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FACULTY OF ELECTRICAL ENGINEERING

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FACULTY OF ELECTRICAL ENGINEERING

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PREFACE

The Third International Conference “Electrical Engineering, Technology, Informatics, Mechanical Engineering and Automation – Technical Sciences in the Service of the Economy, Education and Industry” (ETIMA’25), organized by the Faculty of Electrical Engineering at the “Goce Delchev” University – Shtip, represents a significant scientific event that enables interdisciplinary exchange of knowledge and experience among researchers, professors, and experts in the field of technical sciences. The conference was held in an online format and brought together 78 authors from five different countries.

The ETIMA conference aims to establish a forum for scientific communication, encouraging multidisciplinary collaboration and promoting technological innovations with direct impact on modern life. Through the presentation of scientific papers, participants shared the results of their research and development activities, contributing to the advancement of knowledge and practice in relevant fields.
The first ETIMA conference was organized four years ago, featuring 40 scientific papers. The second conference took place in 2023 and included over 30 papers. ETIMA’25 continued this scientific tradition, presenting more than 40 papers that reflect the latest achievements in electrical engineering, technology, informatics, mechanical engineering, and automation.

At ETIMA’25, papers were presented that addressed current topics in technical sciences, with particular emphasis on their application in industry, education, and the economy. The conference facilitated fruitful discussions among participants, encouraging new ideas and initiatives for future research and projects.

ETIMA’25 reaffirmed its role as an important platform for scientific exchange and international cooperation. The organizing committee extends sincere gratitude to all participants for their contribution to the successful realization of the conference and its scientific value.

We extend our sincerest gratitude to all colleagues who, through the presentation of their papers, ideas, and active engagement in discussions, contributed to the success and scientific significance of ETIMA’25.

The Organizing Committee of the Conference

ПРЕДГОВОР

Третата меѓународна конференција „Електротехника, Технологија, Информатика, Машинство и Автоматика – технички науки во служба на економијата, образованието и индустријата“ (ЕТИМА’25), организирана од Електротехничкиот факултет при Универзитетот „Гоце Делчев“ – Штип, претставува значаен научен настан кој овозможува интердисциплинарна размена на знаења и искуства меѓу истражувачи, професори и експерти од техничките науки. Конференцијата се одржа во онлајн формат и обедини 78 автори од пет различни земји.

Конференцијата ЕТИМА има за цел да создаде форум за научна комуникација, поттикнувајќи мултидисциплинарна соработка и промовирајќи технолошки иновации со директно влијание врз современото живеење. Преку презентација на научни трудови, учесниците ги споделуваат резултатите од своите истражувања и развојни активности, придонесувајќи кон унапредување на знаењето и практиката во релевантните области.

Првата конференција ЕТИМА беше организирана пред четири години, при што беа презентирани 40 научни трудови. Втората конференција се одржа во 2023 година и вклучи над 30 трудови. ЕТИМА’25 продолжи со истата научна традиција, презентирајќи повеќе од 40 трудови кои ги отсликуваат најновите достигнувања во областа на електротехниката, технологијата, информатиката, машинството и автоматиката.

На ЕТИМА’25 беа презентирани трудови кои обработуваат актуелни теми од техничките науки, со посебен акцент на нивната примена во индустријата, образованието и економијата. Конференцијата овозможи плодна дискусија меѓу учесниците, поттикнувајќи нови идеи и иницијативи за идни истражувања и проекти.

ЕТИМА’25 ја потврди својата улога како значајна платформа за научна размена и интернационална соработка. Организациониот одбор упатува искрена благодарност до сите учесници за нивниот придонес кон успешната реализација на конференцијата и нејзината научна вредност. Конференцијата се одржа онлајн и обедини седумдесет и осум автори од пет различни земји.

Изразуваме голема благодарност до сите колеги кои со презентирање на своите трудови, идеи и активна вклученост во дискусиите придонесоа за успехот на ЕТИМА’25 и нејзината научна вредност.

Организационен одбор на конференцијата

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DIGITALIZATION OF BPM USING THE CAMUNDA SOFTWARE TOOL ON THE EXAMPLE OF THE CENTRAL BANK OF MONTENEGRO

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Abstract

In the modern business landscape, the banking sector faces increasing demands for digitalization and process optimization. Traditional business process management approaches, reliant on manual document handling, lengthy procedures, and paper-based workflows, reduce efficiency, increase operational costs, and introduce risks of human error. To address these challenges, this paper focuses on the digital transformation of business processes at the Central Bank of Montenegro (CBCG) through the implementation of the Camunda platform as a key tool for process modeling and automation. By leveraging advanced BPM technologies, this study aims to streamline workflows, enhance operational agility, and ensure regulatory compliance through the implementation of automated approval and verification mechanisms. Additionally, the research explores the development of sophisticated process orchestration models, including automated document generation, distributed notification management, and hierarchical access control systems. This research holds significant relevance for financial institutions and public sector organizations seeking to modernize their operations. By demonstrating the potential of intelligent process automation, the study provides a framework for improving institutional efficiency, transparency, and adaptability in an increasingly complex regulatory and technological environment.

Key words

digital transformation, banking, process optimization, BPM, Camunda, automation

1. Introduction

Digital transformation has emerged as both a strategic imperative and a catalyst for operational excellence within contemporary organizations seeking to enhance efficiency, transparency, and agility across their business processes. In this evolving landscape, Camunda has distinguished itself as a robust, open-source platform for business process automation and orchestration, supporting the implementation of internationally recognized standards, including BPMN 2.0 (Business Process Model and Notation), DMN (Decision Model and Notation), and CMMN (Case Management Model and Notation). These standards empower institutions to exercise fine-grained control over process execution, facilitate seamless integration with legacy systems, and enable scalable, adaptive operations [1].

This research undertakes a comprehensive examination of the digitalization of business processes at the Central Bank of Montenegro (CBCG) as a representative case of institutional modernization within the context of a public financial regulatory authority. Within CBCG, a significant number of internal processes have been identified as candidates for digital transformation, reflecting a broader institutional commitment to increasing automation, transparency, and operational efficiency.

Many organizations across diverse sectors, including financial institutions, insurance companies, healthcare establishments and technology enterprises, have recognized the strategic

value of Camunda in achieving operational efficiency. Through the implementation of this platform, substantial outcomes have been realized in the reduction of manual labor, acceleration of processes, enhancement of regulatory compliance, and improved workflow control. This practice demonstrates that contemporary automation is no longer an option, but rather an imperative for all organizations managing complex processes [2].

Drawing upon these analytical insights, the research subsequently undertakes an empirical examination of the practical implementation of a designated organizational process within CBCG, specifically focusing on the professional development and employee advancement workflow. The selection of this particular (internal) process was predicated upon its inherently complex multi-stage architecture, requisite inter-departmental coordination, and evident necessity for standardized approval and documentation frameworks. The fundamental objective underlying the digitization initiative was the achievement of operational optimization through the systematic elimination of manual documentation processes, augmentation of procedural transparency, and implementation of comprehensive process tracking and automation mechanisms throughout all operational phases.

To achieve this, the solution was implemented utilizing a comprehensive technological stack consisting of Camunda, Spring Boot, and IntelliJ IDEA. The process model is represented using a BPMN diagram, which provides a comprehensive illustration of activity flows, decision points, and participant interactions within the workflow. The model architecture incorporates two fundamental task categories: User Tasks and Service Tasks, aligned with the functional requirements of the process framework [3].

Overall, this research aims to demonstrate how the combination of Camunda and associated technologies can successfully digitize internal workflows within the public sector, offering a practical solution model and strategic vision for broader business process transformation.

The paper is organized as follows. In Section 2, the implementation and utilization of Camunda in large organizations are explained, highlighting how it optimizes and automates business processes. Section 3 presents a practical implementation of a Camunda process, including the process diagram, code, and user forms. Section four presents conclusions and outlines future research opportunities.

2. Camunda in Practice: Leading Organizations Case Studies

To contextualize the implementation of Camunda within the Central Bank of Montenegro, we examined several notable use cases from various industries [4]. These examples provide a comparative perspective on the platform's real-world impact, highlighting its practical advantages and implementation challenges across different organizational settings.

One of these examples is T-Systems Austria, which successfully integrated Camunda into its proprietary *myProcess* platform, resulting in significant operational efficiencies. In 2023 alone, the organization automated IT operations, eliminating over 24,000 hours of manual labor, and showcasing Camunda's potential to reduce human workload and streamline service delivery significantly.

Another example is Generali Switzerland. Operating in a strictly regulated financial environment, Generali Switzerland adopted Camunda within its internal Connection Platform (CoPa) to automate deployment and compliance-related processes. The implementation was completed within six months, resulting in full task traceability, the establishment of an auditable process history, and marked improvements in compliance, transparency, and operational control.

A leading player in the renewable energy sector, Vandebron utilized Camunda in combination with Salesforce to automate complex, customer-facing workflows. This integration improved customer experience and made business operations more flexible and adaptable.

As a global financial services leader, Goldman Sachs employed Camunda to optimize and streamline financial workflows**,** particularly real-time transaction processing**,** demonstrating the platform's robustness in high-volume, high-stakes environments.

These case studies collectively illustrate the adaptability, scalability, and transformative potential of Camunda across various sectors, including energy, finance, IT services, and insurance. Whether in public institutions or private enterprises, Camunda has proven instrumental in enhancing process efficiency, reinforcing governance structures**,** and enabling sustainable automation at scale.

3. Digitalization of Professional Training and Development Process at CBCG

In the contemporary business landscape, the banking sector is increasingly confronted with the imperative to digitalize and optimize its core business processes. Traditional process management depends on manual documents and lengthy procedures. Paper-based documentation is no longer sustainable, as it leads to operational inefficiencies, elevated costs, and a heightened risk of human error. In response to these challenges, this research seeks to address the urgent need for the digital transformation of business processes within the Central Bank of Montenegro**,** through the application of advanced software tools and state-of-the-art technological solutions [5].

In pursuit of these objectives, we adopted a contemporary technological framework grounded in advanced platforms for business process management. Among these, Camunda stands out as a robust, open-source solution that supports the modeling, execution, and real-time monitoring of business processes in accordance with internationally recognized standards, such as BPMN**,** CMMN, and DMN [6]. The implementation of the proposed solution was carried out using the Spring Boot framework, which provides a flexible and scalable environment for backend development. IntelliJ IDEA was utilized as the primary integrated development environment (IDE), enabling efficient Java code development, dependency management, BPMN diagram creation, form design and testing, as well as execution and deployment of the complete application [7].

3.1 Dependency Configuration for Camunda Applications

In Maven-based Java projects, the *pom.xml* (Project Object Model) file serves as the central configuration descriptor that defines project structure, metadata, build instructions, and all external library dependencies. It ensures consistent management of project components and facilitates automatic resolution and integration of required modules during build and runtime. All essential dependencies necessary for the execution of a Camunda-based Spring Boot application are defined in that file. These include modules for email communication via JavaMail, embedded JavaScript support within BPMN models, REST integration with external APIs, and many others.

One of the most essential dependencies is the Camunda Spring Boot Starter, which enables seamless integration of the Camunda process engine into the Spring Boot environment [9]. This dependency is shown in Figure 1.

```
43      <dependency>
44        <groupId>org.camunda.bpm.springboot</groupId>
45        <artifactId>camunda-bpm-spring-boot-starter-webapp</artifactId>
46      </dependency>
```

Figure 1. Maven dependency for integrating Camunda with Spring Boot

It guarantees core integration between the Camunda process engine and the Spring Boot runtime environment, enabling the automated deployment, configuration, and execution of processes.

3.2 Business Process Model and Notation Diagram

In the context of process automation within the Central Bank of Montenegro, a wide range of business processes are carried out daily, ranging from approval procedures and interdepartmental coordination to the formalization and archiving of official decisions. For this study, one representative process – the process for professional training and development – was selected, as other processes follow a similar structural and logical pattern.

The BPMN process was modeled using Camunda Modeler and located in the project directory under *src/main/resources/process.bpmn*. The visual representation of this process is shown in Figure 2.

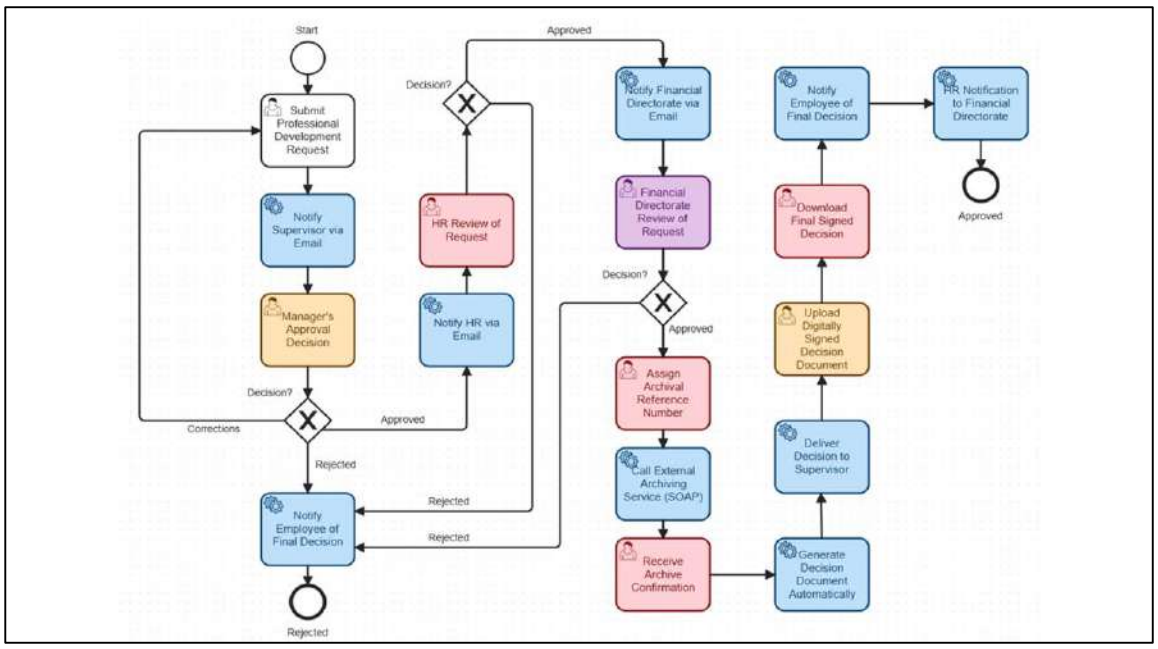


Figure 2. Optimized BPMN process diagram for the Professional Training and Development process

The Professional Training and Development process begins when an employee seeks CBCG funding for further education or certification.

This process illustrates a structured approval flow that spans multiple organizational positions and departments. It begins with a Start Event**,** followed by several User Tasks**,** Service Tasks**,** and Gateways, and concludes with an End Event depending on the approval path taken [9], [10]. The following components detail each step within this workflow:

- Start Event initiates the process when an employee submits a request for professional development.
- User Tasks are manual tasks assigned to specific users or groups, highlighted in different colors based on departmental roles. Red tasks are assigned to the Human

Resources (HR) department, while orange tasks are designated to responsible managers and supervisors. Additionally, purple tasks are executed by the Financial Directorate, ensuring comprehensive organizational involvement throughout the workflow process.

- Service Tasks, shown in blue, are automated tasks implemented in Java and executed by the system. Some of the Service Tasks are sending emails, invoking external services (such as a SOAP-based archive system), and generating digital documents. A detailed discussion of the Java implementation will be given in a subsequent section.

- Gateways are decision points in the process (e.g., approval/rejection branches), allowing conditional progression based on process variables and business rules.

- End Event concludes the process, which may result in rejection, request for corrections, or approval and digital archiving of the decision.

The execution of this process relies on the coordinated participation of four key organizational groups, as defined in the application's identity and authorization database:

1. Employees - process initiators,
2. Managers - responsible for decision-making,
3. Human Resources (HR) - handle internal reviews and coordination,
4. Financial Directorate - provide final approval and archiving.

The process architecture demonstrates sophisticated workflow patterns through its implementation of parallel processing capabilities and conditional branching mechanisms. When a manager approves a professional development request, the system triggers multiple automated actions simultaneously: email notifications are dispatched to relevant stakeholders, process variables are updated to reflect the current status, and conditional logic determines whether Financial Directorate involvement is required based on predetermined criteria, such as cost thresholds or training categories.

The integration of Service Tasks throughout the workflow exemplifies modern BPM automation capabilities. These automated components handle critical functions, including email communication through JavaMail integration, external system connectivity via SOAP web services for generating archival reference numbers, and automatic generation of Word documents. The seamless coordination between manual User Tasks and automated Service Tasks ensures optimal process efficiency while maintaining human oversight at critical decision points.

The process concludes with a comprehensive digital document management phase, where approved requests result in the creation of formal decision documents that are digitally signed and securely archived. This end-to-end digitalization eliminates paper-based workflows, ensures regulatory compliance, and maintains complete audit trails, which are vital for the operations of the CBCG.

However, the primary challenge in implementing such digital transformations often lies not in the technology itself, but in organizational resistance to change, as employees tend to prefer established and familiar manual procedures over new digital workflows.

3.3 Implementation of Service Tasks

Within the architecture of the implemented business process, each Service Task defined in the BPMN model corresponds to a specific Java class located in the *src/main/java* directory of the Spring Boot application. These classes encapsulate the executable logic necessary for interaction with external systems, automation of process actions, and enforcement of organizational rules. This approach ensures tight integration between the process model and its operational environment, in line with the principles of executable BPM [1].

The following components were developed to support the execution of the process:

- Application - the Application class is the main entry point for the Spring Boot application integrated with Camunda BPM platform. The implementation employs two essential annotations: *@SpringBootApplication*, which activates Spring Boot's auto-configuration capabilities, and *@EnableProcessApplication*, which enables integration with Camunda's process engine.
- UserService - is a service class in the *com.example.workflow* package that handles user data operations. It uses Camunda's *IdentityService* to fetch user information from the database based on a user's ID. This makes UserService an intermediary between the business logic and the data layer, allowing the application to easily retrieve details about the currently logged-in user at runtime. The *getCurrentUser* method returns a *User* object containing all the information about the user with the given ID.
- AutoPopulateFormListener - implements a task listener responsible for pre-populating form fields with relevant user data. This reduces manual input, increases data accuracy, and improves user interaction with process forms. Task listeners are components that react to task lifecycle events (like creation or completion) and allow user to run custom logic automatically when those events occur.
- ArchiveNumberDelegate – obtains an archival registration number through the official SOAP web service of the Central Bank of Montenegro (CBCG). This step is essential for the legal formalization of the request within the institution's documentation system.
- CheckGroupTaskListenerHR, CheckGroupTaskListenerSupervisors, CheckGroupTaskListenerFD - listeners that enforce access control based on the user's role, allowing only members of specific organizational groups to view and claim certain tasks. This mechanism ensures that tasks are processed only by authorized personnel.
- CamundaSolutionDevelopment - automatically generates a structured Word document containing the formal decision, based on data provided during the process. This document is an official output and can be archived or forwarded for further review.
- SendEmailMessageSupervisors, SendEmailMessageHR, SendEmailMessageFD**,** SendEmailMessageApproval**,** SendEmailMessageRejection - these classes manage the automated sending of email notifications to relevant participants at key stages of the process. Notifications inform users of task status, approval outcomes, or the need for further action.
- SendCamundaSolutionToSupervisor - sends the automatically generated Word document to the appropriate supervisor via email, ensuring timely delivery of decisions and promoting transparency in the approval workflow.

To illustrate the implementation in more detail, the key functions defined within the ArchiveNumberDelegate class are presented. The *createSoapRequest* is shown in Figure 3, while the *parseSoapRequest* function is given in Figure 4.

```java
private SOAPMessage createSoapRequest(String orgUnit, String docType) throws Exception {
    // Creating a SOAP message
    MessageFactory messageFactory = MessageFactory.newInstance();
    SOAPMessage soapMessage = messageFactory.createMessage();

    SOAPPart soapPart = soapMessage.getSOAPPart();
    SOAPEnvelope envelope = soapPart.getEnvelope();

    // Setting the required namespaces
    envelope.addNamespaceDeclaration( s: "ws", NAMESPACE_URI);

    // Creating the body
    SOAPBody soapBody = envelope.getBody();
    SOAPElement operationElement = soapBody.addChildElement(OPERATION_NAME, s1: "ws");

    // Adding parameters according to the correct structure
    operationElement.addChildElement( s: "orgUnit").addTextNode(orgUnit);
    operationElement.addChildElement( s: "docType").addTextNode(docType);

    soapMessage.saveChanges();
    return soapMessage;
}
```

Figure 3. Implementation of the `createSoapRequest` method, which is responsible for constructing a valid SOAP request to the CBCG web service for archival number retrieval

This *createSoapRequest* method is a private Java function that builds a complete SOAP request message for interacting with a SOAP web service. It takes two input parameters, *orgUnit* and *docType*, which represent the organizational unit and document type to be sent in the request. First, it creates a new SOAP message using the *MessageFactory*. Then, it retrieves the SOAP part and envelope, where it declares the required XML namespace. In the body of the SOAP message, it creates the main operation element and attaches the input parameters as child elements with their respective text values (*orgUnit* and *docType*). Finally, it saves all changes to the SOAP message and returns the entirely constructed SOAP request, ready to be sent to the web service for further processing [7].

The *parseSoapResponse* function processes the SOAP response received from the CBCG's external SOAP service and extracts the official archive number needed in the formalization process. First, it retrieves the SOAP body and checks whether the response faults. If it does, an exception is thrown along with the fault message to stop further processing. If there is no fault, the function searches for the *getArchiveNumberResponse* element within the expected namespace. Then it looks for the nested *return* element, which holds the actual archive number string. If found, it returns this number (for example, "14-8557-748/2025"). Otherwise, it returns a predefined message indicating that the archive number could not be found.

```java
private String parseSoapResponse(SOAPMessage soapResponse) throws Exception {
    SOAPBody body = soapResponse.getSOAPBody();

    // Check for a SOAP fault
    if (body.hasFault()) {
        throw new Exception("SOAP Fault: " + body.getFault().getFaultString());
    }

    // We expect the getArchiveNumberResponse element
    String responseName = "getArchiveNumberResponse";
    SOAPElement responseElement = (SOAPElement) body.getElementsByTagNameNS(NAMESPACE_URI, responseName).item( index: 0);

    if (responseElement != null) {
        // We expect the "return" element  with the archive number
        SOAPElement returnElement = (SOAPElement) responseElement.getElementsByTagName("return").item( index: 0);

        if (returnElement != null) {
            return returnElement.getTextContent(); // This will return, e.g., "14-8557-748/2025"
        }
    }
    // If we cannot extract the specific data, we return an error message
    return "The archive number was not found in the response!";
}
}
```

Fig. 4 Source code of the parseSoapRequest function, which parses the XML response from the CBCG SOAP service and retrieves the corresponding archival number for further processing.

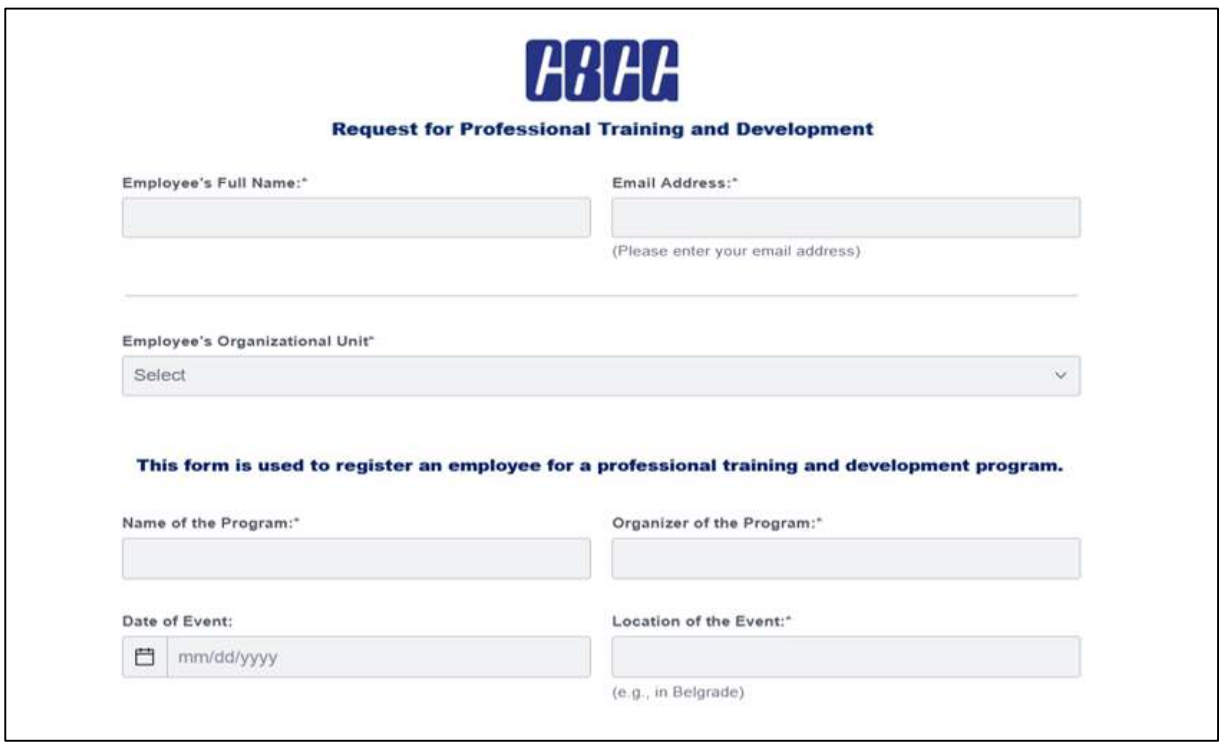
3.4 User Interface Design and Implementation

Within the architecture of business processes implemented using the Camunda platform, forms are a fundamental component of the user interface framework. These interfaces enable dynamic, real-time engagement of end-users with workflow instances, facilitating data acquisition and validation, document examination, and the execution of decision-making protocols within designated task assignments. User forms are intrinsically coupled with User Task activities within BPMN model specifications and function as the intermediary interface between the underlying business process logic and the operational personnel responsible for process execution.

To support these interactions, a set of forms was developed and organized within the *src/main/resources/static/forms* directory. A total of seven embedded forms were created following the Camunda Form format, written in a JSON-like syntax, and directly integrated into the process engine's task execution environment.

The Camunda 7 version suffers from a lack of native support for file upload components (e.g., file pickers) and document preview functionalities. Therefore, we manually developed two additional HTML forms, *upload.html* and *download.html*. These supplementary components address functional gaps by enabling users to upload and retrieve documents outside the standard embedded form structure.

The layout and composition of one of the core forms utilized in the workflow, *submissionRequest.form*, is illustrated in Figure 5 as a representative example of user interaction within the process model.



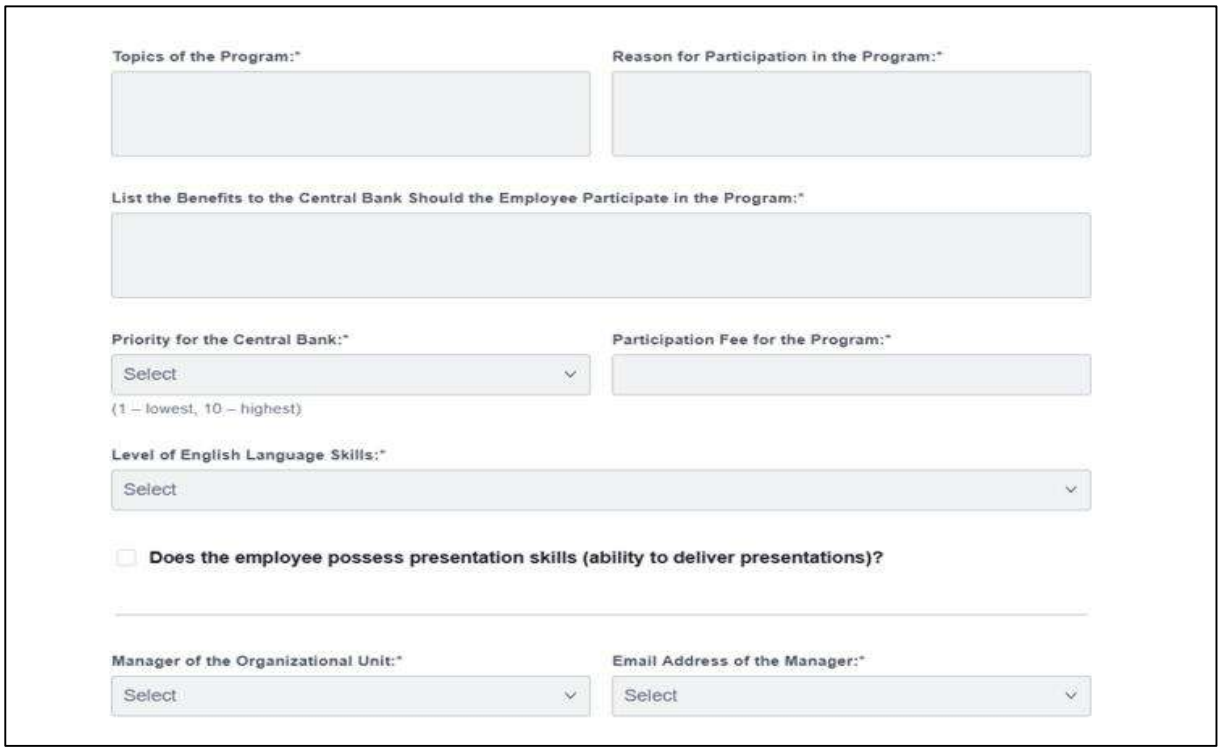


Fig. 5 Initial Camunda Form – submissionRequest.form

4. Conclusions

The research described in this paper presents a comprehensive examination of the Central Bank of Montenegro's (CBCG) transition from manual business workflows to automated processes, achieved through the strategic integration of the Camunda platform with Spring Boot applications. The analysis revealed that a significant amount of existing manual workflows contain repetitive and routine tasks, which are ideally suited for automation. By digitizing these workflows through Camunda's BPMN modeling and Java-based service implementation, the organization significantly improved process accuracy and control while preserving the core business logic.

This study demonstrates how leveraging BPMN workflow design alongside robust Java technologies can transform business operations into streamlined, automated, and auditable processes within a compliant financial organization.

While the implementation demonstrated clear benefits, challenges related to system integration complexity and user adaptation were identified. Addressing these aspects through comprehensive training and iterative refinement will be crucial to fully realize the potential of process automation.

Through the implementation of this solution, CBCG has achieved a substantial advancement toward institutional modernization, establishing a flexible and transparent business process infrastructure that can be readily adapted to evolving changes and future requirements. The resultant system not only enhances internal operational efficiency but also ensures regulatory compliance and greater institutional accountability.

Future research could explore the application of advanced technologies such as predictive analytics and artificial intelligence within the Camunda platform to enable proactive process management and continuous optimization.

References

[1] Madison, Dan: *Process Mapping, Process Improvement and Process Management: A Practical Guide to Enhancing Work Flow and Information Flow*. 1st ed. Productivity Press: New York, 2005.

[2] Buzzelli, Brian: *Data Quality Engineering in Financial Services: Applying Manufacturing Techniques to Data*. 1st ed. O'Reilly Media: Sebastopol, 2022.

[3] Weske Mathias: Business process management: Concepts, languages, architectures, 4th ed. Berlin: Springer, 2024.

[4] Camunda: *Camunda BPM Documentation*. Camunda: Berlin, n.d. Available at: https://camunda.com [accessed May 17, 2025].

[5] Kumar, Akhil: *Business Process Management*. 1st ed. Routledge, Taylor & Francis: London, 2018.

[6] Weske Mathias: Business process management: Concepts, languages, architectures, 4th ed. Berlin: Springer, 2024.

[7] CloudMatrix s.r.o.: *Java for Beginners: A Complete Guide to Learning Java Programming*. Independently published: [n.p], 2024.

[8] Karanam, Ranga Rao: *Microservices with Spring Boot*, 1st ed. Packt Publishing: Birmingham, 2018.

[9] Chang, James F.: *Business Process Management Systems: Strategy and Implementation*. 1st ed. Auerbach Publications: Boca Raton, 2016.

[10] Gadatsch, Andreas: *Business process management: Analysis, modelling, optimisation and controlling of processes*, Springer Fachmedien: Wiesbaden, 2023.