a critical role in the process redesign phase by translating analytical insights into actionable design decisions. Rather than proposing radical or disruptive changes, these principles provide a structured way to rethink processes based on evidence collected during modeling and analysis [1]. Redesign heuristics serve as a bridge between process diagnosis and innovation, helping to move from problem identification to solution design while maintaining process coherence. Examples include eliminating non-value-added activities, combining or simplifying related tasks, increasing parallel execution where dependencies allow, and applying triage to allocate work according to case complexity or resource specialization [1].

Complementing these ideas, Dumas et al. point out that the reshaping heuristic goes beyond operational performance improvements, promoting alignment with broader organizational objectives. These include strengthening customer service, ensuring stakeholder engagement and supporting strategic objectives. By integrating heuristics-driven redesign with these strategic considerations, organizations can strengthen both the efficiency and overall effectiveness of their business processes [1].



**Figure 2.5:** The Devil's Quadrangle [1]

Additionally, the integration of process mining techniques into the redesign phase has emerged as a key enabler of data-driven process improvement. Process mining allows organizations to uncover inefficiencies and validate redesign hypotheses based on real execution data [9].

## 2.7 Process Implementation

Process implementation is the application of the new project in the organizational environment. This phase involves translating future process models into operational, which may require adjustments to organizational structures, employee roles and supporting IT systems. The aim is to ensure that the reformulated process is effectively integrated into the organization and that the necessary changes are accepted and adopted by the stakeholders [1].

Implementation activities often involve two primary dimensions: organizational change management and process automation. Organizational change management addresses the human and structural aspects of implementation, ensuring that employees are trained, informed, and supported during the transition to the new way of working [1]. This is particularly critical because the failure to manage change effectively has been consistently cited as a leading cause of BPM initiative failures [21]. In parallel, process automation involves configuring, developing, or updating the information systems that will support or execute parts of the process, which may include enterprise systems, workflow engines, or robotic process automation tools [1, 21].

Recent studies also highlight that the implementation phase must not be viewed as a linear endpoint but rather as part of a continuous improvement cycle. Many organizations tend to treat process implementation, particularly in Enterprise Resource Planning (ERP) contexts, as a one-off project, neglecting the need for post-implementation review, monitoring, and iterative refinement [21]. This lack of continuous assessment often leads to misalignment between actual process execution and the intended design, undermining the benefits of BPM initiatives.

To address these challenges, Kovach et al. propose integrating structured methodologies, such as Design for Six Sigma (DFSS), into the BPM lifecycle to enhance the rigor and systematicity of the implementation phase. The use of DFSS provides a disciplined approach to validating redesigned processes before full-scale deployment through prototyping, pilot testing, and controlled rollout strategies, ensuring that the redesigned process meets the identified performance metrics and stakeholder needs [22].

Successful process implementation requires a combination of technological enablement, effective change management, and structured validation mechanisms to ensure that redesigned processes are not only deployed but also embraced and institutionalized within the organization [1, 21, 22].

# 3

## Related Work

### Contents

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BPM has been increasingly applied in public administration to improve their services, innovate internal operations and increase process performance [23]. This development is aligned with efforts of administrative modernization and digital transformation. The related work presented in this chapter is structured along three interrelated areas. The first section 3.1 examines how BPM has been applied in public administration, emphasizing both the benefits that have been reported and the challenges that remain. The second section 3.2 turns to process modeling and analysis tools, which are not an independent stream of research but rather provide the methodological foundation for examining and improving public sector processes. The third section 3.3 focuses on approaches to redesign processes on public digital platforms, a relevant domain where decision support and compliance play a central role. These perspectives position this study within the state of the art and highlight the need to investigate more deeply the use of modeling and analysis tools in public administration and their role in enabling effective process redesign.

### 3.1 Applications of BPM in Public Sector

The application of BPM in public sector has gained increasing attention over the past decades, as governments seek to enhance efficiency, transparency, and responsiveness while ensuring compliance with complex regulatory requirements [24]. BPM offers a structured and systematic approach to managing, analyzing, redesigning, and continuously improving business processes, contributing to the modernization of public services and administrative procedures [1].

Several studies illustrate the potential of BPM to support administrative modernization and digital transformation initiatives in the public sector. Mahendrawathi et al. [21] present an empirical model assessing BPM implementation in Indonesian public organizations, highlighting how BPM contributes to improving both internal processes and service delivery. Similarly, Kovach et al. [22] argue that integrating structured methodologies, such as BPM and DFSS, can enhance process implementation rigor and reduce risks in public sector modernization projects.

Case studies further demonstrate the effectiveness of BPM in diverse public administration contexts. In the Brazilian public sector, Santos and Costa [25] describe the successful application of the BPM lifecycle in the debt recovery process of a credit recovery entity, leading to increased efficiency, standardization, and transparency. This example illustrates the applicability of BPM to back-office, compliance-heavy processes that are often overlooked in BPM research, which tends to focus primarily on citizen-facing services [21].

Moreover, the literature emphasizes that the adoption of BPM in public administration requires addressing specific challenges related to organizational complexity, resistance to change, and the coexistence of political and administrative logics [24]. In the study of BPM in the Turkish public sector [26], the implementation within the Social Security Institution emphasizes process standardization, performance improvement, and capacity building through staff training as key enablers for BPM adoption.

Overall, these studies demonstrate that BPM offers valuable methodologies and tools for public administration to streamline processes, enhance decision-making, and support transparency and accountability. However, the literature also reveals a lack of BPM applications in decision support, compliance, and validation processes. This reinforces the relevance of the present research, which aims to apply the BPM lifecycle to a platform within the Portuguese public sector, addressing a gap in current BPM case studies.

Sector	References
BPM culture and adoption in public administration	[23]
Infrastructure and transportation services	[22]
BPM implementation and maturity assessment	[21]
Digital governance and public administration	[24]
Financial sector	[25]
Social security service operations	[26]

**Table 3.1:** Main applications of BPM in the public sector

## 3.2 Process Modeling and Analysis Tools

As discussed in Section 3.1, the use of BPM in public administration highlights both the advantages and the disadvantages of managing processes across organizational boundaries. In this context, the use of appropriate modeling and analysis tools becomes even more critical, given the complexity, multi-stakeholder involvement, and regulatory requirements that typically characterize public sector processes. Such tools support process modeling, analysis, and simulation in order to address these obstacles. They form the methodological basis of the BPM lifecycle, enabling organizations not only to document and understand their processes, but also to identify bottlenecks, evaluate redesign options, and provide evidence-based decision making [1].

The industry standard for process modeling is BPMN 2.0, which facilitates tool support and gives stakeholders a common language [14]. Bizagi, Camunda, bpmn.io, Lucidchart, and ProcessMaker are modeling environments that support this language. Comparative studies like the one conducted by Nikolova et al. [4] point out variations in cost, integration, usability, and simulation capabilities: Lightweight solutions like bpmn.io provide easily accessible entry points for simple modeling tasks, Camunda is good in automation and execution, and Bizagi Modeler stands out for its collaborative modeling and simulation features.

Despite BPMN's expressiveness, simulation and analysis remain partially underdeveloped in many tools. Aspects like resource calendars, probabilistic time distributions, or cost structures are frequently not fully supported, as demonstrated by Pereira and Freitas [5]. One notable exception is Bizagi, which offers what-if simulation scenarios in an easy-to-use environment [5]. It also includes model-driven development, which makes it possible to convert BPMN models into executable applications without the need for manual coding [27].

Beyond technical aspects, several studies demonstrate how modeling and analysis tools are applied

in public sector context, demonstrating their usefulness in supporting digital transformation. In order to assess the effects of an ERP implementation, Gabryelczyk et al. [28] used performance indicators like time, cost, quality, and capacity, in conjunction with BPMN 2.0 in the Adonis CE tool to analyze a Polish public institution. Their findings demonstrate how modeling aided in organizational reorganization as well as IT adoption. Indihar-temberger and Jaklič [29] presented a BPM-based approach to e-government change, showing how process modeling facilitates the alignment of technological innovation and administrative transformation. Niehaves et al. [30] also investigated BPM capabilities in local governments, emphasizing the function of modeling in promoting departmental cooperation and process awareness. Also important is the contribution of Gabryelczyk et al. [28], who analyzed the practical application of process modeling and measurement in a Polish public institution. The study illustrates how the use of BPMN 2.0, modeled through the Adonis CE tool, in conjunction with performance indicators like time, cost, quality, and processing capacity, enables the quantification of improvements resulting from the implementation of an ERP system. This case study highlights the usefulness of process modeling not only as a tool for pre-implementation analysis of IT systems, but also as a start point for organizational restructuring in the public sector [28].

Recent contributions provide additional evidence of BPM's suitability for public sector contexts. Kissa et al. [6] investigated loan and return procedures at a Greek academic library, using BPMN 2.0 to capture workflows and integrating Time-Driven Activity-Based Costing, which estimates activity costs based on time necessary for performing them. Despite the fact that a complete redesign was not executed, this combination of workflow and cost analysis allowed management to discover inefficiencies, such as the excessive expenses associated with collecting fines and storing returned records, estimate process costs, and propose targeted improvements to service. Teixeira et al. [31] conducted a case study on a Portuguese energy firm, whose market research process has a connection to national biofuel legislation. The authors used the whole BPM lifecycle, combining BPMN 2.0 modeling with Value-Added and Waste Analysis to identify inefficiencies. They then improved the process through selective automation using Python scripts and Power BI dashboards, and confirmed changes through monitoring. Their findings show how BPM tools can support decision-critical processes in highly regulated environments, with insights applicable to public administration. Takagi [7] investigated BPM projects in the public sector identifying governance, stakeholder engagement, and strategic alignment as critical success factors. This study emphasizes that modeling and analysis tools alone are insufficient without governance structures that ensure consistency and alignment with organizational objectives.

An empirical assessment of BPM implementation maturity in Indonesian organizations revealed that while process identification and monitoring were effectively supported, significant gaps persisted in the discovery and redesign phases. These gaps were attributed, in part, to limitations in the use of BPM tools, which restricted the ability to conduct detailed modeling and analysis activities necessary for effec-

tive process improvement [21]. The findings highlight the critical role of appropriate tools and techniques not only for documenting and visualizing processes but also for enabling advanced analysis, simulation, and redesign. Furthermore, these tools should be complemented by governance structures that ensure their consistent and effective use throughout the BPM lifecycle [21].

Characteristic	Bizagi Modeler	Camunda Modeler	bpmn.io	Lucidchart	ProcessMaker
BPMN 2.0 modeling support	***	***	**	**	***
Process simulation	***	—	—	—	**
Automation / execution	**	***	—	—	***
Collaboration and sharing	***	*	**	***	***
Integration (APIs / connectors)	**	***	**	**	***
Usability / learning curve	***	**	***	***	**
Cost / accessibility	***	***	***	**	**

Scale: \* = basic/limited; \*\* = adequate; \*\*\* = advanced/complete; — = not supported.

**Table 3.2:** Qualitative evaluation of BPMN 2.0 tools [4, 5]

Table 3.2 compares five BPMN modeling tools mentioned in this study. Together, these studies highlight that process modeling and analysis tools are not only technical enablers of BPM, but also practical instruments that allow public organizations to understand their operations, test reforms, and structure redesign initiatives. They provide the necessary bridge between recognizing challenges in BPM adoption and implementing concrete improvements in public digital platforms, preparing the ground for the discussion in Section 3.3.

### 3.3 Process Redesign Approaches in Public Digital Platforms

Process redesign plays an important role in the digital transformation of public services. Unlike mere digitization, where analog procedures are replicated in digital form, redesign involves rethinking processes to improve efficiency and service integration.

Kubrak et al. [32] conducted a systematic review of business process redesign initiatives driven by digital technologies, analyzing a set of 40 case studies across different sectors. From this analysis, they developed a classification framework that maps five key digital capabilities: digitalization, communication, analytics, digital representation, and connectivity, to a set of common process redesign heuristics such as task automation, integration, and re-sequencing. Although its study does not focus specifically on the public sector, the proposed framework provides a structured perspective through which public organizations can assess how digital capabilities can support process transformation [32].

Teixeira et al. [31] combined BPMN 2.0 modeling with value-added and waste analysis in a Portuguese energy firm, applying selective automation through Python scripts and BI dashboards to improve performance. This case demonstrates the application of task automation and task elimination heuristics in a regulated environment similar to the public sector. Similarly, Kissa et al. [6] integrated BPMN modeling with time-driven activity-based costing in a Greek academic library, uncovering inefficiencies and quantifying costs. Their findings implicitly reflect the elimination heuristic, as they identified redundant steps such as the costly handling of fines and storage of returned records.

Styrin and Evgeny [33] analyze the role of digital platforms in reshaping public service delivery. Although their focus is not on process redesign, their case studies illustrate how platform features such as service standardization, integration, and automation can implicitly drive the reconfiguration of service provision models. These transformations suggest that government platforms can act as enablers of redesign by consolidating fragmented processes.

When taken together, these contributions reveal that although some research explicitly map digital capabilities to redesign heuristics, others illustrate their implicit applicability through case studies in regulated or decision-critical settings. This demonstrates that efficient process redesign on digital public platforms necessitates more than just technology implementation, it necessitates the systematic use of heuristics such as task elimination, automation, integration, and triage. For the Portuguese public sector instance explored in this dissertation, these findings highlight the importance of heuristic-driven redesign in balancing efficiency, compliance, and multi-actor coordination.

<b>Sector</b>	<b>References</b>
Public service design and digital innovation	[32]
Municipal and local government administration	[31]
Higher education and academic libraries	[6]
Government platform and public service provision	[33]

**Table 3.3:** Main sectors applying Redesign Approaches in the public digital platforms

# 4

## Case Study Context

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This chapter presents the institutional and procedural context of the case study analyzed in this dissertation. Since the research applies the BPM life cycle to a specific process in the Portuguese public sector, it is necessary to first describe the organization in which this process is embedded and explain its relevance. The focus is on the ARTE, a public entity with a central role in administrative modernization and digital transformation in Portugal. Among its legal responsibilities is the issuance of prior opinions for public ICT acquisitions.

In order for a Prior Opinion to be issued, there must be a prior assessment process of investments proposed by public sector entities that are particularly relevant to the acquisition of ICT goods and services, with the aim of ensuring that only projects that guarantee a real contribution to the development and modernization of the administration and have a balanced cost structure that is fully justified by the benefits they will achieve are financed and implemented. In this way, using this mechanism ensures that digital transformation projects generate public value and contribute to modernization objectives [8].

ARTE has developed the e-Avalia platform to support the submission, analysis, and issuance of prior

opinions. The evaluation process managed through e-Avalia is the case study of this dissertation and will be examined in detail in the following sections, including the organizational and technological landscape in which it operates and the main stakeholders involved.

## 4.1 The ARTE

Created in 2007 through the merger of several entities, Agência para a Modernização Administrativa (AMA) inherited responsibilities in areas such as services to citizens and businesses, e-government initiatives, and management of essential infrastructure, such as the Citizen Card and the national interoperability platform [34]. In 2025, following Decree-Law No. 96/2025 [35], AMA was renamed ARTE, maintaining its mission to make public administration simpler, more digital, and closer to citizens and businesses.

To carry out this mission, ARTE has gradually built a set of initiatives and platforms that integrate administrative reform with digital innovation. In service delivery, it organizes omnichannel solutions such as the Gov.pt App, which combines access to different public services in a single mobile platform, and the nationwide network of stores, Citizen Stores, which give integrated support both physically and online. Infrastructures like Autenticação.gov, Citizen Card, and Interoperability Platform allow reliable digital identity and communication across government systems. ARTE also runs the open data portal dados.gov.pt, which promotes openness and reuse of public sector information [34].

Beyond the provision of services and infrastructures, ARTE has specific legal responsibilities. One of its statutory roles is the issuance of prior opinions for public ICT acquisitions. Significant ICT investments proposed by public sector entities are subject to an evaluation, guaranteeing that projects are aligned with national digital strategies, legally and financially justified, and non-duplicative. This process promotes transparency, interoperability, and the efficient use of public resources, while ensuring that ICT initiatives contribute to modernization objectives [8]. To operationalize this responsibility, ARTE developed the e-Avalia platform, which manages the submission, assessment, and issuance of prior opinions.

## 4.2 The e-Avalia Platform

To operationalize the prior opinion process for public ICT acquisitions, established by Decree-Law No. 107/2012 [36], ARTE developed the e-Avalia platform, a centralized digital system for the submission, tracking, and evaluation of investment requests. Through e-Avalia, public entities can submit their proposals, respond to requests for clarification, and receive formal feedback. By digitizing a previously bureaucratic and paper-based procedure, the platform reduces administrative costs, speeds up decision-

making, and enforces alignment with national priorities for digital transformation [8].

### 4.2.1 Organizational and Technological Landscape

The organizational structure supporting the e-Avalia process involves multiple levels of validation, coordination, and oversight. Internally, ARTE manages the evaluations through designated technical staff, coordinators, and delegate members. These roles are supported by a technological infrastructure.

Externally, the platform integrates input from various types of stakeholders across the public sector. These include requesting entities, project managers, and ministerial representative, all of whom interact with the system. This landscape reflects a multi-actor governance model, supported by a digital platform that structures process flows in compliance with regulatory requirements.

The organizational structure supporting e-Avalia reflects a multi-level validation and oversight model. Internally, ARTE manages the evaluations through designated technical staff, coordinators, and delegate members, supported by a technological infrastructure that integrates workflow management, role assignment, and decision logging. Externally, the platform enables structured input from multiple stakeholders, including requesting entities, project managers, and ministerial representatives. This combination reflects a governance model that is multi-actor but unified by the digital platform e-Avalia, which ensures compliance with regulatory requirements and consistency in process execution.

### 4.2.2 Key Stakeholders

The e-Avalia process involves several actors with distinct responsibilities:

Stakeholder	Role and responsibilities
Requesting Entity (RE)	Initiates the expenditure request and provides clarifications throughout the process.
First-Line Technicians	Assess proposals against financial, strategic, and technological criteria.
First-Line Coordinator	Reviews evaluations to ensure consistency and quality of decisions.
Delegate Member	Holds final decision-making authority, issuing the opinion or requesting revisions.
Ministerial Representatives	Contribute legal or technical clarifications when needed.
Project Managers	Consulted regarding budget alignment and program context.
Second-Line Support Team	Provides additional input for strategic and technological coherence.

**Table 4.1:** Key stakeholders in the e-Avalia process

The platform supports the coordination of these roles, ensuring that responsibilities and decisions are transparently documented at each stage of the process.

### 4.2.3 Case Study Relevance and Research Objectives

The e-Avalia platform was selected as the case study for this work because it represents a critical process in public sector digital governance. It combines legal obligations, organizational complexity, and multi-stakeholder interactions within a digital environment, making it a relevant example for the application of the BPM lifecycle.

Specifically, e-Avalia supports a continuous and substantial volume of requests from ministries, municipalities, and public agencies, involving significant public investments. Each request typically requires several validation and evaluation stages across different organizational levels [8].

The e-Avalia process was decomposed into nine sub-processes. Each sub-process was modeled using BPMN and analyzed according to qualitative and quantitative dimensions. In total, four issues were identified and categorized in an Issue Register, supporting the subsequent simulation and redesign phases.

By modeling and analyzing the e-Avalia process, this study aims to identify inefficiencies, bottlenecks, and opportunities for redesign. There are four objectives [1]:

- **Qualitative analysis:** Focuses on assessing processes based on descriptive criteria, such as value-added or non-value-added activities, waste identification, and issue analysis. It does not rely on numerical data but instead uses expert knowledge to uncover weaknesses and opportunities for improvement.
- **Quantitative analysis:** Examines processes using measurable indicators such as cycle time, cost, resource utilization, or throughput. It requires data from logs, observations, or estimates, and provides evidence-based information into process performance and bottlenecks.
- **Simulation:** It involves creating a computational model of the process that mimics real-world execution in different scenarios. By adjusting parameters such as arrival rates, resource availability, and probabilities, simulation allows professionals to predict outcomes and compare alternative designs before implementation.
- **Redesign:** Refers to rethinking and restructuring processes to achieve significant performance improvements. It goes beyond incremental fixes, using redesign heuristics (e.g., task elimination, automation, parallelization) to create more efficient, effective, and customer-oriented processes.

The results are expected to provide actionable insights into how a legally mandatory and strategically relevant process can be optimized using BPM methods in public ICT investments.

# 5

## Methodology

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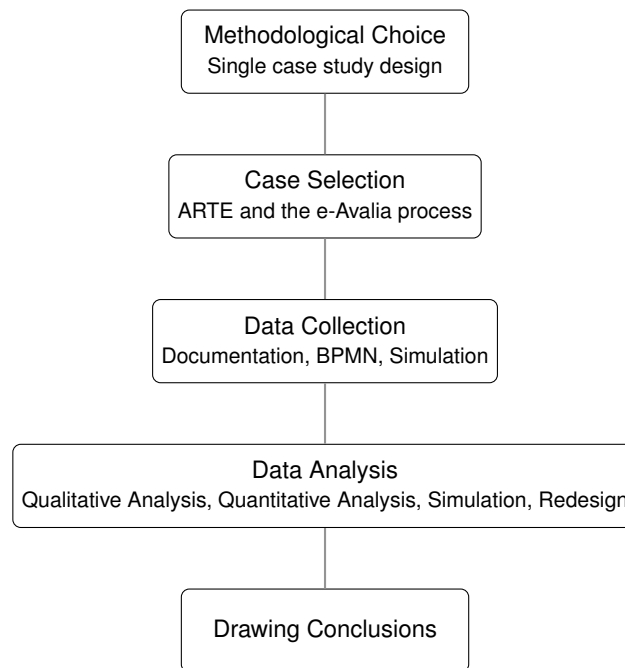
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This chapter describes the methodological approach adopted in this dissertation. As the objective of the research is to apply the BPM lifecycle to the e-Avalia process, it is essential to clarify the research design, the reason for selecting the case study, and the methods used in each phase of the BPM lifecycle. The chapter begins by describing the general research design and case study approach, followed by an explanation of how the BPM lifecycle was implemented through process modeling, qualitative and quantitative analysis, simulation, and redesign.

### 5.1 Research Design and Case Study Approach

This research adopts a case study design, with the aim of investigating how the BPM lifecycle can be applied to a real-world process in the public sector in order to identify opportunities for improvement. The case study strategy is appropriate because it allows an in-depth analysis of a single process within

its organizational setting, combining qualitative and quantitative perspectives to support understanding, analysis, and redesign, as illustrated in the sequential phases of the methodology presented in Figure 5.1.



**Figure 5.1:** Sequential phases of the case study methodology, adapted from [3].

The selected case study applies the BPM lifecycle to the expense request evaluation process managed by the ARTE, with particular focus on the e-Avalia platform. This process was chosen because it constitutes a legally mandated procedure and a key digital governance tool. The issuance of prior opinions on ICT acquisitions is a legal requirement that ensures strategic alignment, regulatory compliance, and financial justification of public investments, while the e-Avalia platform simultaneously incorporates the ongoing digital transformation of public administration, where multiple stakeholders interact. These combined characteristics make this case particularly relevant for exploring how BPM methods can be applied to digital platforms in the public sector.

The methodological approach follows the phases of the BPM lifecycle [1], covering process modeling, qualitative and quantitative analysis, simulation, and redesign. The lifecycle provides a structured path from defining process scope and objectives, through the development of the As-Is BPMN model and analyses, to the simulation of scenarios and the design of improved design options. By applying this BPM lifecycle to a single integrated process model of e-Avalia, including its sub-processes as embedded units of analysis, the research demonstrates the practical utility of BPM in identifying inefficiencies, evaluating performance, and formulating redesign alternatives.

The objectives of this study are to:

1. Identify and distinguish between value-adding and non-value-adding activities in the e-Avalia process.
2. Evaluate process performance through both qualitative and quantitative analyses.
3. Test alternative scenarios using simulation techniques.
4. Propose redesign options based on established BPM heuristics.
5. Demonstrate the applicability of the BPM lifecycle in the context of a public sector digital platform.

## 5.2 Data Collection and Analysis Strategy

The data collection and analysis strategy was designed to provide a robust empirical basis for applying the BPM lifecycle to the e-Avalia process. A combination of documentary sources and direct clarification with the organization was used to ensure an accurate understanding of the process and to support both qualitative and quantitative perspectives.

The analysis relied primarily on official documentation describing the e-Avalia process, regulatory frameworks governing prior opinion requests, and performance indicators publicly available online [8]. In addition, a clarification meeting was held with an ARTE technician, which played an important role in validating the interpretation of procedural steps, confirming decision flows, and resolving ambiguities identified during process modeling.

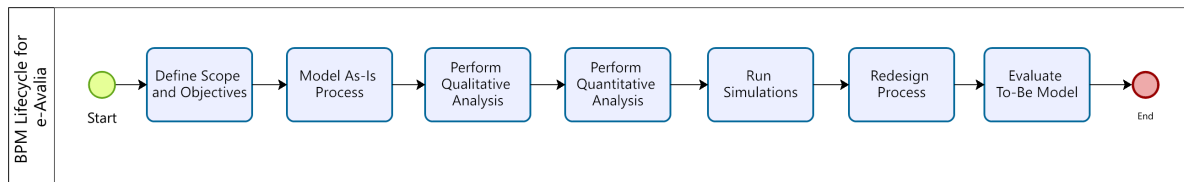
Simulation parameters in Bizagi Modeler were defined using estimated task durations, activity frequencies, and resource availability. The number of monthly requests, the distribution of request types, and average response times were obtained from official public data [8], complemented by reasoned assumptions where specific figures were unavailable.

By combining official documentation, regulatory guidelines, one targeted interaction with an ARTE technician, and official performance indicators published online [8], the data collection was sufficiently comprehensive to capture the formal definition of the process and clarify key aspects of its practical execution. This integration provided a reliable basis for parameterizing simulations, increased the robustness of conclusions, and allowed for the identification and testing of possible improvements in the process.

## 5.3 Application of the BPM Lifecycle

This research followed the BPM lifecycle framework proposed by Dumas et al. [1], applying its phases to the case study of the expenditure request evaluation process managed through the e-Avalia platform at ARTE.

As illustrated in Figure 5.2, the lifecycle was implemented in this study through successive phases of scoping, modeling, qualitative and quantitative analysis, simulation, and redesign. The adoption of this structured approach ensured that the process was documented, evaluated, and redesigned.



**Figure 5.2:** BPM lifecycle applied to the process

The application began with process identification, where the scope and boundaries of the analysis were established. The e-Avalia process was selected given its strategic importance for public ICT investments, and its dual role as both a legally mandated procedure and a digital governance tool. This phase clarified the process interrelations, stakeholders, and sub-processes.

The following discovery phase focused on documenting the current state of the process. Relying on official documentation and procedural guidelines, an As-Is model was developed in Bizagi Modeler using BPMN. The choice of Bizagi was based on a comparative analysis of modeling and simulation tools carried out in Section 3.2, where Bizagi was identified as the most suitable option for this research context. The model captured the complete flow of activities, decision points, exceptions, and interactions between actors. Bizagi was selected due to its adherence to BPMN specifications and ability to generate clear diagrams suitable for analysis and simulation.

Process analysis then combined qualitative and quantitative techniques. Value-Added Analysis, Waste Analysis, and the development of an Issue Register were applied to classify activities according to their contribution to process value, to identify redundancies, and to discover critical issues. In parallel, Bizagi's simulation functionality was used to measure cycle times, waiting times, resource utilization, and workload distribution. These complementary perspectives revealed some inefficiencies and bottlenecks in the As-Is model, thereby highlighting sub-processes with potential improvement.

Based on these findings, process redesign applied established BPM heuristics to propose concrete changes. Redesign proposals aimed at reducing non-value-adding activities, eliminating sources of waste, and improving overall efficiency and stakeholder experience. The redesigned processes were modeled as To-Be diagrams in Bizagi, allowing direct comparison with the As-Is diagram.

# 6

## As-Is Process Modeling

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The As-Is modeling of the e-Avalia process provides a structured representation of its current scope, objectives, and workflow using BPMN, serving as the foundation for analysis, simulation, and redesign.

### 6.1 Scope of the Process

The scope of the process modeled in this study is the entire lifecycle of a financial expenditure request, starting from the expense request sent by RE and concluding with the formal communication of an evaluation outcome by ARTE. This outcome may be in the form of a favorable, unfavorable, or conditioned opinion.

The process includes a wide range of activities, beginning with the initial submission of requests in the e-Avalia platform. Once submitted, requests are categorized by their typology, distinguishing between prior opinions and duty of information validations. Once categorized, each request is analyzed

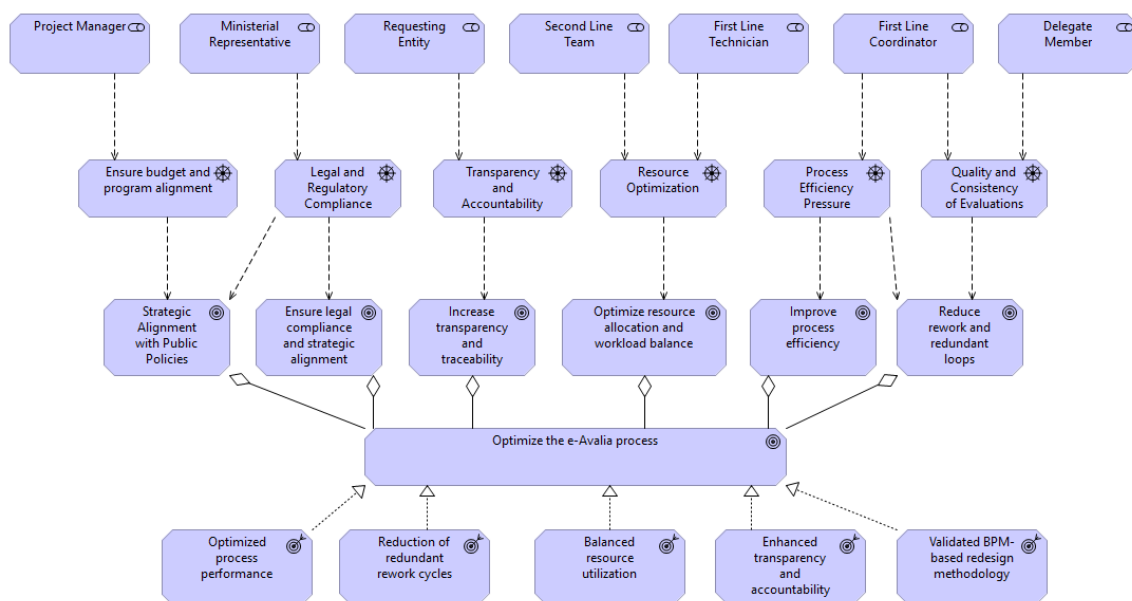
by the technical staff of ARTE, comparing the information provided against a predefined set of strategic, regulative, and financial parameters, ensuring that each evaluation follows a consistent approach.

An important part of the scope also involves handling of Request for Clarification sub-process, in which evaluators may request additional information from external stakeholders, including the Requesting Entity, Ministerial Representatives, Project Managers, or second line Support Team. These interactions are represented in the As-Is BPMN model through asynchronous communication flows in order to maintain the evaluation process complete and consistent. Additionally, the process is designed to handle exceptional situations, such as when the Requesting Entity submits a request for edition or annulment. These cases are captured using boundary events.

The process model integrates internal evaluation operations and external communication flows, allowing a comprehensive review of the evaluation cycle.

## 6.2 Process Objectives

The ArchiMate motivation view represented in Figure 6.1 illustrates the alignment between stakeholders, their motivational drivers, and the process improvement goals defined for e-Avalia.



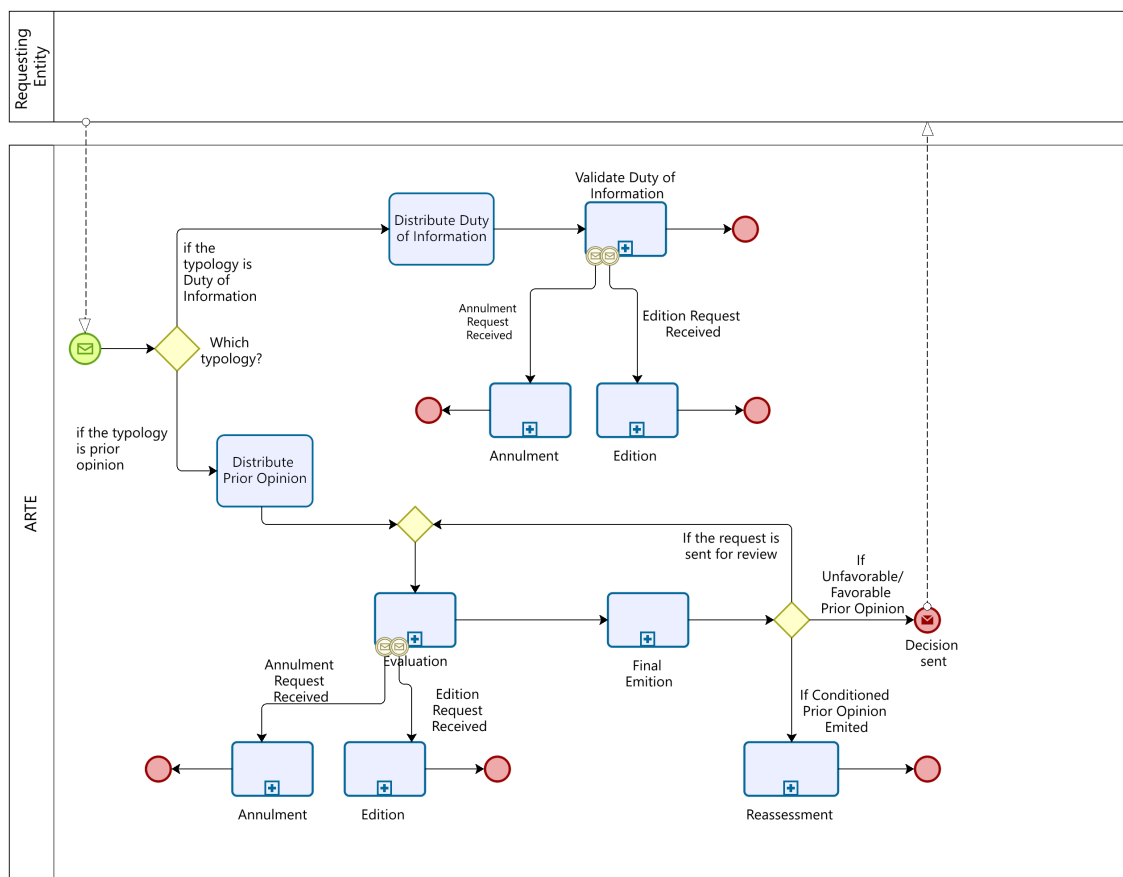
**Figure 6.1:** ArchiMate Motivation View for e-Avalia Process

Each stakeholder influences a specific driver that reflects their operational or strategic concerns, which in turn motivate the goals that guide the redesign of the process. The aggregated goal to optimize the e-Avalia process integrates these objectives, linking regulatory compliance, efficiency, transparency, and resource optimization under a unified purpose of improvement. The outcomes, derived from sim-

ulation and redesign analysis, provide measurable evidence of the process's improved performance, transparency, and compliance in the public administration context.

### 6.3 Process Description

This section provides a detailed description of the current implementation of the public expenditure evaluation process supported by the e-Avalia platform. The process is modeled in Figure 6.2 and structured around distinct phases that represent the core sub-processes and interactions between stakeholders.



**Figure 6.2:** High-level BPMN model of the e-Avalia process

Once the expenditure request is submitted by the RE, the process is handed over to the ARTE team and directed to the appropriate evaluation path based on the typology of the request.

In *Duty of Information Validation* path, ARTE performs the evaluation of the duty of information. The sub-process records the validation outcome and notifies the RE, ending this path.

In the prior opinion path, the case enters *Evaluation* sub-process; Inside this *Evaluation* there's other sub-process: the *Clarifications* sub-process. Once finished the *Evaluation* sub-process it proceeds to

*Final Emission.* Once the opinion is issued, a gateway determines the outcome: favorable or unfavorable leads to sending the decision to the RE and closing the case; conditioned activates *Reassessment*, after which the opinion is re-issued and the decision communicated; or sent for review to another cycle in *Evaluation*.

Exceptions for *Edition* and *Annulment* are modeled as interrupting message boundary events attached to *Duty of Information Validation* or *Evaluation*. *Edition* sub-process allow RE to edit the request authorizing the RE to modify the request; in *Annulment* sub-process the request is simply canceled and the process ends.

Only the determinant interactions are represented in 6.2 by message events: initial submission from the RE and delivery of the final decision. When decision is sent by ARTE through a message, the RE executes *Decision Receivment* to complete its part of the process.

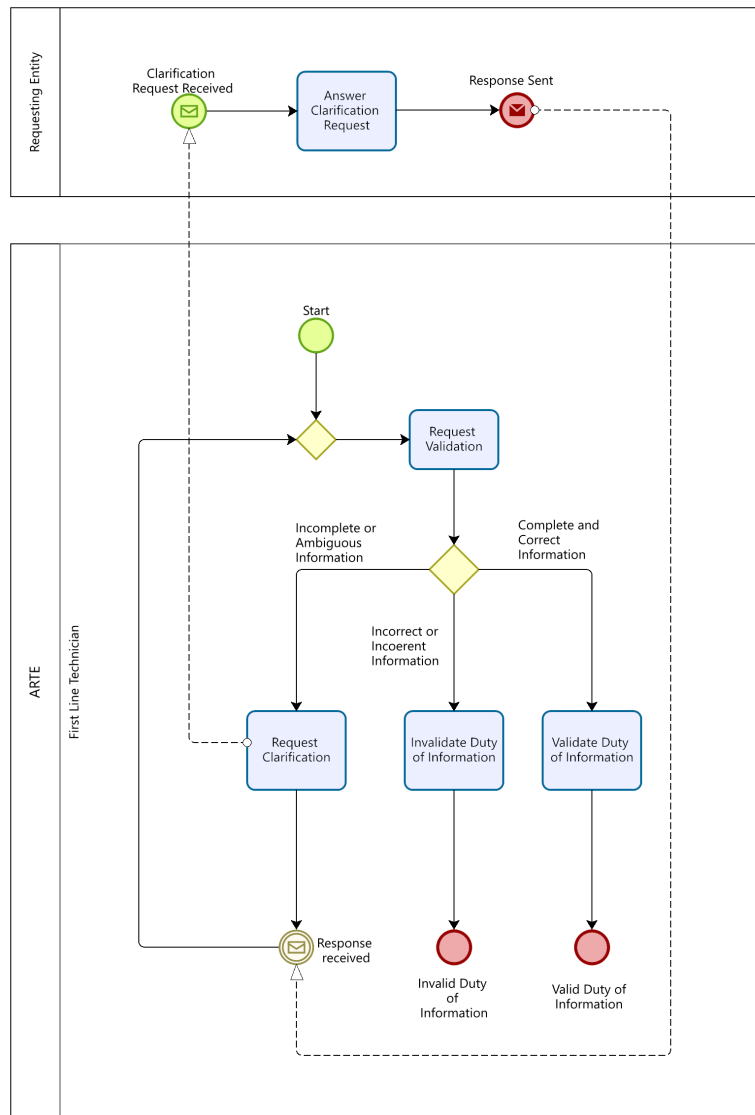
An overview of the main phases of the process is first provided in Table 6.1. Each section in the table corresponds to a distinct sub-process, and the respective description.

Number	Section	Description
1	Duty of Information Validation	For requests concerning the duty to inform, the evaluator checks the completeness and validity of the submitted data.
2	Evaluation	For preliminary opinion requests, technical assessment is carried out, potentially leading to clarifications or forwarding for validation.
3	Clarifications	If needed, the evaluator may request additional information from internal or external stakeholders through asynchronous communication.
4	Final Emission	All evaluations are subject to review and approval by a Delegate Member, who issues the final decision.
5	Reassessment	If a conditioned opinion is issued, the Requesting Entity may submit a reassessment request, triggering re-evaluation.
6	Edition	If a message boundary event related to edition is triggered, then ARTE team receives and allows RE to edit.
7	Annulment	If a message boundary event related to annulment is triggered, then ARTE team receives and cancel the request.

**Table 6.1:** Overview of the Process Description Structure

### 6.3.1 Duty of Information Validation sub-process

The Duty of Information Validation sub-process is initiated when the first line coordinator distributes the request. This sub-process is handled internally by ARTE's first line technical evaluator and verifies whether the submitted documentation is coherent, and compliant with established requirements, as shown in Figure 6.3.



**Figure 6.3:** BPMN model of the Duty of Information validation sub-process

The initial step involves a validation task, in which the evaluator analyzes the request details. Following this task, an exclusive gateway determines the appropriate course of action based on the outcome of the validation:

- If the information is consistent, the evaluator confirms the duty to inform as valid, and the sub-process finishes. A message is then sent to the RE to communicate the result, and the overall process concludes.
- If the request is clearly non-compliant or contains omissions, the evaluator marks it as invalid finishing the sub-process. The general process ends also with a message to the RE.

- If the evaluator finds the information insufficient or unclear, the process enters a request for clarification cycle.

In need of clarification, the evaluator sends a request to the RE via a message event. The process then waits for a response via a message capture event. Once the additional information has been received, the process returns to the initial validation task, ensuring that the request is re-validated.

### 6.3.2 Evaluation sub-process

The Evaluation sub-process is triggered when a request is classified as requiring a prior opinion. This pathway involves multiple decision layers and interactions between technical evaluators and the coordination role within ARTE.

The sub-process begins with the evaluation task, where a first line technician analyses the request against evaluation criteria, including strategic alignment, regulatory compliance, and cost adequacy. If the request lacks sufficient evidence, the evaluator may initiate the Request for Clarification sub-process. This decision is modeled through an exclusive gateway, as illustrated in the BPMN diagram in Figure 6.4.

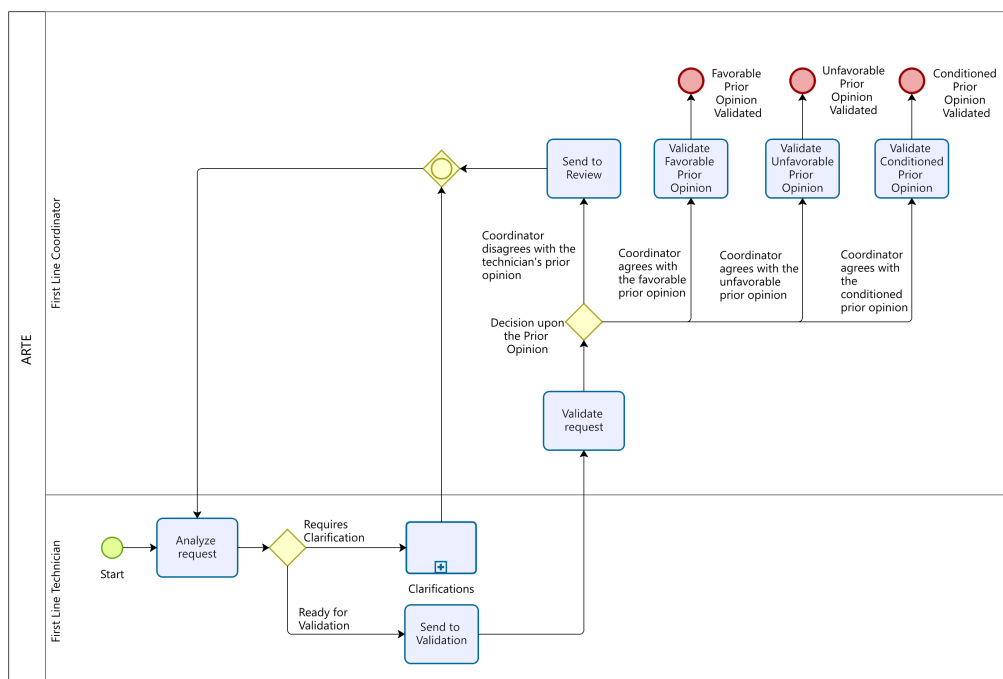


Figure 6.4: BPMN model of the evaluation sub-process

If the evaluator identifies gaps or inconsistencies, the sub-process diverts to the Request for Clarification sub-process, where targeted requests are sent to relevant stakeholders, such as the Requesting

Entity, Ministerial Representative, or specialized support. Upon receiving the responses, the process resumes at the initial evaluation task, ensuring the updated information is incorporated into the decision-making process.

Once the technical assessment is complete, the request proceeds to a validation task where the evaluator confirms the consistency of the opinion. It is then forwarded to the first line Coordinator, who reviews the content. The coordinator's decision is modeled through an exclusive gateway with four possible paths:

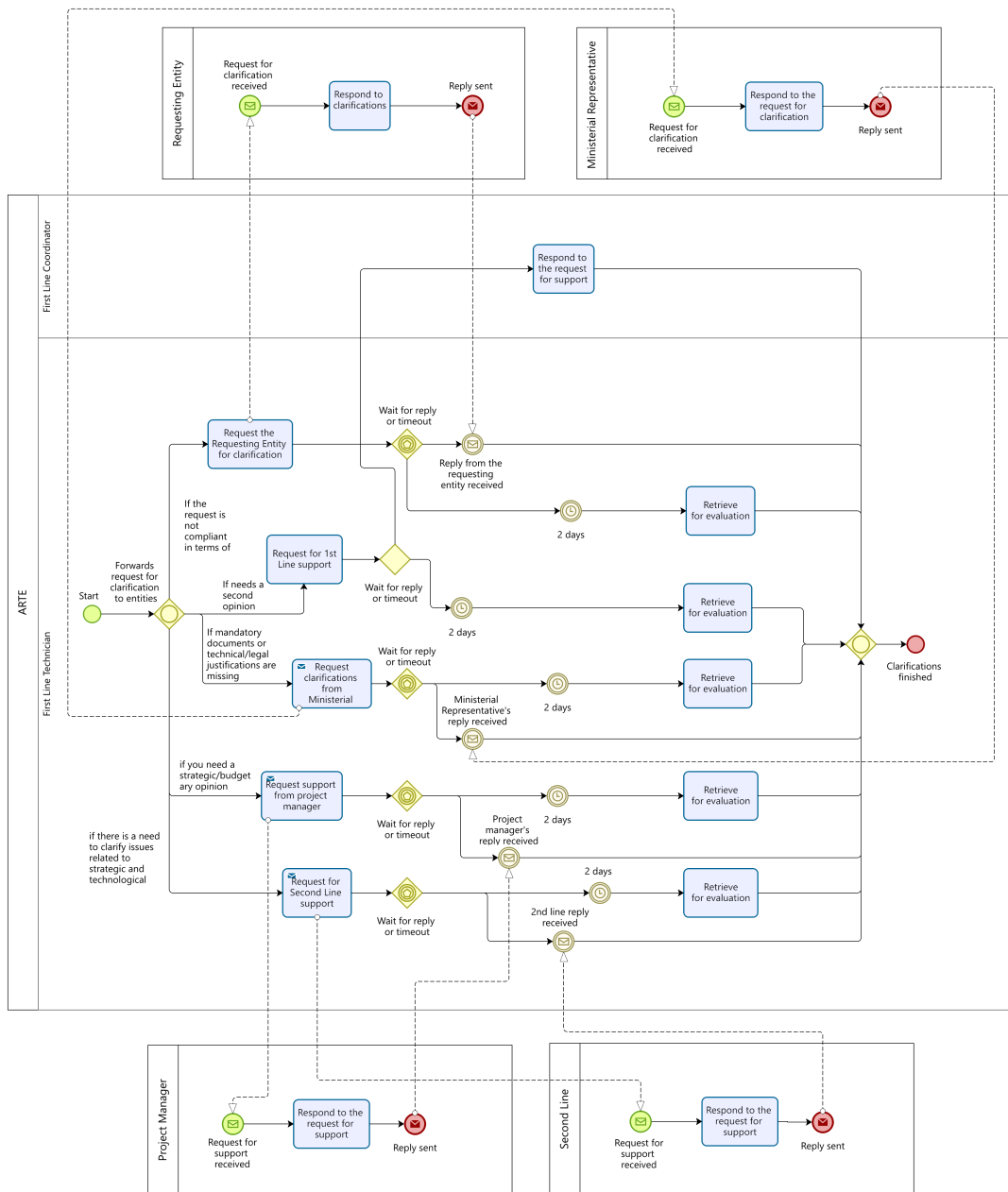
- If the coordinator agrees with the proposal for a favorable opinion, the process moves forward, the opinion is approved and the sub-process ends.
- If the opinion is unfavorable and the coordinator agrees with the assessment, the process concludes with a negative decision, ending the sub-process.
- If the coordinator considers that the application is suitable for a conditional opinion, the process is concluded with this result and the conditions are formally issued concluding the sub-process.
- If the coordinator disagrees with the evaluator's assessment, regardless of the proposed outcome, the request is sent back for revision and re-evaluation.

During the entire evaluation sub-process, the Requesting Entity may at any moment request to edit or cancel the request. These exception flows are handled using interrupting boundary events. If an edition request is submitted and accepted, the process stops, and a message is sent authorizing the RE to revise the request. If RE requests cancellation, the process is terminated.

Once the sub-process is complete, the flow goes to a routing gateway that sends the request to the Delegated Member for its final analysis. At this point, the assessment is complete, but pending final confirmation, which is described in the next section.

### **6.3.3 Clarifications sub-process**

The Clarification sub-process, shown in Figure 6.5, is a support component within the evaluation workflow, designed to resolve uncertainties or address missing or inconsistent information identified during the technical analysis. It is initiated by the first line evaluator and functions as an event-driven interaction between ARTE and internal or external stakeholders.



**Figure 6.5:** BPMN model of the Clarification sub-process

This sub-process begins when the evaluator determines that a request lacks the necessary clarity, justification, or supporting documentation. An inclusive OR gateway models this decision point, from which five possible clarification paths may be activated depending on the type of issue:

- If the request is unclear in terms of information quality, cost justification, alignment, or software details, the evaluator sends a clarification request to the Requesting Entity.
- If a legal or procedural confirmation is needed, the evaluator contacts the first line Support team

for guidance.

- If mandatory documents or legal/technical justifications are missing, a message is sent to the Ministerial Representative.
- If the request requires strategic or budgetary input, the Project or Program Manager is consulted.
- If the clarification relates to strategic and technological alignment, the second line Support team is involved.

Each clarification path follows the same pattern: the technician sends a message to the appropriate party, triggering a start event in their respective pool. The receiver then executes a task to formulate and send a reply, which is captured by the evaluator through an intermediate message catch event. To avoid indefinite waiting, a timer event is associated with each message reception. If no response is received within two business days, or within one business day in the case of first line support, the evaluator retrieves the request and re-starts the evaluation task.

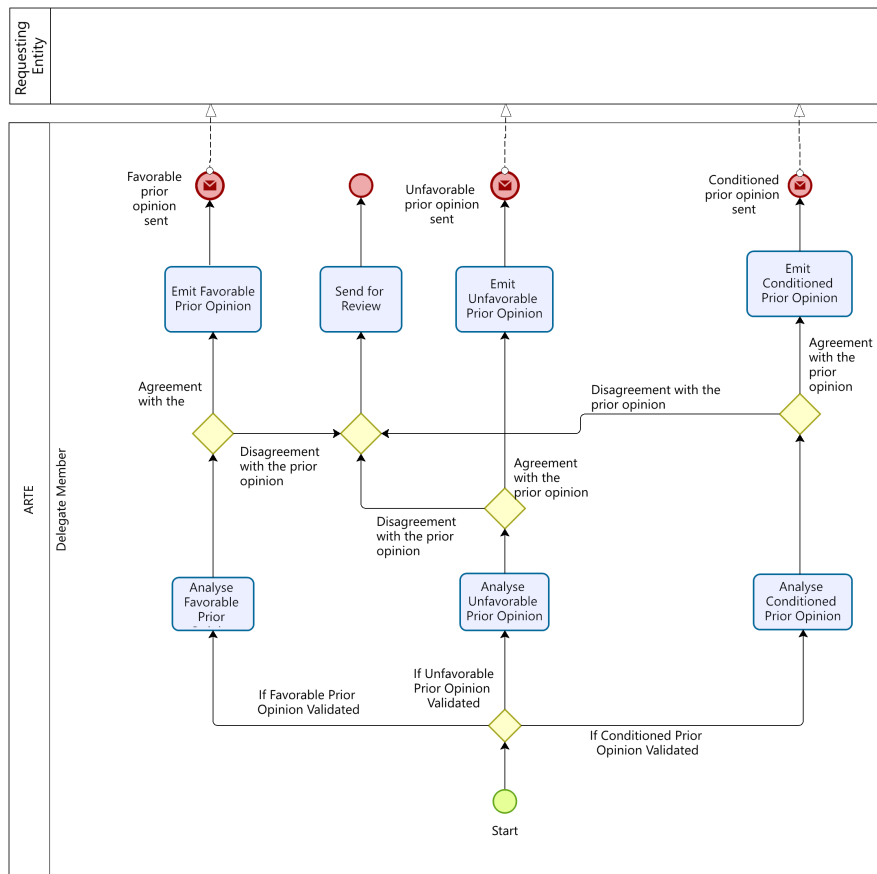
After the necessary clarifications are received or the timeout is reached, the process converges through an OR gateway, allowing it to continue regardless of which clarification path was followed. This design supports parallel or sequential clarifications.

Furthermore, as in other sub-processes, edition or annulment requests from the RE may occur at any time. These are handled via interrupting boundary events, enabling the evaluator to stop the clarification flow and authorize a modification to the request.

### **6.3.4 Final Emission sub-process**

The Final Review of the process represents the conclusive stage of the evaluation process and is the responsibility of the Delegate Member. At this point, the request has already undergone technical assessment and coordinator-level validation. The Delegate Member holds the authority to issue the final opinion and formally close the evaluation procedure.

As illustrated in Figure 6.6, the sub-process begins when the Delegate Member gets a request with an opinion validated by the first line Coordinator. Depending on whether the opinion is favorable, unfavorable, or conditioned, the Delegate Member initiates the corresponding review activity. In the BPMN model, this step is followed by an exclusive gateway that determines whether the Delegate agrees with the proposed decision or requests a revision.



**Figure 6.6:** BPMN model of the Final Emission sub-process

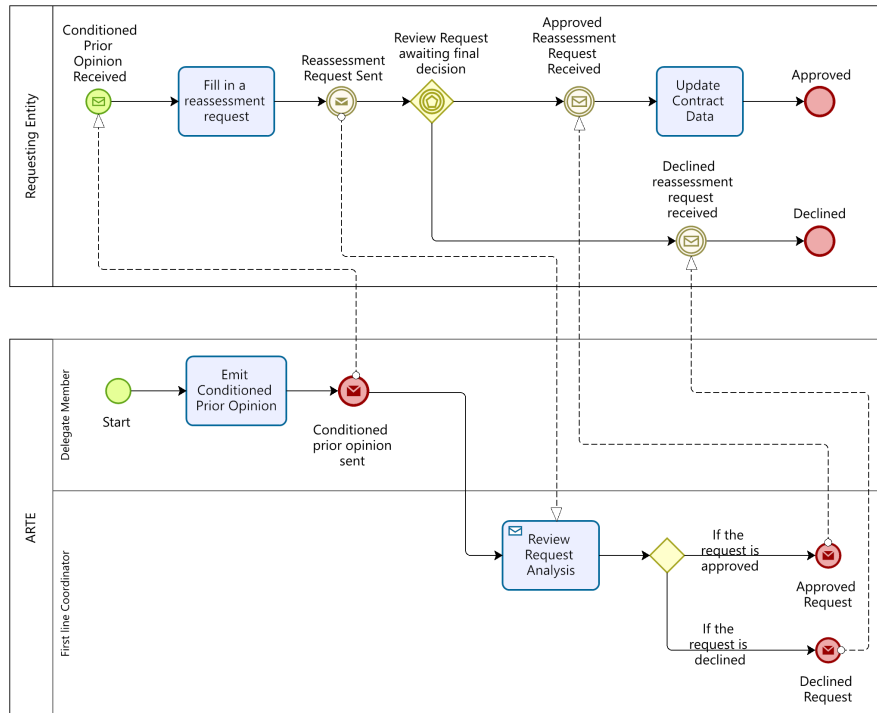
If the Delegate Member agrees with the coordinator’s opinion, the process proceeds directly to the issuance of the final opinion, which is communicated to the Requesting Entity through a message end event. This closes the process on both the evaluator’s and the RE’s side. The final outcome is recorded as either:

- Favorable prior opinion sent,
- Unfavorable prior opinion sent, or
- Conditioned prior opinion sent.

If, however, the Delegate does not agree with the proposed decision, the sub-process terminates. Consequently, process loops back and returns the request to the evaluation team. This feedback triggers a revision cycle, beginning again at the Evaluation sub-process.

### 6.3.5 Reassessment sub-process

The Reassessment sub-process offers the RE an opportunity to contest a previously issued conditioned opinion. This can be seen detailed in this sub-process 6.7.



**Figure 6.7:** BPMN model of the reassessment of conditioned opinion

The reassessment is triggered after the RE receives a conditioned opinion and chooses to submit a formal request for reassessment. This request is sent via the e-Avalia platform and received by the first line coordinator, who is responsible for its analysis. In BPMN terms, this part begins with a message start event from the RE, which activates the task of reviewing the reassessment request.

After the analysis, there's a decision gateway that defines the next course of action:

- If the reassessment request is approved, the flow proceeds to a message end event notifying the RE. On the RE side, the message is received and is followed by a task in which the RE can update contractual data as required, and then an end event indicating successful reassessment.
- If the request is rejected, a separate message end event is triggered to inform the RE. The process then terminates with an outcome formally recorded as denied, without further modification to the initial conditioned opinion.

### 6.3.6 Edition and Annulment sub-processes

The Edition and Annulment sub-processes represent exception-handling mechanisms that ensure flexibility and responsiveness during the evaluation workflow. These sub-processes are triggered when the RE submits a request to modify or cancel an ongoing evaluation. Both follow a message-based interaction pattern between the RE and ARTE.

The Edition sub-process, illustrated in Figure 6.8, begins when the RE issues a message requesting permission to edit a previously submitted evaluation request. Upon receipt of this message, the first line coordinator allows the edition, and sends the permission to the RE, concluding the sub-process. This allows the RE to reopen and update the submission form in the e-Avalia platform.

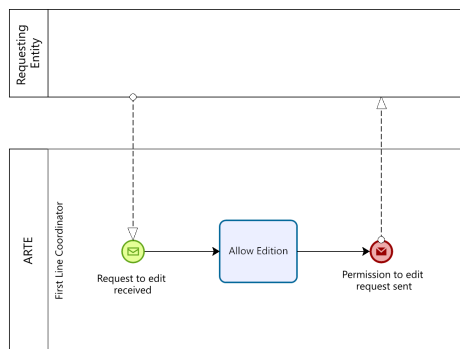


Figure 6.8: BPMN model of the Edition sub-process

The Annulment sub-process, shown in Figure 6.9, handles annulment requests initiated by the RE. When the first line coordinator receives an annulment request message, the request is canceled, terminating the sub-process.

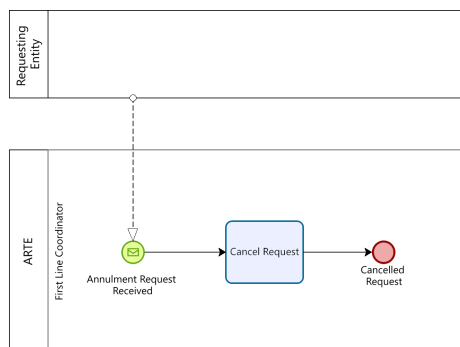


Figure 6.9: BPMN model of the Annulment sub-process

# 7

## Process Analysis

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The e-Avalia process analysis combines qualitative and quantitative perspectives, identifying bottlenecks, inefficiencies, and opportunities for improvement through techniques such as value-added analysis, waste analysis, and issue register, providing the basis for simulation and redesign.

### 7.1 Analysis Approach

The analysis conducted in this chapter aimed to evaluate the current e-Avalia process in order to identify structural inefficiencies, performance bottlenecks, and opportunities for improvement. This analysis served as a starting point for the subsequent redesign phase, providing evidence-based insights into what needs to be changed and which redesign heuristics were most appropriate.

The analysis relied on a combination of internal documentation, input from stakeholders, reasoned assumptions, and information available online. Activity durations were defined using estimated values

and modeled with probabilistic distributions, primarily triangular, to reflect expected variability. Resource availability was based on standard calendars, assuming full-time availability from Monday to Friday, between 9:00 and 17:00, and decision gateways were assigned probabilities aligned with scenario configurations. These assumptions were documented to ensure consistency and transparency throughout the analysis and simulation phases.

The modeling and simulation activities were performed in Bizagi, which provided an integrated BPMN environment and simulation engine. Bizagi enabled the configuration of task durations, resource assignments, calendars, decision logic, and exception handling. Qualitative analysis techniques such as value-added analysis and issue identification were used to understand the strategic alignment and value of process activities. Quantitative evaluation was then carried out through simulation, allowing the measurement of process duration, resource utilization, waiting times, and the impact of design changes across alternative scenarios.

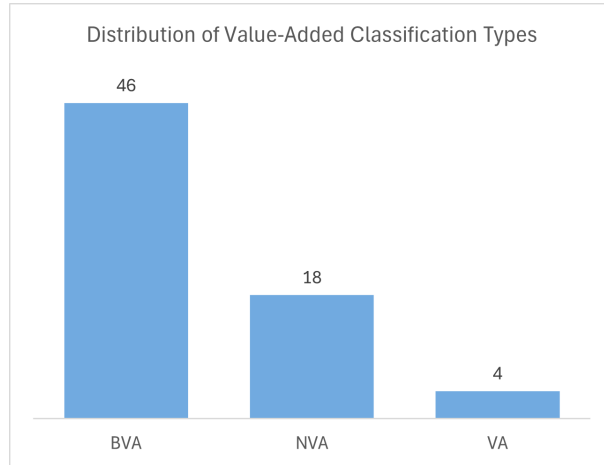
## **7.2 Qualitative Analysis**

This chapter presents a qualitative analysis of the current process for the evaluation of expenditure requests, as implemented through the e-Avalia platform. The aim is to identify inefficiencies, bottlenecks, and improvement opportunities by applying qualitative techniques. The analysis is based on the BPMN model of the process and focuses on three methods: value-added analysis, waste analysis and issue identification.

### **7.2.1 Value-Added Analysis**

Value-added analysis is a technique used to identify unnecessary steps within a process, with the objective of improving efficiency by redesigning or eliminating them. In this context, a step may refer to an entire task or a specific part of a task, as most process activities involve several distinct actions. Steps are categorized as VA, BVA, or NVA. VA steps directly satisfy stakeholder needs; BVA steps do not directly benefit the customer but are necessary for regulatory or organizational reasons; and NVA steps provide no clear value and are candidates for elimination or automation.

All 71 steps in the As-Is model of the e-Avalia process were analysed and classified. The classification was based on each step's expected contribution to process goals, its necessity for compliance or internal control, and its impact on the overall efficiency of the workflow. The results of this classification are visualized in figure 7.1.



**Figure 7.1:** Distribution of Value-Added Classification Types in the As-Is Process

Step	Type	Justification
Start new request	VA	Directly initiates the process and represents a stakeholder action to request service.
Fill in mandatory fields	VA	Captures essential input for the evaluation, enabling the core process to begin.
Assign to first line evaluator	BVA	Internal coordination step for task distribution; necessary for managing workload.
Confirm distribution	BVA	Ensures accountability and registration of internal decisions; supports traceability.
Save request	NVA	Does not advance the process; adds no value given automatic system tracking.
Wait for clarification	NVA	Introduces delay without contributing to stakeholder value; suitable for automation.

**Table 7.1:** Examples of Classified Steps in the As-Is Process

These value-adding tasks are focused on the initial stage of the process, including *Start new request* and *Fill in mandatory fields*, which directly initiate and enable the evaluation of the expenditure request. By contrast, the majority of steps fall under the BVA category. These include administrative and coordination tasks, such as *Assign to first line evaluator* and *Confirm distribution*, which are essential for workload allocation and procedural traceability but do not directly improve the requester’s experience. Finally, 19 steps were identified as NVA, indicating potential inefficiencies in the process. For instance, *Save request* was considered NVA because the system already performs automatic tracking and data persistence; as such, the explicit save step adds neither business value nor operational ne-

cessity. Similarly, *Wait for clarification* introduces delays that prolong the process without creating value. These NVA steps highlight opportunities for simplification or automation in process redesign, provided that compliance and auditability requirements are safeguarded.

Of the 71 analyzed steps, only four were classified as VA, meaning that very few directly contribute to the creation of value for the requesting entity. These value-adding tasks are focused on the initial stage of the process, including *Start new request* and *Fill in mandatory fields*, which serve to initiate and start the evaluation of the expenditure request. By contrast, the majority of steps fall under the BVA category. These include administrative and coordination tasks, such as *Assign to first line evaluator* and *Confirm distribution*, which are essential for workload allocation and procedural traceability but do not directly affect the requester's experience. Finally, 19 steps were identified as NVA, indicating potential inefficiencies in the process. For instance, *Save request* was considered NVA because the system already performs automatic tracking and data persistence; as such, the explicit save step adds neither business value nor operational necessity. Similarly, *Wait for clarification* introduces delays that do not contribute to value. These NVA steps highlight opportunities for process redesign.

These examples, presented in Table 7.1, illustrate how different types of steps are distributed throughout the process and underscore the need to streamline activities that offer limited or no added value. The complete classification of all steps is available in Appendix A.2.

## 7.2.2 Waste Analysis

Waste analysis offers a complementary perspective to value-added analysis. While value-added analysis approaches the process by identifying the activities that contribute positively to the results, and then classifying the rest as necessary or without added value, waste analysis starts from the opposite angle. It seeks to discover inefficiencies at all levels of the process, regardless of whether they are visible in specific tasks or embedded between process steps. Some forms of waste can be associated with clearly defined actions, while others are more subtle, showing up through transitions or persisting throughout the workflow. There are several types of waste that can appear during process execution, including over-processing, over-production, inventory, waiting, rework, motion, and unnecessary transportation.

In the case of the As-Is process implemented via the e-Avalia platform, several steps were identified as contributing to one or more types of waste. Table 7.2 presents selected examples.

Over-processing remains a common problem, particularly in tasks such as *Save expenditure request* and *Confirm request deletion*, which require manual confirmations that could be automated. However, it is important to recognize that confirmation steps can serve a valuable protective function, especially in the case of deletions, where an explicit confirmation helps prevent accidental cancellations. The problem, therefore, lies not in the presence of a confirmation step, but in its current design: if the system already provides automated release and recovery mechanisms, additional manual confirmations risk

Process Step	Type of Waste
Save expenditure request	Over-processing
Select request for deletion	Over-production
Confirm request deletion	Over-processing
Request cancellation by requester	Over-production
Select duty of information/opinion request	Over-processing
Recover request for new evaluation	Rework and Waiting
Wait for response to support request	Waiting
Between distribution and technician assignment	Transportation
Task duplication across user roles	Over-processing and Motion

**Table 7.2:** Examples of Waste Identified in the As-Is Process

becoming redundant. Similarly, over-production appears in steps like *Select request for deletion* and *Request cancellation by requester*, where actions are triggered unnecessarily or redundantly. In this case, for example, *Retrieve request for new evaluation* reflects the rework caused by iterative cycles, often aggravated by delays and accumulated work. *Waiting for response to request for support* is a case of passive delay, which highlights communication failures with external actors.

The handoff between distribution and technician assignment represents a transportation type of waste, where process fragmentation introduces unnecessary transitions. Additionally, the step *Task duplication across user roles* points to motion and over-processing, where similar actions are repeated by different actors. The full table of waste analysis is present in the Appendix A.1.

### 7.2.3 Stakeholder Analysis

Before delving into the process issues, it is important to conduct a stakeholder analysis to understand the roles, interests, and influence of each party involved in or affected by the e-Avalia process, as summarized in Table 7.3.

<b>Stakeholder</b>	<b>Role</b>	<b>Interest</b>	<b>Influence</b>
ARTE (Process Owner)	Owns and governs the e-Avalia process	Seeks improved performance, compliance with public policy, and high-quality digital service	High
First line Technicians	Perform technical validation and evaluation of requests	Want efficient workflows, clear task assignments, and a usable system	High
First line Coordinator	Oversee evaluation quality and manage first line team	Interested in timely evaluations, quality assurance, and workload control	High
Delegated Member	Validates evaluations at a high level	Ensures technical quality, and adherence to criteria	High
Ministry Representative	Validates the request by checking for mandatory documents and legal/technical justifications	Interested in ensuring workflow compliance, and policy alignment	Medium
Requesting Entity	Submit expenditure requests to be evaluated	Interested in favorable and timely approvals, transparency in decision criteria	High
Program Manager	May be involved when strategic or budgetary opinions are required to support or justify the evaluation	Interested in timely and favorable outcomes, and in alignment with program priorities and budget constraints	Medium
Second Line Support Team	Supports the resolution of complex technical cases and clarifies issues related to the strategic and technological alignment of the process	Interested in ensuring consistency with the system architecture, well-documented functional decisions, and strategic technology choices	Medium

**Table 7.3:** Stakeholder Analysis of the e-Avalia Process

### 7.3 Issue Analysis

To support a structured qualitative evaluation of the As-Is process, the issues listed in Table 7.4 represent the main qualitative inefficiencies observed in the current process. Each issue in the register is described in terms of its context, qualitative impact, such as waiting, rework, or process instability, and priority level. While this section focuses on identifying and describing these issues from a qualitative standpoint, their quantitative impact on process duration, resource utilization, and workload will be analyzed in detail in the following section 8 through simulation.

ID	Issue	Qualitative Impact	Priority
1	Delays due to clarifications	Waiting time during evaluation phase and communication loops	Medium
2	Rework from review requests issued by the First Line Coordinator	Rework and additional waiting time	High
3	Rework from review requests issued by the Delegate Member	Rework and additional waiting time	High
4	Rework due to reassessment requests	Rework and prolonged cycle time	Medium

**Table 7.4:** Issue Register - Summary of Identified Process Issues

### 7.3.1 Issue 1: Delays due to clarifications

Issue	Qualitative Impact	Priority
Delays due to clarifications	Waiting time during evaluation phase	Medium

**Table 7.5:** Issue 1 – Delays Due to Clarifications

During the evaluation phase, the first line Technician may need to request clarifications regarding the submitted request. These clarifications may involve either internal or external stakeholders. In the case of external clarifications, sent to actors such as the Requesting Entity, Ministerial Representative, Project Manager, or Second Line Team, the process is suspended until a response is received or a predefined deadline of two business days is reached. For internal clarifications, the technician may consult the Coordinator, triggering a shorter internal loop with a response time expectation of a maximum of two business days.

Both situations represent a form of waiting waste, as the evaluator remains assigned to the case without the ability to progress. Although the process model includes timers to resume the evaluation after a specified delay, these interruptions contribute to increased throughput time and reduced process efficiency.

### 7.3.2 Issue 2: Rework Resulting from Review Requests Issued by the First Line Coordinator

Issue	Qualitative Impact	Priority
Rework from revision requests issued by the Coordinator	Rework and additional waiting time	High

**Table 7.6:** Issue 2 – Rework Triggered by First Line Coordinator

Following the submission of the technical opinion by the first line Technician, the Coordinator may disagree with the evaluation and return the request for revision.

As shown in Table 7.6, this issue is associated with both rework and waiting waste. Each review implies a repetition of the technical evaluation loop. This not only lowers efficiency but also extends the time to resolution from the requester’s perspective.

### 7.3.3 Issue 3: Rework Resulting from Review Requests Issued by the Delegate Member

Issue	Qualitative Impact	Priority
Rework from revision requests issued by the Delegate Member	Rework and additional waiting time	High

**Table 7.7:** Issue 3 – Rework Triggered by Delegate Member

The Delegate Member, who holds final decision authority, can request a review of the opinion, requiring the evaluator to reprocess the request. The process enters a rework cycle that disrupts the flow and adds delay.

### 7.3.4 Issue 4: Rework Due to Reassessment Requests

Issue	Qualitative Impact	Priority
Rework due to reassessment requests	Rework and prolonged cycle time	Medium

**Table 7.8:** Issue 5 – Rework Due to Reassessment Requests

When a conditioned opinion is issued, the Requesting Entity has the option to submit a reassessment request. This request is directed to the Coordinator, who is responsible for reviewing the case again, making a new decision, and responding to the Requesting Entity. This extends the decision time and consumes coordination resources.

As shown in Table 7.8, this scenario introduces rework waste. The Coordinator is required to analyze previously validated information, which usually involves reassessing the request’s context and reformulating justifications. The recurrence of this task increases the cycle time and intensifies the coordinator’s workload.

# 8

## Simulation

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To support the quantitative analysis of the issues identified during the qualitative analysis phase, individual simulations were conducted for each issue. This approach assesses the isolated impact of each problem in order to later apply redesign heuristics that can be applied to the as-is model.

The simulation required the specification of resources involved in the process, including their availability and associated costs. Table 8.1 summarizes the resource configuration adopted in the simulation model. These values are assumptions regarding the number of available workers per role and their hourly cost to the organization. The RE is not associated with any internal cost, as it represents the external stakeholder who initiates the process, acting as the client of the e-Avalia platform.

Resource	Quantity	Cost per Hour (€)
Second Line Team	1	8
First Line Technician	3	8
Project Manager	1	12
Requesting Entity	1	0
Ministerial Representative	1	12
Delegated Member	1	12
First Line Coordinator	1	10

**Table 8.1:** Resource configuration used in simulation

Schedule	Duration	Working Days
09:00–17:00	8 hours	Monday to Friday

**Table 8.2:** Working Schedule Used in the Simulation

In addition, all resources were assigned a shared working calendar. As shown in Table 8.2, the defined schedule consists of standard business hours, from 09:00 to 17:00, Monday to Friday.

## 8.1 Simulation of Clarifications Sub-process

Clarification requests are issued when the initial request for a prior opinion lacks sufficient information or requires additional justification. These are directed to one or more of stakeholders: Project Managers, Ministerial Representatives, or First Line Coordinator, Second Line Team. Once the request has been sent, the process waits for a response or, failing that, a timer is triggered. As identified in Subsection 7.3.1, this issue generates significant delays within the evaluation phase of the process. Each clarification cycle introduces a waiting period during which the evaluation task is suspended, creating idle time for the technical staff and increasing the

### 8.1.1 Simulation Setup and Assumptions

To evaluate the impact of the identified inefficiencies in the clarification sub-process, a baseline simulation scenario was developed, as shown in Table 8.3. This baseline represents the current configuration of the process, reflecting the observed behavior in terms of task durations, decision probabilities, and resource allocation.

**Table 8.3:** Simulation Setup and Assumptions of Clarifications Sub-process

Parameter	Description
Simulation duration	60 working days
Number of clarification requests	85 requests simulated
Gateway distributing clarification requests	OR gateway with 20% probability for each outgoing path
Request tasks duration	Fixed duration of 1 hour
Retrieve tasks duration	Fixed duration of 30 minutes
1st line response gateway	95% probability to respond directly, 5% to trigger the timer
External entity reply task duration	Distribution triangular(60, 240, 840) minutes
1st line reply task duration	Distribution triangular(60, 240, 840) minutes
Event-based gateways	Message event with distribution triangular(60, 360, 900) or a timer set to 2 working days
Resources involved	1st line technical staff responsible for handling request and reply tasks, with support from the First Line Coordinator. Clarification requests are directed to external entities: RE, Second Line Team, Ministerial Representative, and Delegated Member, who are responsible for replying.

### 8.1.2 Scenarios and Parameters

To assess the impact of clarification delays and test potential redesign strategies, four simulation scenarios were defined. Each scenario introduces specific changes to the baseline configuration in terms of task durations or routing logic.

Table 8.4 introduces the main characteristics of each scenario, highlighting the specific variations applied in each case.

**Table 8.4:** Simulation Scenarios of Clarifications Sub-process

Scenario	Description	Scenario Focus
Scenario 1: Baseline	All external entities respond to clarification requests with a Triangular Distribution triangular(60, 240, 840) minutes.	Represents the current situation.
Scenario 2: Critical Entity	The Requesting Entity responds with triangular(60, 480, 1080).	Models a bottleneck caused by one specific external entity.
Scenario 3: Partial Improvement	The First Line Coordinator and Project Manager respond faster with triangular(60, 180, 600).	Simulates improved time response from selected entities.
Scenario 4: Strategic Priority	Requests are routed with higher probability to Requesting Entity (60%), followed by Project manager(10%), Ministerial Representative (10%), and First Line Coordinator(10%) and Second Line Team (10%).	Tests a strategy to reduce reliance on slower entities.

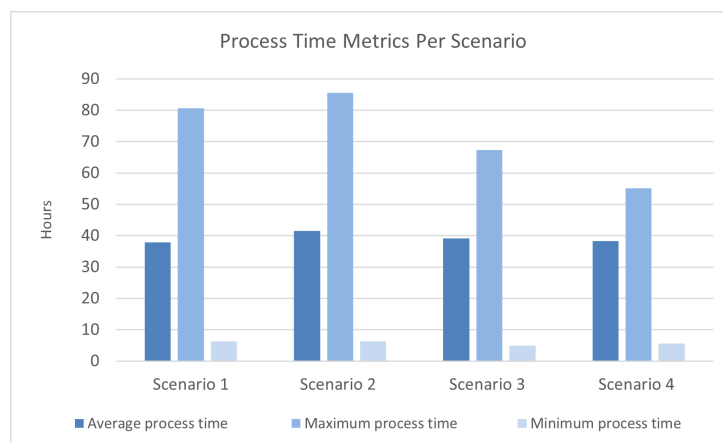
The baseline scenario reflects the current configuration, where all external entities respond with a

triangular distribution triangular(60, 240, 840) minutes. Scenario 2 simulates a bottleneck by assigning a significantly slower response time to the RE, using triangular(60, 480, 1080). Scenario 3 introduces selective improvements, where the First Line Coordinator and Project Manager respond faster, with triangular(60, 180, 600). Finally, Scenario 4 alters the routing probabilities to prioritize certain actors, with 60% of requests directed to the RE and the remaining 40% distributed among other stakeholders.

### 8.1.3 Results and Interpretation

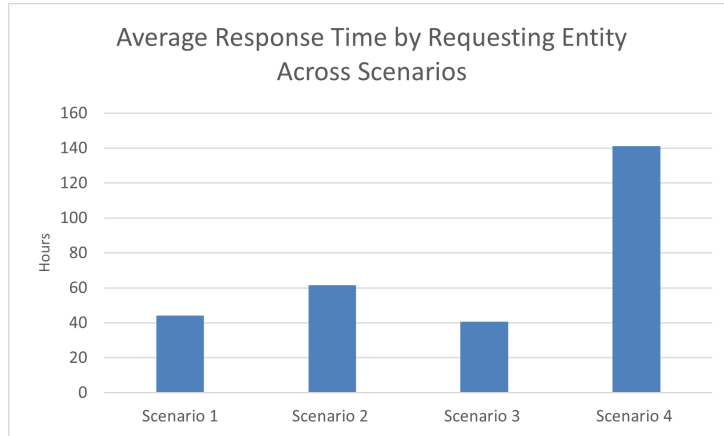
This section presents and interprets the results obtained from the simulation of the clarifications sub-process. The analysis is structured around five dimensions: process duration, response times, timeouts, resource utilization, and operational cost.

The analysis of overall process duration, present in figure 8.1, shows that Scenario 2 results in the highest average and maximum process times, due to the introduction of a single slow external stakeholder. This scenario serves as a stress test to identify the effect of a bottleneck. Scenario 4 achieves a lower process duration, but redirects the delay to a different point in the process, namely the requesting entity.



**Figure 8.1:** Process Time Metrics per Scenario

The performance of the RE is a critical aspect of Scenario 4. As illustrated in figure 8.2, the average response time for the RE rises drastically when they have more clarification requests, reaching over 140 hours. This contrasts with the 44 hours observed in Scenario 1. While the intention was to reduce overall throughput time by focusing on a central actor, the results show that the RE becomes a bottleneck due to resource constraints and increased workload.



**Figure 8.2:** Average Response Time by Requesting Entity Across Scenarios

This overload is further confirmed by the timeout distribution. Figure 8.3 presents a combined view of the timeouts per entity in Scenarios 1 and 4, with pie charts showing the proportional distribution and a table detailing the number of timeouts. In Scenario 4, the RE accounts for approximately 79.3% of all timeouts, a significant increase compared to just 21.3% in Scenario 1. Although Scenario 4 successfully reduces the workload on other stakeholders, such as the Second Line Team and the Ministerial Representative, it does so at the cost of substantially overloading the RE.



**(a)** Timeout distribution in Scenario 1

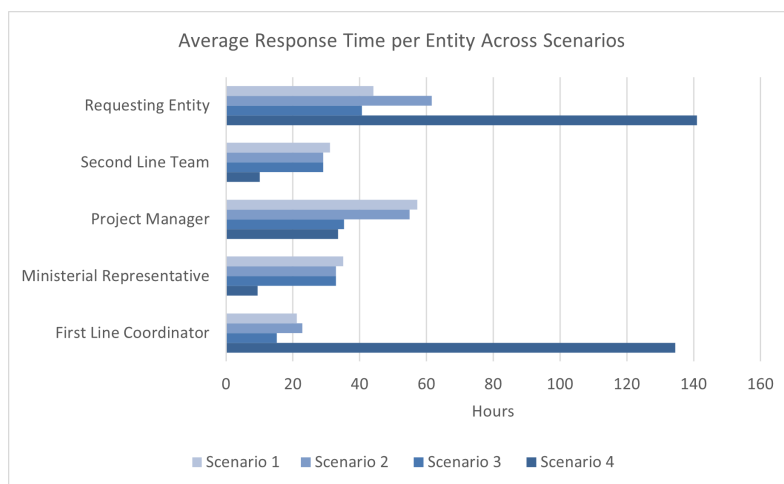
**(b)** Timeout distribution in Scenario 4

**Table 8.5:** Timeouts per Entity in Scenarios 1 and 4

Entity	Scenario 1	Scenario 4
First Line Coordinator	1	1
Ministerial Representative	15	1
Project Manager	20	10
Second Line Team	12	0
Requesting Entity	13	46

**Figure 8.3:** Visual and quantitative comparison of timeout distribution across Scenarios 1 and 4.

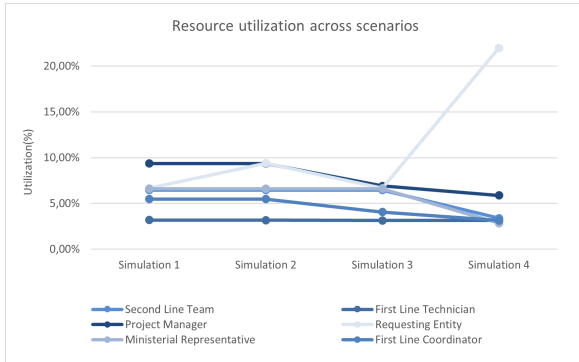
The number of timeouts for the RE increases from 13 in Scenario 1 to 46 in Scenario 4, confirming the appearance of a new bottleneck. The cross-scenario comparison of response times, presented in Figure 8.4, highlights Scenario 3 as the most balanced configuration. It improves response times for the Project Manager and First Line Coordinator without negatively impacting other stakeholders. In contrast, Scenario 4 shows a significant increase in the RE's response time, caused by the centralization of clarification requests. While this reduces the load on other entities, it creates a new bottleneck. Scenarios 1 and 2 remain more balanced overall, with Scenario 2 revealing the impact of a single slow stakeholder, the RE, without disrupting the entire system.



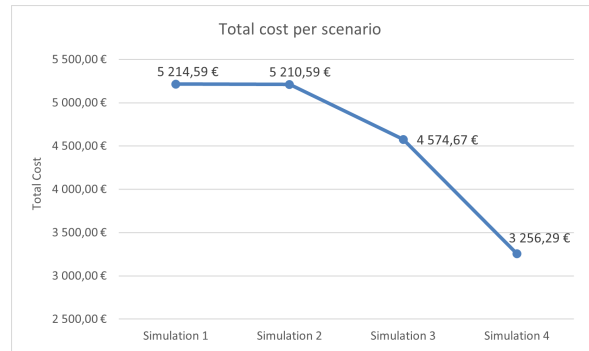
**Figure 8.4:** Average Response Time per Entity Across Scenarios

The analysis of resource utilization across the four simulation scenarios reveals insights into workload distribution. As shown in Figure 8.5, the RE exhibits an increase in workload in Simulation 4, with utilization rising to nearly 22%. The First Line Technician, by contrast, appears consistently underutilized (around 3%). The simulation does not record waiting time during clarifications as active work, even though these idle periods directly influence process duration. In practice, the technician's effective contribution is higher than suggested by utilization metrics alone.

The impact of these changes on operational cost is illustrated in figure 8.5. The progressive reduction in total cost, from 5214,59€ in Simulation 1 to 3256,29€ in Simulation 4, reflects both a redistribution of workload and a more efficient routing of clarification tasks. Scenario 4 achieves the lowest overall cost by reducing the workload of higher cost roles. The redirection of clarification flows helps to simplify the process, reducing rework and unnecessary downtime throughout the process.



(a) Resource utilization across scenarios



(b) Total cost per scenario

**Figure 8.5:** Clarifications Sub-Process: resource utilization and total cost across scenarios.

## 8.2 Simulation of Evaluation Sub-process

The evaluation sub-process is a core component of the e-Avalia workflow, since it evaluates prior opinion requests. It involves a sequence of decision points and validations that ensure each request aligns with strategic, legal, and financial criteria. As discussed in Section 7.3.2, an issue was identified related to rework resulting from review requests issued by the first line coordinator. This rework occurs when the Coordinator disagrees with the technical assessment and returns the request for further review, leading to repeated evaluation cycles and increased workload.

### 8.2.1 Simulation Setup and Assumptions

To understand the performance of the evaluation sub-process, a simulation was carried out with adequate parameters, as shown in Table 8.6. This sub-process involves both first line technicians, responsible for the technical assessment, and the first line coordinator, who carries out the subsequent validation and decision-making tasks.

**Table 8.6:** Simulation Setup and Assumptions of Evaluation Sub-process

Parameter	Description
Simulation duration	60 working days
Number of requests being evaluated	100 requests simulated
Analyze request task duration	Distribution triangular(180, 240, 360)mins
Exclusive gateway	XOR gateway with 70% probability for clarifications sub-process and 30% to send to validation
Clarifications sub-process duration	Distribution triangular(120, 300, 1200)mins
Send to Validation task duration	Fixed duration of 15 minutes
Validate request task duration	Distribution triangular(60, 90, 120)mins
Exclusive gateway: Decision upon the prior opinion	XOR gateway with 25% probability to send to review, 25% to validate favorable prior opinion, 25% to validate unfavorable prior opinion, 25% to validate conditioned prior opinion
Validate Favorable Prior Opinion task duration	Fixed duration of 15 minutes
Validate Unfavorable Prior Opinion task duration	Fixed duration of 15 minutes
Validate Conditioned Prior Opinion task duration	Fixed duration of 15 minutes
Send to Review task duration	Fixed duration of 15 minutes
Resources involved	3 first line technical staff and 1 first line coordinator

## 8.2.2 Scenarios and Parameters

Scenario	Configuration	Purpose
Scenario 1: Base	Review at 25%, 3 technicians available, and 70% of requests sent for clarifications.	Reference configuration reflecting the current process.
Scenario 2: Review Intensified	Review increased to 50%, with 3 technicians and 70% clarifications.	Stress test to evaluate the impact of high review frequency.
Scenario 3: Combined Improvement	Review reduced to 15%, 5 technicians assigned, and 70% clarifications.	Best-case scenario combining reduced reviews and increased capacity.
Scenario 4: Reduced Review	Review reduced to 15%, with 3 technicians and 70% clarifications.	Isolates the effect of reduced review, keeping resource levels constant.
Scenario 5: Clarifications Reduced	Review at 25%, 3 technicians, 20% of requests sent to clarifications.	Tests the impact of fewer clarification loops through improved submission quality.
Scenario 6: Clarifications Moderate Reduction	Review at 25%, 3 technicians, only 50% of requests routed to clarifications.	Tests the impact of a moderate reduction in clarification loops.

**Table 8.7:** Simulation scenarios and their configurations

Six simulation scenarios were defined, as shown in Table 8.7 to analyze the evaluation duration and the rate of rework.

### 8.2.3 Results and Interpretation

To evaluate the performance of *e-Avalia* process, six simulation scenarios were defined, progressively adjusting the number of technicians and the gateway distributions. These scenarios were compared based on process times, waiting times, resource utilization, and cost efficiency.

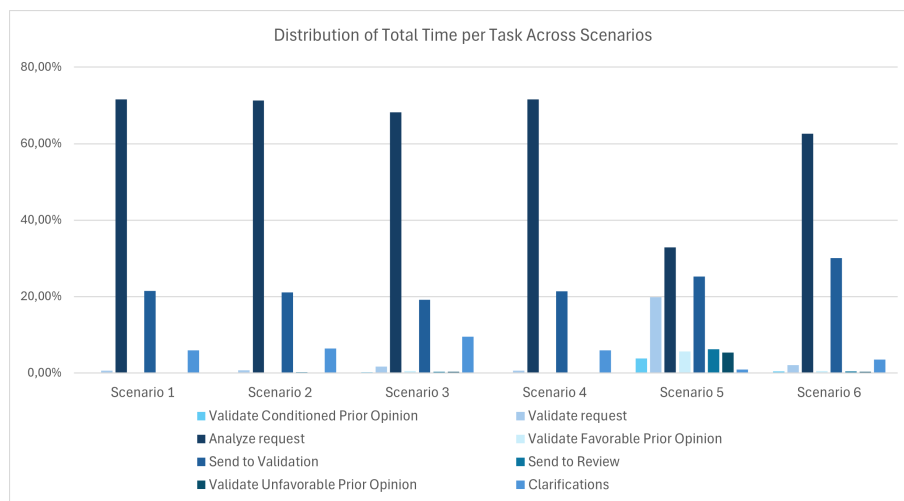


Figure 8.6: Distribution of total time per task across scenarios

Figure 8.6 shows that in all scenarios, a significant portion of time is spent on core decision tasks such as request analysis and validation. However, in Scenario 5, the workload is more evenly spread across sub-processes, suggesting greater dispersion due to technician under-utilization.

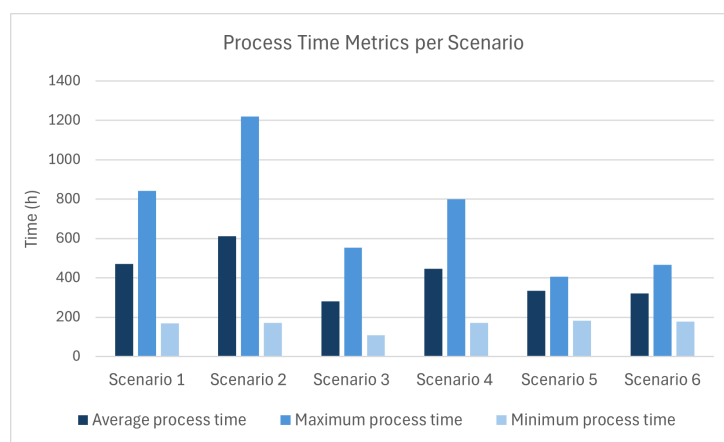
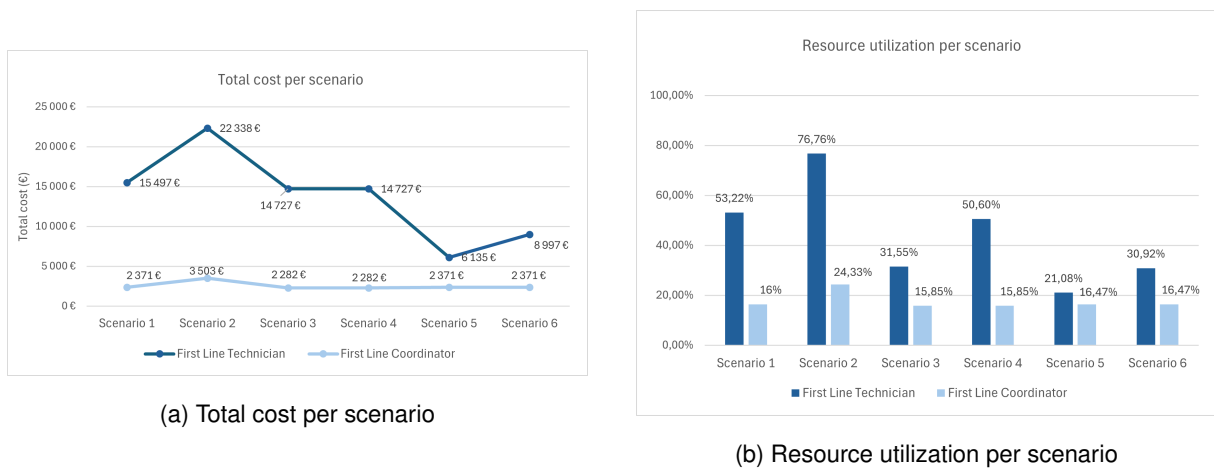


Figure 8.7: Process time metrics per scenario

Figure 8.7 shows that Scenario 2 results in the longest process times, due to high rework and technician saturation. In contrast, Scenario 3 achieves the shortest average and total times by combining reduced rework with increased capacity. Scenarios 4 and 6 also perform well individually by isolating one of these improvements. Scenario 5, despite a lower clarification rate, does not produce significant time gains due to the under-utilization of resources.



**Figure 8.8:** Evaluation Sub-Process: total cost and resource utilization per scenario.

Figure 8.8 illustrates the trade-off between performance and cost across the six simulation scenarios. While Scenario 2 maintains the same technician capacity as Scenario 1, its intensified rework rate leads to the highest cost and workload saturation, with First Line Technicians reaching 76.76% utilization, shown in Figure 8.8. In contrast, Scenario 3 combines a reduction in rework with an increase in the availability of technicians, resulting in a shorter process time and lower total cost. Despite the greater availability of resources, there are significantly fewer task repetitions and delays.

Scenario 4 isolates the impact of rework reduction while keeping the base team size. It achieves greater efficiency compared to Scenario 1, but continues to operate under limited resource conditions. Scenarios 5 and 6 focus on the proportion of requests requiring clarifications. Scenario 5, with fewer clarifications, shows only modest gains and suffers from overcapacity, with technician utilization dropping to 21.08% and time dispersed across non-critical tasks. On the other hand, Scenario 6, with clarifications reduced to 20%, demonstrates a more balanced scenario, achieving **53.22%** utilization and an improved process time, indicating that less external dependence significantly increases response capacity without requiring additional resources.

## 8.3 Simulation of Final Emission Sub-process

The simulation of Final Emission sub-process addresses the rework generated when the Delegate Member disagrees with the previously validated opinion and requests a review, an issue identified in Subsection . In the e-Avalia process, after a request is evaluated by a first line technician and validated by the first line coordinator, it proceeds to the Delegate Member for final review. At this stage, the Delegate Member may either agree with the proposed opinion or return it for re-evaluation, initiating a new evaluation cycle and contributing to technical rework.

### 8.3.1 Simulation Setup and Assumptions

To simulate this behavior, a base configuration was established with 100 requests over 60 working days. The simulation assumes an equal distribution of opinion types (favorable, unfavorable, and conditioned), each represented by distinct process paths. Each opinion type includes its own pair of tasks for analysis and emission. Upon reaching the Delegate Member, each path is governed by a dedicated XOR gateway with a 70% probability of agreement and a 30% probability of triggering a review cycle. This setup is detailed in Table 8.8.

**Table 8.8:** Simulation Setup and Assumptions of the Final Emission Sub-process

Parameter	Description
Simulation duration	60 working days
Number of requests	100 requests simulated
Evaluation sub-process duration	Distribution triangular(390, 660, 1710) minutes
Opinion type distribution	XOR gateway with equal distribution: 33% favorable, 33% unfavorable, and 33% conditioned
Gateways: Delegate Member decision	Three separate XOR gateways (one for each opinion type), each with 70% probability of agreement and 30% probability of returning the opinion for review
Analyse Prior Opinion task duration	Three tasks (one per opinion type), each with distribution triangular(30, 60, 90) minutes
Emit Prior Opinion task duration	Three tasks (one per opinion type), each with fixed duration of 15 minutes
Resources involved	3 first line technical staff, 1 first line coordinator, 1 delegate member

### 8.3.2 Scenarios and Parameters

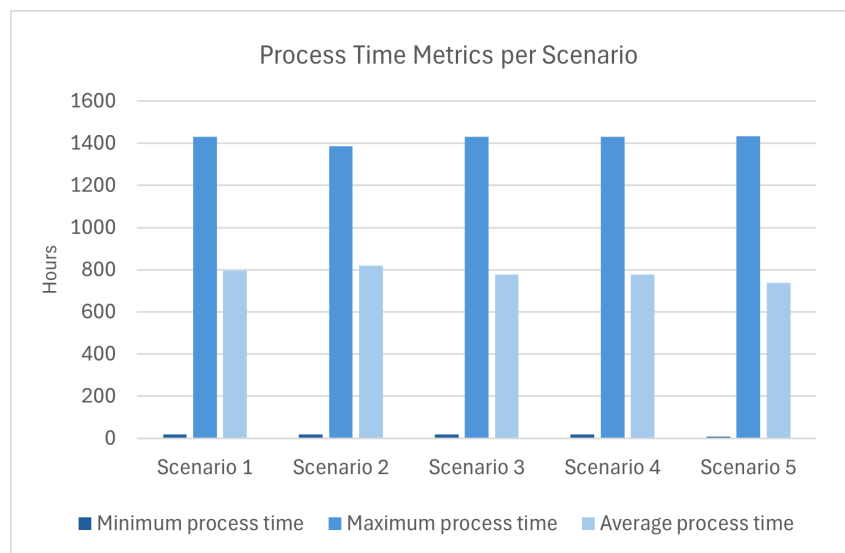
These scenarios enable a comparative analysis of how changes in rework frequency, team size, and task efficiency impact overall process performance in terms of duration, completion rates, and resource utilization. To evaluate the effect of different review rates and resource configurations, five simulation scenarios were defined. Table 8.9 summarizes the configuration and purpose of each scenario.

Scenario	Configuration	Purpose
Scenario 1: Base	Review at 30%, 3 first line technicians, standard evaluation duration triangular(390, 660, 1710).	Reference scenario representing the current process.
Scenario 2: High Review	Review increased to 50%, with 3 technicians and standard evaluation duration.	Stress test to evaluate the impact of high review frequency on performance and resource load.
Scenario 3: Low Review	Review reduced to 15%, keeping 3 technicians and standard evaluation duration.	Isolates the effect of reduced rework without changing team capacity.
Scenario 4: Low Review + Capacity Increase	Review at 15%, 4 technicians assigned, and standard evaluation duration.	Assesses the combined effect of reduced rework and increased technical capacity.
Scenario 5: Optimized Evaluation	Review at 30%, 4 technicians, with improved evaluation duration triangular(240, 480, 720).	Simulates an optimized process with both technical reinforcement and faster evaluation.

**Table 8.9:** Simulation scenarios and their configurations for the Review Issue

### 8.3.3 Results and Interpretation

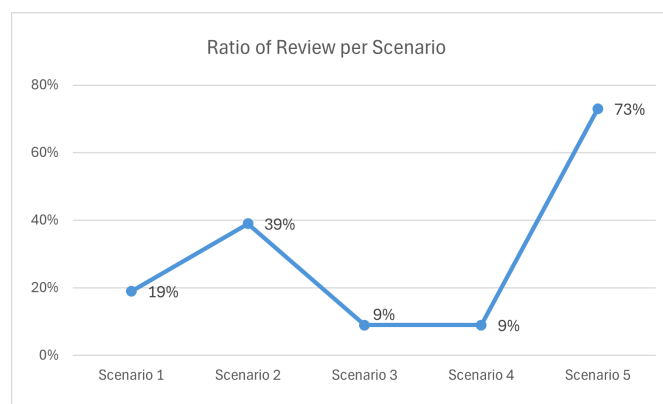
To evaluate the performance of the e-Avalia process in relation to review requests issued by the Delegate Member, five simulation scenarios were considered. The impact of these scenarios was evaluated across different dimensions: process time, rework ratio, rework intensity, completion rate, resource utilization, cost.



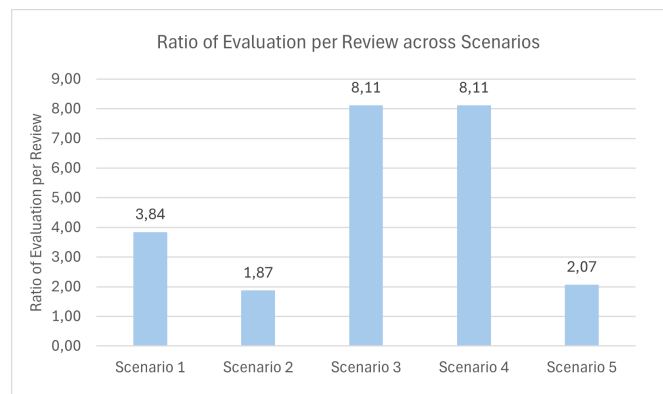
**Figure 8.9:** Process time metrics per scenario

Process time remain relatively stable across the five scenarios, indicating that the system is operating

near its maximum capacity, shown in 8.9. This uniformity suggests that variations in review probability or team size have a limited impact on performance under current workload conditions. Scenario 5 is an exception, which achieves a lower average process time—likely due to the combined effect of reduced evaluation duration and increased resource availability. The ratio of requests sent for review, shown in figure 8.10, is calculated by dividing the number of review requests by the number of started instances of the process. Scenario 5 has the highest review ratio at 73%, which reflects the fact that a bigger number of instances reached the Delegate Member decision point and triggered the review gateway. In contrast, scenarios 3 and 4, configured with a revision probability of 15%, produced the lowest ratios at 9%, confirming the correct behavior of the gateway and a reduction in rework loops.



**Figure 8.10:** Ratio of review per scenario

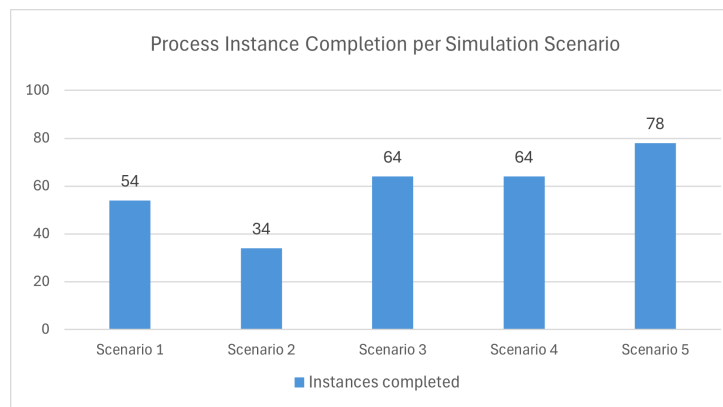


**Figure 8.11:** Ratio of Evaluation per Review across scenarios

Rework intensity, measured as the number of evaluations performed per review request, is shown in Figure 8.11. Scenarios 3 and 4 reveal the highest rework intensity, with more than 8 evaluations performed per review request. This means that each time the Delegate Member rejected a prior opinion, the process looped back to the evaluation step multiple times. Since evaluation is a time-consuming task, repeating it excessively increases the overall process duration and resource consumption. Scenarios 2

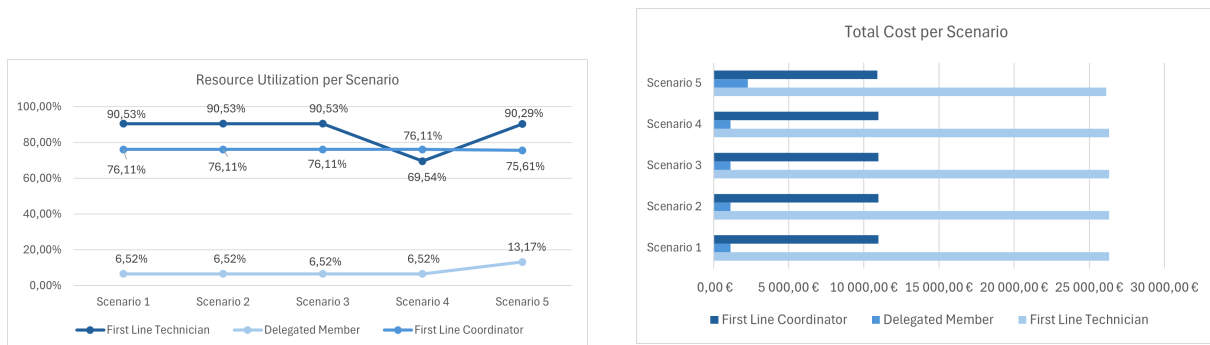
and 5 show a more efficient analysis cycle, in which the result of each assessment is more likely to be accepted at the first attempt.

The completion rate results are shown in Figure 8.12. Scenario 2 resulted in the lowest process completion rate, with only 34 out of 100 instances reaching the end of the workflow, as shown in Figure 8.12. This inefficiency is due to the high volume of rework combined with insufficient resource capacity. In contrast, Scenario 5 achieved the highest completion rate at 78%, highlighting the positive impact of shorter evaluation durations and an expanded team of first-line technicians.



**Figure 8.12:** Process instance completion per scenario

In resource utilization, shown in Figure 8.13, increasing the number of technicians in Scenario 5 did not reduce utilization levels as might be expected.



(a) Resource utilization per scenario

(b) Total cost per scenario, distributed across First Line Coordinator, Delegate Member, and First Line Technician

**Figure 8.13:** Final Emission Sub-Process: Resource utilization and total cost distribution across scenarios.

This suggests that the overall workload was simply distributed among a larger pool of resources, but all remained fully occupied, indicating persistent pressure on the system. Scenario 4, which also introduced an additional technician, showed a more noticeable decrease of approximately 20% in utilization,

although the value remains relatively high. The roles of Delegate Member and First Line Coordinator remained stable across all scenarios, reflecting their limited but consistent involvement in the process.

Figure 8.13 illustrates the distribution of total cost across the main roles involved in the evaluation sub-process. Overall, cost values remain relatively stable across Scenarios, reflecting a state of resource saturation in which higher utilization does not translate into proportionally higher completion rates. Scenario 5 stands out as an exception: while it reduced average process time, the involvement of the Delegate Member in a larger number of decisions increased their share of total cost, slightly raising overall expenditure for that role.

## 8.4 Simulation of Reassessment Sub-Process

The reassessment sub-process plays a complementary but critical role in the e-Avalia workflow, specifically in cases where a conditioned prior opinion is issued. The Delegate Member issues the conditioned opinion and invites the RE to submit a reassessment, allowing them to revise their expenditure request. This action triggers a review by the First Line Coordinator, leading to rework and additional processing time, an issue identified in Section 7.3.4.

### 8.4.1 Simulation Setup and Assumptions

To evaluate the impact of reassessment requests, a simulation was carried out using the configuration present in Table 8.10. The sub-process was modeled to activate in 25% of the 100 simulated prior opinion requests.

**Table 8.10:** Simulation Setup and Assumptions of the Reassessment Sub-process

Parameter	Description
Simulation duration	60 working days
Total requests	100 prior opinion requests simulated
Requests reassessed	25 (25% of total instances)
Emit conditioned prior opinion	Fixed duration of 15 minutes
Fill in reassessment request	Distribution triangular(30, 60, 120) minutes
Reassessment request analysis	Distribution triangular(60, 120, 180) minutes
Gateway decision (Approved or Rejected)	70% probability of approval, 30% rejection
Update contract data (if approved)	Fixed duration of 20 minutes
Resources involved	One Requesting Entity, One Delegate Member, One First Line Coordinator

### 8.4.2 Scenarios and Parameters

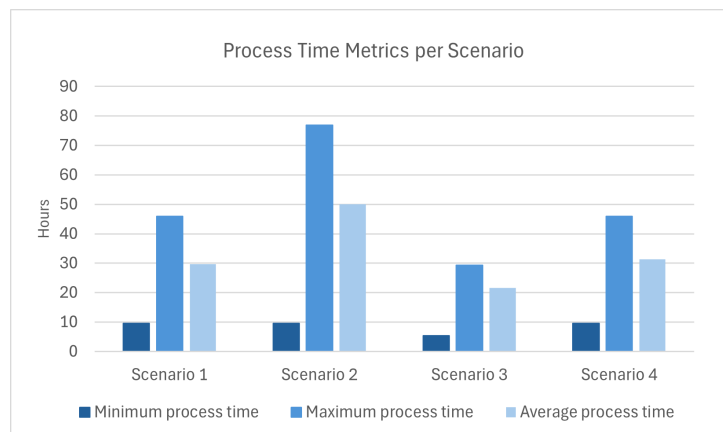
The following scenarios, shown in Table 8.11, allow a comparative analysis of how changes in the frequency of reassessment, the duration of the task, and the decision-making rules affect the performance of the reassessment sub-process.

Scenario	Configuration	Purpose
Scenario 1: Base	25% of requests reassessed; standard task durations; approval gateway at 70%.	Reference scenario representing the current reassessment process.
Scenario 2: Higher Reassessment Rate	45% of requests reassessed; standard durations; approval gateway at 70%.	Stress test to evaluate the impact of increased reassessment frequency on task load and waiting time.
Scenario 3: Faster Evaluation	25% reassessed; shortened duration of the analysis task (Triangular(30, 60, 90)); approval gateway at 70%.	Evaluate the potential time savings resulting from improved reassessment analysis times.
Scenario 4: Increased Approval Rate	25% reassessed; standard durations; approval gateway increased to 90%.	Evaluate the effect of having a higher percentage of reassessment approvals on the efficiency of the process.

**Table 8.11:** Simulation scenarios and their configurations for the Reassessment Sub-process

### 8.4.3 Results and Interpretation

Following the execution of the four simulation scenarios, the reassessment sub-process was evaluated across key performance dimensions: process time, task duration, resource utilization, and total cost.



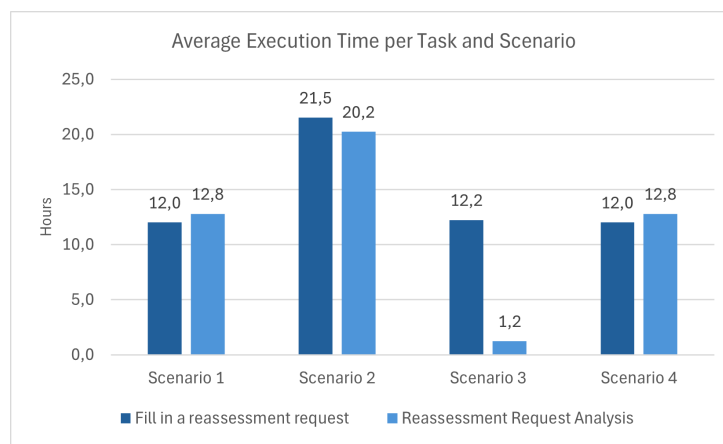
**Figure 8.14:** Process Time Metrics per Scenario

Regarding process time, Scenario 2 revealed the least favorable performance, with both the average

and maximum durations exceeding those of all other scenarios, as seen in Figure 8.14. This outcome can be attributed to the increased number of loops through the reassessment path. In comparison, Scenario 3 achieved the most efficient performance, recording the lowest average and maximum times.

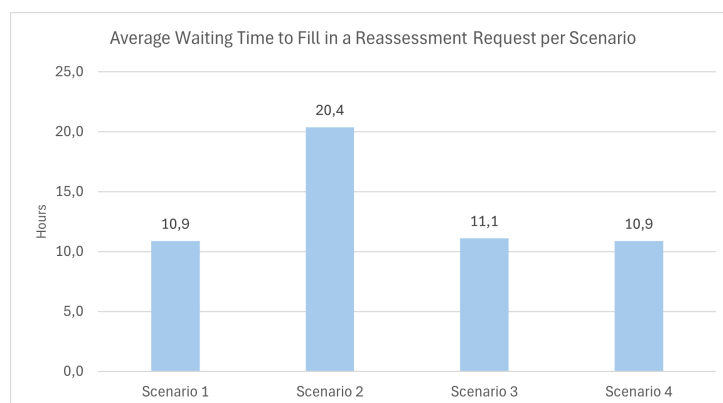
Two key tasks in the reassessment sub-process: Fill in a Reassessment Request and Reassessment Request Analysis, were evaluated in terms of average execution time and average waiting time for resource allocation.

Figure 8.15 shows that Scenario 2 has the highest execution times, with both tasks exceeding 20 hours due to the increased reassessment load. Scenario 3 performs best, reducing the analysis task to 1.2 hours. Scenarios 1 and 4 present similar and moderate durations around 12 hours.



**Figure 8.15:** Average Execution Time of Reassessment Tasks per Scenario

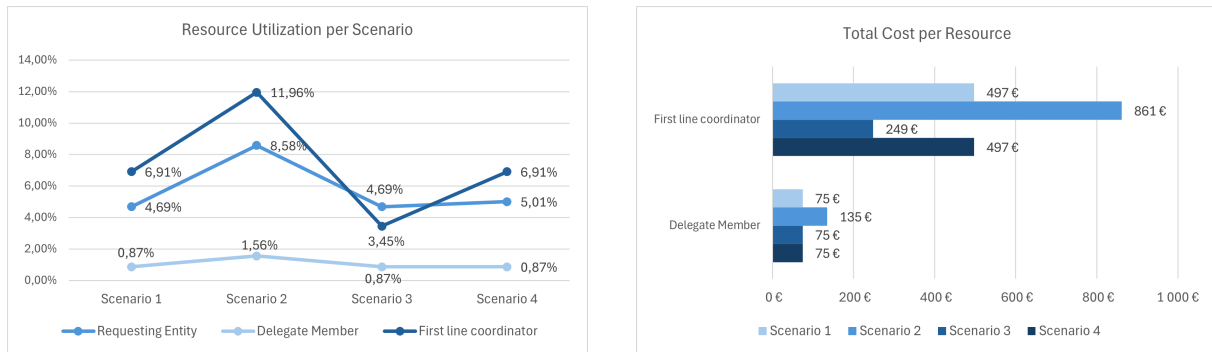
In terms of waiting time for resource allocation, as shown in Figure 8.16, Scenario 2 again performs worst, with approximately 20 hours of waiting time, whereas the other scenarios remain near 11 hours, indicating lower system load.



**Figure 8.16:** Average Waiting Time to Fill in a Reassessment Request per Scenario

Although not shown graphically, the Reassessment Request Analysis task was also analyzed. Sce-

nario 2 recorded the longest average waiting time at around 50 hours, confirming that the system is overloaded. Scenario 3 recorded the lowest value at approximately 6 hours, while Scenarios 1 and 4 showed moderate delays.



**Figure 8.17:** Reassessment Sub-Process: Resource utilization and total cost distribution across scenarios.

In terms of resource utilization, Scenario 2 presented the highest saturation levels across all involved roles, with the First Line Coordinator reaching 11.96% and the Requesting Entity 8.58%, as shown in Figure 8.17. It's reflected the increased reassessment rate configured in this scenario, which placed greater demand on process resources. In contrast, Scenario 3, which implemented a reduced task duration for the reassessment analysis carried out by the First Line Coordinator, showed the lowest utilization rates, which suggests that a shorter task duration can significantly reduce the pressure on resources.

In terms of costs, in Figure 8.17, Scenario 2 has the highest total cost, with the First Line Coordinator's total cost exceeding 900 euros. This is due to the increase in the number of reassessment cases and the longer average processing times, which significantly increase the workload. Scenario 3, on the other hand, records the lowest costs for all the roles involved, reflecting the benefits of reducing task duration.

# 9

## Process Redesign

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This chapter presents the redesign changes proposed for the e-Avalia process, guided by established process redesign heuristics from the BPM literature [1]. Following the identification of performance issues and the results of the simulation, particularly related to excessive internal waiting times and stakeholder overload, specific heuristics were selected to address the underlying causes and improve process efficiency.

Each of the following subsections details how one or more of these heuristics were implemented in specific parts of the process, resulting in a To-Be model.

## 9.1 Redesign of Clarifications Sub-process

The Clarifications sub-process was redesigned with the objective of reducing internal processing time within the e-Avalia platform and mitigating the overload observed in specific external stakeholders, particularly the RE. The performance issues were identified through simulation and analysis.

The As-Is model, where the first-line technician initiates clarification requests directly to multiple stakeholders, followed by separate wait and receive flows. While functionally correct, this structure resulted in redundancy, increased complexity, and poor adaptability to different types of clarification needs.

The most significant change involves the application of the **task reassignment heuristic** [1]. A classification step was introduced to determine the type of clarification required. This is followed by a decision gateway that dynamically routes each request to the most appropriate external stakeholder, such as the RE, Project Manager, Second Line Team, First Line Coordinator, or Ministerial Representative, based on the nature of the issue.

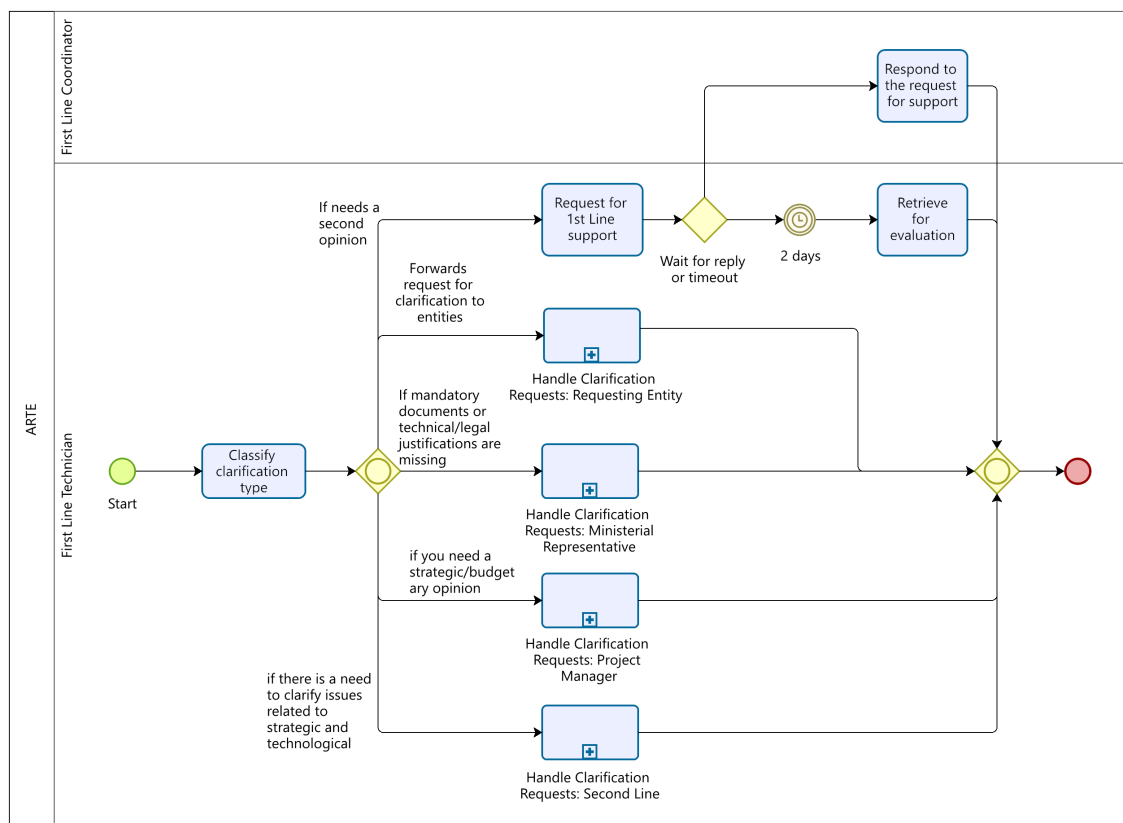
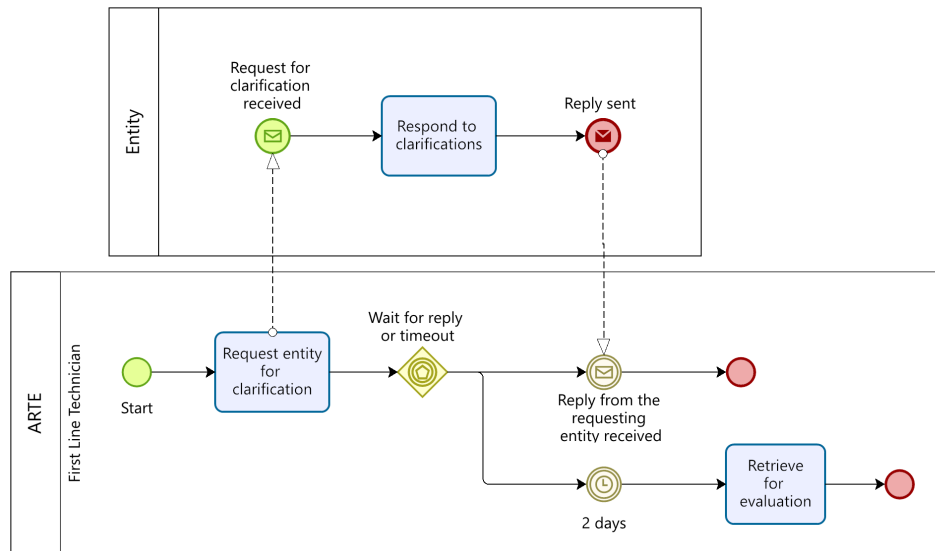


Figure 9.1: To-Be Model of Clarifications Sub-Process

As shown in Figure 9.1, the structure maintains the existing parallel behavior for sending multiple clarification requests, using an OR gateway. This reflects the process reality in which several clarifications

may be issued simultaneously, depending on the specific doubts identified during technical analysis. The parallel design is now better integrated with the classification logic and modular sub-processes.



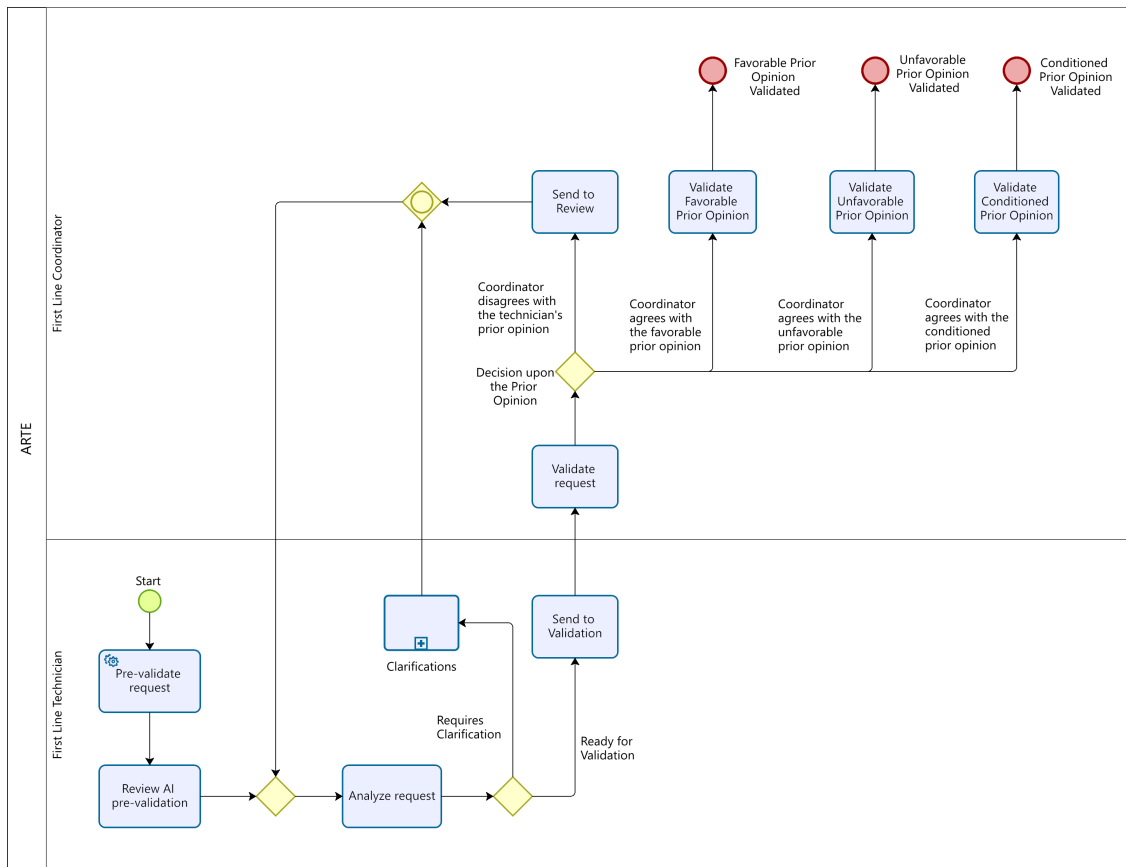
**Figure 9.2:** Reusable sub-process: Process Clarification Request

To simplify the structure and eliminate redundancy, a reusable sub-process was created to encapsulate the logic to handle clarifications. This sub-process, presented in Figure 9.2, includes the sending of the clarification, waiting for a response or timeout, and receiving the reply. The use of a single generic sub-process aligns with the **task elimination heuristic** by replacing repeated logic [1].

## 9.2 Redesign of Evaluation Sub-process

The current model of the Evaluation sub-process reveals a recurring issue associated with reworking requests issued by the first line coordinator. These revision cycles introduce significant inefficiencies, through increased processing time and resource load, often leading to rework cycles that delay final decision-making. This issue was classified in the waste analysis as a defect and highlighted by the value-added analysis, which classified repeated review activities as BVA, but with diminishing returns when iterations become excessive.

Simulation results confirmed this inefficiency, especially in Scenario 2 in Section 8.2, where the increased review rate led to elevated process times and higher utilization of the coordinator. The average process duration increased substantially in this scenario, confirming that review triggered rework loops have a major impact on overall performance.



**Figure 9.3: To-Be Model of Evaluation Sub-Process**

To resolve these inefficiencies, a reformulation of the sub-process in figure 9.3 is proposed. The redesign focuses on reducing rework while preserving the necessary control over the final result.

The first redesign action focuses on supporting the technician during evaluation, before the request is sent to the coordinator for review. The new approach integrates an AI-based pre-analysis tool that automatically highlights the specific fields in the original request that require revision. These suggestions are reviewed and confirmed by the technician during analysis. By integrating this guidance directly into the interface, the technician receives support, reducing the likelihood of submitting incomplete or incorrect information that would otherwise be returned by the coordinator for further analysis. This solution applies the **integral technology heuristic** [1], which incorporates technology directly into the process to support task execution and reduce manual effort, thus minimizing the chances of rework.

At the same time, the reformed process introduces a formal pre-assessment validation stage, through which the technician ensures that all the essential requirements are met before presenting them to the coordinator. This structural change reflects the **error-proofing heuristic** [1], as it proactively prevents common issues from reaching the final review stage. Additionally, it applies the **triage heuristic** by functionally separating technical analysis from strategic decision-making [1]. Together, these changes

reduce workload on the coordinator.

### 9.3 Redesign of Final Emission Sub-process

The Final Emission sub-process, which involves the review of requests issued by the Delegate Member, was identified as a critical point of inefficiency in the e-Avalia workflow. In the current configuration, requests for reassessment or clarification by the Delegate Member result in rework loops, where prior opinions are sent back for revision. These loops contribute to increased process time, higher resource consumption, and frequent repetition of the evaluation task. This issue was identified as a Defect in the waste analysis and categorized as a BVA activity in the value-added analysis, though its contribution declines significantly after repeated iterations.

The simulation results confirmed the impact of this inefficiency, particularly in Scenario 2 in Section 8.3, where a higher rate of revised opinions led to a longer process duration and a bigger load on technical and coordination staff. The rework cycles not only delayed the final decision, but also congested key functions with redundant tasks, reducing performance. To address this issue, a redesigned sub-process is proposed, as shown in Figure 9.4. The purpose of this redesign is to reduce unnecessary review cycles, ensuring that the delegate member's time is not wasted. The most significant change concerns the handling of opinions sent for review by the delegate member. In the As-Is model, a disagreement by the Delegate triggered a new evaluation cycle, involving both the technician and the coordinator. In the to-be model, the opinion is forwarded directly to the First Line Coordinator, who is now responsible for reviewing and adjusting the content, without invoking the technician or restarting the entire evaluation sub-process.

This structural change applies the **activity elimination heuristic** [1], as it eliminates the redundant re-execution of technical evaluation tasks when only a targeted review is required. The coordinator's role is adapted to include a targeted review function, which speeds up the review process and reduces the number of rework cycles.

In addition, this reformulation reflects the **triage heuristic** [1], clarifying the division of responsibilities. The technician remains responsible for the initial evaluation, while the coordinator now manages all the review iterations coming from the Delegate Member, before sending them back to him. The final strategic validation remains under the authority of the delegated member, but the handling of rework is centralized at the level of the coordinator, reducing the unnecessary involvement of technical staff.

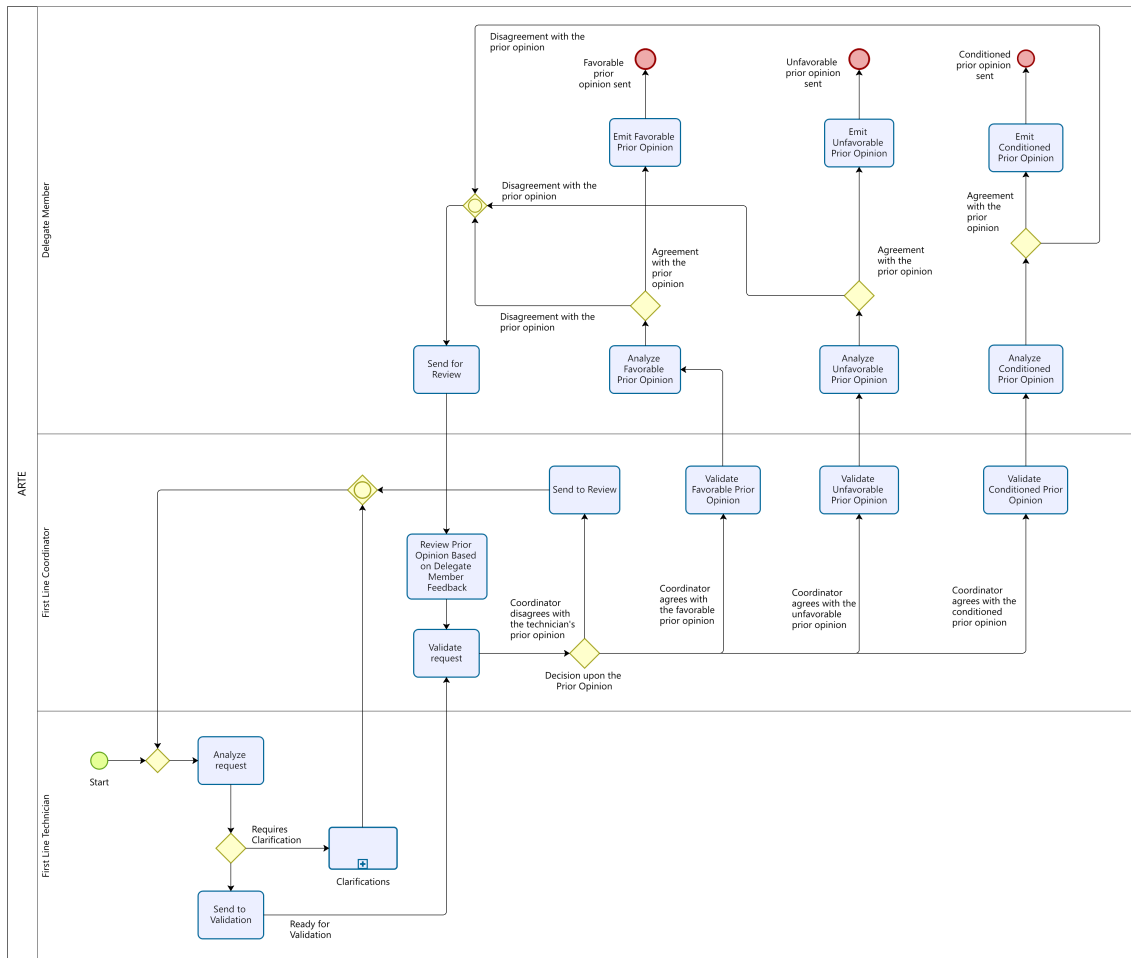


Figure 9.4: To-Be Model of the Final Emission Sub-Process

## 9.4 Redesign of Reassessment Sub-process

The reassessment sub-process was found to be particularly affected by recurring rework cycles. Although the reassessment request should always be completed, the current process requires the RE to interpret a comment provided by the first line coordinator and manually identify which sections of the original submission should be updated. This unstructured approach introduces ambiguity and delays, resulting in rework cycles, as confirmed by the simulation results. The redesigned sub-process is illustrated in Figure 9.5.

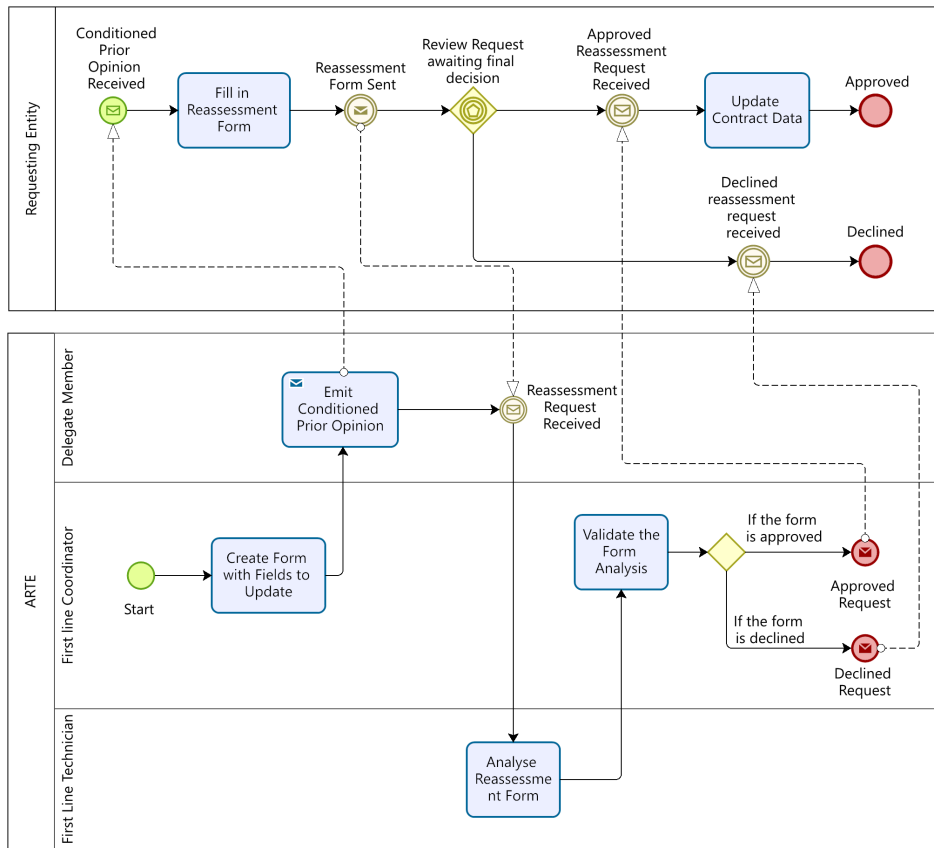


Figure 9.5: To-Be Model of the Reassessment Sub-Process

### 9.4.1 Activity Elimination Heuristic

The first heuristic applied is activity elimination [1]. The reassessment task itself remains necessary, but the redesign eliminates the non-value-adding activity embedded within it: the redundant cognitive effort involved in interpreting unstructured comments and reassessing the entire request. The task can be simplified by introducing a structured reassessment form that includes only the fields that require review. This targeted form eliminates the need for the RE to reassess the entire request, reducing effort for both the RE and the coordinator.

### 9.4.2 Empowerment Heuristic

The second heuristic applied is **empowerment**. According to this heuristic, process actors should be given more autonomy by providing them with the information and authority needed to perform their tasks without unnecessary control or repeated interactions [1]. In the redesigned reassessment sub-process, the RE receives a structured form instead of vague comments, which enables them to complete

the reassessment independently. This application of the empowerment heuristic reduces the need for clarifications, increasing transparency.

### **9.4.3 Task Redistribution and Triage Heuristics**

The inefficiencies identified are also linked to the execution of the Reassessment Request Analysis task, currently assigned to the first line coordinator. This task is considered BVA, as it ensures that reassessed requests meet the necessary requirements, but its execution in the current form introduced delays and rework. Simulation results showed that in Scenario 2 of Subsection 8.4.2, where the reassessment rate increased, the coordinator's utilization was significantly higher and the average process time approached 50 hours.

To resolve this, the redesign redistributes responsibilities by transferring the analysis activity to a first line technician, while the coordinator retains only the final validation stage. This reflects two additional heuristics: triage, by separating the analysis and validation into distinct tasks, and task delegation, by shifting workload to a resource with greater availability.

### **9.4.4 Redesigned Reassessment Sub-process**

By eliminating redundant activities, empowering the RE, and redistributing tasks more efficiently, the redesign simplifies reassessment, reduces the risk of recurring rework, and improves performance by resolving the main inefficiencies identified in the qualitative and simulation-based analyses.

# 10

## Process Evaluation

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The Process Evaluation phase completes the BPM lifecycle by assessing whether the redesigned models achieve the intended performance improvements compared to the As-Is model. The evaluation focuses on verifying the expected and measured impacts of the redesigns proposed in Chapter 9 on the e-Avalia process. Specifically, it assesses whether the BPM heuristics applied contribute to reducing process duration, rework, and resource overload.

The evaluation combines quantitative analysis generated from simulation tests comparing As-Is and To-Be models with qualitative reasoning based on the theoretical implications of the applied heuristics. The results are interpreted through the four performance dimensions of the Devil's Quadrangle [1]: time, cost, quality, and flexibility; ensuring a comprehensive evaluation of the redesigned process.

## 10.1 Evaluation Criteria

This section defines the criteria and performance indicators used to assess the redesigned models of the e-Avalia process. The evaluation follows the four classical dimensions of the BPM performance model known as the Devil's Quadrangle [1]: time, cost, quality, and flexibility. Time and cost indicators derive directly from the Bizagi simulation results, quality and flexibility are interpreted through both quantitative evidence and qualitative reasoning based on the redesign heuristics. Each dimension is supported by a set of measurable or observable indicators that can be compared with the results obtained from the As-Is simulations presented in Chapter 8.

For comparability and methodological consistency, only the Scenario 1 configuration was used to evaluate and contrast the To-Be models against the As-Is simulations. This approach makes sure that the performance differences we see are mainly because of the structural and operational changes made to the redesigned models.

The four dimensions and their respective indicators are summarized in Table 10.1. Together, they offer a comprehensive perspective on the expected performance improvements in the To-Be models.

**Table 10.1:** Summary of present evaluation dimensions and indicators

Dimension	Key Indicators
Time	Average process duration, Minimum process duration, Maximum process duration, Average task duration
Cost	Total cost per resource, Total cost
Quality	Rework Rate
Flexibility	Exception handling, task reassignment, responsiveness to stakeholders

## 10.2 Evaluation of Clarifications Sub-process

The Clarifications sub-process was redesigned to address inefficiencies identified in the As-Is model, particularly the redundancy and overload associated with multiple parallel clarification requests initiated by the first-line technician.

The simulation setup followed the same configuration described in Table 8.3, except that the To-Be simulation introduced the structural modifications in Table 10.2. The new task *Classify clarification type* routes each clarification to the appropriate reusable sub-process. All other parameters, such as task durations, resource allocation, and probability distributions, remained unchanged, allowing a direct comparison between As-Is and To-Be models.

**Table 10.2:** Modifications to the setup for simulation of the To-Be Model of the Clarifications Sub-process

Parameter	Description
Classify Clarification Type	Fixed duration of 10 minutes

The impact of the changes is presented in Table 10.3, which compares the As-Is and To-Be models based on quantitative indicators.

**Table 10.3:** Quantitative Comparison between As-Is and To-Be: Clarifications Sub-Process

Metric	As-Is	To-Be	Difference	Percentage Change (%)
Average process time (h)	37.91	38.16	0.25	0.66%
Minimum process time (h)	6.30	6.47	0.17	2.64%
Maximum process time (h)	80.56	80.73	0.17	0.21%
Total process cost	4,290.59	5,283.56	992.97	23.14%
Second Line cost	744.60	715.79	-28.82	-3.87%
First Line Technician cost	924.00	973.40	49.40	5.35%
Project Manager cost	1,618.02	1,618.02	0.00	0.00%
Ministerial Representative cost	1,138.91	1,187.30	48.39	4.25%
First Line Coordinator cost	789.05	789.05	0.00	0.00%
Second Line utilization (%)	6.46%	6.21%	–	-3.87%
First Line Technician utilization (%)	3.18%	3.25%	–	2.20%
Project Manager utilization (%)	9.36%	9.36%	–	0.00%
Requesting Entity utilization (%)	6.65%	6.78%	–	1.95%
Ministerial Representative utilization (%)	6.59%	6.87%	–	4.25%
First Line Coordinator utilization (%)	5.48%	5.31%	–	-3.10%

### Percentage Change metric

The *Percentage Change (%)* column shows the relative difference between the As-Is and To-Be results.

It was calculated as:

$$\text{Percentage Change (\%)} = \frac{\text{To-Be} - \text{As-Is}}{\text{As-Is}} \times 100$$

Negative values indicate an improvement, while positive values represent an increase.

## Process performance

The introduction of the *Classify Clarification Type* task slightly increased the average process time by 0.66%, while the minimum and maximum durations also rose by 2.64% and 0.21%, respectively. Although these variations are minimal, they indicate that the redesign introduced a small overhead without generating efficiency gains. Process performance remained stable, suggesting that the main benefits of the redesign are structural rather than temporal.

## Resource utilization

The redesign did not result in significant efficiency gains in resource utilization. As shown in Table 10.3, the distribution of the workload changed only slightly, with small decreases for the Second Line and Coordinator (−3.87% and −3.10%) and slight increases for the Technician and Ministerial Representative (+2.20% and +4.25%). These variations suggest a minor redistribution of effort rather than an overall improvement in resource performance. The total process cost increased by 23.14%, indicating that the new configuration did not bring clear benefits in terms of productivity.

## Discussion

Overall, the redesign of the Clarifications sub-process did not yield measurable performance improvements, but it achieved structural and organizational benefits. The addition of the *Classify Clarification Type* task and the creation of a reusable sub-process simplified the model's logic and improved its maintainability, although at the cost of slightly higher execution time and process cost. These results indicate that the applied heuristics, task reassignment and task elimination, were effective in reducing model redundancy and clarifying responsibilities but did not translate into operational gains.

## 10.3 Evaluation of Evaluation Sub-process

The evaluation sub-process was redesigned to address inefficiencies identified in the As-Is model, particularly the high rate of rework resulting from review requests issued by the first line coordinator. The simulation setup was identical to that described in Subsection 8.2.1, except that the To-Be simulation introduced several structural and parameter changes to reflect the redesigned model. Table 10.4 summarizes the changes applied to the To-Be Model of the Evaluation Sub-process.

**Table 10.4:** Modifications to the setup for simulation of the To-Be Model of the Evaluation Sub-process

Parameter	Description
Pre-validate request task	Fixed duration of 5 minutes
Review AI pre-validation	Fixed duration of 1 hour
Analyze request task duration	Distribution triangular (120, 170, 250) minutes
Exclusive gateway	XOR gateway with 65% probability for the clarifications sub-process and 35% to send to validation
Exclusive gateway: Decision upon the prior opinion	XOR gateway with 19% probability to send to review, 27% to validate favorable prior opinion, 27% to validate unfavorable prior opinion, and 27% to validate conditioned prior opinion

Two new activities were added: a short *Pre-validate request* task and an *AI-based pre-validation* task. In addition, the *Analyze Request* task duration was reduced and set as a triangular distribution (120, 170, 250) minutes, while the probability of rework loops was reduced through adjusted XOR gateway configurations. The probability of triggering the clarifications sub-process was reduced from 70% to 65%, and the probability of initiating a review request was reduced from 25% to 19%. Table 10.5 presents the quantitative comparison between the As-Is and To-Be versions of the Evaluation sub-process.

**Table 10.5:** Quantitative Comparison between As-Is and To-Be: Evaluation Sub-Process

Metric	As-Is	To-Be	Difference	Percentage Change (%)
Average process time (h)	471.61	308.65	-162.96	-34.55%
Minimum process time (h)	169.61	162.70	-6.91	-4.08%
Maximum process time (h)	842.26	515.62	-326.65	-38.78%
Average <i>Analyze Request</i> task duration (h)	77.41	57.37	-20.03	-25.88%
Total process cost (€)	17,868.46	11,407.96	-6,460.50	-36.16%
First Line Technician cost (€)	15,496.97	9,218.23	-6,278.74	-40.52%
First Line Coordinator cost (€)	2,371.48	2,189.72	-181.76	-7.66%
First Line Technician utilization (%)	53.22	31.87	–	-40.12%
First Line Coordinator utilization (%)	16.47	15.21	–	-7.65%
Rework rate: Review Requests only (%)	34%	26%	–	-23.53%
Number of Requests for Clarification	302	215	-87	-28,81%

## Results and interpretation

The redesigned model of the evaluation sub-process achieved consistent performance improvements across all quantitative indicators. Average process time decreased by 34.6%, while the longest cases were reduced by 38.8%, demonstrating shorter and more predictable completion times. The duration of the core task *Analyze Request* was reduced by 25.9%, confirming that AI-assisted guidance and the pre-validation step improved efficiency during technical analysis.

Total process cost decreased by 36.2%, mainly driven by a 40.5% reduction in technician costs, while coordinator costs remained almost stable (−7.7%), indicating that oversight activities were maintained even as workload shifted away from repetitive rework. Technician utilization decreased by 40.1%, confirming a significant relief in operational pressure, whereas coordinator utilization remained practically unchanged.

## Rework behaviour

Rework was defined as any return of a request to a previous phase for clarification or correction. As shown in Table 10.5, both types of rework decreased in the To-Be model. Formal review requests dropped from 34% to 26% (−23.5%), while clarification requests decreased from 302 to 215 (−28.8%). These reductions demonstrate the preventive effect of the redesign described in Subsection 8.2.1, where the inclusion of AI-based pre-validation and structured pre-assessment improved first-time quality and reduced redundant iterations.

## Discussion

Overall, the To-Be simulation shows that integrating technological support and preventive validation mechanisms can significantly reduce cycle time, total cost, and technician workload while preserving decision quality and throughput. The combined application of the integral technology, error-proofing, and triage heuristics effectively minimized both administrative and technical rework.

## 10.4 Evaluation of Final Emission Sub-process

In the As-Is model, review requests from the Delegate Member triggered full re-evaluation cycles involving both the technician and the coordinator. These repeated loops increased process time and technical workload, as the same evaluation tasks were executed multiple times.

The To-Be model eliminated this redundancy by introducing the *Review Prior Opinion Based on Delegate Member Feedback* task, which handles delegate feedback directly, without re-involving the technician. To achieve this, the Evaluation sub-process within the Final Review sub-process was expanded to

prevent reviews requested by the delegate member from passing through the entire evaluation process again.

The redesigned sub-process reused the To-Be evaluation model described in the previous section in Table 10.4. Additionally, the inclusion of the new coordinator review task applies the activity elimination and triage heuristics, ensuring that rework is handled at the appropriate level while reducing unnecessary iterations. Table 10.6 summarizes the changes introduced in the simulation setup for the redesigned model.

**Table 10.6:** Modifications to the setup for simulation of the To-Be Model of the Final Review Sub-process

Parameter	Description
Review Prior Opinion Based on Delegate Member Feedback task	Distribution triangular (120, 170, 250) minutes

The impact of these changes on process performance is presented in Table 10.7, which compares the As-Is and To-Be models based on quantitative indicators.

**Table 10.7:** Quantitative Comparison between As-Is and To-Be: Final Review Sub-process

Metric	As-Is	To-Be	Difference	Percentage change (%)
Average process time (h)	796.01	657.10	-138.91	-17.45%
Minimum process time (h)	17.52	17.29	-0.23	-1.31%
Maximum process time (h)	1,429.92	1,412.91	-17.01	-1.19%
Total process cost (€)	38,391.16	33,941.34	-4,449.82	-11.60%
First Line Technician cost (€)	26,304.00	21,027.33	-5,276.67	-20.06%
First Line Coordinator cost (€)	10,960.00	11,860.02	+900.02	+8.21%
Delegate Member cost per resource (€)	1,127.16	1,053.99	-73.17	-6.49%
First Line Technician utilization (%)	90.53%	72.48%	–	-19.94%
Delegate Member utilization (%)	6.52%	6.10%	–	-6.44%
First Line Coordinator utilization (%)	76.11%	82.36%	–	+8.21%

## Results and interpretation

The redesigned Final Review sub-process achieved the intended goal of avoiding unnecessary re-evaluation cycles triggered by the Delegate Member. By expanding the embedded evaluation sub-process and introducing the *Review Prior Opinion Based on Delegate Member Feedback* task, the

coordinator became the only person responsible for handling feedback reviews.

The simulation results confirm these improvements. Average process time decreased by 17.45%, demonstrating an acceleration of the overall cycle. The minimum and maximum durations changed only slightly (−1.31% and −1.19%, respectively), indicating that the redesign primarily reduced the duration of typical cases, while extreme cases remained stable. Process cost had a total reduction of 11.6%. This was mainly driven by a 20.06% decrease in technician cost, offset by a 8.21% increase in coordinator cost, consistent with the new review responsibility attributed to this role. Resource utilization results reinforce this redistribution of workload: technician utilization dropped by nearly 20%, while coordinator utilization rose by approximately 8%, confirming that the coordinator absorbed the rework effort previously shared with the technician. The delegate's utilization decreased marginally (−6.44%), indicating reduced dependency on their repeated input.

### **Coordinator review task impact**

The To-Be configuration added a specific *Coordinator Review in Response to Delegate Feedback* task with an average duration of 1,516.51 minutes, executed 17 times during the simulation. This targeted task replaced the need to restart the entire evaluation sub-process (which in the As-Is model lasted 45,766.38 minutes in total), effectively avoiding 17 full evaluation cycles. This structural improvement directly contributed to the observed reduction in average time and technician cost.

### **Discussion**

Overall, the redesign demonstrates that applying the activity elimination and triage heuristics effectively improved the efficiency of the Final Review sub-process. The coordinator centered handling of delegate feedback reduced unnecessary rework and shortened processing time without compromising control or output quality.

## **10.5 Evaluation of Reassessment Sub-process**

The reassessment sub-process was simulated to evaluate the impact of the redesign proposed in Section 9.4. The main inefficiencies identified in the As-Is model were linked to redundant rework cycles and excessive dependence on the First Line Coordinator for reassessment handling. The process required the RE to interpret unstructured feedback and manually determine which sections of the original submission should be modified, which often led to ambiguity, delays, and reprocessing of information.

In the To-Be model, these issues were addressed through the application of three main redesign heuristics: activity elimination, empowerment, and task redistribution. The redesign introduced a structured reassessment form containing only the fields that required update, empowering the RE to act

autonomously and reducing the need for clarifications. Additionally, the analysis task was delegated to the First Line Technician, while the First Line Coordinator retained only the validation stage, ensuring a more balanced workload distribution.

The setup for the To-Be model simulation was based on the configuration described in Table 8.10, with only a few adjustments introduced in the To-Be setup, as summarized in Table 10.8.

**Table 10.8:** Modifications to the setup for simulation of the To-Be Model of the Final Review Sub-process

Parameter	Description
Create Form with Fields to Update task	Fixed duration of 30 minutes
Analyze Reassessment Form task	Distribution triangular (100, 40, 140) minutes
Validate the Form Analysis task	Fixed duration of 20 minutes

Table 10.9 compares the main performance indicators between the As-Is and To-Be models related to the Reassessment sub-process.

**Table 10.9:** Quantitative Comparison between As-Is and To-Be: Reassessment Sub-Process

Metric	As-Is	To-Be	Difference	Percentage Change (%)
Average process time (h)	27.87	28.14	+0.28	+0.99%
Minimum process time (h)	4.23	3.30	-0.93	-22.05%
Maximum process time (h)	51.38	53.12	+1.74	+3.40%
Total process cost (€)	572.29	499.55	-72.74	-12.71%
First Line Technician cost (€)	0.00	416.22	-416.22	–
Delegate Member cost (€)	75.00	75.00	0.00	0.00%
First Line Coordinator cost (€)	497.29	83.33	-413.95	-83.24%
Requesting Entity utilization (%)	4.69%	2.29%	–	-51.17%
First Line Technician utilization (%)	0.00	3.61%	–	–
Delegate Member utilization (%)	0.87%	0.43%	–	-50.57%
First Line Coordinator utilization (%)	6.91%	0.58%	–	-91.61%

### Process performance

The results indicate that the redesigned reassessment sub-process achieved an improvement in resource balance and cost efficiency. Although the average process time increased slightly by approximately 10%, this variation is justified by the verification step added to the task *Validate Form Analysis*.

It is important to note that the total cost of the process decreased by 12.7%, mainly due to the reduction in the coordinator's workload (83.24%) and the redistribution of tasks to the technician.

### Resource utilization

The introduction of the new structured reassessment form contributed to process stability by eliminating rework loops and clarifying responsibilities. Technician utilization increased to 3.61%, reflecting their new analytical role, while Coordinator utilization dropped from 6.91% to 0.58%, confirming that the redesign effectively reduced costs.

### Discussion

The To-Be model of the Reassessment sub-process demonstrates a clear trade-off between slightly longer cycle times and considerable gains in cost efficiency and workload distribution. These results confirm that the redesign successfully addressed the primary inefficiencies identified in the As-Is model.

## 10.6 Discussion of the Evaluation results

The evaluation of the redesigned models demonstrates how the application of BPM heuristics influenced the overall performance of the e-Avalia process.

**Table 10.10:** Overview of evaluation results: As-Is vs To-Be Model

Sub-process	Average process time	Maximum process time	Total cost
Clarifications	+0.66%	+0.21%	+23.14%
Evaluation	-34.55%	-38.78%	-36.16%
Final Review	-17.45%	-1.19%	-11.60%
Reassessment	+0.99%	-3.40%	-12.71%

The Evaluation sub-process recorded the most significant improvements, with a 34.6% reduction in average process time and a 36.2% decrease in total process cost. Technician workload dropped by 40%, mainly due to the pre-validation and AI-based analysis tasks that minimized rework. These results demonstrate the effectiveness of the applied *integral technology*, *error-proofing*, and *triage* heuristics in reducing redundant work and improving first-time quality.

The Final Review sub-process achieved a 17.5% reduction in average duration and an 11.6% decrease in costs, eliminating the complete re-evaluation cycles previously triggered by feedback from Delegate Members. Technician utilization fell by 19.9%, while Coordinator utilization increased by 8.2%, confirming a more efficient redistribution of responsibilities.

The Reassessment sub-process reduced total cost by 12.7%, mainly through workload transfer from the Coordinator to the Technician (–91.6% vs. +3.6% utilization), although total time slightly increased by 10.3% due to the addition of a validation step.

In contrast, the Clarifications sub-process showed no significant performance improvements. Average process time increased by 0.66% and total cost by 23.1%, as the redesign primarily improved structure and maintainability rather than execution efficiency.

Overall, the simulations done confirmed that the redesigned models improved process cost and workload balance, particularly in the Evaluation and Final Review stages, while Clarifications and Re-assessment achieved more structural and organizational benefits.



# 11

## Conclusion

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This chapter concludes the dissertation by summarizing the main findings, highlighting the contributions and limitations of the research, and outlining directions for future work. The study applied the BPM lifecycle to the case of the e-Avalia platform at ARTE, using qualitative and quantitative analysis supported by simulation to identify inefficiencies and propose process redesign.

### 11.1 Main Findings

The research demonstrated that the e-Avalia process presents several inefficiencies that reduce its operational efficiency. The qualitative analysis identified four main issues: excessive waiting times in clarification requests, rework loops caused by Coordinator reviews, redundant evaluation cycles triggered by Delegate Member feedback, and ambiguity in reassessment handling. These inefficiencies were mainly associated with redundant communication flows and unclear role responsibilities.

Quantitative and simulation analyses confirmed these findings. In the As-Is configuration, bottlenecks were concentrated in the Requesting Entity and Coordinator roles, leading to increased process time and cost. Changes in review and reassessment rates showed that higher feedback frequencies could raise total duration and workload by more than 30%. The redesigned To-Be models addressed these problems by applying BPM heuristics such as activity elimination, triage, and task redistribution. As a result after simulating the To-be model, the Evaluation sub-process achieved a 34.6% reduction in time and 36.2% in cost, while the Final Review reduced total duration by 17.5% and cost by 11.6%. The Reassessment redesign lowered cost by 12.7% and significantly reduced Coordinator utilization, although Clarifications remained limited by external response times.

Overall, the results confirm that the BPM lifecycle provided a structured approach to diagnosing and quantifying inefficiencies, while simulation and redesign heuristics enabled tangible improvements in terms of time, cost, and workload balance. The results reinforce BPM's relevance as an evidence-based method for improving efficiency and accountability in digital public administration processes.

## 11.2 Contributions

The main contribution of this dissertation lies in the integration of analysis and simulation within the BPM lifecycle to provide a comprehensive evaluation of a complex public sector process. This includes:

- (i) Process modeling and issue identification: Ten BPMN diagrams were developed to represent the e-Avalia workflow and its nine sub-processes. The qualitative analysis identified four main inefficiencies: redundant clarification cycles, coordinator-driven rework, repetitive delegate feedback, and ambiguous reassessment handling, revealing that some activities were non-value-adding.
- (ii) Quantitative analysis and simulation: Simulation of the As-Is model quantified the impact of the four issues. Several scenarios were simulated to test how variations in review probability, reassessment frequency, and external response times affected process performance.
- (iii) Redesign and performance improvements: Four To-be sub-processes were redesigned and then applied BPM redesign heuristics, like *Activity Elimination*, *Empowerment*, *Triage*, and *Task Redistribution*. The Evaluation sub-process achieved a 34.6% reduction in time and 36.2% in cost, the Final Review reduced duration by 17.5% and cost by 11.6%, and Reassessment improved cost efficiency by 12.7%. Clarifications gained structural simplicity but remained limited by external delays.

The study provides the ARTE with actionable redesign proposals, such as AI pre-validation, structured reassessment forms, and centralized review handling, and contributes academically by demonstrating how simulation enhances BPM analysis in public sector contexts.

### **11.3 Limitations and Future Work**

The main limitations of the study are the absence of execution logs, which required reliance on assumed probability distributions, and the context-specific nature of the case, which may restrict generalization. Future research should validate the redesigned process with real execution data once it becomes available, extend the approach to other processes within ARTE, and explore hybrid methods combining process mining with simulation to improve accuracy. More broadly, further case studies in public administration would strengthen the evidence base for BPM lifecycle applications in multi-stakeholder digital platforms. In closing, this dissertation demonstrates that combining analysis and simulation within the BPM lifecycle provides a powerful approach for uncovering inefficiencies and supporting evidence-based redesign. By applying this approach to the e-Avalia platform, the study not only delivers practical recommendations for ARTE but also advances the understanding of how BPM methods can enhance digital public services.



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**A**

# Appendix A: Qualitative Analysis

**Table A.1:** Identified Waste and Waste Type in the e-Avalia Process

Waste	Waste Type
Record expense request	Over-processing
Select request for deletion	Over-production
Confirm request deletion	Over-processing
Select request for prior opinion or duty of information to distribute	Over-processing
User requests cancellation	Over-production
Insert justification for edit request	Defect (Rework)
Submit edit request	Defect (Rework)
Save draft of clarification request	Over-processing
Record support request	Over-processing
Record clarification request	Over-processing
Send request to Ministerial Representative	Over-processing
Submit opinion to Project Manager	Over-processing
Request cancellation	Over-production
Accept request and cancel process	Over-production
Grant permission to edit	Defect (Rework)
Retrieve request for review	Defect (Rework) + Waiting
Wait for response to support request from requesting entity / external parties	Waiting
Fill out review request	Defect (Rework)
Submit review request	Defect (Rework)
Multiple submission and approval steps	Waiting
Between distribution and technical assignment	Transportation
Recurring rework cycles	Defect (Rework)
Presence of redundant sub-processes	Over-processing
Task duplication across profiles (Ministerial Representative, Manager, Second line Team)	Over-processing + Motion

**Table A.2:** Value-Added Analysis of e-Avalia Activities

Activity	Profile/Role	Type
Open new request	Requesting Entity	VA
Fill in mandatory fields	Requesting Entity	VA
Record expense request	Requesting Entity	NVA

Activity	Profile/Role	Type
Send expense request for evaluation	Requesting Entity	VA
Delete request	Requesting Entity	NVA
Select prior opinion request to distribute	1st Line Coordinator	NVA
Assign 1st line technician	1st Line Coordinator	BVA
Confirm distribution	1st Line Coordinator	BVA
Select request with duty of information to distribute	1st Line Coordinator	NVA
Assign 1st line technician	1st Line Coordinator	BVA
Confirm distribution	1st Line Coordinator	BVA
User requests cancellation	Requesting Entity	NVA
Confirm cancellation by coordinator	1st Line Coordinator	BVA
Insert justification for edit request	Requesting Entity	NVA
Submit edit request	Requesting Entity	NVA
Technician completes assessment	1st Line Technician	BVA
Submit for validation	1st Line Technician	BVA
Draft clarification request	1st Line Technician	BVA
Save draft of clarification request	1st Line Technician	NVA
Send clarification request	1st Line Technician	BVA
Select support technician/coordinator	1st Line Technician	BVA
Record support request	1st Line Technician	NVA
Submit support request	1st Line Technician	BVA
Select 2nd line support	1st Line Technician	BVA
Record clarification request	1st Line Technician	NVA
Submit clarification request	1st Line Technician	BVA
Record clarification request to Ministerial Rep.	1st Line Technician	NVA
Submit clarification request to Ministerial Rep.	1st Line Technician	BVA
Select project/program manager	1st Line Technician	BVA
Record opinion request to project/program manager	1st Line Technician	NVA
Submit opinion request to 1st Line Coordinator	1st Line Technician	BVA
Request cancellation	Requesting Entity	NVA
Accept and cancel request	1st Line Coordinator	NVA
Grant edit permission	1st Line Coordinator	NVA
Analyze favorable opinion	1st Line Coordinator	BVA
Validate favorable opinion	1st Line Coordinator	BVA
Analyze unfavorable opinion	1st Line Coordinator	BVA
Validate unfavorable opinion	1st Line Coordinator	BVA
Analyze conditional opinion	1st Line Coordinator	BVA
Validate conditional opinion	1st Line Coordinator	BVA
Submit opinion for review	1st Line Coordinator	BVA
Analyze favorable opinion decision	Delegate Member	BVA

<b>Activity</b>	<b>Profile/Role</b>	<b>Type</b>
Validate favorable opinion decision	Delegate Member	BVA
Issue favorable opinion	Delegate Member	BVA
Send favorable opinion for review	Delegate Member	BVA
Analyze unfavorable opinion decision	Delegate Member	BVA
Validate unfavorable opinion decision	Delegate Member	BVA
Issue unfavorable opinion	Delegate Member	BVA
Send unfavorable opinion for review	Delegate Member	BVA
Analyze conditional opinion decision	Delegate Member	BVA
Validate conditional opinion decision	Delegate Member	BVA
Issue conditional opinion	Delegate Member	BVA
Send conditional opinion for RE review	Delegate Member	BVA
Analyze clarification request	Requesting Entity	BVA
Respond to clarification request	Requesting Entity	BVA
Retrieve request for review	1st Line Technician	NVA
Analyze clarification request	1st Line	BVA
Respond to clarification request	1st Line	BVA
Analyze clarification request	2nd Line	BVA
Respond to clarification request	2nd Line	BVA
Analyze clarification request	Ministerial Rep.	BVA
Respond to clarification request	Ministerial Rep.	BVA
Analyze clarification request	Project/Program Manager	BVA
Respond to clarification request	Project/Program Manager	BVA
Fill in reassessment request data	Requesting Entity	NVA
Submit reassessment request	Requesting Entity	NVA
Analyze reassessment request	1st Line Coordinator	BVA
Insert contract into BaseGov	Requesting Entity	VA