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A Comprehensive BPMN Approach for Data-Driven Optimization of Italian Civil Proceedings

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Abstract

The integration of Business Process Model and Notation (BPMN) and process mining techniques offers a promising path for analysing and improving judicial proceedings. This study investigates into the utilization of BPMN for modelling judicial processes and employs process mining to analyse process logs obtained from the Employment section of the Turin Court.

Data extraction and identification of the attributes were followed by a Statistical analysis, to reveal general patterns of the logs. Preprocessing included removal of outliers, cleaning of inconsistencies and redundancies, data aggregation. The result allowed our interdisciplinary team to focus only on critical elements.

Thanks to a process mining tool (Apromore) we could visualize and analyse the process map, allowing comparison with the BPMN model from previous work.

The "Hearing waiting time and hearing" activity significantly impacts the duration of the proceeding.

This activity may occur repeatedly, and its duration is especially noticeable for the initial hearing.

The analysis of process variations concentrated on differences in the closing phase of the proceeding and its influence on the overall duration. Variations ending with premature and anomalous termination show the smallest average time, followed by proceedings involving settlements or Fornero procedures.

Understanding the factors influencing these outcomes contributes to a deeper understanding of process dynamics.

Overall, this research underscores the value of process-oriented analysis in judicial settings, offering useful vision to improve efficiency and performance. By focusing on specific activities and phases, our study provides a foundation for further investigations into court proceedings, with broader implications for judicial practice and policy.

Keywords – Judicial Proceedings, Data Mining, BPMN, Optimization

Paper type – Academic Research Paper

1 Introduction

1.1 Process Modelling with BPMN

A business process, by definition, comprises a series of activities, events, and decision points, all aimed at delivering value to an organization's customers through services or products. The task of business process modelling involves visually representing these processes in a graphical workflow format, with the goal of depicting the current state of the organization's processes for further analysis and improvement.

Despite the availability of various modelling languages, Business Process Model and Notation (BPMN) has emerged as the predominant standard for business process modelling. BPMN is widely adopted due to its expressiveness, simplicity, and semantic richness. It employs an intuitive flowchart-like notation that remains independent of any specific implementation environment (Aagesen, 2015).

BPMN has been used in various fields of public administration, including healthcare (Pufahl, 2022).

In our previous research (Bruni, 2023), we demonstrated the possibility of using the BPMN language in the judicial domain and recommended guidelines for its modelling. Thanks to an interdisciplinary team composed of modelling and legal experts, we built upon prior research where our team mapped the workflow of the Employment proceedings using Business Process Model and Notation (BPMN).

In this work, we will utilize this previous model as a foundation for studying real data extracted from the court.

1.2 Data mining of process logs

A log consists in a collection of process instances, each defined by a sequence of events, often accompanied by additional information such as timestamps indicating event recording times. These logs serve as the basis for constructing process models through process discovery (Van der Aalst, 2004).

Process mining involves automatically discovering process models from recorded process behaviour, enabling comparison with designed models to detect deviations and their root causes. However, significant resources are typically required for event data extraction and preparation before analysis can commence (Diba, 2020), posing a challenge for process mining application.

To address this challenge, we meticulously analysed case file logs from the Employment section of the Turin Court. This involved initial data cleansing and statistical analysis, followed by process discovery using the software Apromore. Comparing these processes with our BPMN model allowed us to identify areas of convergence and divergence.

Moreover, leveraging data mining techniques, we uncovered patterns essential for understanding underlying mechanisms in the Employment proceedings. A detailed examination of critical activities was conducted to identify bottlenecks and inefficiencies within the process.

1.3 Previous works

With the advent of the Telematic Civil Process, all documentation is received digitally, leading to a abundance of analysable data.

Many studies have examined the performance of judicial structures by analysing the flow of incoming and outgoing proceedings and other high-level metrics, such as personnel assigned to the section or changes in backlog numbers (Troisi, 2023). Others have analysed the difference in the duration of digital and paper proceedings (Amantea et al., 2023).

Starting from court logs, Pernici (2024) conducted a temporal analysis of process variations and the codes involved in juridical matters.

Although a process mining approach has been used to analyse data and identify bottlenecks and causes of inefficiencies, it was employed in a different process from that of the Italian courts (Unger, 2021).

The gap we aim to bridge with our research is to analytically identify the reasons for the poor performance of Italian courts using real and detailed data.

2 Methods

We assembled a team including both experts in business modelling and law to facilitate interaction and exploration of various perspectives on the issue. Our research questions revolve around distinguishing excessively lengthy processes and identifying critical activities or variants within the process.

2.1 Data Extraction and identification:

After signing the necessary confidentiality and data security agreements, we requested and obtained from the Employment court of Torino the extraction of the historical files relevant to our interests. We decided to consider only those files from completed processes whose start dates fell within the period 2017-2022.

This vast amount of data represents a valuable resource for our analyses. Before proceeding with process mining activities, it is essential to conduct a thorough cleaning and analysis of the extracted dataset because it is highly likely to contain missing data, erroneous data, or inconsistencies.

First of all, we aggregated together all the data in one single file.

To analyse the data effectively, it is necessary to understand the information that is present and how it can be utilized. With the support of the General Directorate of Statistics and the Clerk's office, we have identified the meaning of the various attributes present.

We then proceeded to eliminate attributes useless or redundant.

2.2 Data Analysis

We performed statistical analysis of the data to understand the general patterns and trends in the log data and in different time periods. This paved the way for the subsequent cleaning activities.

2.3 Data cleansing and preprocessing

Mapping out all the possibilities that can occur in the Employment section of the Court would have made the map we were creating complex, scattered, or even unreadable. For this reason, we removed the files concerning proceedings with variations in the procedure (e.g. Social Security and Welfare proceedings and Fornero procedure

proceedings -now abolished, but existing at the time of our BPMN mapping-) and retained the “pire” employment proceedings.

During the database review, we identified some incorrect dates represented as "01/01/1900". We corrected by replacing these dates with the correct years. This ensures that the temporal information is consistent and accurate for our analyses.

We conducted an analysis to identify any duplicate elements in the database. The aim was to eliminate these duplicates as they could affect the accuracy and reliability of our results. Through this process, we were able to retain unique entries in the final database.

We assessed the case statuses present in the database and decided to remove all cases with a pending status. This allows us to focus solely on cases that have been completed or have reached a final state.

The original log contained numerous administrative activities that had no significant impact on the duration of the proceedings, such as lawyer payments or annotations. These activities were deleted from the logs. Additionally, outliers—activities occurring with very low frequency—were removed.

Data abstraction, as outlined by Wiley (2019), serves to resolve differences in the granularity of recorded data. We identified and merged data elements that collectively represent the execution of a single activity. For instance, the "Report from impartial court expert" was fragmented into multiple small data records, with significant variation across proceedings, thus complicating flow comparison.

Data aggregation aims to condense data into a more logical and informative form. For instance, during the final stage of the proceedings, activities with low frequency and analogous meanings (e.g., "Lack of jurisdiction," "Inadmissibility of proceeding," "Bar on proceeding" "Striking of the cause") were consolidated under the designation "premature and anomalous termination."

2.4 Process Mining

All the preprocessing work allowed us to simplify the analysis while preserving the essential information about the process execution, eliminating redundant or unnecessary information and obtaining a representation suitable for analysis, modelling, and visualization.

The event log was imported in the process mining tool Apromore, which can produce the business process map and the main process metrics, such as frequency and duration of the activities. It also allows filtering different variations of the process and thus compare the average duration and elements of the variants of the proceeding.

We evaluated the frequency and duration of the single activities and the most frequent variants of the proceeding and identified the critical steps in the employment proceeding.

3 Results

After extracting the logs and identifying the relevant items, we proceeded with a preliminary statistical scrutiny.

By analysing the average durations in days of the case files of the proceedings in the Employment Section of the Court of Turin from 2017 to 2022, we can obtain an approximate estimate of the average timing of proceedings in this Section. However, it is important to emphasize that the data provided only concern the case files opened during that period and do not consider the case files that were initiated before 2017 but closed subsequently.

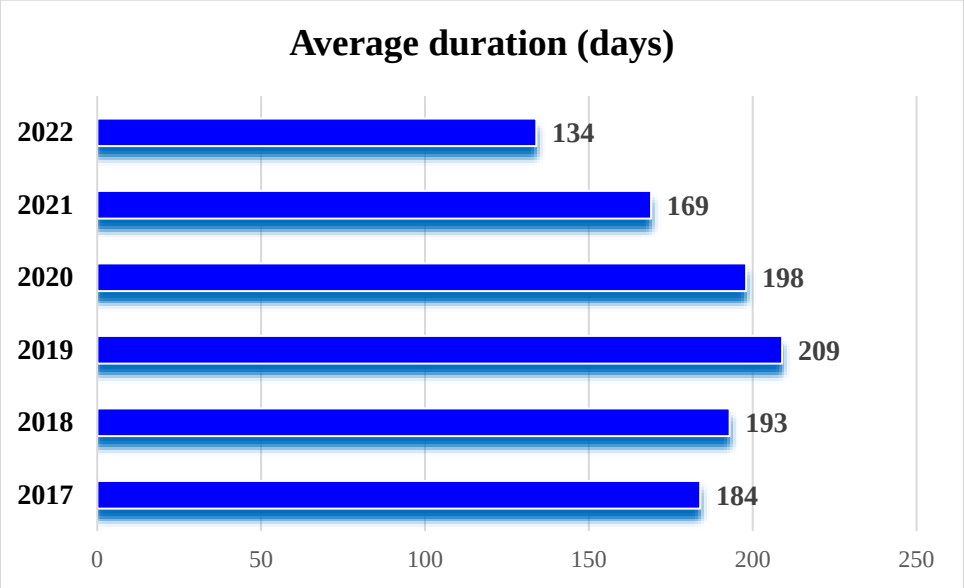

Table 1: Average duration of Employment proceedings (all codes, including e.g. Social Security and Welfare proceedings and Fornero proceedings).

3.1 Process discovery

Upon inputting the file into Apromore, we revealed the process from the event logs. A comparison between the BPMN extracted from the court logs and the model created previously was conducted. While the Apromore model lacks detail, with several activities not generating events recorded in the computer system, the sequence of phases aligns.

The primary goal these analyses is to attain a broader and more precise understanding of the duration of proceedings, facilitating the identification of areas where efficiency can be improved. Throughout the analysis, numerous factors affecting the duration of a process were identified.

In the following paragraphs, we will examine the differences among individual activities that impact the average duration of proceedings and among variations of the process.

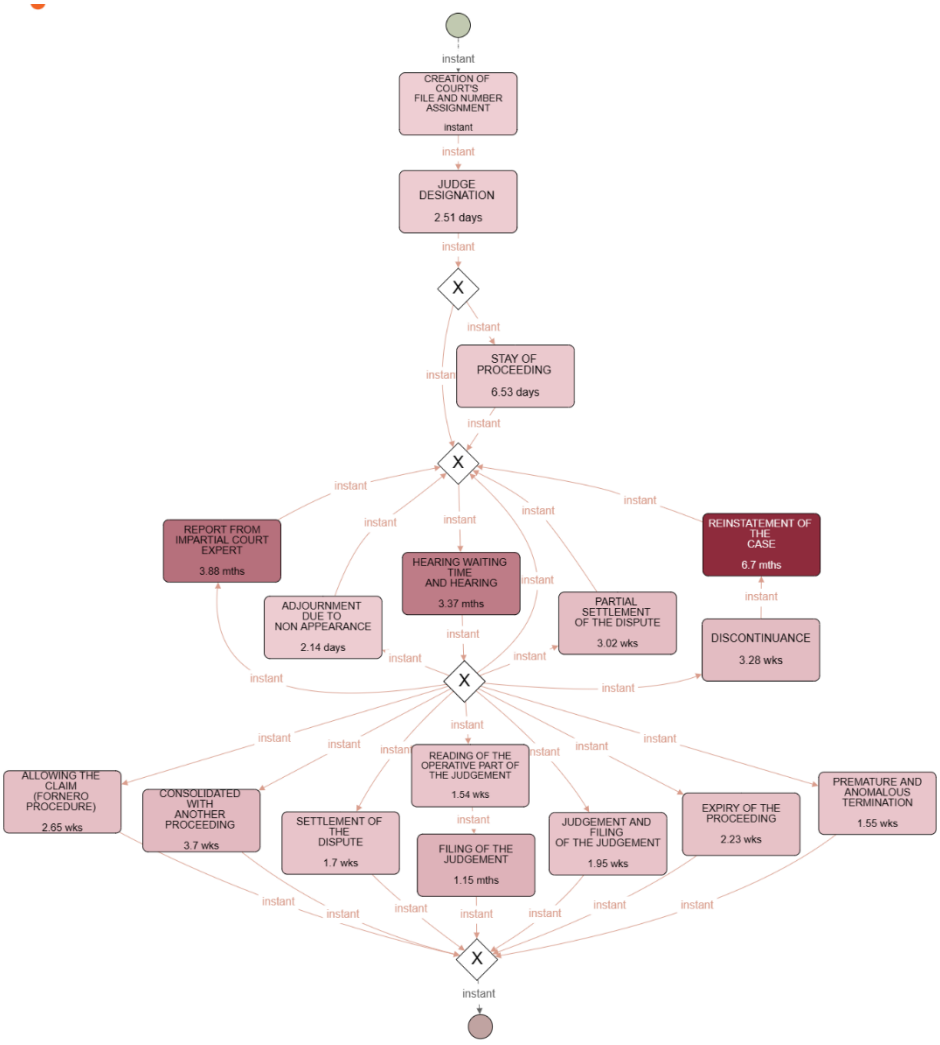

Figure1: BPMN process of the employment proceeding as discovered by Apromore with average time for every activity.

3.1.1 Activities with extended duration

The “Report from impartial court expert” phase has an average duration of 3.88 months, during which the judge nominates an expert, the expert accepts the nomination and then fills a technical report with the finding. The phase concludes with the report's upload into the court software, followed by the scheduling of a new hearing.

While this phase can be prolonged, its occurrence is infrequent. Only 599 logs include this activity, affecting less than 3% of the proceedings. Consequently, its impact on

overall court efficiency is deemed negligible.

A total of 395 proceedings are discontinued (interruption), with only 208 of them subsequently reinstated and resuming activities. The "Reinstatement of the case" phase represents the waiting period before activities are reinstated, averaging approximately 6.7 months. However, given its low frequency of occurrence, it is not worthy of further investigations.

3.2 The Hearing Phase

Typically, hearings are brief, often lasting only a few hours, yet the waiting period averages approximately 3.37 months. This activity, in our model named as "hearing waiting time and hearing," presents a significant duration, particularly for the initial hearing. Moreover, the first hearing may be followed, in practice, by multiple subsequent hearings (adjournments), the number of which can sometimes be considerable. Consequently, the total duration of a proceeding is greatly influenced by the total number of hearings.

At the Turin Court, the Employment Judge intentionally schedules the initial hearing well in advance, aligning with their schedule, to facilitate the scheduling of subsequent hearings closer together. This practice ensures compliance with the principle of concentration, which is fundamental in Employment proceedings and may not be universally observed across the national territory.

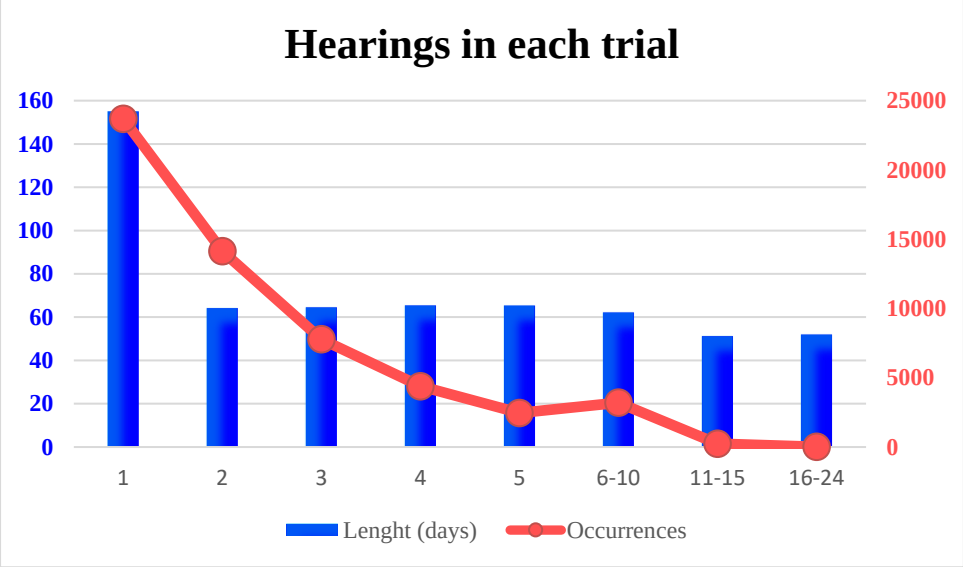

Table 2: Number of Hearings Correlated with Overall Duration of the Proceeding.

Table 2 illustrates that every proceeding undergoes an initial hearing, which typically has a lengthy average waiting time of 155 days. Additionally, over half of the proceedings continue to a second hearing, with a smaller fraction progressing to a third hearing. In rare instances, there may be more than 10 hearings.

On average, parties wait approximately 155 days for the initial hearing, while subsequent hearings occur within a shorter timeframe of around 60 days.

Hence, the primary factor to consider is the duration between the case assignment to the Judge and the scheduling of the initial hearing. This timeline is primarily influenced by the Judge's workload and the volume and nature of cases in their schedule. A higher caseload or cases of particular significance may result in delays in scheduling the initial hearing.

Another crucial factor is the Judge's comprehensive examination of the case before the initial hearing, which significantly impacts various aspects of the process. Firstly, adequate preparation by the Judge facilitates the effective management of the first hearing. Additionally, reviewing the case before the hearing impacts the management of proceedings concerning the admission of evidence. If the Judge has meticulously reviewed the case beforehand, they can admit only pertinent evidence, thus preventing the inclusion of unnecessary or redundant evidence.

How evidence-taking hearings are conducted can also impact the overall duration of the process. For instance, it is considered suboptimal to admit numerous witnesses and examine them across multiple hearings spread over time. This approach leads to the dispersion of information across different hearings and often necessitates repeating questions for witnesses who haven't been examined yet. Conversely, it's preferable to examine all witnesses together, even if their number is substantial, to consolidate the collected data and minimize the need for repetitive questioning.

Lastly, the duration between the conclusion of the evidence-taking hearing and the discussion hearing holds significant importance. If not much time has passed since the examination of witnesses during the hearing, the Judge, being well-prepared on the case, can actively and attentively listen to the parties. This increases the likelihood of issuing a judgment during the same hearing.

Furthermore, the potential for reconciling the parties depends also on the Judge's profound comprehension of the case. If the Judge hasn't thoroughly studied the case, they

may struggle to facilitate satisfactory settlement between the parties before the Court. This could result in the rejection of the conciliation proposal or the dissatisfaction of at least one of the involved parties.

3.3 The Closing Phase

In most instances (42%), proceedings conclude with a judgment, which can be given during the hearing or afterwards; in the second scenario, the process tends to be slower. Another common occurrence is the settlement of disputes (39%), resulting in a swifter resolution.

The length of the closing phase varies, with premature or irregular terminations typically taking less than two weeks, while the operative part of judgments and subsequent filings of judgements with reasons can extend the process to nearly two months on average.

If we widen our perspective and consider the entire duration of the proceedings, we may find interesting observations.

Proceedings that conclude with premature and anomalous termination are extremely fast, averaging only 129 days and accounting for a small fraction (1.5%) of cases. Proceedings involving Settlements before the Court or Fornero procedures generally have shorter durations (210 days) compared to those resulting in judgments during hearings (270 days). Proceedings where the operative part of judgments is read during the hearing and the filing of judgement with reasons takes place post-hearing tend to have lengthier durations not only for the final phases but also overall (428 days), possibly indicating their inherent complexity, which could be worth exploring further in subsequent studies.

4 Conclusions

Our analysis highlighted the most important metrics, revealing bottleneck activities and suggesting ideas for improvement, which would not have been possible without a process-oriented approach. We focused on the overall durations of processes and on individual activities, particularly on the hearing and the conclusive phases of the Employment proceeding.

As can be observed, the judgment contextual to the hearing generally allows a process to conclude earlier compared to the reading of the operative part of the judgement followed by the filing of the judgment with reasons. The issuance of a contextual judgment can be favoured by several factors, such as the judge's initial thorough study of the case and the short time elapsed between the end of the evidence-taking phase and the

final hearing. The considerable length in the overall duration of a process with a judgment published after the hearing may perhaps be due to an inherent complexity of the case file. In the future, this could be subject to further investigation.

The most impactful activity on the duration of proceedings is the hearing, both because it is often repeated multiple times and due to the long waiting time. In our opinion, only with greater resources (judges and courtrooms) could we have quicker hearings. Additionally, judges could be assisted in processing more case files by employing a greater number of trained and experienced collaborators.

At this point, we must emphasize that our work does not aim ultimately only at improving the Employment proceeding or the Judge's performance, but rather serves as a tool for investigating the functioning of any Court. Therefore, our study wishes to identify and propose a possible method of analysis, applicable to any other Court or section of the Judicial Office.

5 Acknowledgements

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English translations of Italian legal terms could be imprecise due to the distinction between common law and civil law.

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