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eBPM-C for e-Justice

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Abstract: Business Process Management (BPM) has long been employed as a structured methodology for optimizing complex processes. Electronic Business Process Management (e-BPM) extends traditional organizational optimization to encompass technological dimensions. A key limitation of BPM and e-BPM is the tendency to optimize processes in a compartmentalized way, often leading to solutions that are theoretically optimal but impractical in real-world contexts. To address this, we propose the Electronic Business Process Management Context-aware (eBPM-C) methodology, an extension of e-BPM that adopts a holistic, context-aware approach, ensuring that optimization accounts for interdependencies and supports effective real-world implementation. By maintaining a high-level view while enabling detailed analysis of specific process segments, the methodology supports integrated and sustainable innovation, particularly where digitalization and artificial intelligence-based tools are introduced. This evolution makes the methodology especially suitable for highly regulated and technologically evolving sectors, including e-healthcare and e-justice, where organizational efficiency and technological innovation must be aligned within a coherent systemic design. This article shows the application of eBPM-C to a complex process: the e-justice. In particular, to the optimization of civil trial workflows within Italian courts, a context marked by structural delays despite the formal recognition of the right to a reasonable trial duration at both European and national levels. The methodology guides the balanced integration of telematization, dematerialization of case files, and decision-support systems, ensuring that local technological interventions contribute coherently to overall system performance.

Keywords: e-BPM, e-justice, fair trial, backlog reduction

1. Introduction

Delayed justice is equivalent to denied justice.

The right to a trial within a reasonable time constitutes a core component of the right to a fair trial[1] and, as recognized at the international level, is absolute and inviolable, so directly enforceable by individuals before any judicial authority [1].

In Italy, Article 111 of the Constitution enshrines this principle, mandating that "Jurisdiction is exercised through fair trial regulated by law. [. . .] The law ensures its reasonable duration"[2]. Yet, in practice, the length of proceedings frequently exceeds acceptable standards, also because the violation of time limits does not generally entail procedural inadmissibility [2]. This structural inefficiency underscores the urgent need to enhance the performance and organizational effectiveness of courts.

With this regard, the European Union has developed a digitalization agenda to be followed by the Member States[3] to accelerate Europe's digital transformation by supporting businesses and public administrations through coordinated funding, innovation hubs, and policy frameworks. In Italy, ongoing reforms of civil procedure aim to reduce backlogs, modernize judicial offices, and accelerate proceedings through telematization. However, reorganizing judicial offices remains particularly complex: statutory constraints (e.g., mandatory timeframes for judicial deliberation), chronic understaffing, and the limited or ineffective use of available digital technologies hinder sustainable improvements. Technological tools, even when introduced, often lack adequate integration strategies and staff training, resulting in underutilization.

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[1] Established by Article 6, paragraph 1, of the European Convention on Human Rights: "In the determination of his civil rights and obligations or of any criminal charge against him, everyone is entitled to a fair and public hearing within a reasonable time by an independent and impartial tribunal established by law [...]".

[2] Italian translation: "La giurisdizione si attua mediante il giusto processo regolato dalla legge. [. . .] La legge ne assicura la ragionevole durata."

[3] The European Commission has proposed a Regulation for the Digital Europe Program (2021–2027), a funding program designed to bring digital technology to businesses, citizens, and public administrations. During the first part of the Digital Europe Program (2021-2023), the institution of the European Digital Innovation Hubs (EDIH) has been established. They support European private organizations and public administrations in their digital transition with specific funds, policies, and reinforced networks. Another relevant European initiative is the "Next Generation EU," a recovery instrument to support Europe toward a more digital and a more resilient future. In that context, the Next Generation Office for Trials (NGUPP—namely, "Next Generation Ufficio per il Processo") project has aimed at the digitalization of Italian tribunals and courts.

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Business Process Management (BPM) has long served as a methodology for process optimization and has proven effective even in highly complex organizational systems. Electronic Business Process Management (e-BPM) was the evolution of traditional BPM as an effective methodology in contexts where process optimization involves the introduction of digitalization tools or AI-based solutions, in fields such as e-Health or e-justice.

A recurring limitation in both BPM and e-BPM approaches lies in the tendency to optimize processes through compartmentalized interventions. When the broader context and the interactions among technologies, organizational constraints, and regulatory factors are not adequately considered, proposed solutions may appear optimal in theory but prove impractical or unimplementable in real-world settings.

In processes particularly complex, different instruments may need to be deployed across distinct phases of a process or tailored to specific functions. As e-BPM preserves a systemic, high-level perspective, it enables the optimization of the entire process while continuously accounting for the impact that each task experts on the others.

A recurrent challenge in complex environments is the tendency to optimize processes through compartmentalized interventions. While such approaches may improve individual components, they risk generating unintended cascading effects on other, unexamined parts of the system.

To address this issue, we introduce Electronic Business Process Management Context-aware (eBPM-C), an extension of e-BPM that emphasizes a holistic, context-aware perspective. The methodology is designed to optimize processes involving digital and technological components while explicitly accounting for interdependencies with existing tools, constraints, and external factors. By integrating these dimensions, eBPM-C aims to support solutions that are not only theoretically sound but also practically implementable in real-world environments.

This paper presents a case study to show an example of the applied methodology to a real situation. The use case is about an Italian court and the lifecycle of a civil case file. Throughout its trajectory, a case file moves repeatedly among administrative officers, judges, and, at times, external offices, each characterized by distinct roles, constraints, and legal obligations. Effective optimization therefore requires the analysis of the specific context, the simultaneous consideration of these interdependencies, and the legal requirement related to the process. The paper proposes a dual optimization strategy based on two distinct tools, leading to an integrated overall outcome.

The paper is divided as follows: Section 2 represents the methodological framework; Section 3 introduces the case study of the Court of Cuneo; and Section 4 closes with conclusions and future works.

2. Background and Challenges

BPM [3] has traditionally proven effective in optimizing processes within highly structured and complex organizational environments; building on this foundation, e-BPM has emerged alongside the rapid expansion of the internet and electronic commerce, extending BPM to enhance connectivity and to support process optimization through the integration of digitalization instruments and AI-based tools [4, 5].

In particular, BPM and e-BPM were used to optimize some complex systems as healthcare departments. This approach has often led to improvements confined to individual departments or specific activities, without adequately accounting for the broader system of interconnected processes. Such a compartmentalized perspective has frequently resulted in optimizations that remain largely theoretical and difficult to implement in practice. Indeed, enhancing a single component in isolation may encounter constraints unrelated to that specific activity, such as organizational dependencies, human resource limitations, or downstream bottlenecks. In some cases, what appears to be an optimal improvement at a local level may even generate inefficiencies or overload in subsequent processes [6, 7].

The eBPM-C methodology proposed in this work addresses these limitations by explicitly considering the interdependencies among all relevant factors, rised by the analysis of the whole context. Rather than pursuing the maximal optimization of isolated components, it aims to balance multiple dimensions within the broader ecosystem. This systemic perspective enables more sustainable and coherent improvements, increasing both the overall performance of the system and the practical feasibility of implementing the proposed solutions in real-world contexts. We already used the eBPM-C approach in process optimization in fields such as e-health [8, 9] to introduce different technologies in home hospitalization processes, assess risks, and legal compliance for optimization in e-health processes [10].

The case study helps to show the application of the eBPM-C methodology to optimize a complex process as an Italian Civil Court. To better give an idea of the context, in this case, both the dematerialization and telematization of documents and the provision of decision-support tools for judges are taken into account. This combined approach is necessary because focusing exclusively on telematization would lead to only marginal improvements in organizational efficiency. Indeed, the primary bottlenecks are not located in administrative processing times, but rather in the legally defined timeframe available to judges for issuing decisions. For instance, reducing administrative tasks by a few hours would have a negligible impact if judges were still entitled to take up to six months to deliver a ruling.

While this decision-making timeframe is established by law and cannot be directly modified, it can be indirectly optimized. Judges are allowed up to six months but are not required to use the entire period. By providing decision-support tools that reduce the time needed for legal research and information retrieval, it becomes possible to shorten the effective duration of decision-making.

This demonstrates the importance of addressing interdependent processes in an integrated manner. Treating administrative workflows and judicial decision-making as separate domains would not yield meaningful improvements, as constraints in one area would limit the benefits achieved in the other. The proposed methodology therefore integrates these dimensions, balancing different constraints and resources to enable effective and practically applicable system-wide optimization.

Therefore, the case study illustrates the application of the eBPM-C methodology to the optimization of a complex process within an Italian Civil Court. The primary objective was the transition to the telematic management of civil case files in order to reduce processing times and backlogs. However, the contextual analysis demonstrated that focusing exclusively on the dematerialization and telematization of administrative processes would yield only marginal improvements. This is due to a second factor not considered from the beginning, the inherently iterative nature of judicial workflows, in which case files repeatedly circulate between administrative staff and judges, and where the

main bottlenecks are linked to legally defined decision-making timeframes.

Crucially, the achievement of the initial objective—reducing processing times and backlogs through telematization—requires a holistic perspective and a context-aware approach. Administrative digitalization, judicial support mechanisms, and legal constraints must be treated as interconnected elements rather than isolated components. Only by explicitly accounting for their interdependencies and mutual impact is it possible to design an optimization strategy that is not only theoretically sound but also practically effective.

To this end, the eBPM-C framework evaluates multiple technological solutions in parallel, assigning them to different process segments. This dual optimization strategy ensures that improvements at the task level are coherently aligned with overall system performance, accounting for interdependencies among organizational, technological, and legal factors. Only by considering these elements and their mutual impact is it possible to design a comprehensive and effective optimization strategy. Last but not least, this integrated approach enables a truly real-world applicable optimization.

3. Methodological Framework

The e-BPM methodology is based on four phases:

Phase 1: context analysis. The context analysis is aimed at establishing the general strategic scenario of the company in order to determine the organizational components (that will be investigated), the objectives to be achieved, the definition of user requirements, and the opportunities for innovative solutions. After that, the context analysis selects the company functions and activities that affect these objectives, and consequently, resources involved, issues, and requirements. This phase is important both for the management of the company and for the team that has to carry out the intervention, taking into account the limits and constraints of the intervention itself.

Phase 2: process engineering. Based on the knowledge acquired in the context analysis, the purpose of this phase is to create a model based on the true and fair view of the current process (the As-Is model). The initial aim of this phase is the determination of the activities taking place in the business functions involved in the process, and of the causal factors that create relationships between them. The process is then reconstructed from external input/output events and/or objects, leading to the definition of the process diagram (or process map, or flow chart).

The map of the business is created using the Business Process Model and Notations (BPMN) standard language [11]. In this way, it is possible to analyze the activities, the related resources, time, costs, delays, and bottlenecks [12–14]. The whole analysis is based only on real data stored in the information system (IS) [10].

A set of process performance measures, commonly known as key performance indicators (KPIs), is employed to assess both the overall and specific functioning of the process [15].

The evaluation of the process is centered on three primary KPIs: time, costs, and quality. To assess the temporal efficiency, time is monitored to examine the process from initiation to completion. In parallel, working time metrics are incorporated to evaluate the workload of the operators involved, which contributes to an understanding of the process's overall quality. Additionally, the focus is placed on identifying opportunities to reduce or optimize activities, directly influencing both the efficiency and quality of the process. The cost dimension is also thoroughly analyzed to ensure financial sustainability.

The process model is validated using BPMN and simulation results, providing a reliable framework for stakeholders to assess the effectiveness of the process.

Phase 1 and phase 2 are the most important phases. To complete both of them it is important to really be involved in the processes, look at the real business situation, talk with all level of stakeholders involved. These for a dual point of view: stakeholders involved in a specific task already know direct problems related to the specific task, the analyst point of view at both high or detailed levels allow to detect indirect problems or boundaries. Exactly the context point of view that in able to elaborate a real applicable and useful optimization without simply moving a problem from the segment of the process analyzed to another.

Phase 3: technology analysis. In alignment with the previously established objectives, and upon identifying the areas for improvement, this phase focuses on the exploration of optimization strategies. The primary aim of the technological analysis is to determine the most suitable technologies or devices to be introduced, in order to enhance the process, as well as to identify the optimal points within the process for their implementation. The ultimate goal of this phase is to tailor the selection of technologies to address specific challenges effectively, resulting in "tailor-made technology."

The introduction of new technologies necessitates a thorough assessment of potential risks and existing legal constraints, both those inherent in the process and those that may arise from the implementation of the new technologies. Consequently, the selection of technologies must consider not only organizational factors but also compliance with the legal requirements.

Phase 4: process optimization. The aim of this phase is to formulate proposals to restructure processes through the application of typical re-engineering tools. Thus, selecting the most efficient and effective alternative, compatible with the constraints imposed (by company management: e.g., by the costs of the intervention; or by law: e.g., by procedural rules for decisions). The final optimized scenario is called the To-Be model.

3.1. Technology analysis premises to better understand the case study context

In the case study, we focused on two technologies:

1) The telematization of the dossier.
2) A platform to support judges in the decision-making phase.

Telematization. Several laws have been approved—both at the European and national levels—with the aim of improving the efficiency and productivity of courts (i.e., the ones relating to the Registry of courts' and judges' activities, etc.). In Italy, there has been the establishment of rules requiring the digitization of files in civil litigation and labor sections (see below). This initiative has led to a reduction of costs, as well as a reduction of spaces and resources previously occupied by printed documents.

Telematization in courts is generally done through the introduction of a specialized workflow that telematizes certain steps of the trial, making it telematic (e.g., filing of briefs, notifications between judges and Registry, etc.). This optimization is essential for judicial processes, as it reduces the need for staff and

material resources, thereby enhancing efficiency and leading to more timely outcomes.

The context analysis within the courts has highlighted a need for higher precision in terminology. Accordingly, the following terms are defined:

1) Telematic dossier: A telematic dossier is registered within the information system upon its creation. All relevant documents are processed through the system's workflow, and communications and tasks are tracked electronically. The dossier's contents are managed electronically, so there is no requirement for printing. However, the original dossier, including some initial documents, remains in physical form.
2) Digital copy: A digital copy refers to an electronic backup of a physical document. It is essential to note that the original document stays as a paper version, thus not reducing the volume of printed material. Furthermore, having a digital copy does not necessarily ensure a workflow or digital traceability for the full history of the dossier.
3) Dematerialized dossier: A dematerialized dossier is entirely electronic, with no paper versions of any document or initial paperwork. The dossier is created, handled, and deleted solely through digital processes. While full dematerialization is not yet achievable for all types of dossiers, that is the case of all civil case dossiers, which can be completely managed in a telematic manner.

e-Justice: The e-justice can be integrated into courts through the use of digital tools, which can perform various functions. Some of these tools support the storage, easy retrieval, and search for judicial information through functions such as automatic classification, while others can also find similarities between cases and support the drafting of judgments. All these functions are carried out while ensuring adequate levels of security, protection, and privacy.

In Italy, judicial databases are available for storing and consulting previous judgments [16]. These databases typically either cover only judgments issued by the higher judiciaries (such as the Supreme Court of Cassation) or offer limited search capabilities, such as filtering by date, case number, or specific keywords. They neither facilitate in-depth research into the content of judgments nor enable comparative analysis and assessment of similarities between cases.

A way to implement computerized databases is by adopting a technology for Similar Case Matching (SCM). SCM refers to the process of identifying legal cases that share comparable facts, legal issues, or citation of precedents, mainly aiming at discriminating whether legal case documents are similar or not [17]. It is often used in legal research and decision-making to help lawyers, judges, or legal scholars in finding relevant previous cases that may provide guidance or insight into the resolution of a current case.

SCM typically involves the use of advanced search algorithms or AI tools that analyze legal documents and case law to find similarities in patterns and arguments. This helps legal professionals in building stronger reasoning, in anticipating outcomes, or in identifying relevant legal precedents more efficiently.

Several techniques are employed in SCM. First attempts include text-based similarity measures such as TF-IDF [18], which alone often fails to capture the semantic meaning of legal texts. Alternative methods focus on extracting core elements, including citations within documents, to calculate a similarity score. This second approach, besides granting a deeper level of analysis, often yields to extract information such as collateral outputs, enhancing the interpretability of the results [19, 20].

Citation-based techniques can be further subdivided into two categories: mere citation analysis [21] and citation-graph analysis [22]. The latter enables the use of graph-based deep learning models like Graph Neural Networks [23]. When text-based and graph-based methods have been combined, the resulting performance has been suboptimal [24].

4. The Case Study: Court Optimization

To decrease the considerable amount of backlog currently existing in Italian tribunals and courts, changes in the judicial systems are needed at different levels.

In Italy, judicial offices are understaffed and have limited resources, despite the relevant workload of pending cases every year [25]. The Italian judicial system has been modified more than once, with the goal of increasing efficiency.

In the last years, both at the European and national levels, there have been some reforms in order to reduce the staff and to modify some of its activities, in order to "force" the introduction of telematization. This has been done in order to achieve the optimization of tribunals and courts, but also to achieve the European goals of reducing backlog and speeding up decisions.

Nevertheless, in reality, in the Italian judicial offices—despite the objectives imposed from above—there is no guide to make the transition from paper to telematics. So most of them still work on paper documents, which are printed, transported, and archived physically.

Not to mention the natural aversion to change of any judicial worker.

The Italian Ministry of Justice has provided some tools, such as software for the digitalization of dossiers, but they have been furnished with no instructions or training courses. As a consequence, in fundamental institutions with consolidated processes, such as tribunals and courts, encountering resistance to change the work activities is likely, especially without proper updating of courses and information.

Reforms tried to force this switch with some staff modifications, but often, there is a lack of manuals that can explain in detail how to carry out specific procedures and activate the entire workflow step by step.

On the other side, judges' activities are those that can require a great amount of time, depending on the complexity of cases and on fixed prescriptions relating to time limits. The latter are established by law and concern activities that cannot be diminished or changed, both for legal and ethical reasons. However, from the perspective of reducing backlogs, judges have been provided with support given from the institution of the UPP ("Ufficio per il Processo," namely, "Office for Trial"). Both judges and UPP employees can be helped by external tools of e-justice to shorten the reading and researching times of previous cases and judgments.

The goal of this work is precisely to provide different tools and methodologies to guide the staff of tribunals and courts to make this change: moving from paper to digital and getting support from computer tools. Thus, we represent partial results of what was experienced on a case study, highlighting the potential exportability of the proposed optimization, at least in the Italian panorama.

We chose the explicative example of the Court of Cuneo. This was chosen because it is a virtuous court in which it was possible to telematize and sometimes dematerialize civil area files.

4.1. The context analysis

Italian courts are divided into civil and criminal areas. We will analyze the civil area, as it is the area that was also first addressed by the reforms.

Figure 1 shows the organization of an Italian court civil area.

The civil area is composed of further divisions: the commercial one, the labor one, the litigation one, and so on. In big judicial offices, each division tends to have its own dedicated staff. On the contrary, in small ones, staff is more likely to be shared across the divisions.

There are two staff categories: the decision-making staff and the Registry staff.

Previously, the decision-making staff was composed of judges only. Nowadays, judges are supported by UPP employees, as mentioned above.

The Registry is composed of the chief clerk and subordinate clerks. Before the Cartabia Reform, there was the court runner. The main task of the court runner was to physically carry paper documents from one office to another within the court or to search for or store them in the archives. Nowadays, the figure of the "court runner" has been eliminated, and "judicial operators" have been added as clerks' support. The judicial operators' main task is to support clerks in drafting documents.

The decision-making staff and the Registry staff are composed of different bodies, with different tasks. They are subjected to different regulations and requirements, but they are inextricably linked as they are co-dependent. This leads to two assumptions:

1) To streamline procedures and reduce backlog effectively, it is essential to address both bodies simultaneously. Focusing only on one of them, while neglecting the other one, would merely shift the bottleneck rather than resolve it.
2) Although overall optimization must consider both bodies, their differences necessitate the use of distinct tools tailored to each one.

In detail, in the Civil Area of the Court of Cuneo, there are 15 judges, of which 4 are in charge of the labor division and 11 are shared between the other divisions. Currently, there are 10 UPP employees shared among the total number of judges.

There is 1 main chief of the Civil Area, 4 chief clerks (of which 1 is the coordinator), and 14 clerks. Finally, there were 2 court runners to carry documents among all the offices. Nowadays, they have been reallocated as, with the use of the workflow, there should be no more need for physical transport. Thus, 2 judicial operators have been introduced as additional support for the clerks of the Registry.

Moreover, there was 1 car driver available for all civil and criminal areas to carry documents and judges. Currently, the driver is solely available to transport judges.

Furthermore, there is the UNEP (the office for notifications and enforcement, namely, "Ufficio Notifiche Esecuzione Protesti"). It is composed of officers of the court who are responsible to personally notify and execute orders at the request of private parties and judicial authorities, both in civil and criminal matters.

Finally, there could be the office of the Public Prosecutor (PP), inside or outside the judicial office itself.

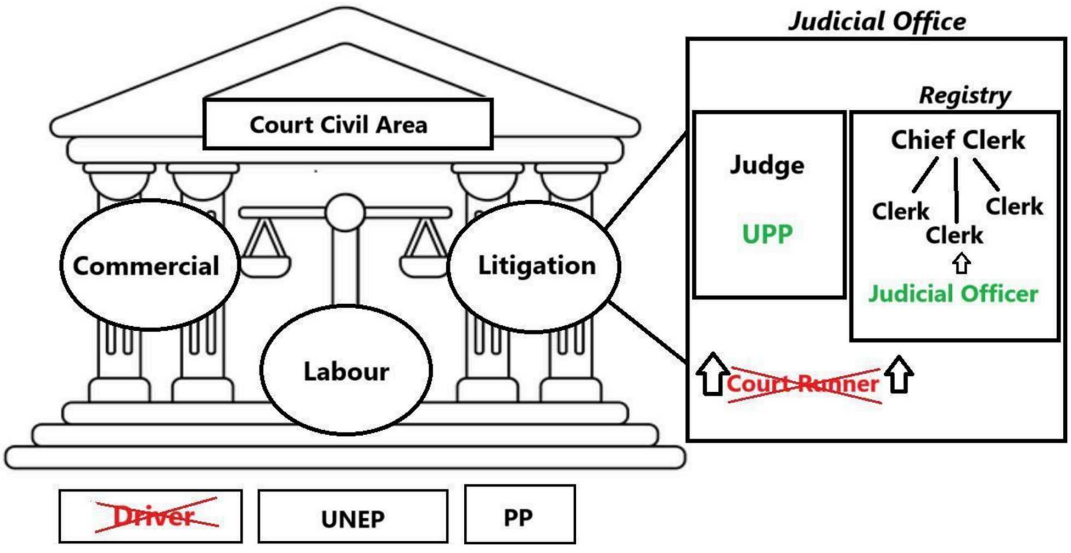
4.2. As-Is model

To show the potential of the use of telematization and digital tools in the field of justice, we start by showing an As-Is paper process, as it is the current starting situation of most of the Italian courts. This was the state of the art—until a few years ago—at the Court of Cuneo too (object of the case study).

Figure 2 shows a sample of the proceedings about divorce or separation by mutual consent, belonging to the civil area, litigation division, of the Court of Cuneo. We chose these types of proceedings since these cases are less subject to the whims of external parties. Therefore, all the following observations and results are more dependent on the court's agents' activity and not on external factors.

The Court of Cuneo is an excellent example of a tribunal that has been able to start the telematization process of some dossiers: it started around 2010 and developed slowly until today. In this way, we were able to simulate the past process and the new

Figure 1
Structure of an Italian court civil area



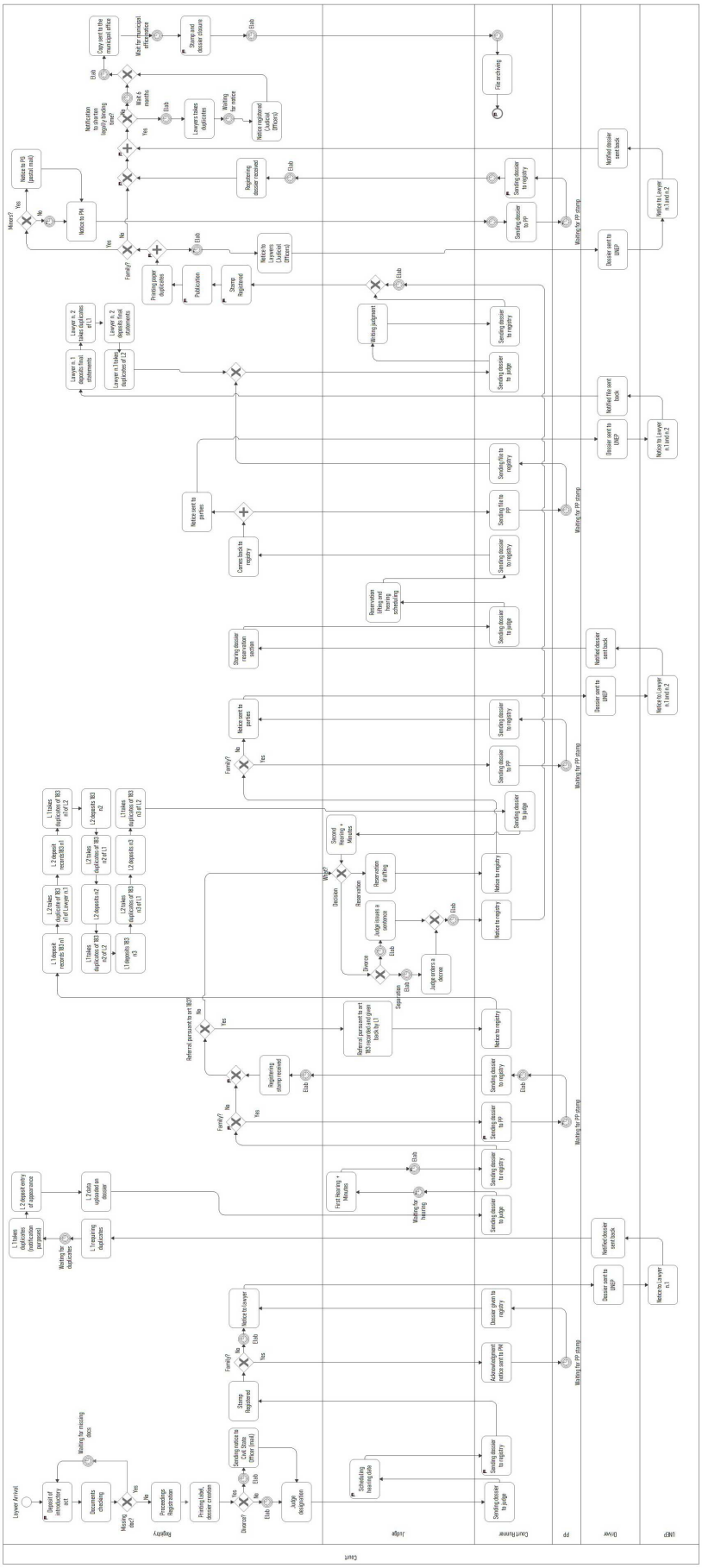
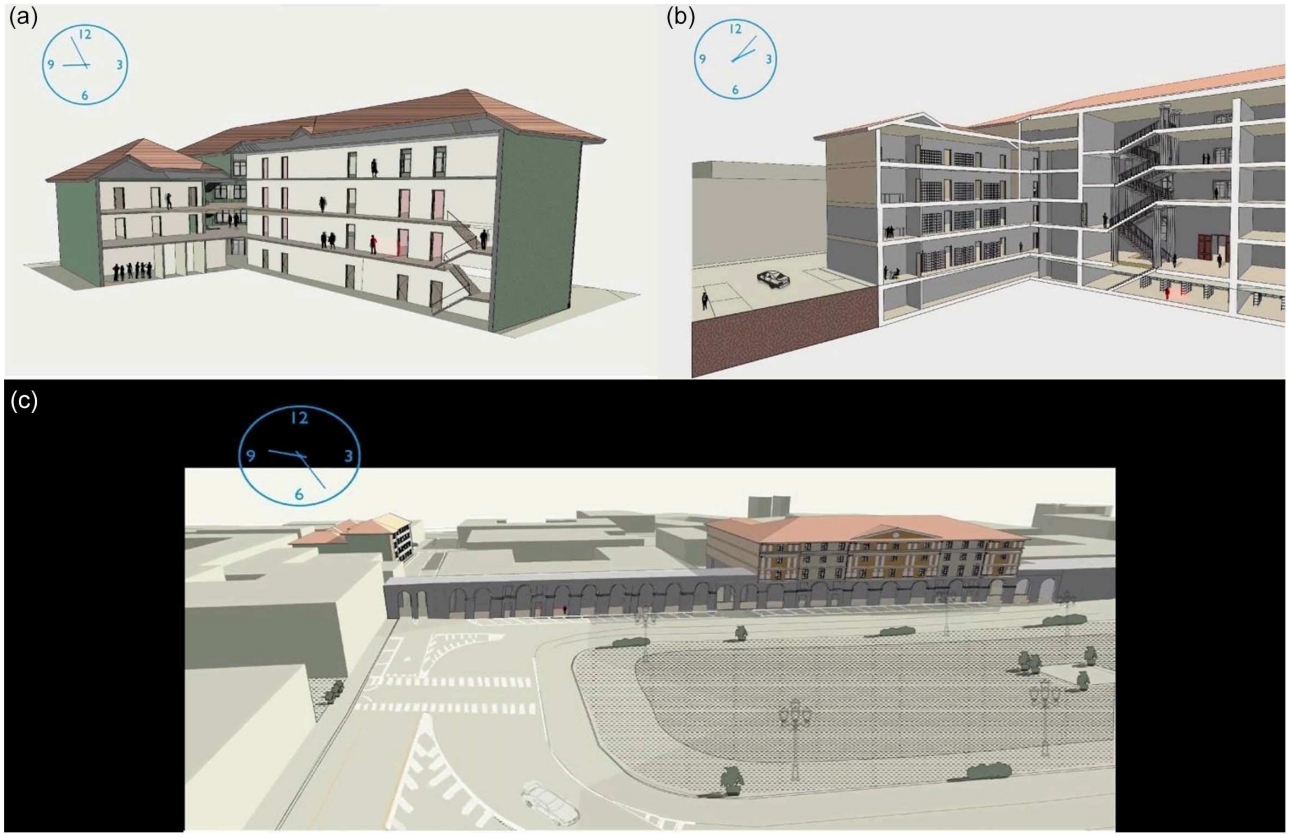


Figure 2
As-Is model: process of a consensual divorce or separation proceeding of the Court of Cuneo

Figure 3
3D reconstruction of: (a) the civil section building of the Court of Cuneo, (b) the criminal section building of the Court of Cuneo, and (c) the distance covered by the court runner when going from one building to another, more than one time during the day



Note: Video available at https://github.com/NGUPPCuneo/Project-Cuneo.git

process, with the improvement made with real data workload for the generators.

As is visible from Figure 2, the process is really complex, since it is characterized by a multitude of activities and a multitude of waiting times (represented by the clocks in the process), when moving from one lane to the other. The complexity of Figure 2 is a precise choice of the authors to show how redundant and intricate these internal processes can get. The complexity of Figure 2 has to function to show how convoluted such processes can get, even such processes that are less dependent on external factors[4].

Proceedings about divorce or separation are on paper; thus, they move thanks to the court runner (lanes "court runner" in the process). In Figure 2, it is noticeable that the role of the court runner is to connect the various court officials by physically carrying the paper files. As you can see from the image, the process is really permeated by the activities of the court runner, which means that this role is pivotal to such a process.

Nonetheless, the court runner is not pre-assigned to a specific officer but shared among every court office.

This means that when a judge or clerk needs to hand over a document to another office, they call the court runner by phone, who physically goes to the requiring office, takes the documents, and goes to deliver them physically. It is obvious that, if the court runner is called while already delivering something else, the second caller will have to try to call again or wait. It is also obvious that when the documents are delivered, they will likely be stacked on other stacks of documents. As a consequence, there is not only waiting time in the procedure for the file under consideration but also possible loss of documents, or it can occur that a document remains "buried" under newer ones, without real awareness of the arrival order or priority index of the dossier.

To have an idea of the role of the court runner, Figure 3 shows three screenshots of a video[5] representing the simulation of the daily tasks and movements, based on the real monitoring of a court runner of the Court of Cuneo.

At the Court of Cuneo, court runners have two fixed rounds (morning and afternoon): passing through all the offices of judges and officers of the civil section building (Figure 3(a)); through the prosecutor's offices and often through the archive in the criminal section building (Figure 3(b)); and through a path in the city center (Figure 3(c)).

Through the video, it is possible to have an idea of a normal working day with all the physical steps made by a court runner of the Court of Cuneo. It highlights the quantity of movements needed to carry paper files around the civil and criminal sections of the Court of Cuneo and the archive.

At the beginning of 2024, the Cartabia Reform formally abolished the role of the court runner. This decision was grounded

[4]Figures 2 and 4 are available at https://github.com/Marinelele/Project-Cuneo.

[5]Video available at the following link: https://github.com/NGUPPCuneo/Project-Cuneo.git.

in the assumption that, with the mandatory implementation of digital procedures, such a professional function had become obsolete. However, in practice, the process of digitalization has not yet been fully implemented and, in certain contexts, has not even been initiated.

The court runners can only be replaced by an efficient workflow software, which allows a real telematization of files, from the initiation of the case to its archiving.

A comparable situation, although with more limited implications, concerns the role of the driver. At present, this position remains operative; however, its functions have been substantially reduced and are now confined exclusively to the transportation of judges.

With regard to the work of judges, until last year, they were solely responsible for independently identifying and examining all relevant materials, including case documents, jurisprudence, and scholarly doctrine, in order to draft the most well-reasoned and comprehensive decision possible.

Although the Codes of Procedure (both Civil and Criminal) help judges by ensuring a relatively abundant maximum time and also ensuring that no one can impose a shorter time, the Italian Ministry of Justice and the European Union are asking for a reduction of backlogs.

On one side, the reforms have provided judges with UPP employees to support their tasks; on the other side, the research of the materials is not yet an easy charge.

In particular, there are some databases available for storing and consulting case law. However, these databases typically either cover only the higher judiciaries (such as the Supreme Court of Cassation) or offer limited search capabilities, such as filtering by date, case number, or specific keywords. They do not facilitate in-depth research into the content of judgments or enable comparative analysis and assessment of similarities between cases. Therefore, the activity of researching the correct solution for the case at hand can be hard and long.

Rules state the maximum time assigned to the judges, but of course, they can finish before the time allowed.

Since this maximum time assigned cannot be reduced from the outside, the only way to reduce it is to provide the judge with support to finish the work in advance and accurately.

Finally, there are some other tasks with pre-assigned time by law. Generally, these amounts of time have the role of protecting a right or to balance some rights, i.e. time for prescription. In this case, the telematization of the documents can support the processes, but with a lot of limits, because time is seen not as waste but as protection.

4.3. Technology selection

As mentioned above, the decision-making process is made by several figures within the court. We can group them into two main categories:

1) The decision-making part: made by judges (with their staff: the UPP employees);
2) The administrative part: made by the Registry (composed of the chancellors).

They are different bodies, with different functions, which follow different rules and influence different factors.

For these reasons, it is not possible to use only one technology to optimize both, but two different interventions are required.

Consequently, we will use:

1) The telematization of the dossier to improve the administrative tasks in terms of the quantity of activities, time, and costs;
2) And we developed a platform to support judges and UPP employees in the decision-making.

Figure 4 shows the impact of the two technologies on the As-Is process activities. In particular:

1) The blue activities are the judges' tasks affected to the platform;
2) The red activities are the Registry's tasks that will be deleted by the telematization;
3) The white activities are the ones that remain formally the same but will probably undergo changes especially in terms of time (generally thanks to the telematization).

4.3.1. Telematization of Registry administrative process

Telematization has a greater effect on the administrative process and in particular on the reduction of time.

Given the strict interconnection between judges and the Registry, and since judges cannot be compelled to reduce their working time, monitors have been introduced into the process to show the amount of time for the dossiers.

Looking into the archive of the Court of Cuneo, we realize that, on average, every year, there are 800 new dossiers of the specific type of object of the case study. Improvements related to the past, during the full-on paper process, and to 2022, at the end of the telematization, are reported above.

800 are the received requests in one year. It is important not to be deceived by this data, which remains the same before and after the telematization. The number of citizens who decide to separate or divorce does not depend on telematization. The court, such as an emergency room, does not have the power to decide how many requests to let in. Rather, the Court can be responsible for the time of the dossier's closure.

Considering this assumption, it is possible to run a simulation of the As-Is on paper process and then of the To-Be telematic process, using the same generator in order to better compare the two processes.

Furthermore, for the simulation, monitors are useful to isolate and measure specific parts of the process, during each single token run. In this way, it is possible to measure the total just of the administrative time taken by each token to complete the entire process, excluding the time of the decision-making activities performed by judges.

In particular, starting from the paper process of Figure 2, monitors were put to isolate the pieces of the path of the token (dossier) excluding the lane of the judge. For example, Monitor 1 measures the average time from the beginning of the process ("Lawyer arrival") to the beginning of the activity "Scheduling hearing dates." Then, Monitor 2 measures the average time of the path from the beginning of the activity "Sending dossier to the registry" until the end of the activity "Sending dossier to the judge." The activities of the judge and the related waiting times are excluded, and it is monitored again the duration from the begin of the activity "Sending dossier to the registry," and so on. Table 1 shows the average time of each section of the path, during the whole simulation (so one year) of the paper process.

As shown in Figure 4, the workflow of the telematization affects a lot of Registry activities and, of course, will remove the

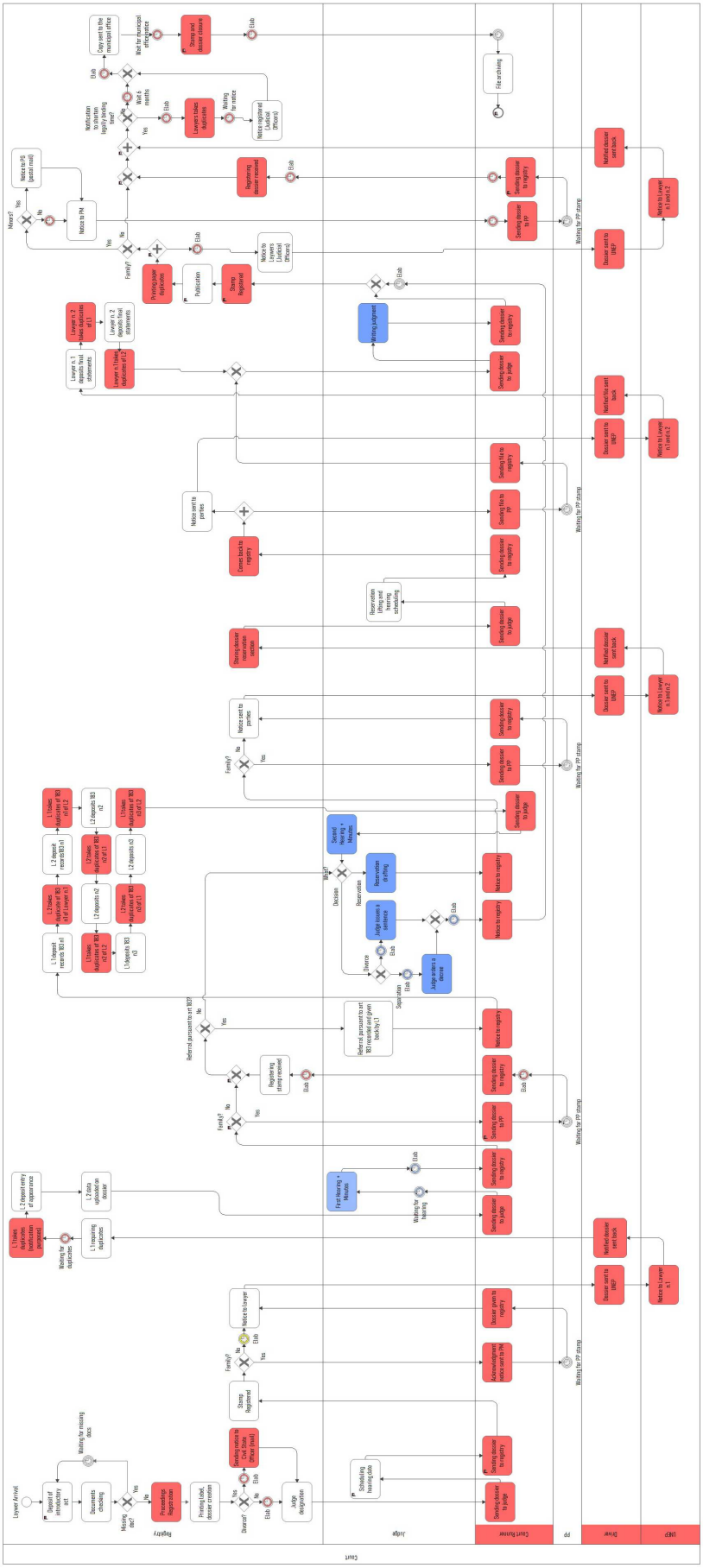


Figure 4
Impact of the telematizazion (red) and of the support platform (blue) on the As-Is process activities

Table 1
Average cycle time measured in hours in the different Registry steps in the As-Is paper process

	As-Is paper process (h)
Monitor 1	133.47
Monitor 2	197.58
Monitor 3	42.99
Monitor 4	0.95
Monitor 5	949.47
Monitor 6	5.92
Monitor 7	0.41
Monitor 8	1352.68
Monitor 9	1277.85
Monitor 10	1400.17
Monitor 11	3434.78

transport time and the waiting time from when a clerk wanted to hand over a document, to when the recipient (i.e., the judge) was physically in possession of the document itself and had knowledge of having it.

The workflow of the Information System (IS), implemented in the telematic process, allows to make all the communications at its inside. In this way, it is possible to send the document with a click, and the document will be received instantly, and above all, also a notification of the existence of that new document on the virtual desktop is received.

Two problems arise from this situation:

1) Although the software provided can be extremely useful, it involves a flood of functionality (to allow every vicissitude). Unfortunately, there are no manuals for usability. This drastically reduces the possible usefulness;
2) The actual workflow software does not really allow all possible steps. The more a process needs to exit the workflow, the more exponentially monitoring and optimization are reduced (these are the reasons why workflow software is used).

It is easy to imagine that all the data in the telematic workflow are sensitive data. For this reason and to ensure communication between all the Italian courts, the Minister of Justice has provided only workflow software or tools that courts are allowed to use.

For this reason, we create a handbook for users called "Handbook for Telematization and Dematerialization of dossiers" (namely, "Manuale per la Telematizzazione e Dematerializzazione dei fascicoli"[6]). The handbook manual will guide clerks to some specific activities. In particular, the activities that are fundamental for the telematization of the all type of litigation dossiers and:

1) Are not intuitive within the information system; or
2) To perform that activity, some required tasks are not carried out within the information system but through other Ministerial tools. However, using the official tools provided to courts by the Ministry of Justice, it is possible to carry out that task while keeping the file in the workflow and entering the information system. Thus, maintaining the traceability and the official status of the documents, allowing full telematics. Previously, these tasks involved printing the document and running the task on paper, implying lost the traceability and time delay.

Each procedure is described step by step with photos attached on .pdf, and with a video tutorial, to facilitate the understanding.

4.3.2. NGUPP search platform

Conversations with judges have revealed the need for a more efficient platform for searching decisions, particularly those related to merit judgments.

As mentioned above, while numerous databases contain rulings from the Court of Cassation, there are fewer that include merit decisions, and the existing databases offer limited search capabilities.

Additionally, merit judgments lack a standardized structure, making them more challenging to compare or to automatically extract relevant sections.

The NGUPP Search Platform is a demo that implements a series of mechanisms that allow navigation of judgments of merit.

Judgments pertaining to the merit, namely, those from Tribunals and Courts of Appeal, are territorially closer to individuals as they address the first and second levels of jurisdiction. Ensuring consistency and coherence in these decisions is crucial to uphold the principle of legal certainty. To achieve this, it is vital that judges have access to prior rulings in cases similar to those they are handling, especially within the same district. This helps to guarantee not only legal certainty but also equal treatment of similar cases at the local level. On a broader national scale, this consistency is maintained by the Supreme Court of Cassation, which serves as the court of legitimacy and is tasked with upholding legal uniformity. The court host the Office of Massimario, responsible to extract legal maxims from rulings that are compiled into databases.

On the contrary, for merit judgments, current tools available on the market do not support the immediate filing of rulings. These decisions must first be labeled to be archived, which is a time-consuming process that would require a dedicated office: a resource that is lacking in first- and second-instance courts. This task is often left to the judges themselves. In practice, judges may either voluntarily create their own filing systems or, more commonly, disregard the decisions of their colleagues, even in similar cases from the same period.

To address this issue, the NGUPP platform was developed to meet these needs as directly expressed by judges. It enables the extraction of judgments based on similarities using different methods than manual labeling, even allowing real-time access as soon as a ruling is issued.

One key component of the platform is the classification comparison, with filters of cases based on their legal categories, such as issuing section or judicial office. This component was chosen because it allows the system to immediately focus on cases that share relevant legal contexts, mirroring the initial filtering process used by legal experts. Following this, decision-based similarity was introduced to capture the semantic meaning of judgments. The platform relies on advanced NLP techniques, including Italian Legal BERT embeddings, to compare the text of decision paragraphs, as these contain crucial legal reasoning. This ensures that the platform provides more than just surface-level comparisons, enabling a deeper analysis of legal judgments.

Further, citation overlap methods have been used to evaluate the relevance of legal citations within judgments. By comparing the legislative and case-law references cited in different rulings, the

[6]See the following link: https://www.nextgenerationupp.unito.it/contenuti#h.ezvrgi6dw7lq.

system highlights the juridical proximity between cases. Citations are a critical element of legal reasoning, often connecting different judgments through shared legal principles. The combination of these methods, resulting in a total similarity score, was designed to provide a comprehensive view of case similarity, integrating both classification and content-based comparisons.

Overall, the platform's methodology ensures that it aligns with the complex demands of judicial processes, offering not only efficiency but also transparency and interpretability, essential for maintaining trust within legal frameworks.

The platform has several features:

1) Login: This is to ensure the privacy of some data or allow non-anonymized access for insiders. In this way, the database is usable by all legal experts, even those outside the court, but the data that has to be not public can be access just after the login. This function may be important especially with regard to research among judgments of merit, even not yet officially published. Thus, in order to maintain the coherence of decisions within the same court, without make them visible from outside.
2) File archive: It is possible to make research in full or through a filter based on the general roll number. Each file can be explored, and the rulings associated with it can be viewed. This is the classic research modality existing in all the other typical databases of judgments.

Moreover, there is also a section "Evidence", where the evidence related to the file itself is listed.

1) Document archive: This section allows to explore through filters the archive of judgments, orders, and regulations in the platform. These filters are customizable. The demo makes available only the judgments of merit for research. The judgment filters are related to the type of area, which can be civil or criminal, the court of origin, the year of the ruling, the issuing section, and the entries relating to it. You can also search for a ruling by keyword. Each judgment found is summarized by a series of information such as Type of judgment, Section, Year, Subject, and others. Also, this type of research is the basic and most common research modality present on the other databases.
2) Research for similarity: This is one of the most important features of the platform and allows users to filter judgments basing on similarity. This result was achieved through a computational pipeline extracting core information from legal judgments in order to output a similarity score and the information retrieved to calculate it (as shown in Figure 5). This methodology was inspired by the way legal experts compare legal judgments. Analyzing legal experts' modus operandi, it was possible to replicate their reasoning in an automatic manner and achieve high-level performances in the SCM task.

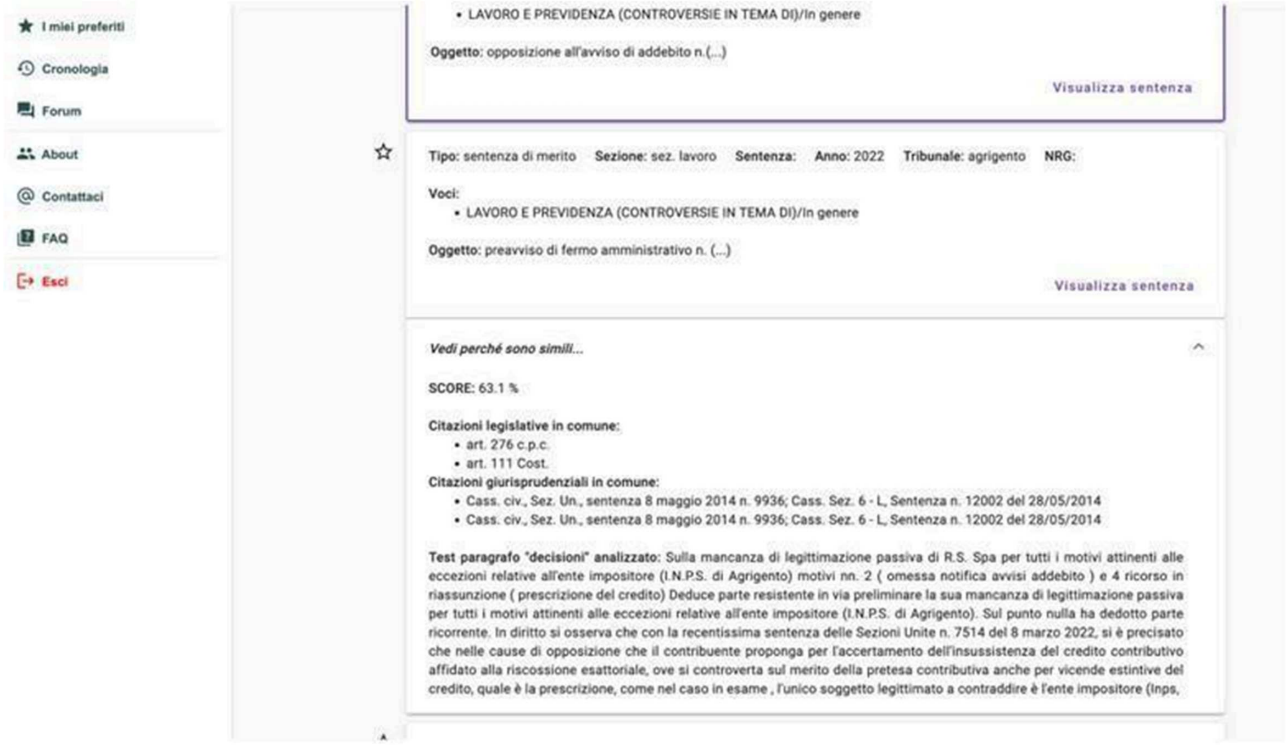
The information used to assess document similarity and outputted by the system is:

1) The shared citations of laws and regulations ("Citazioni legislative in comune").
2) The shared citations of judgments ("Citazioni giurisprudenziali in comune").
3) The shared part of text of decision ("Test paragrafo "decisioni" analizzato"). This is the most advanced feature.

It resulted that similar rulings usually have at least one "Item" in common, with the references.

All these information contribute to the calculation of the similarity score (which is also visible on the page). The score is in percentage, and its calculation depends on the overlap of the

Figure 5
Platform detail—Research for similarity



judicial and legislative citations (for 50%) and on the similarity between the first portions of the paragraph *"Decisions"* in the pair of comparative judgments (for the other 50%).

The higher the score percentage, the more similar the judgments are. This means that the higher the score, the more a consistent line of decision on the subject is maintained, and legal certainty is ensured.

1) Notes: In the judgment view section, it is also possible to add, edit, and delete annotations (Figure 6). This option makes the platform itself an eco-sustainable tool, since the users addressed are always taking notes on sheets of paper. This section allows to avoid this waste and even to have more organized notes.
2) Dashboard: This section shows statistics on pending cases and backlogs for each court (Figure 7). The amount of pending cases can be a mirror of the speed in closing cases. Therefore, indirectly if the telematization is implemented, even in some section step by step, this platform can be an indicator of how much the telematization also can help in time.
3) Map: The distribution of judgments on the national territory is accessible from the platform. For each city, the number of civil and criminal judgments is visible, and there is direct access to the "document archive" section, once the site of interest is selected. This allows the whole visualization of the list of judgments related to a specific court (Figure 8).
4) My works: This section shows the marked rulings in chronological order of modification (Figure 9).
5) My favorites: In this section, all the rulings labeled as preferred are listed. It gathers the selected judgments in a directly accessible way (Figure 10).
6) History: This section displays actions carried out on the platform including: File view, File search with list of applied filters, Search rulings with filters' list applied, Judgment View, Add and remove Favorites, Add, Edit or delete notes on ruling (Figure 11).
7) FAQ: List of the most frequently asked questions relating to the platform with attached answers, for a more intuitive use of the system.
8) Tutorial: As a user support, in each section, there is an "info" button at the top right, which shows a tutorial with a brief explanation of all the functionalities of the single analyzed section.

4.4. To-Be results and insights

Starting from Figure 2 and passing through the modifications reported in Figure 4, it is possible to reach the optimized To-Be process shown in Figure 12.

As expected, the process visibly shows how the number of activities is drastically reduced.

All the communications are made inside the IS: all the dossier delivery activities to the different authorities are deleted; thus, the court runner's, the driver's, and the UNEP's activities are expired (and the lanes related to these functions are deleted too in the process). Also the PP stamps are done by the IS and not anymore using the court runners. Furthermore, also communication with external authorities are made via IS. Thus, while on paper process they were made via post paper and they have to wait for the confirmation of the receiving before archive the dossier; with the telematic process, once the communication has been sent, it can be considered as received and the dossier can be classified as closed in that moment.

This latter assumption also contributes to the number of backlogs that still appear suspended for the court and for the specific judge. To give an example, the communication of a divorce to the marriage council could take from six months to—in some cases—two years.

Therefore, a reduction in activities is equivalent to a reduction in time.

Figure 6
Platform detail—Notes

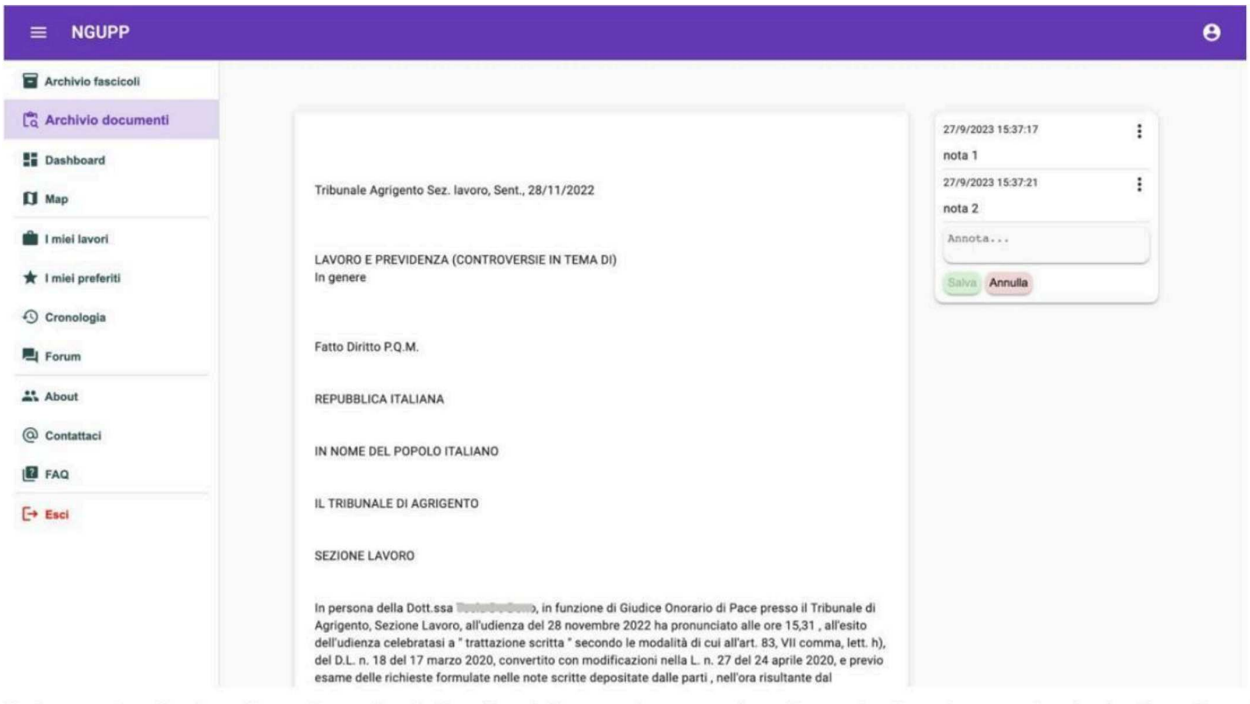


Figure 7
Platform detail—Dashboard

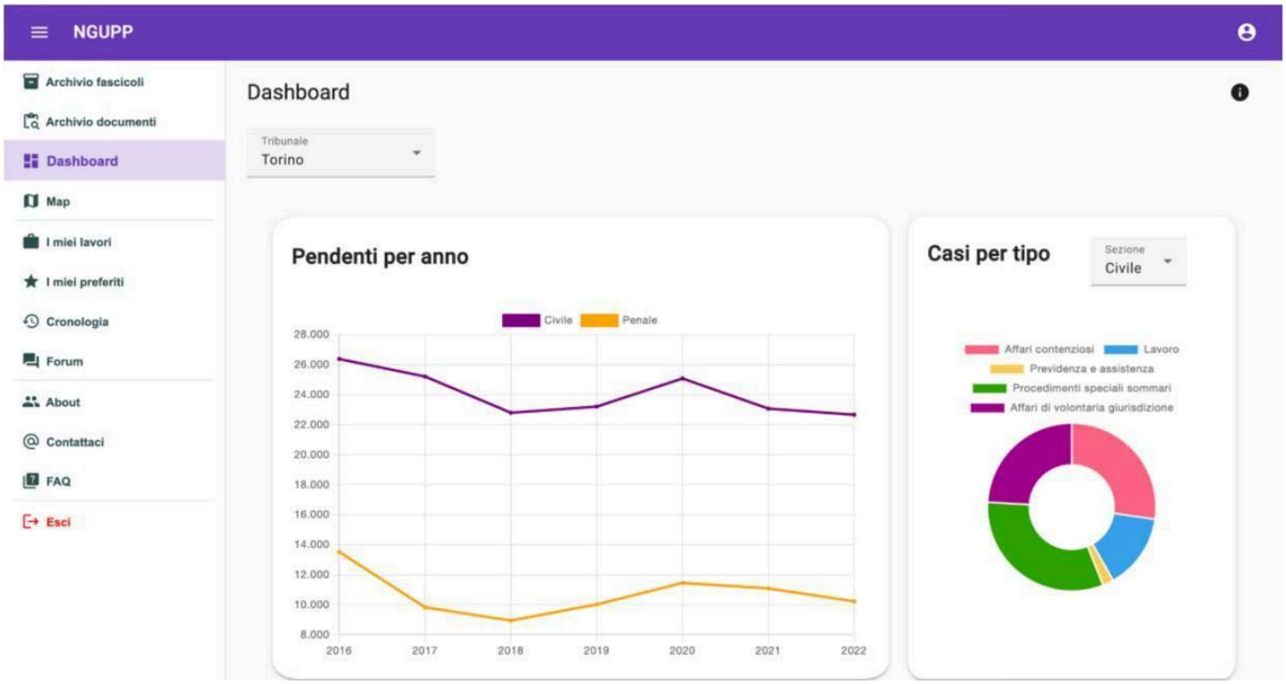


Figure 8
Platform detail—Map

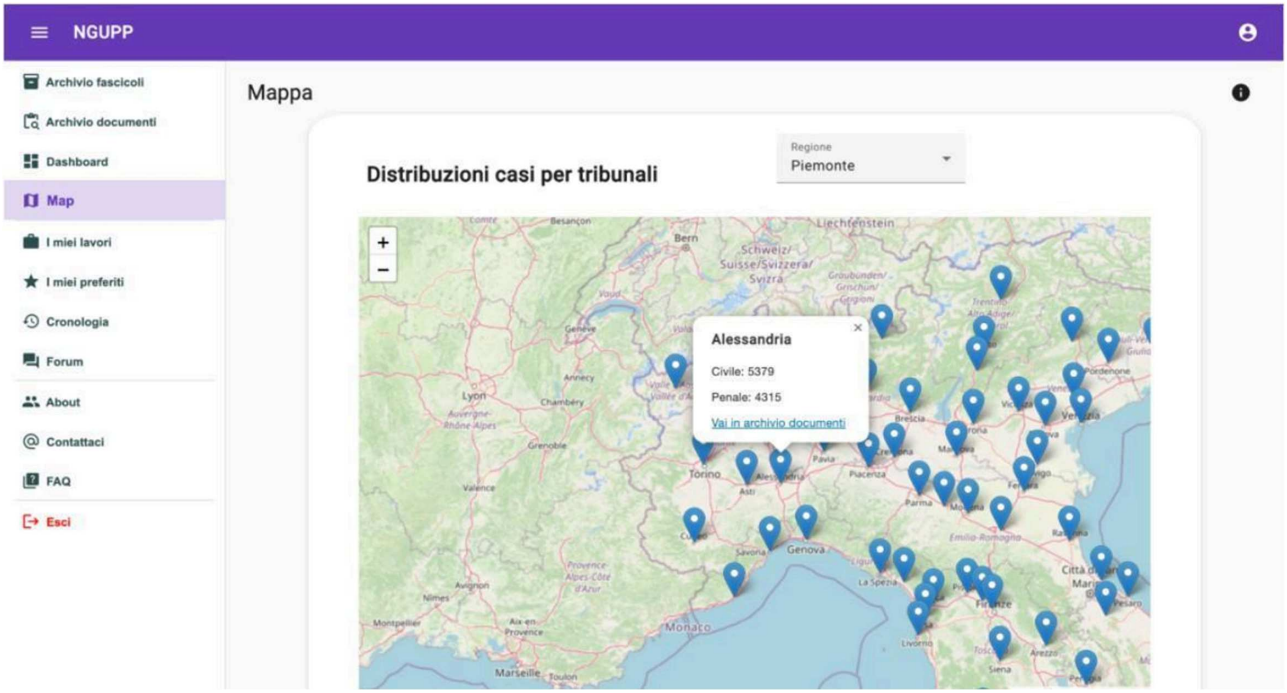


Figure 9
Platform detail—My works

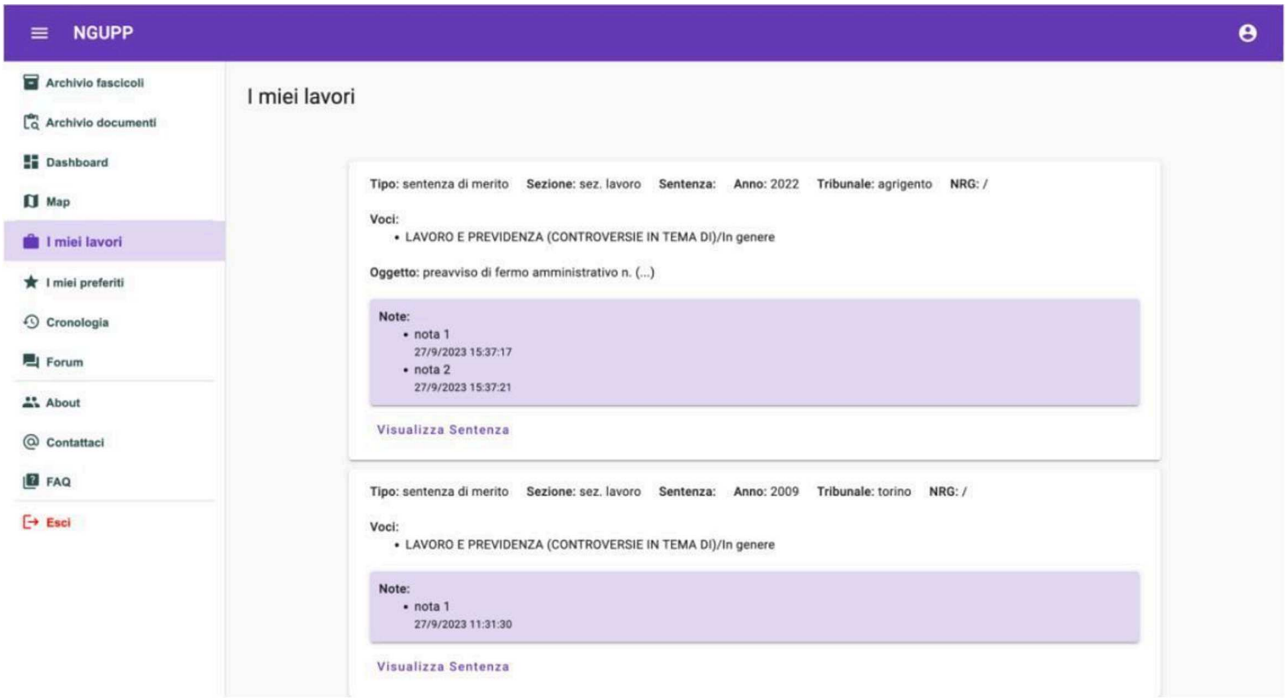


Figure 10
Platform detail—My favorites

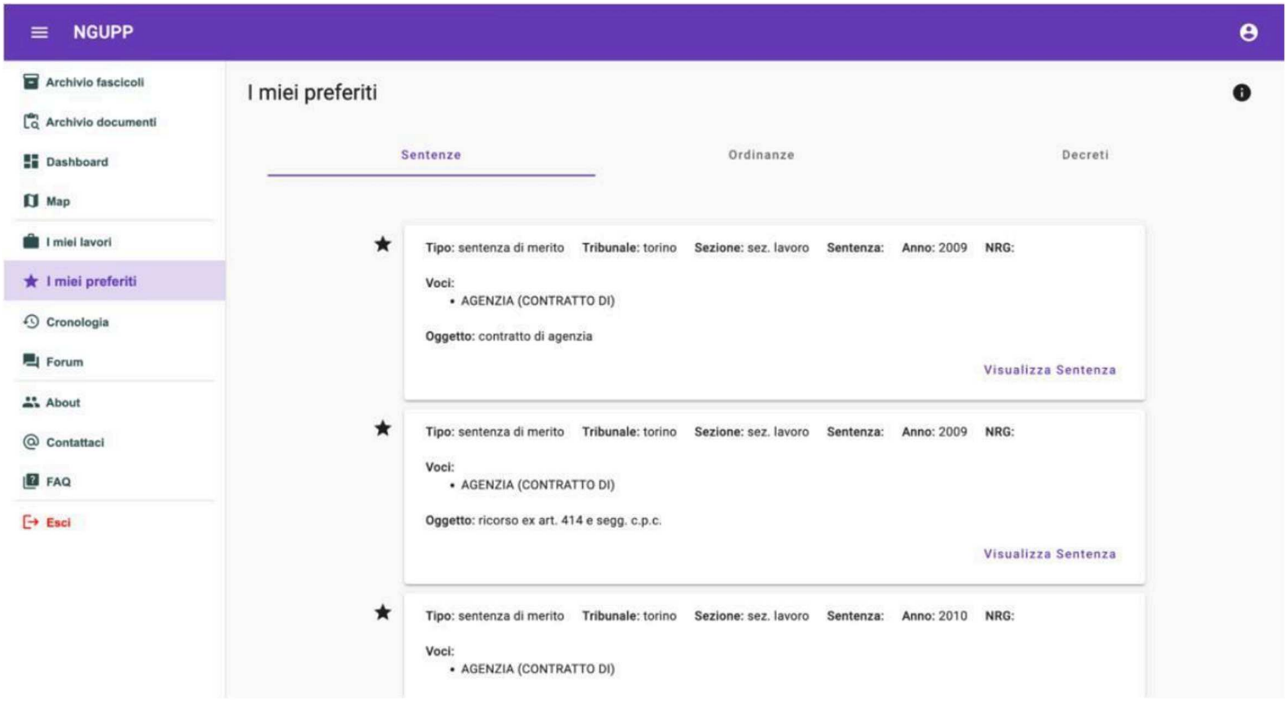


Figure 11
Platform detail—History

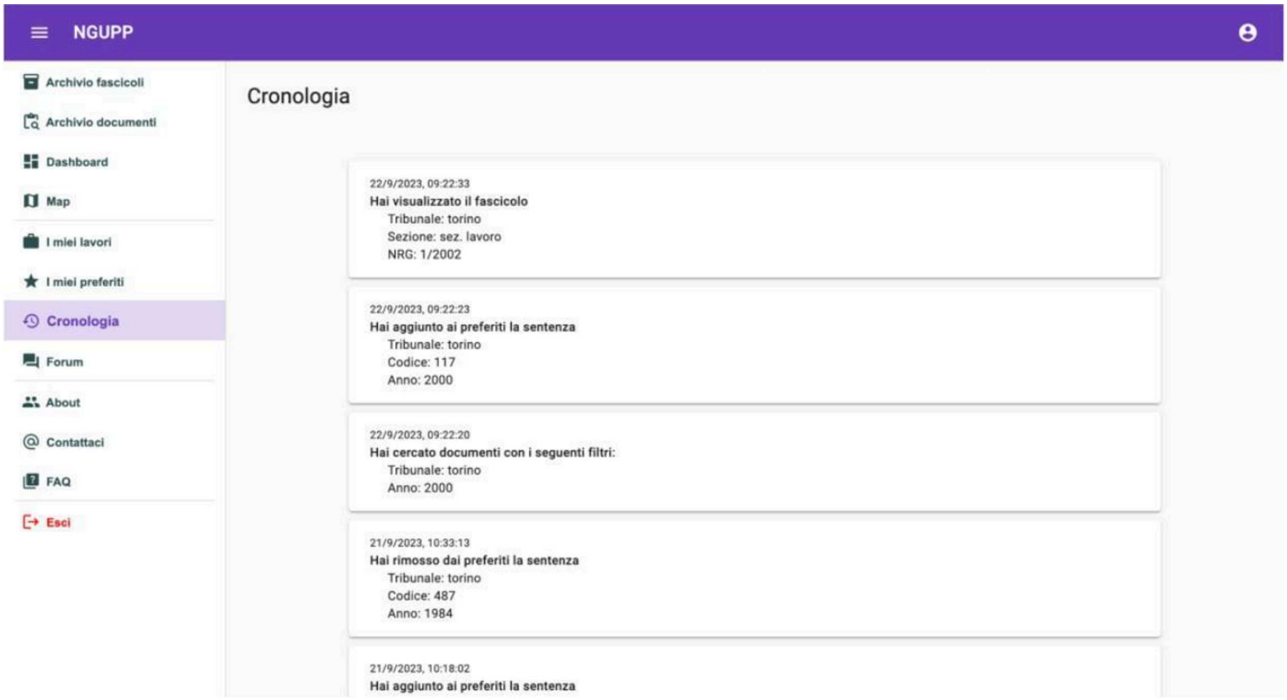


Table 2 shows the time comparison between the As-Is monitors (of Table 1) and the To-Be monitors.

Thanks to the simulation is possible to see the drastic reduction of time (in terms of hours) in the 11 segments of the process related to the administrative functions. In particular, the Monitors 8, 9, and 10, related to the part of communications between different offices and archiving tasks and, therefore, the tasks that required more time have been completely reset. It is also noteworthy that Monitor 5 has undergone a drastic reduction. Moreover, all monitors have experienced a decrease in processing time. Although Monitor 8 appears to show an increase in duration, it actually consolidates the activities of the last four monitors of the As-Is process. Therefore, when aggregating Monitors 8 to 11 of the Paper Process and comparing them with Monitor 8 of the e-dossier process, a substantial reduction can also be observed in this case.

Generally, Table 3 shows that given an equal input (number of incoming cases), the cycle times are drastically reduced.

The reduction of cycle time and the archiving of cases decided—but waiting for communication times—begins to provide a more realistic picture of the situation of backlogs. Moreover, the reduction of the time taken by the Registry may help to speed up even some minor activities of judges (i.e., setting the dates of hearings, etc.).

In addition to what may emerge from modeling and simulation, there are other more hidden and consequential results, which stem from these first goals achieved, but they are not secondary.

First of all, the reduction of the printing paper, so the consuming of paper and the derived reduction of costs. Although it has not yet been possible to estimate the reduction in the number of printed copies of each official document and accompanying documents, it has been possible to verify a constant reduction of costs. In particular, it was possible to examine a part of the communication's external costs: the postal costs. These are not the only external costs existing, but the easiest to extract and those that are more likely to occur in any kind of section.

Although they are just partial results of the existing costs, Table 4 gives an idea of the spending reduction from the first improvement actions for telematization till the end of 2022. The column "Average Postal Costs" indicates the average amount of costs for each related year. The column "Average difference compared to previous year" indicates the difference of amount for each year in relation to the previous one. It is possible to see that a saving of costs of on average 2500 € per year is recorded with respect to the precedent one. The last column "Average difference compared to 2018" shows the saving costs compared to the starting year (2018). It is possible to see that in just four years of improvement through telematization, the Court of Cuneo reduced the spending costs for postal communications by half (in 2018 18,000 € and in 2022 9000 €). It is possible to conclude that in four years, the Court of Cuneo has saved 20,000 € for postal communications only, thanks to the improvement of the telematization of the e-dossiers in some civil area sections.

Other hidden achievements regard the possibility through IS to have the archive of documents always available, and an easier and faster research. This represents a speedup, both for the processing of certain documents by the Registry and for the decision-making activities by judges.

With regard to the archive, these optimizations also reduce the space required for the physical archive. Space, which, at the moment, at least in the Italian panorama, is very limited.

Furthermore, since dossiers contain many documents must often be moved between offices within or sometimes outside the court. As a result, it can occur to lose some documents or disperse some sensitive.

Moreover, eliminating the presence of lawyers for the delivery and withdrawal of the documents, or the presence of other

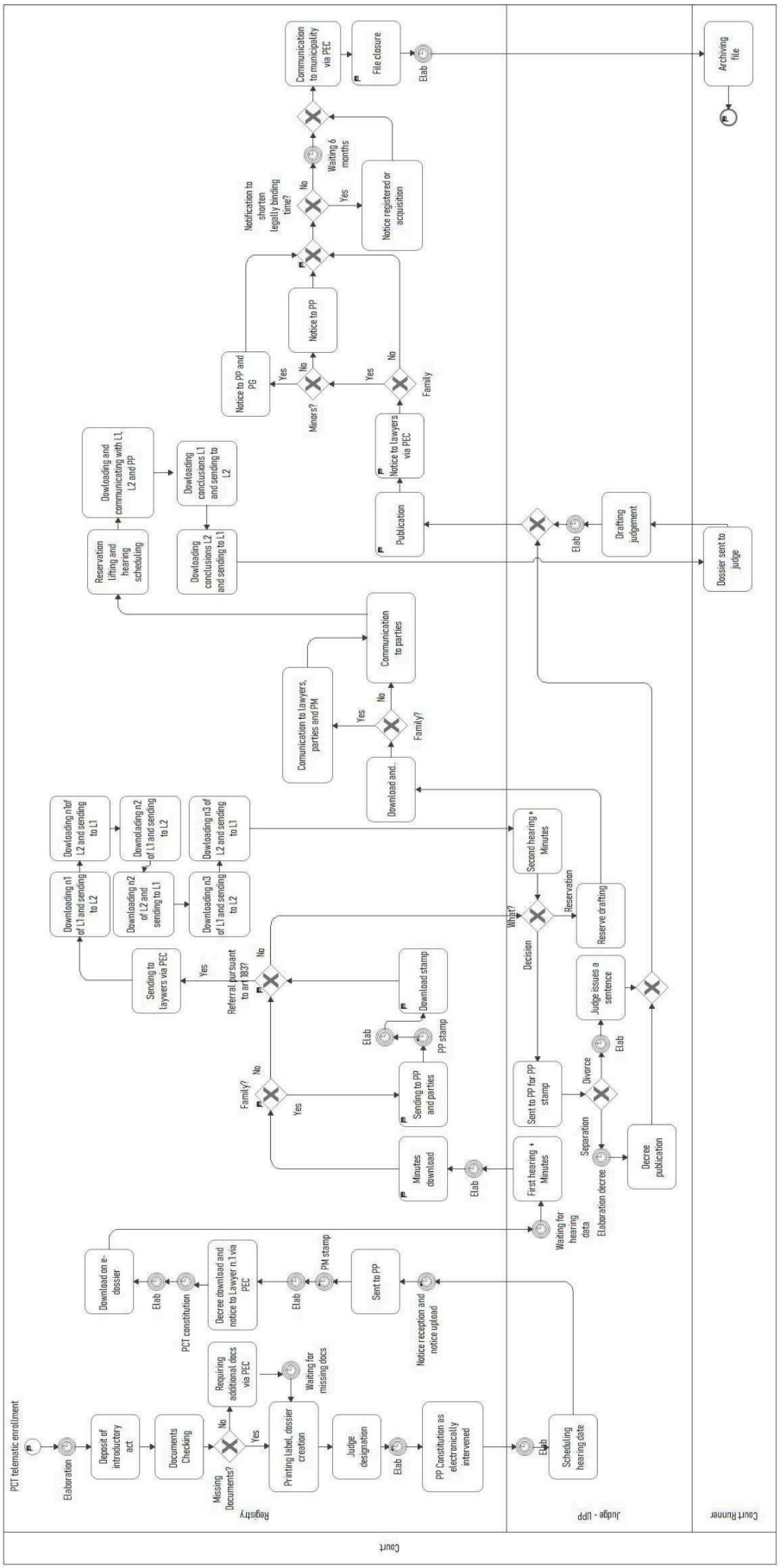


Figure 12
To-Be process

Table 2
Comparison monitor average cycle time measured in hours between the paper process and the e-dossier process

	Paper process (h)	E-dossier (h)
Monitor 1	133.47	76.67
Monitor 2	197.58	107.03
Monitor 3	42.99	13.69
Monitor 4	0.95	0.03
Monitor 5	949.47	15.79
Monitor 6	5.92	0.02
Monitor 7	0.41	0.01
Monitor 8	1352.68	3142.77
Monitor 9	1277.85	–
Monitor 10	1400.17	–
Monitor 11	3434.78	–

Table 3
Comparison of the input transactions and the average cycle time measured in weeks of the whole process by As-Is on paper and To-Be telematic

	Number of transactions	Average cycle time (week)
On paper	800	67.98
E-dossier	800	22.12

Table 4
Postal costs of Cuneo Court—year by year—from 2018 to 2022

Year	Average postal costs (€)	Average difference compared to previous year (€)	Average difference compared to 2018 (€)
2018	18,000	–	–
2019	17,000	1000	1000
2020	14,500	2500	3500
2021	11,500	3000	6500
2022	9000	2500	9000

agents of the parts, or the parts themselves, implies less noise, less interruptions, and an easier passing through the court. This promotes concentration of the whole court staff and a speeding up of the activities.

Finally, the telematization of all the flow implies the possibility of smart working also for the Registry staff, and not only for judges. This can be a benefit for the judicial workers, in order to contribute to an improvement of the working conditions as perceived and, thus, of the quality of work provided in terms of time and efficiency.

5. Conclusions and Future Works

This paper underscores the utility of the eBPM-C methodology for optimizing systems that need the introduction of digitalization and AI tools, but in particular when the system or the field is complex and with a lot of factors. Unlike compartmentalized approaches that risk generating unintended cascading effects, eBPM-C maintains a systemic perspective while allowing detailed analysis of individual process components. Its strength lies in managing interdependencies, heterogeneous actors, and differentiated constraints within a coherent optimization strategy. By aligning local technological interventions with overall system performance, eBPM-C offers a robust framework for sustainable and strategically integrated process innovation in complex organizational environments.

Optimizing complex judicial systems requires a holistic perspective capable of capturing interdependencies across administrative and decision-making levels. The eBPM-C methodology enables both a systemic, high-level view and targeted optimization of specific process segments, guiding the appropriate integration of digital and technological solutions. The proposed improvements, illustrated through a case study and supported by measurable indicators the scalability and transferability of the approach across Italian courts at first, but in general to complex processes intended as context with a lot of sub-processes, stakeholders, interdependencies, legal boundaries, etc. By supporting telematization, archival management, and judicial decision-making, the framework enhances efficiency while promoting greater transparency and accessibility for legal professionals and citizens alike.

In the next future, within the framework of the project European Digital Innovation Hub (EDIH)[7] we would like to follow the application of the eBPM-C methodology to optimize other complex business processes that need a significant improvement at technological level and that need not just an empirical optimize solutions but a real application of them, remaining competitive in the business.

Acknowledgment

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Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

Ilaria Angela Amantea is the Peer Review Board Member for *Journal of Computational Law and Legal Technology* and was not involved in the editorial review or the decision to publish this article. The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

Data sharing is not applicable to this article for privacy issue (GDPR and Italian Law about courts' personal data).

Author Contribution Statement

Ilaria Angela Amantea: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing,

[7]European Digital Innovation Hub (EDIH) for the Public Administration Intelligence (PAI) at https://european-digital-innovation-hubs.ec.europa.eu/edih-catalogue/pai.

Visualization, Supervision, Project administration. **Marinella Quaranta:** Validation, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing. **Marianna Molinari:** Investigation, Resources, Data curation.

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