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# Digital transformation in public universities: BPMN-based process automation and enterprise architecture redesign

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## Abstract

The primary objective of this study is to analyze the impact of digital transformation on process management in universities and to propose process improvement strategies. Within this scope, approximately 100 processes carried out in the Strategy Development, Student Affairs, and Information Technologies departments were examined, with specific processes analyzed in detail. The study identified key challenges such as inefficiencies, administrative delays, and lack of financial integration. In the student registration process, while academic and administrative procedures are well-defined, financial components (such as tuition fees, scholarships, and payments) are insufficiently integrated. In the server request process, the absence of procurement, budget planning, and supply chain management may contribute to resource shortages and delays. In the budget distribution process, lengthy approval stages and the absence of strategic performance indicators (KPIs) make it difficult to align budget allocations with institutional goals. As part of the study, process improvement recommendations were developed. Threshold-based approval mechanisms, automated budget tracking systems, and financial process integration are proposed. The use of e-signature systems, electronic document management, and Robotic Process Automation (RPA) can help reduce administrative delays and accelerate processes. Quantitative analyses reveal differences in processes based on processing time, error rate, and efficiency scores. The IT department has a low error rate but a limited efficiency score. The Strategy Development department has a long processing time but a high efficiency score, whereas approval steps in Student Affairs slow down the processes. In conclusion, this study demonstrates that BPMN-based modeling, automation systems, and process integration can enable faster, more transparent, and strategically aligned decision-making mechanisms in universities. Improved data sharing between departments, automation-driven process optimization, and financial management integration is expected to contribute to more effective management of institutional workflows.

**Keywords** BPMN, Digital Transformation, Enterprise Architecture, State Universities, Process Modeling, Process Automation, Process Performance

**Jel Codes** O33, M15, L86, H83, I23

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# 1. Introduction

Organizational processes have been profoundly reshaped by the past two decades of technological developments. Advances in sectors such as cloud computing, big data, mobile technologies, robotic process automation (RPA), and artificial intelligence (AI) have driven businesses and government agencies to reconsider their policies, operating models, and administrative structures (Nalbantoğlu, 2021). Referred to as “digital transformation,” this broad change calls for institutions to change their business models, organizational structures, and technology infrastructure as well as their cultures (Rogers, 2016; Westerman et al., 2014). Higher education institutions must carefully navigate digital transformation processes to manage increasingly complex operations, meet rising stakeholder expectations, and sustain global competitiveness under persistent resource constraints.

For Turkish universities, this transition process causes several challenges. In public-sector contexts, digital transformation is shaped by additional institutional characteristics, including regulatory obligations, centralized governance structures, and multi-layered approval mechanisms. Universities' increasingly important role in the development of creative technologies has been highlighted in prior work (Yıldırım & Tunçalp, 2023). Accordingly, digital transformation in public universities extends beyond the deployment of digital tools and requires coordinated changes in administrative processes, governance arrangements, and inter-departmental integration. Universities are expected to choose high-impact policy topics and take various stakeholders' points of view into account while developing their digital transformation plan.

Primarily through BPMN-based process modeling and enterprise architecture redesign, the digital transformation of public universities in Turkey marks the strategic junction of Business Process Management (BPM) and Enterprise Architecture. Enterprise Architecture provides a high-level blueprint that aligns organizational strategy, data, applications, and technology (Ross et al., 2006), whereas Business Process Management focuses on the analysis and improvement of operational workflows. However, existing literature often treats Enterprise Architecture and BPM as analytically separate domains, leaving the process-level operationalization of architectural strategies insufficiently explained, particularly in public-sector and higher education settings. This development aims to improve operational effectiveness, data management, and the learning process.

By using BPMN (Business Process Model and Notation), universities can model, analyze, and redesign their processes to align with digital transformation goals. This helps optimize workflows and integrate new technologies, such as blockchain, to improve transparency and security. In this study, BPMN is positioned not merely as a technical documentation tool, but as a dynamic linkage mechanism that translates enterprise-level transformation objectives into executable, analyzable, and improvable administrative workflows.

The effectiveness of universities' digital transformation projects depends on their ability to adapt to technology developments and the competent use of process management and strategic planning. This paper shows how the objectives of standardizing processes and enhancing communication among stakeholders via BPMN, addressing the challenges of data and technology integration within university units under the Enterprise Architecture framework, and automating processes as part of digital transformation, thereby minimizing erroneous transactions and accelerating approval mechanisms, can be achieved. Nevertheless, this study emphasizes that automation alone does not necessarily ensure effective or sustainable digital transformation, particularly when financial, administrative, and governance processes remain fragmented at the workflow level. An extensive literature review, administrative process models, BPMN diagrams, accessible datasets, and Python-based visualizations strengthen the study. Empirically, the study examines administratively critical units within a public university context and combines BPMN-based process modeling with qualitative interview insights and quantitative system log analysis to evaluate efficiency, approval complexity, and financial integration. This paper seeks to provide a scientific and pragmatic foundation for the operations of digital transformation in institutions. The remainder of the paper is structured as follows: Section 2 reviews the literature, Section 3 presents the methodology and data sources, Section 4 reports the findings, and Section 5 concludes with theoretical and practical implications and directions for future research. From a theoretical perspective, this study contributes to the digital transformation and Enterprise Architecture literature by clarifying how enterprise-level architectural intent can be operationalized through process-level modeling in public universities. While prior work often treats Business Process Management (BPM) and Enterprise Architecture (EA) as conceptually related yet analytically separate domains, our findings position BPMN as a linkage mechanism that translates strategic EA principles into executable and measurable administrative workflows. In doing so, the study refines the understanding of digital transformation in higher education by emphasizing that sustainable transformation depends not only on deploying digital systems, but also on embedding governance structures, approval logic, and financial feasibility constraints into the operational design of processes. This perspective extends existing BPMN research by demonstrating that process completeness and redesign eligibility are central conditions for effective automation, especially under complex public-sector approval regimes.

## 2. Literature Review

Based on scholarly literature, this part explores digital transformation, BPMN, and enterprise architectural concepts. First, preliminary background is provided on the fundamental elements of each concept, their interrelationships, and selected public university implementation examples. Digital transformation is widely defined as the comprehensive restructuring of institutions through the effective use of technological opportunities combined with corporate strategy, business processes, and organizational structures (Rogers, 2016). Usually, three aspects of this transformation are particularly significant. Automating tasks, guaranteeing data integrity, and lowering mistakes and expenses all help to define operational excellence.

In higher education institutions, digital transformation focuses on improving the experience of students and academic stakeholders rather than traditional customer experience concepts. Redefining organizational roles and responsibilities into data-driven, flexible, and sustainable structures that replace conventional business models is known as business model and organizational renewal. In public institutions (especially universities), it might be understood as “student and academic stakeholder experience” rather than “customer experience”. Furthermore, public responsibility and legal obligations might drive digital transformation initiatives into more constrained and compliance-oriented models than in other industries.

The fundamental components of digital transformation provide a wide framework requiring both technological integration, organizational transformation, and the human factor. First of all, it is important to integrate emerging technologies, including artificial intelligence, cloud computing, and the Internet of Things (IoT), into organizations (technology integration). This stage boosts operational capacity and accelerates data processing and data sharing. Using tools like Robotic Process Automation (RPA) and Business Process Management Systems (BPMS) supports process improvement and automation by maximizing workflows, reducing repetitive errors, and minimizing manual interventions. In data management and analytics, data warehouses, real-time reporting systems, and information gathered via big data platforms guide strategic decision-making processes, enhancing organizational flexibility and competitiveness. Improving employees' digital abilities and addressing organizational resistance points (Kane et al., 2015) is also crucial for all these technical components to be applied properly and sustainably. Therefore, it becomes difficult for organizations to apply technologies such as artificial intelligence, automation, and data analytics holistically and successfully without a human resource strategy and a shared, vision-driven transformation agenda.

Restructuring administrative processes in university management systems to maximize data management and boost process efficiency, adaptability, and innovation helps summarize the strategic value of enterprise architecture in digital transformation (Hindarto, 2023). Blockchain technology, when integrated into the Enterprise Architecture infrastructure to satisfy digital transformation needs such as data security, operational efficiency, and transparency, supports smooth integration between systems and facilitates regulatory compliance within the same framework. However, this stage calls for strategic planning and gradual implementation (Iswahyudi et al., 2023).

By allowing the modeling of both existing (AS-IS) and future (TO-BE) states at universities (Ammirato et al., 2024), BPMN stands out as a major instrument that helps significantly enhance bureaucratic settings in business process management. Simultaneously, BPMN-based modeling supports organizational communication by enabling transparent and standardized representations of internal processes, thereby allowing both formal and informal interactions within the university's process architecture to be visualized more precisely (Polančič & Orban, 2023).

The fact that BPMN is used in several universities also supports its effectiveness. For instance, the method of structured BPM used in a public university in Italy showed notable increases in process quality and organizational impact, therefore stressing the ability of BPMN to guide technical and organizational decisions (Ammirato et al., 2024). Using BPMN in the digital transformation process, a process architecture was developed at De La Salle University, whereby inefficiencies and non-value-added activities were identified, and organizational flexibility and student experience were reported to have improved (Lamsin & Tangkeko, 2023).

Nonetheless, it is important to note that digital transformation might be challenging in the bureaucratic and complex procedures used in the public sector, which is a conclusion applicable also to universities. Public-sector contexts often require systematic and algorithmic process redesign approaches to improve service automation and operational effectiveness, especially under complex governance constraints (Charalabidis et al., 2023). In this regard, systematic and algorithmic approaches to process management have been shown to increase stakeholder satisfaction and operational efficiency. Furthermore, incorporating IoT and BPMN extensions into public administration systems generates new opportunities in human–process–data interactions and opens the door to new designs to satisfy various user demands and skills (Ardito et al., 2020).

Because of their public character and semi-autonomous organization, state universities differ from other public institutions. However, the context of digital transformation initiatives is shaped by centralized audits, statutory requirements, and bureaucratic approval systems. Still, digital transformation has multifaceted advantages such as faster processes, improved data consistency, increased student satisfaction, and strengthened support for scholarly and research activities (Valdez-de-Leon, 2016).

Defining Business Process Management (BPM) as the systematic planning, implementing, monitoring, and optimizing of organizational workflows (vom Brocke & Rosemann, 2015), the modeling stage under BPM helps clarify interactions among stakeholders and enables the graphical representation of procedures. Developed and maintained by the Object Management Group (OMG), BPMN (Business Process Model and Notation) is the standard notation for modeling and visualizing organizational processes. Since BPMN is a standardized notation maintained by the Object Management Group (OMG), it provides a common modeling language that supports consistency, interoperability, and shared understanding across stakeholders (Object Management Group, 2014). BPMN's fundamental components are the building blocks of process modeling since they offer a thorough and structured depiction of workflows.

The fundamental dynamics of a process are expressed in flow objects through elements including activities (tasks), events, and decision points (gateways). These objects help explain process progression and the actions carried out. Connectors define relationships between process elements: sequence flow determines the order of operations, message flow illustrates communication between processes or actors, and associations link artifacts and data elements. Swim lanes, such as pools and lanes, symbolize which departments or roles carry out the procedure, clarifying task distribution and supporting the modeling of organizational responsibilities.

Finally, artifacts provide the modeling more background and explanation. Data objects represent data consumed or produced during the process, data stores refer to persistent data storage, and annotations provide explanatory notes. These components make the BPMN model more detailed and meaningful, managerially as well as technically. Since BPMN is independent of the platform and promotes technical–business collaboration, it is widely adopted (Silver, 2009). BPMN has also been evaluated as a formal modeling notation that supports semantic interpretation and analytical verification of process models, strengthening its role in process improvement research (Dijkman et al., 2008).

Simultaneously, BPMN diagrams are increasingly important for the planning stage of automation projects, since they can be integrated into BPMS or RPA technologies to enable executable workflows (van der Aalst, 2013). BPMN clearly defines who or which system initiates process steps when transformed into executable form by a workflow engine. A user task, for instance, calls for human involvement, whereas a service task indicates that a web service can automatically handle tasks. Including stages such as permission in grade entry systems or advisor signatures in university BPMN models helps determine whether process points are suitable for automation (Reijers & Mendling, 2011). Automation-driven digital transformation initiatives increasingly incorporate RPA to reduce manual workload and improve process speed and consistency, particularly in administrative workflows (van der Aalst et al., 2018).

Using a comprehensive framework, Enterprise Architecture tackles the layers of an organization's business strategy, operations, data architecture, applications, and technology infrastructure (Ross et al., 2006). Among the most often used Enterprise Architecture frameworks is TOGAF, The Open Group Architecture Framework. It emphasizes managing transformation plans step by step by examining the present situation (AS-IS) and developing a desired scenario (TO-BE) (Josay, 2018). In complicated systems like universities, Enterprise Architecture provides a guide that connects relationships between stakeholders, data sharing, application portfolios, and security regulations. Process diagrams developed using BPMN represent the business layer dimension of Enterprise Architecture and align with other levels, such as the data layer and technology layer (Winter & Fischer, 2006).

In higher education digital transformation, enterprise architecture-based approaches provide a structured way to align strategic transformation goals with technological and process-level implementation (Perez Gama et al., 2018). Enterprise Architecture contributes to organizations by supporting strategic alignment, improving decision-making capabilities, and increasing the coherence of business and IT transformation initiatives (Tamm et al., 2011). Enterprise Architecture research also emphasizes the need for structured architectural frameworks to support the organization and governance of complex information systems landscapes (Zachman, 1987). ENTERPRISE ARCHITECTURE modeling can also benefit from advanced visualization approaches that improve stakeholder understanding of architecture elements and their connections to BPMN-based business process representations (Oberhauser & Pogolski, 2019).

Many Turkish public universities have lately adopted technological solutions including staff automation, learning management systems (LMS), and student information systems (SIS). Most of these systems, however, are designed to satisfy the requirements of a particular department, and project tracking and integration across the university remain limited when a comprehensive digital transformation strategy is lacking (Kane et al., 2015). Public-sector tenders and procurement procedures are governed by centralized policies that may impede the planning and execution of new technology investments. Furthermore, legislative requirements governing academic and administrative staff add complexity to process modeling efforts.

Still, BPMN-based techniques can help expose this complexity. Public universities sometimes have complex approval systems, where workflows are slowed down by long permission chains from faculty administration to department heads, the Rectorate, and external authorities such as the Council of Higher Education (YÖK). Clear visibility of these chains, made possible by BPMN diagrams, supports the identification of bottlenecks and provides a foundation for evidence-based process redesign.

Although BPMN is widely adopted, prior research notes that its practical use involves both opportunities and constraints, particularly regarding modeling complexity and interpretability across different stakeholder groups (Recker, 2010). BPMN models can also be assessed in terms of their eligibility for redesign initiatives, and process structure can influence how effectively improvement opportunities are identified and implemented (Tsakalidis et al., 2019).

Taken together, the literature indicates that although strategic alignment and process improvement are widely recognized as essential, the process-level operationalization of enterprise architecture strategies in public universities remains insufficiently explained. This study addresses this gap by positioning BPMN as a concrete mechanism that embeds enterprise architecture principles, governance structures, and performance considerations into executable administrative workflows in higher education institutions.

## 3. Method and Data

This study adopts a mixed-method research design to examine digital transformation processes in a public university context through BPMN-based process modeling and data-driven performance analysis. The methodological approach integrates qualitative and quantitative data sources to ensure analytical depth, triangulation, and methodological robustness. By combining process modeling, interview-based insights, and system-generated transactional data, the study provides a comprehensive evaluation of how digital transformation initiatives influence administrative workflows, efficiency, and governance structures.

### 3.1. Research Design

The research is designed as an in-depth institutional case study focusing on administrative digital transformation in a Turkish public university. Case study methodology is particularly suitable for investigating complex organizational phenomena embedded within real-life institutional contexts, where boundaries between processes, technologies, and governance mechanisms are not clearly separable. The unit of analysis in this study is the administrative process, examined at both the strategic and operational levels.

The research design follows three sequential stages. First, an institutional process inventory was developed to identify administrative processes affected by digital transformation initiatives. Second, selected processes were modeled using BPMN to analyze their structural characteristics, approval mechanisms, and integration points. Third, qualitative and quantitative data were analyzed to evaluate process performance and identify improvement opportunities. This sequential structure ensures consistency between data collection, modeling, and performance assessment.

### 3.2. Process Identification and Selection

In the first stage, a total of approximately 100 administrative processes were identified through a comprehensive inventory analysis of the university's service catalogue, internal regulations, and administrative documentation. These processes span multiple functional areas, including student administration, information technologies, and strategic and financial management. The inventory aimed to capture processes that are operationally critical, recurrent, and directly affected by digital systems.

From this initial pool, 10 core processes were selected for detailed analysis based on three explicit criteria:

- High transaction frequency, indicating processes with significant operational volume and workload.
- High inter-departmental dependency, reflecting processes that require coordination among multiple administrative units.
- Strategic alignment with the university's digital transformation roadmap, ensuring relevance to institutional transformation objectives.

These criteria were applied jointly to balance analytical depth and institutional representativeness, allowing the study to focus on processes that are both operationally significant and strategically meaningful. The selected processes include student registration, server service requests, and budget distribution, all of which play a central role in institutional efficiency and governance.

## 3.3. Data Collection

Data collection involved two primary components: semi-structured interviews and transactional system records.

### 3.3.1. Qualitative Data

Semi-structured interviews were conducted with 12 participants, including department heads and operational experts from the Student Affairs, Information Technologies, and Strategy Development units. Participants were selected based on their direct involvement in the selected processes and their institutional responsibilities. To ensure systematic analysis while preserving confidentiality, department heads were coded as B1–B3, and operational experts were coded as U1–U8.

Interview questions focused on process execution, approval mechanisms, system integration challenges, digitalization barriers, and perceived efficiency issues. Interviews were conducted face-to-face and transcribed verbatim to ensure data accuracy.

Qualitative data analysis followed a two-stage procedure. First, Python-based scripts were used for keyword extraction and frequency analysis to identify recurring themes and dominant concepts. Second, thematic coding was performed manually by the researchers to ensure semantic validity and contextual interpretation. To enhance reliability, a second researcher independently reviewed a randomly selected subset of coded interview data, and discrepancies were discussed until consensus was reached. This procedure ensured methodological rigor and reduced subjective bias in qualitative interpretation.

### 3.3.2. Quantitative Data

Quantitative data were obtained from transactional logs of institutional information systems managed by the Information Technologies Department. These datasets include time stamps, approval records, error logs, and system usage data related to the selected processes. All records were retrieved from up-to-date databases to ensure accuracy and consistency. Quantitative data were used to objectively assess process performance and complement qualitative findings.

## 3.4. Performance Indicators and Measurement

To evaluate process performance, four quantitative indicators were defined and operationalized. All indicators were selected to capture both efficiency and governance dimensions of administrative workflows.

Process Duration $(T_p)$

The average completion time of a process was calculated as:

$$T_p = \frac{1}{N}\sum_{i=1}^{N} t_i \tag{1}$$

where $t_i$ denotes the completion time of the i-th transaction and $(N)$ represents the total number of observed transactions.

Number of Approval Steps $(N_a)$

Approval complexity was measured as:

$$N_a = \frac{1}{N}\sum_{j=1}^{k} a_j \tag{2}$$

where $(a_j)$ denotes each distinct approval activity and $(k)$ represents the total number of approval points.

Error Rate $(E_r)$

The proportion of erroneous transactions was calculated as:

$$E_r = \left(\frac{n_e}{N_t}\right) \times 100m \tag{3}$$

where $(n_e)$ is the number of erroneous records and $(N_t)$ is the total number of transactions.

Efficiency Score $(\mathrm{ES})$

To capture overall process performance, a composite Efficiency Score (ES) was constructed on a scale from 1 (low efficiency) to 10 (high efficiency). Throughout this study, the term "efficiency" is used consistently to denote process-level performance outcomes, whereas "productivity" is avoided to prevent ambiguity with labor-output or organizational productivity measures.

The score integrates three normalized dimensions:

$$\mathrm{ES} = (0.40 \cdot P_s) + (0.30 \cdot U_s) + (0.30 \cdot C_e) \tag{4}$$

where $(P_s)$ represents normalized processing speed, $(U_s)$ represents normalized user satisfaction, and $(C_e)$ represents normalized error-free completion rate.

Values below 5 indicate processes requiring urgent re-engineering, values between 5 and 8 represent moderate efficiency, and values above 8 indicate optimized and stable workflows.

### 3.5. Data Analysis Tools

Quantitative analyses and visualizations were conducted using the Python programming language, employing libraries such as pandas, NumPy, Matplotlib, and Seaborn. Python was selected due to its flexibility in data manipulation, statistical analysis, and visualization. All analysis scripts were prepared by the authors to ensure consistent processing and evaluation of performance indicators.

### 3.6. Methodological Validity and Limitations

The mixed-method design enhances the validity of the study through data triangulation. Combining BPMN-based process modeling with qualitative insights and quantitative performance metrics reduces reliance on a single data source. Nevertheless, the study has certain limitations. First, it focuses on a single public university, which may limit the generalizability of the findings. Second, although inter-coder reliability was addressed, qualitative interpretation inherently involves subjective judgment. Third, the Efficiency Score (ES) partially incorporates user satisfaction measures, which may introduce perceptual bias. Despite these limitations, the methodological framework provides a robust foundation for analyzing digital transformation processes in higher education institutions and offers a replicable structure for future comparative studies.

# 4. Findings

This section presents a process improvement approach aimed at improving key institutional workflows, specifically selected examples such as the Student Registration Process, the Server Service Request and Evaluation Process, and the Budget Distribution Process. The study identifies structural inefficiencies, procedural bottlenecks, and gaps in financial integration, emphasizing the need for process redesign, automation, and strategic alignment. These processes operate within the broader institutional framework, and the proposed improvements focus on reducing administrative delays, strengthening coordination between units, and integrating financial considerations into decision making, ultimately supporting a more efficient and adaptable system.

Additionally, quantitative analyses were conducted to evaluate process performance using key metrics such as processing time, error rate, number of approval steps, and the Efficiency Score (ES). The findings indicate variations in processing times across departments, weak correlations between efficiency and error rates, and efficiency trade-offs across cost, quality, and speed dimensions. These insights highlight the need for a holistic optimization strategy that integrates automation, workflow standardization, and data-driven decision making to enhance institutional processes.

To strengthen integration between qualitative and quantitative evidence, interview themes were interpreted together with log-based performance indicators. For example, interview participants repeatedly emphasized that manual approvals and hierarchical authorization chains are major sources of delay and operational workload. This qualitative theme aligns with the quantitative structure of the dataset, where the number of approval steps ($N_a$) is used as an indicator of bureaucratic complexity and is examined alongside processing time ($T_p$) and the Efficiency Score (ES). Similarly, stakeholder statements regarding system integration gaps and data duplication are interpreted together with variations in error rates ($E_r$) and efficiency outcomes across units. This mixed interpretation enables the study to link perceived bottlenecks to measurable performance patterns and to propose redesign actions that are grounded in both stakeholder experience and system-level evidence.

## 4.1. As-Is Process Analysis Findings and Improvements

Analyzing the “General Student Registration Process” BPM process card (see Figure 1) provides a comprehensive view of the process throughout its lifecycle.

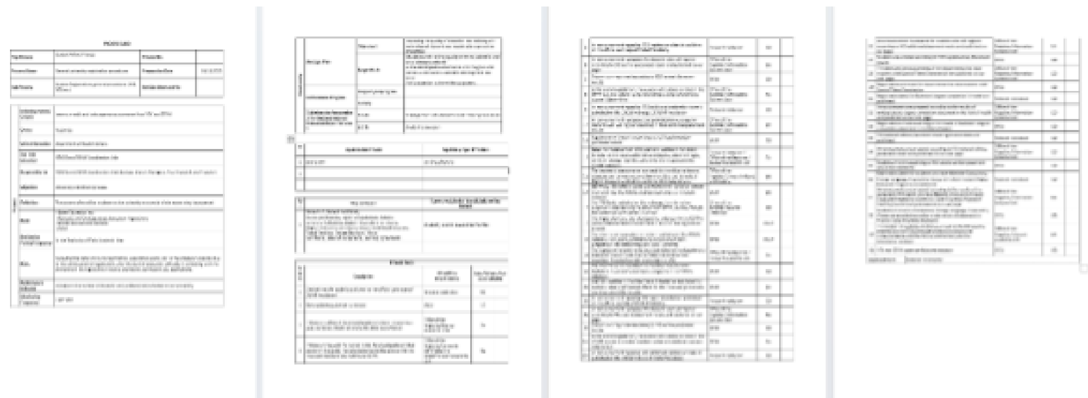

**Figure 1.** General Student Registration Process

The enrollment process exhibits a multi-layered and dynamic structure, necessitating the coordination of various stakeholders within a complex system. The process is shaped by guidelines published by ÖSYM and YÖK and encompasses different categories such as central placement, vertical transfer, special talent exams, undergraduate completion, and special group registrations. Although this structure may initially seem complex, it becomes more systematic and manageable when divided into subcategories (see Figure 2).

**Figure 2.** Registration of Students Placed by ÖSYM

Each type of enrollment requires specific procedures while sharing common stages such as preparing announcements, completing registrations, and processing data into relevant systems. However, while the academic and administrative aspects of the process are thoroughly addressed, financial components (such as tuition fees, scholarship processes, and financial transactions) are not emphasized. These findings indicate the need to address academic, administrative, and financial components within a holistic framework.

The process card (see Figure 3) of the "Receiving and evaluating Server Requests" process in the IT Department provides a detailed visualization of how it works. The process starts with the submission of the units' additional server resource request form as the initial event.

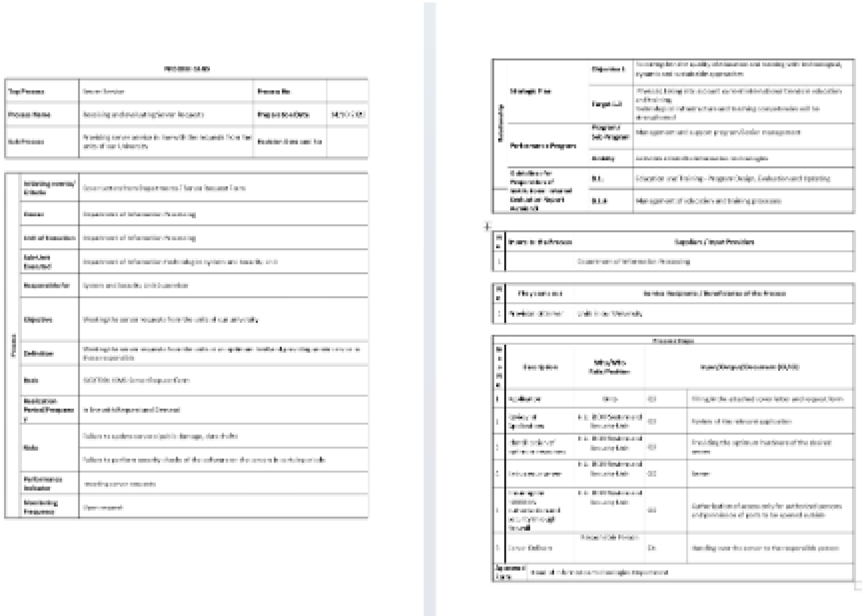

**Figure 3.** Receiving and evaluating Server Requests

The Server Service Request and Evaluation Process outlines the steps involved in receiving, assessing, and fulfilling server requests within the university. The process begins with units submitting a cover letter and request form, followed by the Information Technologies Department (IT Department) reviewing the application. Once approved, appropriate resources are identified, and the server is set up and configured. Security measures, including firewall configurations and access authorizations, are implemented before the server is delivered to the designated responsible person.

While the process effectively details technical and administrative aspects of server provisioning, it lacks a well-defined procurement component. There is no reference to purchasing new servers, budget allocation, or vendor management, which are essential for capacity planning and sustainability. The absence of procurement steps creates a gap in the process definition, as server requests might require additional resources that are not immediately available. Without an integrated purchasing mechanism, the process implicitly assumes that necessary infrastructure is always in place, potentially leading to delays, resource shortages, and inefficiencies in server allocation. To ensure a comprehensive and sustainable system, this study recommends incorporating procurement workflows, including budget planning, supplier selection, and asset management.

The server service request process is modeled in a simplified manner, primarily focusing on the technical and administrative steps required for provisioning servers within the university. However, it overlooks the inherent complexities of the direct procurement process, which is essential for ensuring the availability of necessary infrastructure. The BPMN representation of procurement workflows is inherently complex due to multiple layers of budget approvals, supplier evaluations, contract negotiations, and regulatory compliance requirements. These additional steps introduce sequential decision-making processes that involve financial oversight, legal constraints, and institutional procurement policies, making procurement significantly more intricate than the current model suggests.

A critical issue with the current process is its implicit assumption that sufficient budget and appropriate server resources are always available. However, in practice, IT infrastructure requires careful financial planning, asset evaluation, and resource allocation, which are absent from the existing workflow. If a requested server is unavailable or beyond the department's financial capacity, the process lacks a mechanism to handle these constraints. Procurement workflows typically involve market research, pricing assessments, purchase approvals, supplier coordination, and delivery timelines, all of which add layers of complexity that are essential for operational sustainability.

The direct procurement process (Figure 4) is highly intricate, involving multiple verification, authorization, and control stages to ensure financial accountability and regulatory compliance. Unlike the server provisioning process, which assumes the availability of necessary resources, this procurement workflow follows a structured sequence of budget approvals, price research, financial oversight, contract management, and final payment processing.

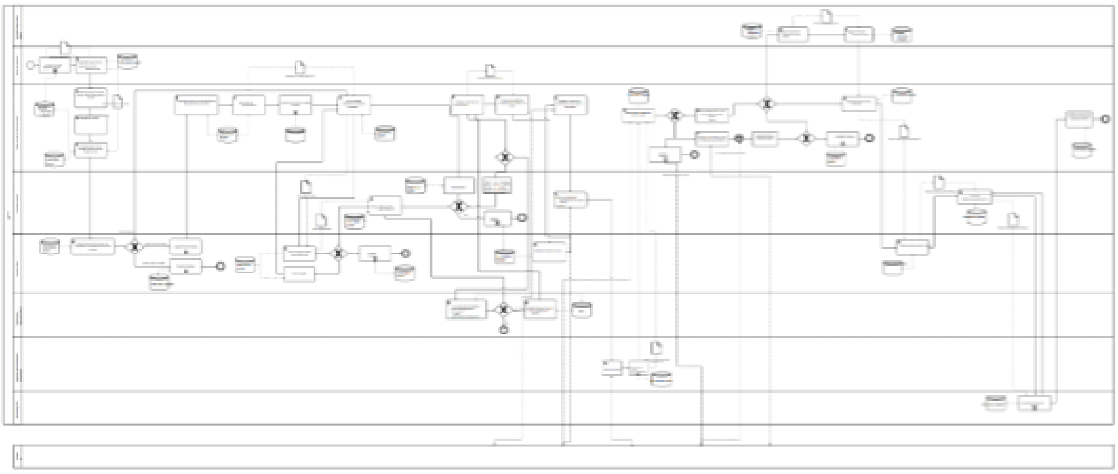

**Figure 4.** The Direct Procurement Process

The process begins with the identification of procurement needs, followed by budget verification to determine if funds are available. If funding is insufficient, the request is rejected. If approved, market price research is conducted, and an Approval Document is prepared and reviewed by both the Realization Officer and the Preliminary Financial Control Unit. The Expenditure Authority then decides whether the procurement will proceed. Once approved, contract negotiations begin, involving document collection, contract signing by both the supplier and the university, and subsequent inspection of goods or services.

If deficiencies are found during inspection, a warning letter is issued to the company, and in some cases, penal procedures are initiated. If the goods or services meet the requirements, invoices are processed, and the financial department ensures that payments are completed following approval by the Accounting Unit.

This structured and regulated procurement framework highlights the critical gap in the server request process, which lacks provisions for financial feasibility, market research, and contract execution. The absence of these steps in the server provisioning workflow creates an unrealistic assumption that required infrastructure is always available, overlooking potential delays due to budget constraints or supplier limitations. Accordingly, this study recommends integrating procurement workflows into IT service requests to support sustainable resource management and uninterrupted service delivery.

Moreover, BPMN representations of procurement processes (Figure 4) tend to be significantly more detailed than service provisioning models due to the inclusion of decision points related to budgetary constraints, bid evaluations, financial clearances, and supplier agreements. Excluding procurement from the server request process creates a major gap in process definition, as it assumes uninterrupted access to IT resources. Therefore, incorporating procurement-related activities into the workflow is recommended to strengthen financial accountability, regulatory adherence, and operational feasibility, thereby reducing the risk of service disruptions caused by budgetary limitations or resource shortages.

The Budget Distribution Process reflects the structured and multi-step nature of financial resource allocation within institutions. It ensures that budget requests are collected, analyzed, approved, and distributed in an organized manner, maintaining financial accountability and aligning with institutional priorities and regulatory requirements. Each stage plays a crucial role in facilitating efficient resource allocation; however, several inefficiencies exist that are common in complex financial workflows.

One of the key challenges in the current structure is the requirement for multiple approvals from senior management, which extends decision-making timelines, leading to delays in budget allocation and increased administrative workload. This rigid approval mechanism reduces institutional agility, making it difficult to respond quickly to changing financial needs or urgent funding requests. Additionally, the process assumes stable budgetary conditions and lacks built-in flexibility to accommodate unforeseen financial demands.

Beyond these operational inefficiencies, the Budget Distribution Process is closely linked to an institution's strategic plan, as financial resources must be allocated in alignment with long-term institutional goals. Ideally, budget planning should be guided by key performance indicators (KPIs) derived from the strategic plan, ensuring that financial decisions support measurable objectives such as academic quality improvement, infrastructure development, and research expansion. However, a critical gap in the current process is the lack of a well-defined connection between budget allocation and strategic performance metrics within process documentation.

Process cards primarily focus on operational execution, outlining procedural steps but failing to explicitly link budget decisions to strategic priorities and institutional performance outcomes. Without clear performance indicators, it becomes difficult to assess whether allocated budgets effectively contribute to institutional goals or whether adjustments are needed to optimize resource use. Additionally, the absence of well-defined KPIs in process models limits the ability to track the efficiency and impact of financial decisions, reducing transparency and accountability.

As part of this study, several improvements were proposed to enhance the efficiency of the Budget Distribution Process and strengthen its strategic alignment. A threshold-based approval mechanism is recommended to optimize the approval process, ensuring that budget requests below a certain amount require fewer authorizations. This adjustment is expected to reduce unnecessary bureaucratic delays while maintaining financial oversight in a sustainable manner.

In addition, this study recommends adopting automated budget tracking and reporting systems to enable real-time monitoring of expenditures, increase transparency, and support faster responses to changing financial conditions. Such automation may also improve the ability to anticipate budget requirements, thereby supporting more proactive and effective resource allocation.

Another significant update to the budget distribution process has been the integration of strategic performance indicators (KPIs). To strengthen strategic alignment, this study proposes incorporating KPIs that evaluate how budget allocations contribute to institutional goals and establishing a mechanism for revising allocations when necessary. Furthermore, enhanced coordination between financial planning and procurement processes is recommended to prevent delays in funding critical needs and to improve cross-process integration within institutional operations.

The issue of budget inflexibility, resulting from a model based on fixed budget conditions, is also highlighted as a key limitation. To address this limitation, this study proposes the development of emergency planning and budget reallocation mechanisms that allow resources to be redirected in response to shifting priorities. Such mechanisms can increase flexibility and responsiveness, enabling institutions to adapt more effectively to evolving financial needs.

### 4.2. Numerical Findings

This section discusses the results of statistical and visual analyses performed on datasets generated and processed using Python. Table 1 details the performance indicators for each process. Key metrics such as Processing Time (min), Error Rate, Number of Approval Steps, and Efficiency Score (ES) form the basis for analyzing and comparing the processes. The average processing time was 120 minutes, ranging from 30 minutes (minimum) to 240 minutes (maximum). Error rate, which reflects the proportion of inaccurate or erroneous transactions, has an average value of 0.25% and ranges from 0.05% to 0.90%. The number of approval steps, used as an indicator of bureaucratic complexity, averages 5 steps, with values ranging from 1 to 10. The Efficiency Score (ES), used to capture overall process effectiveness, has an average score of 5.5, ranging from 1 (minimum) to 10 (maximum).

**Table 1.** Process Metrics

| Process | Department | Processing Time (min) | Error Rate | Number of Approval Steps | Efficiency Score |
|---|---|---|---|---|---|
| S0001 | Information Technology | 130 | 0.30 | 4 | 5.8 |
| S0002 | Student Affairs | 90 | 0.22 | 6 | 6.4 |
| S0003 | Strategy Development | 160 | 0.10 | 5 | 5.2 |
| ... | ... | ... | ... | ... | ... |

This data allows process performance levels to be assessed both from an overall perspective and through detailed metrics. The results indicate that processing time and error rate highlight critical areas for process improvement, while the number of approval steps and Efficiency Score (ES) values provide guidance for understanding the bureaucratic burden and user-oriented performance characteristics of the processes.

In Figure 5, the distributions of four variables (Processing Time, Error Rate, Number of Approval Steps, and Efficiency Score (ES)), as well as their relationships, are analyzed. Processing time exhibits a bimodal distribution, indicating the presence of two distinct transaction groups. Error rate is generally concentrated at low levels, while relatively few observations display high error rates. The number of approval steps shows a relatively unimodal and homogeneous distribution. Furthermore, Efficiency Score (ES) values cluster within a moderate range, suggesting that the score reflects a consistent and systematically applied evaluation criterion across processes.

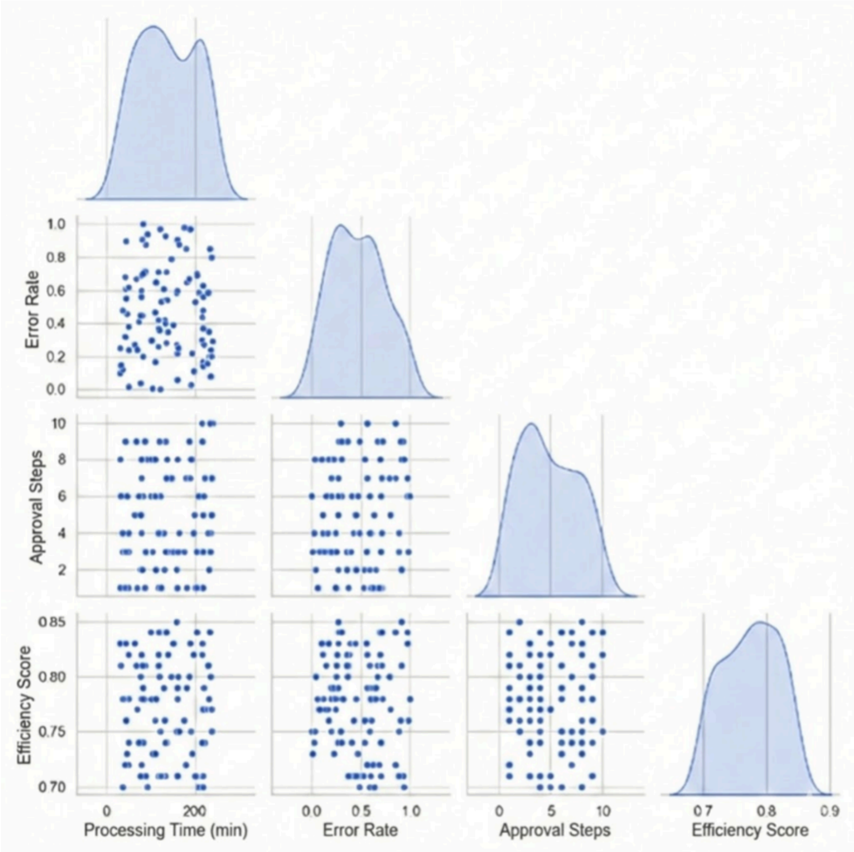


**Figure 5.** Relationships and Distributions among Performance, Error and Efficiency Indicators

When the relationships between variables are analyzed, a weak positive relationship between Processing Time and the number of approval steps is observed, indicating that approval requirements may increase as Processing Time increases. However, no significant relationship is observed between transaction time and error rate or the Efficiency Score (ES). The weak correlation between the Efficiency Score (ES) and error rate suggests that other factors, such as process complexity, resource constraints, or the approval hierarchy, may have a stronger influence on efficiency outcomes. Overall, variables do not exhibit strong linear relationships, although some weak trends are visible. These patterns can be further examined through additional statistical modeling.

Figure 6 presents the histogram for the Efficiency Score (ES), showing that scores are mostly concentrated in the range of 4 to 7. The Kernel Density Estimate (KDE) curve indicates a unimodal distribution.

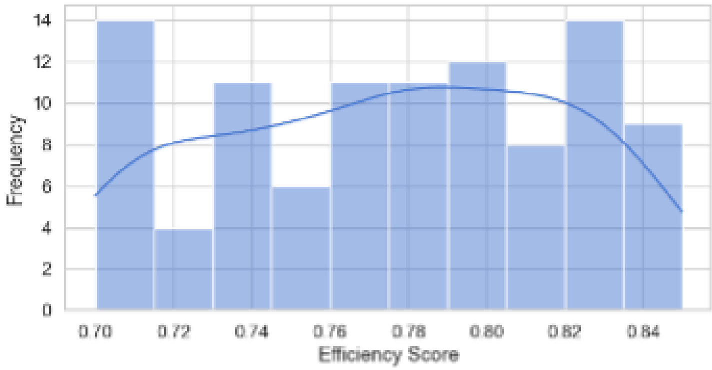


**Figure 6.** Efficiency Score (ES) Distribution

Figure 7 presents the mean values of processing times for the Strategy Development, IT, and Student Affairs departments, with variability represented by standard deviations. The graph shows limited differences across departmental means, while standard deviation ranges indicate substantial variability across processes. This suggests that some processes are relatively stable in duration, whereas others vary considerably, indicating opportunities for improvement. Examining variability alongside mean values provides guidance for increasing stability and optimizing resource utilization.

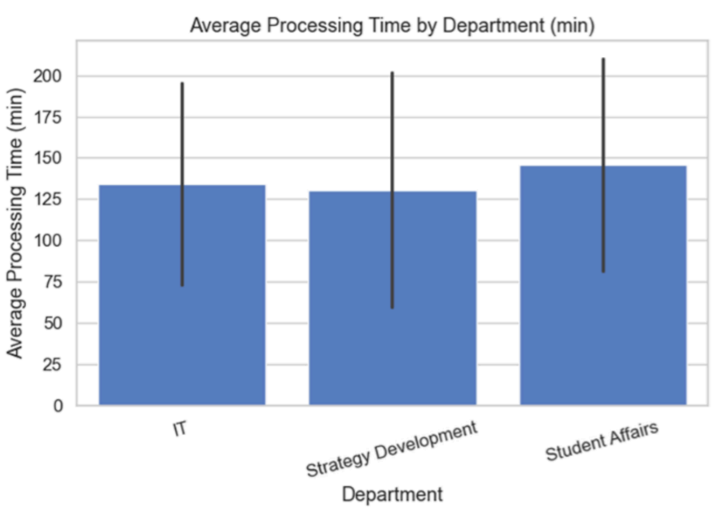


**Figure 7.** Average Processing Time per Department

The variation in processing times across the three units indicates that some processes take considerably longer than others, while some are completed quickly. In Strategy Development, average processing time is higher than in the other units, although variability is comparable. IT and Student Affairs show similar patterns in both average and variability. These findings suggest that differences between units are not pronounced in terms of average duration; however, inconsistencies within specific processes warrant closer examination. An in-depth analysis of factors affecting processing times is recommended, as it can guide process optimization and efficiency improvements.

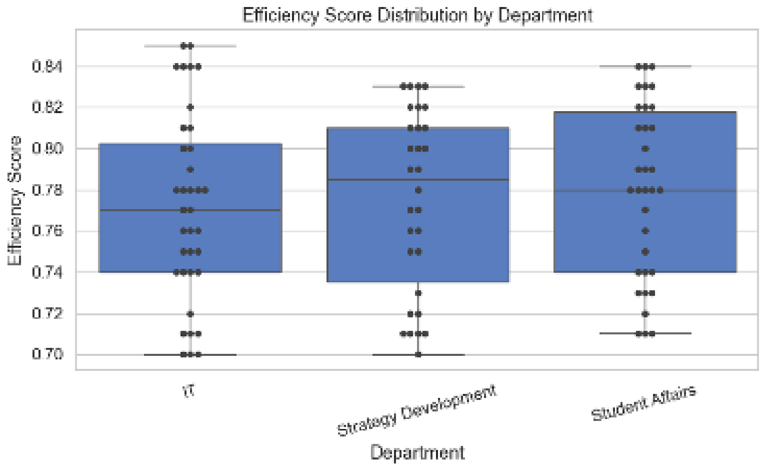


**Figure 8.** Efficiency by Department

Figure 8 shows that the median Efficiency Score (ES) of the Strategy Development department is relatively high, but the distribution is wider. The IT department's Efficiency Score (ES) values are concentrated in a narrower range, and the median is lower than that of the other departments. Student Affairs is close to Strategy Development in terms of the median but displays a wider distribution. Overall, this graph indicates that some departments have more homogeneous efficiency outcomes, while others show wider variation. These findings point to the need for more detailed analysis at the unit and process levels, including the role of workload, staffing, and system integration.

Figure 9 presents the relationship between error rate and Efficiency Score (ES) for the three units. The graph indicates no clear linear relationship between error rate and Efficiency Score (ES), suggesting that error rate alone does not directly determine efficiency. On a unit-specific basis, Strategy Development generally shows higher Efficiency Score (ES) values with a broader spread of error rates. In IT, error rates are concentrated at relatively low levels, while Efficiency Score (ES) values remain moderate. Student Affairs exhibits a wider variation in both error rate and Efficiency Score (ES), with some processes showing comparatively lower efficiency outcomes.

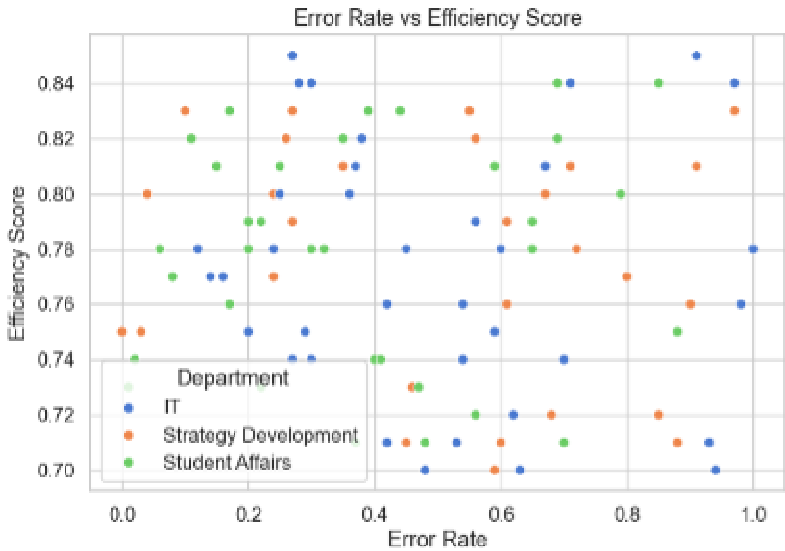

**Figure 9.** Error Rate and Efficiency Score (ES) By Departments

These findings indicate that units have different dynamics in terms of error rates and Efficiency Score (ES) values. For example, Strategy Development generally demonstrates higher efficiency outcomes, whereas IT shows low error rates but only moderate efficiency, suggesting that factors other than data accuracy, such as resource constraints or approval procedures, influence overall performance. This graph provides useful insights for targeted process optimization and the improvement of performance standards across units.

Figure 10 presents a correlation heatmap illustrating the relationships among processing time, error rate, number of approval steps, and Efficiency Score (ES). The results show that correlations between variable pairs are relatively weak, suggesting limited linear dependence among these indicators. The correlation between processing time and other variables is notably low, indicating that longer duration does not necessarily imply higher error rates, more approvals, or lower efficiency. Similarly, error rate exhibits minimal correlation with other indicators. The highest observed positive correlation occurs between number of approval steps and error rate (0.11), suggesting only a slight tendency for more approvals to be associated with increased error rates. Efficiency Score (ES) shows no statistically meaningful correlation with the other variables, implying that efficiency is influenced by additional structural, organizational, or technological factors beyond those captured by these four indicators.

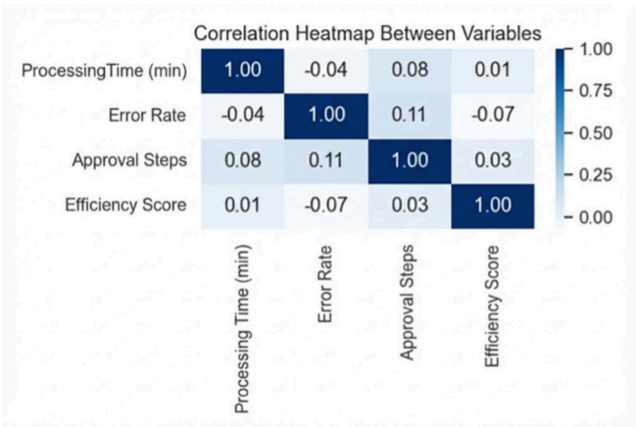


**Figure 10.** Correlation Heatmap Between Variables

The weak correlations suggest that process optimization should not rely solely on linear assumptions. Alternative analytical approaches, including non-linear regression, clustering, or machine learning-based pattern recognition, may be more effective in identifying latent dependencies. It is also possible that relationships among variables involve non-linear or threshold effects. For example, although approval steps may not linearly correspond to higher error rates or lower efficiency, excessive approvals beyond a certain point may introduce procedural delays or redundant verification steps that hinder performance. Exploring such conditional dependencies through segmented or hierarchical analyses could provide deeper insights into inefficiencies.

The absence of strong correlations underscores the complexity of administrative process performance. Efficiency is unlikely to improve through isolated changes to a single indicator. Instead, a holistic strategy is required that integrates structural process redesign, technological automation, and organizational adjustments. Since Efficiency Score (ES) remains largely independent of processing time, error rates, and approval steps, improving overall efficiency may require systemic interventions such as integrated workflow automation, standardized decision protocols, and more effective resource allocation. Future research may apply advanced methodologies such as network analysis and process mining to uncover hidden patterns and provide more targeted guidance for digital transformation initiatives.

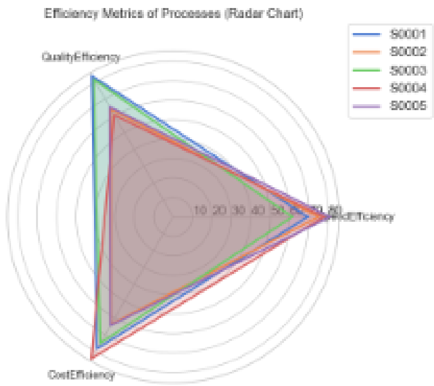


**Figure 11.** Comparison of Efficiency Metrics of the Processes

Figure 11 visualizes the efficiency metrics of five distinct processes (S0001, S0002, S0003, S0004, and S0005) across three primary efficiency dimensions: Quality Efficiency, Cost Efficiency, and Speed Efficiency. Each process is represented by a separate color, and the coverage of each shape within the radar plot indicates relative performance across these criteria.

The chart indicates that processes exhibit efficiency trade-offs, suggesting that no single process excels uniformly across all three efficiency dimensions. For instance, S0001 and S0003 display higher Quality Efficiency, indicating stronger accuracy, reliability, and adherence to standards. In contrast, S0004 shows superior Cost Efficiency, implying greater financial sustainability and lower operational expense. Speed Efficiency appears relatively balanced across processes, suggesting comparable completion-time performance for these workflows.

The overlapping areas indicate shared characteristics but also demonstrate distinct prioritizations across workflows. An inverse relationship between Quality Efficiency and Cost Efficiency is notable. Processes with higher Quality Efficiency, such as S0001 and S0003, tend to have lower Cost Efficiency, suggesting that maintaining high quality may involve additional costs, potentially due to more verification, manual intervention, or stricter compliance practices. Conversely, S0004's high Cost Efficiency corresponds with lower Quality Efficiency, implying that cost savings may come at the expense of quality, potentially through reduced oversight or simplified controls.

Overall, Figure 11 highlights the need to balance cost, quality, and speed considerations when optimizing administrative workflows. Targeted improvements may include investing in automation to improve speed without compromising quality, or reallocating resources to sustain performance in critical processes while optimizing costs elsewhere. Further modeling approaches, including regression or clustering, could provide deeper insights into drivers of efficiency patterns across processes.

### 4.3. Interview Findings

The word cloud in Figure 12 represents the dominant themes in university digital transformation discussions and highlights the critical areas frequently addressed by stakeholders. The prominence of “digitalisation” indicates a strong institutional focus on transitioning towards technology-driven workflows and modernizing administrative processes. This central theme is reinforced by high-frequency words such as “system,” “budget,” “student,” “processes,” and “projects,” which indicate challenges related to funding, technology integration, and workflow optimization.

The need for financial and technical support is evident in frequent words such as “resources,” “infrastructure,” “affairs,” and “development,” which reflect essential requirements for effective digitalisation. The frequency of “registration” suggests that student-related operations, especially during peak periods, require robust and scalable systems. The term “approval” underscores a persistent reliance on manual authorizations, indicating a clear demand for workflow automation through e-signatures and electronic document management systems.


**Figure 12.** Word Cloud of the Top 100 Words from the Interviews

The importance of IT integration is reflected in terms such as “web,” “service,” and “integration,” pointing to the need for a strong IT backbone for smoother data flow, reduced duplication, and stronger departmental coordination. The interconnected nature of these concepts aligns with Figure 13, where thematic clusters reveal interdependencies among technological infrastructure, bureaucratic processes, and financial constraints.

The word frequency analysis derived from the stakeholder interviews further validates these findings, with the most prominent terms reinforcing the central themes identified in Figure 12. The dominance of “digitalisation” and “student” reinforces the priority of process transformation in student-related operations. “Registration,” “budget,” and “data” reflect critical bottlenecks that require resolution through integrated digital systems. Stakeholders across departments emphasized that the absence of integrated digitalization processes and web services disrupts operations, particularly during student enrollment periods and budget approvals.

IT experts highlighted server limitations and system load balancing issues as key constraints, especially during peak operational periods. The absence of a standard API-based architecture exacerbates inefficiencies and forces manual interventions, increasing risks of errors, slowdowns, and operational delays.

Stakeholders emphasized the strategic value of BPMN-driven digital planning. IT experts and administrators agreed that enterprise-wide digital planning structured with BPMN models would enable universities to prioritize projects strategically and align them with institution-wide objectives. While investments in e-signature, RPA, and web service projects were viewed as essential, concerns were raised regarding "evergreen" software development projects that may consume resources through continuous updates without clear strategic direction.

Overall, the findings emphasize the need for a unified digital strategy. Rather than piecemeal initiatives, universities should adopt an enterprise architecture-driven approach to integration, automation, and budgeting to prevent redundant investments and fragmented digital initiatives. A BPMN-driven framework can prioritize essential projects and support long-term institutional efficiency and sustainability.

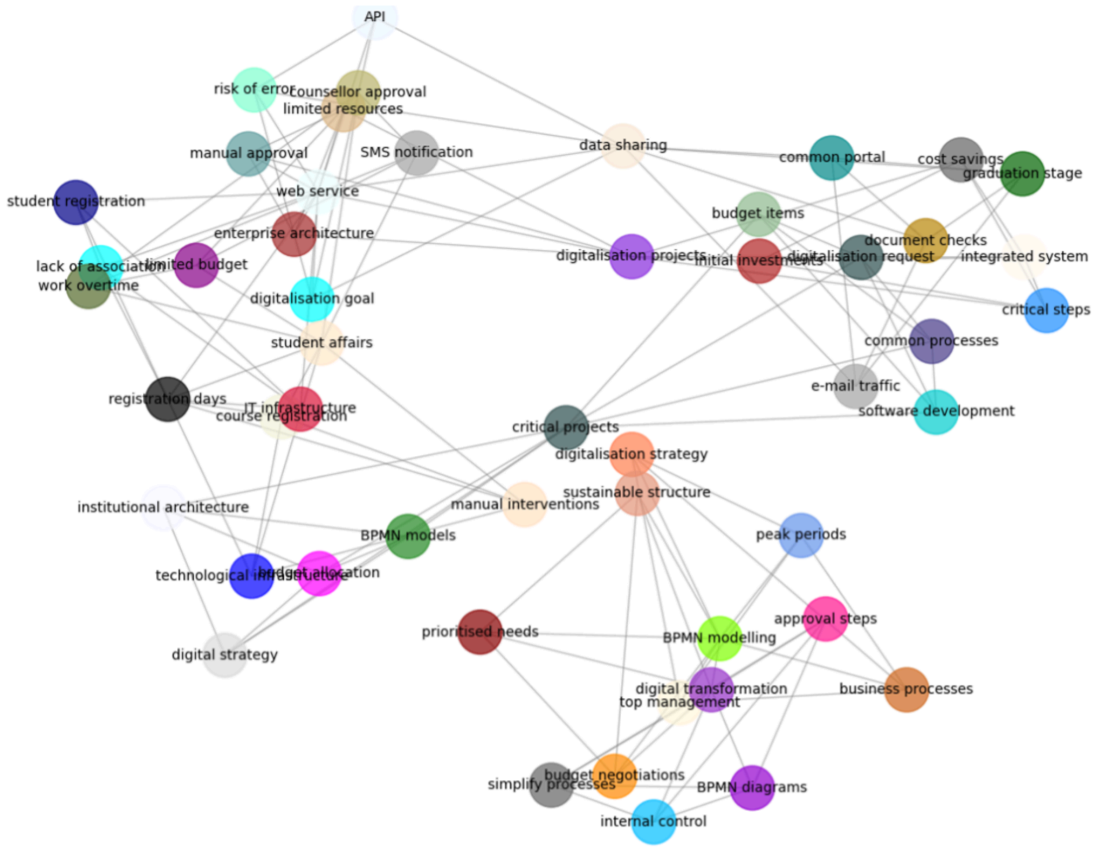


**Figure 13.** Thematic Clusters in University Digital Transformation and Process Improvement

As illustrated in Figure 13, the following summary captures the clusters and thematic groupings that reflect different facets of digital transformation and process improvement within a university context.

- Process Integration & Transformation Cluster: Concepts such as "digital transformation," "BPMN modelling," "business processes," "approval steps," "top management," "budget negotiations," and "simplify processes" highlight the need for high-level oversight and structured workflow redesign.

- Student & Academic Services Cluster: Terms such as “registration days,” “student affairs,” “course registration,” “IT infrastructure,” “work overtime,” and “limited budget” reflect bottlenecks during high-volume periods and the human and financial pressures associated with inadequate integration.
- Technical Implementation & Data Exchange Cluster: Concepts including “API,” “web service,” “manual approval,” “data sharing,” and “risk of error” emphasize standardized integration and the limitations of paper-based or partially automated processes.
- Resource Allocation & Project Prioritization Cluster: Themes such as “common portal,” “cost savings,” “initial investments,” “critical steps,” “budget items,” “software development,” and “common processes” reflect funding trade-offs and the need for system-wide coordination.
- Overarching Institutional Architecture & Strategy: Terms such as “institutional architecture,” “digital strategy,” “enterprise architecture,” and “BPMN models” connect clusters and indicate the need for a high-level architectural approach that integrates technical and organizational dimensions.

Evaluating Figure 12 and Figure 13 together reveals multiple opportunities for process improvement that are consistent with an integrated digital transformation agenda. First, the prominence of “approval” in the interview themes indicates that manual authorization steps remain a major contributor to administrative delays. In this context, we recommend evaluating the feasibility of digitizing approval workflows through e-signature systems and electronic document management platforms. Such interventions may reduce bottlenecks and accelerate process completion while strengthening traceability and control.

Second, the repeated occurrence of terms such as “data,” “budget,” and “system” suggests that data integration gaps between administrative and financial workflows remain a persistent challenge. We propose strengthening database integration and automating financial data flows to minimize duplication and reduce delay risks associated with manual entry. Such improvements may contribute to better coordination across departments and support timelier decision making.

Third, the findings indicate that repetitive administrative tasks continue to require substantial manual effort. We recommend assessing Robotic Process Automation (RPA) opportunities for repetitive workflows such as invoice registration, inventory tracking, and petition approvals. This may improve accuracy, reduce workload intensity, and allow personnel to focus on higher-value activities. Finally, stakeholder themes also imply that digital transformation success is closely linked to organizational readiness and user adoption. We therefore recommend emphasizing training and change management initiatives to support staff engagement with BPMN-driven redesign and automation projects.

In conclusion, Figure 12 and Figure 13 indicate that digital transformation in universities requires a synchronized strategy across technological, financial, and managerial dimensions. By addressing interdependencies among budget constraints, IT infrastructure, and bureaucratic approvals, institutions can develop a scalable and sustainable digital ecosystem. Combining BPMN models, data analytics, and strategic planning enables process optimization, improved service delivery, and long-term digital transformation in higher education.

## 5. Conclusion

This study examined the digital transformation of administrative processes in a public university through BPMN-based process modeling and data-driven performance analysis. By focusing on three institutionally critical workflows, namely the Student Registration Process, the Server Service Request and Evaluation Process, and the Budget Distribution Process, the study identified structural inefficiencies that constrain operational effectiveness in higher education institutions.

The findings indicate that many administrative processes continue to be shaped by long processing times, excessive manual approvals, fragmented financial integration, and limited coordination between organizational units, despite the presence of digital systems. This result suggests that digitalization alone may not guarantee process efficiency when financial governance structures and institutional constraints are not explicitly embedded into operational workflows.

The quantitative analysis demonstrates that process performance varies across departments and that there are generally weak linear relationships among processing time, error rate, number of approval steps, and the Efficiency Score (ES). This finding provides a clearer interpretation of performance patterns by indicating that administrative efficiency cannot be explained or improved through single indicators in isolation. Instead, efficiency outcomes appear to be shaped by broader organizational structures, approval hierarchies, and governance mechanisms, reinforcing the need for holistic process redesign.

From a theoretical perspective, the study positions BPMN as a linkage mechanism between Enterprise Architecture strategies and operational execution. While Enterprise Architecture frameworks define strategic intent and target states, the findings demonstrate that BPMN can operationalize these architectural principles by embedding them into day-to-day administrative workflows, thereby clarifying how strategic alignment is realized at the process level in public universities.

A further theoretical contribution lies in refining the understanding of digital transformation in public-sector and higher education contexts by emphasizing process completeness and governance alignment. The results show that processes assuming constant resource availability, particularly in IT service requests, may overlook financial feasibility and procurement constraints, leading to recurrent inefficiencies. By explicitly modeling procurement, budgeting, and approval thresholds within BPMN workflows, the study highlights that sustainable digital transformation requires the integration of financial and governance components alongside technical redesign.

Revisiting the theoretical contribution, the findings demonstrate that BPMN can serve as a concrete operational layer of Enterprise Architecture by embedding architectural alignment, governance requirements, and performance considerations into day-to-day administrative workflows. This contributes to the digital transformation literature by showing that institutional effectiveness in public universities is constrained not only by technology availability, but also by workflow-level fragmentation in budgeting, procurement, and approval structures. Accordingly, the study refines the relationship between EA and BPM by providing evidence that architectural transformation goals require BPMN-driven process redesign to become implementable, analyzable, and automation-ready within bureaucratic environments.

Methodologically, the study demonstrates the use of a composite Efficiency Score (ES) that integrates processing speed, quality, and user satisfaction on a unified scale. Unlike single-dimensional performance measures, this composite metric enables a more comprehensive assessment of administrative efficiency in bureaucratic environments where service quality and stakeholder experience are as critical as speed and error reduction.

From a practical perspective, the findings offer actionable implications for university administrators and decision-makers. The BPMN-based analyses provide replicable process models that can be used to identify bottlenecks, redundant approvals, and missing financial controls. In this context, threshold-based approval mechanisms provide a governance-oriented pathway to reduce bureaucratic delays while maintaining financial accountability. Likewise, integrating procurement and budgeting workflows into IT service request processes supports infrastructure sustainability, capacity planning, and service continuity.

Overall, this study moves beyond descriptive process modeling by demonstrating how BPMN supports both theoretical insight and practical decision-making in digital transformation initiatives. The findings suggest that purely top-down digital transformation approaches may remain insufficient in public universities, and that Enterprise Architecture should be treated as a dynamic construct requiring continuous BPMN-driven refinement.

Despite its contributions, this study has limitations. The empirical analysis is limited to a single public university, which may affect generalizability across different regulatory and cultural contexts. Additionally, the Efficiency Score (ES) partially relies on user feedback, introducing potential perception bias. Future research may extend this framework to multiple institutions and apply advanced techniques such as process mining or machine learning to identify non-linear efficiency drivers and support predictive performance monitoring.

In conclusion, the study demonstrates that effective digital transformation in higher education is not solely a technological challenge but also a systemic process redesign task. Aligning operational workflows with financial structures, governance requirements, and performance monitoring mechanisms is essential for achieving sustainable improvements in efficiency, transparency, and institutional performance.

## Declarations

**Ethics Committee Approval** Ethical approval for this study was obtained from the Hacettepe University Social and Human Sciences Research Ethics Committee (Meeting Date: February 11, 2025; Decision No: 2025/03).

**Conflict of interest** The author(s) have no competing interests to declare that are relevant to the content of this article.



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