ҚАЗАҚСТАН РЕСПУБЛИКАСЫНЫҢ ҒЫЛЫМ ЖӘНЕ ЖОҒАРЫ БІЛІМ МИНИСТРЛІГІ
МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ РЕСПУБЛИКИ КАЗАХСТАН
MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE REPUBLIC OF KAZAKHSTAN

ХАЛЫҚАРАЛЫҚ АҚПАРАТТЫҚ ЖӘНЕ КОММУНИКАЦИЯЛЫҚ ТЕХНОЛОГИЯЛАР ЖУРНАЛЫ

МЕЖДУНАРОДНЫЙ ЖУРНАЛ ИНФОРМАЦИОННЫХ И КОММУНИКАЦИОННЫХ ТЕХНОЛОГИЙ

INTERNATIONAL JOURNAL OF INFORMATION AND COMMUNICATION TECHNOLOGIES

2024 (20) 4

қазан - желтоқсан

ISSN 2708–2032 (print)
ISSN 2708–2040 (online)

Халықаралық ақпараттық және коммуникациялық технологиялар журналы
ISSN 2708–2032 (print)
ISSN 2708–2040 (online)
Меншіктенуші: «Халықаралық ақпараттық технологиялар университеті» АҚ (Алматы қ.).
Қазақстан Республикасы Ақпарат және әлеуметтік даму министрлігінің Ақпарат комитетінде – **20.02.2020** жылы берілген.
№ KZ82VPY00020475 мерзімдік басылым тіркеуіне қойылу туралы куәлік.
Тақырыптық бағыты: ақпараттық технологиялар, әлеуметтік-экономикалық жүйелерді дамытудағы цифрлық технологиялар, ақпараттық қауіпсіздік және коммуникациялық технологияларға арналған.
Мерзімділігі: жылына 4 рет.
Тиражы: 100 дана
Редакцияның мекенжайы: 050040, Алматы қ-сы, Манас к-сі, 34/1, 709-кабинет, тел: +7 (727) 244-51-09.
E-mail: ijict@iitu.edu.kz Журнал сайты: https://journal.iitu.edu.kz

Международный журнал информационных и коммуникационных технологий
ISSN 2708–2032 (print)
ISSN 2708–2040 (online)
Собственник: АО «Международный университет информационных технологий» (г. Алматы).
Свидетельство о постановке на учет периодического печатного издания в Министерство информации и общественного развития Республики Казахстан **№ KZ82VPY00020475,** выданное от **20.02.2020 г.**
Тематическая направленность: информационные технологии, информационная безопасность и коммуникационные технологии, цифровые технологии в развитии социо-экономических систем**.**
Периодичность: 4 раза в год.
Тираж: 100 экземпляров.
Адрес редакции: 050040 г. Алматы, ул. Манаса 34/1, каб. 709, тел: +7 (727) 244-51-09.
E-mail: ijict@iitu.edu.kz Сайт журнала: https://journal.iitu.edu.kz

«International Journal of Information and Communication Technologies»
ISSN 2708–2032 (print)
ISSN 2708–2040 (online)
Owner: International Information Technology University JSC (Almaty).
The certificate of registration of a periodical printed publication in the Ministry of Information and Social Development of the Republic of Kazakhstan, Information Committee No. KZ82VPY00020475, issued on 20.02.2020.
Thematic focus: information technology, digital technologies in the development of socio-economic systems, information security and communication technologies
Periodicity: 4 times a year.
Circulation: 100 copies.
Editorial address: 050040. Manas st. 34/1, Almaty. +7 (727) 244-51-09. E-mail: ijict@iitu.edu.kz
Journal website: https://journal.iitu.edu.kz

МАЗМҰНЫ

ӘЛЕУМЕТТІК-ЭКОНОМИКАЛЫҚ ЖҮЙЕЛЕРДІ ДАМЫТУДАҒЫ ЦИФРЛЫҚ ТЕХНОЛОГИЯЛАР

АҚПАРАТТЫҚ ТЕХНОЛОГИЯЛАР

АҚПАРАТТЫҚ ҚАУІПСІЗДІК ЖӘНЕ КОММУНИКАЦИЯЛЫҚ ТЕХНОЛОГИЯЛАРҒА АРНАЛҒАН

СОДЕРЖАНИЕ

ЦИФРОВЫЕ ТЕХНОЛОГИИ В РАЗВИТИИ СОЦИО-ЭКОНОМИЧЕСКИХ СИСТЕМ

ИНФОРМАЦИОННЫЕ ТЕХНОЛОГИИ

ИНФОРМАЦИОННАЯ БЕЗОПАСНОСТЬ И КОММУНИКАЦИОННЫЕ ТЕХНОЛОГИИ

CONTENT

DIGITAL TECHNOLOGIES IN THE DEVELOPMENT OF SOCIO-ECONOMIC SYSTEMS

INFORMATION TECHNOLOGY

INFORMATION SECURITY AND COMMUNICATION TECHNOLOGIES

ӘЛЕУМЕТТІК-ЭКОНОМИКАЛЫҚ ЖҮЙЕЛЕРДІ ДАМЫТУДАҒЫ ЦИФРЛЫҚ ТЕХНОЛОГИЯЛАР
ЦИФРОВЫЕ ТЕХНОЛОГИИ В РАЗВИТИИ СОЦИО-ЭКОНОМИЧЕСКИХ СИСТЕМ
DIGITAL TECHNOLOGIES IN THE DEVELOPMENT OF SOCIO-ECONOMIC SYSTEMS

INTERNATIONAL JOURNAL OF INFORMATION AND COMMUNICATION TECHNOLOGIES
ISSN 2708–2032 (print)
ISSN 2708–2040 (online)
Vol. 5. Is. 4. Number 20 (2024). Pp. 8–21
Journal homepage: https://journal.iitu.edu.kz
https://doi.org/10.54309/IJICT.2024.20.4.001

IMPROVING THE EFFICIENCY OF BANKING OPERATIONS THROUGH AUTOMATION: A MODELING APPROACH

N.E. Artyk*, G.K. Sembina
International Information Technology University, Almaty, Kazakhstan.
E-mail: gnurilaartyk38@gmail.com

Artyk Nurila — Master's student, IT Project Management, International Information Technology University, Almaty, Kazakhstan
E-mail: nurilaartyk38@gmail.com, https://orcid.org/0009-0003-9147-9052;
Sembina Gulbakyt — Candidate of Technical Sciences, associate professor, Information Systems Department, International Information Technology University, Almaty, Kazakhstan

E-mail: g.sembina@iitu.edu.kz, https://orcid.org/0000-0003-2920-1490.

Abstract. Automation of business processes has emerged as a key factor in the ongoing development of the banking industry. This study is dedicated to a comprehensive analysis of the impact of automation on the efficiency and competitiveness of banks in today's dynamic financial environment. The paper explores the main trends in the automation of business processes within the banking sector and provides an in-depth analysis of successful case studies that highlight the effective introduction of automated systems. Special emphasis is placed on how automation enhances the quality of customer service, leads to a significant reduction in operating costs, and improves the efficiency of decision-making processes. Furthermore, the study evaluates the potential risks associated with automation and offers strategic recommendations aimed at minimizing these risks. The findings presented in this study are invaluable for bank managers, software developers, and financial market regulators, guiding them to make informed decisions regarding business process automation in their organizations.

Keywords: automation of business processes, banking industry, customer service quality, modeling approach, reduced operating costs.

For citation: N.E. Artyk, G.K. Sembina. IMPROVING THE EFFICIENCY OF BANKING OPERATIONS THROUGH AUTOMATION: A MODELING APPROACH// INTERNATIONAL JOURNAL OF INFORMATION AND COMMUNICATION TECHNOLOGIES. 2024. Vol. 5. No. 20. Pp. 08–21 (In Eng.). https://doi.org/10.54309/IJICT.2024.20.4.001.

АВТОМАТТАНДЫРУ АРҚЫЛЫ БАНК ОПЕРАЦИЯЛАРЫНЫҢ ТИІМДІЛІГІН АРТТЫРУ: МОДЕЛЬДЕУ ТӘСІЛІ

Н.Е. Артық*, Г.К. Сембина
Халықаралық Ақпараттық Технологиялар Университеті, Алматы, Қазақстан.
E-mail: nurilaartyk38@gmail.com

Артық Нурила — магистратура студенті, IT проект менеджменті, Халықаралық Ақпараттық Технологиялар Университеті, Алматы, Қазақстан
E-mail: nurilaartyk38@gmail.com, https://orcid.org/0009-0003-9147-9052;
Сембина Гүлбақыт — техника ғылымдарының кандидаты, «Ақпараттық жүйелер» кафедрасының қауымдастырылған профессоры, Халықаралық Ақпараттық Технологиялар Университеті
E-mail: g.sembina@iitu.edu.kz, https://orcid.org/0000-0003-2920-1490.

Аннотация. Бизнес-процестерді автоматтандыру банк саласының үздіксіз дамуының негізгі факторына айналды. Бұл зерттеу автоматтандырудың қазіргі динамикалық қаржылық ортадағы банктердің тиімділігі мен бәсекеге қабілеттілігіне әсерін жан-жақты талдауға арналған. Мақалада банк секторындағы бизнес-процестерді автоматтандырудың негізгі тенденциялары зерттеледі және автоматтандырылған жүйелерді тиімді енгізуді көрсететін сәтті практикалық мысалдарға терең талдау жасалады. Автоматтандырудың тұтынушыларға қызмет көрсету сапасын қалай жақсартатынына, операциялық шығындардың айтарлықтай төмендеуіне және шешім қабылдау процестерінің тиімділігін арттыруға ерекше назар аударылады. Сонымен қатар, зерттеу автоматтандыруға байланысты ықтимал тәуекелдерді бағалайды және осы тәуекелдерді азайтуға бағытталған стратегиялық нұсқауларды ұсынады. Осы зерттеуде ұсынылған нәтижелер банк менеджерлері, бағдарламалық жасақтама жасаушылар және қаржы нарығын реттеушілер үшін баға жетпес маңызға ие, бұл оларға өз ұйымдарындағы бизнес-процестерді автоматтандыруға қатысты негізделген шешімдер қабылдауға көмектеседі.

Түйін сөздер: бизнес-процестерді автоматтандыру, банк саласы, клиенттерге қызмет көрсету сапасы, операциялық шығындарды азайту, модельдеу тәсілі

Дәйексөздер үшін: Н.Е. Артық, Г.К. Сембина. АВТОМАТТАНДЫРУ АРҚЫЛЫ БАНК ОПЕРАЦИЯЛАРЫНЫҢ ТИІМДІЛІГІН АРТТЫРУ: МОДЕЛЬДЕУ ТӘСІЛІ//ХАЛЫҚАРАЛЫҚ АҚПАРАТТЫҚ ЖӘНЕ КОММУНИКАЛЫҚ ТЕХНОЛОГИЯЛАР ЖУРНАЛЫ. 2024. Т. 5. No. 20. 08–21 бет. (ағылшын тілінде). https://doi.org/10.54309/IJICT.2024.20.4.001.

ПОВЫШЕНИЕ ЭФФЕКТИВНОСТИ БАНКОВСКИХ ОПЕРАЦИЙ ЗА СЧЕТ АВТОМАТИЗАЦИИ: ПОДХОД К МОДЕЛИРОВАНИЮ

Н.Е. Артык*, Г.К. Сембина
[1]Международный Университет Информационных Технологий, Алматы, Казахстан.
E-mail: nurilaartyk38@gmail.com

Артык Нурила — магистрант спец. IT проектный менеджмент, Международный университет информационных технологий, Алматы, Казахстан
E-mail: nurilaartyk38@gmail.com, https://orcid.org/0009-0003-9147-9052;
Сембина Гулбакыт — кандидат технических наук, ассоц. профессор кафедры «Информационные системы», Международный университет информационных технологий, Алматы, Казахстан

E-mail: g.sembina@iitu.edu.kz, https://orcid.org/0000-0003-2920-1490.

Аннотация. Автоматизация бизнес-процессов стала ключевым фактором в непрерывном развитии банковской отрасли. Данное исследование посвящено всестороннему анализу влияния автоматизации на эффективность и конкурентоспособность банков в современной динамичной финансовой среде. В статье исследуются основные тенденции в автоматизации бизнес-процессов в банковском секторе и приводится углубленный анализ успешных практических примеров, свидетельствующих об эффективном внедрении автоматизированных систем. Особое внимание уделяется тому, как автоматизация повышает качество обслуживания клиентов, приводит к значительному снижению операционных расходов и повышает эффективность процессов принятия решений. Кроме того, в исследовании оцениваются потенциальные риски, связанные с автоматизацией, и предлагаются стратегические рекомендации, направленные на минимизацию этих рисков. Результаты, представленные в этом исследовании, имеют неоценимое значение для банковских менеджеров, разработчиков программного обеспечения и регуляторов финансового рынка, помогая им принимать обоснованные решения относительно автоматизации бизнес-процессов в своих организациях.

Ключевые слова: автоматизация бизнес-процессов, банковская отрасль, качество обслуживания клиентов, снижение операционных затрат, подход к моделированию

Для цитирования: Н.Е. Артык, Г.К. Сембина. ПОВЫШЕНИЕ ЭФФЕКТИВНОСТИ БАНКОВСКИХ ОПЕРАЦИЙ ЗА СЧЕТ АВТОМАТИЗАЦИИ: ПОДХОД К МОДЕЛИРОВАНИЮ//МЕЖДУНАРОДНЫЙ ЖУРНАЛ ИНФОРМАЦИОННЫХ И КОММУНИКАЦИОННЫХ ТЕХНОЛОГИЙ. 2024. Т. 5. No. 20. Стр. 08–21. (На англ.). https://doi.org/10.54309/IJICT.2024.20.4.001.

Introduction

A business process in banking is an ordered set of actions that are performed in order to achieve a specific task or solve a specific problem. This process begins with the identification of the client's needs and continues until the provision of the appropriate financial product or service. It is difficult to overestimate the importance of formalization and regulation of business processes in the banking sector, since they directly affect the operational and strategic effectiveness of the bank, which, in turn, affects the profitability indicators and ratings of the bank.

The current year 2024 has witnessed a number of significant innovations in the banking sector.The popularity of cryptocurrencies and blockchain technologies continues to grow. These innovations promise a revolution in the field of interbank settlements, allowing instant payments on a global level without intermediaries. Digital platforms are becoming the norm in commercial banking. From mobile apps to online platforms, customers expect access to their finances 24/7. This trend also implies the need to integrate different service channels to provide a unified and consistent experience for customers, regardless of whether they use a mobile application, website or visit a bank branch.

The aim of the study is explore how automation can speed up routine tasks, reduce errors, and increase the overall productivity of the finance department and evaluate how automation contributes to improving the accuracy of financial data and reporting, minimizing the risk of the human factor.

Research objectives:

- Identify the main financial processes to be automated (accounting, payroll, cash flow management, etc.);
- Analyze the current productivity, accuracy and cost of manual operations;
- Identify areas where automation can bring the greatest benefit.

The novelty of the research lies in the fact that it presents a comprehensive analysis of the automation of business processes in the financial industry, considering modern technological solutions, market requirements and the needs of companies.

Automation of banking processes is a crucial step in improving the efficiency of financial institutions. One of the striking examples of successful digitalization of credit transactions is demonstrated by Kaspi Bank, the largest bank in Kazakhstan. Prior to the introduction of automated solutions, the credit process was characterized by a lengthy processing of applications, a high workload on staff and limited transparency for customers. On average, it took three to five business days to process a loan application, which reduced the speed of service and increased transaction costs. Customers were forced to personally visit bank branches to submit documents, and their creditworthiness was checked manually, which often led to errors and delays.

To solve these problems, Kaspi Bank has implemented comprehensive automation of the loan processing process, including digital processing of applications through a mobile application and a web platform. Automated algorithms have been integrated with databases of credit bureaus and state registers for instant verification of customers' credit history. The key innovation was the use of scoring models based on machine learning, which made it possible to speed up loan decision-making and significantly reduce the risks of non-repayment. Customers were able to track the status of their applications in real time through a mobile application, which increased the transparency of the process.

The automation results were impressive: the time for reviewing loan applications was reduced to one minute, and about 80% of all applications are now processed without human intervention. This has led to an increase in the number of customers and an expansion of the bank's geographical coverage. As of 2023, the number of active users of the application Kaspi.kz exceeded thirteen million. At the same time, operating costs have decreased due to

optimization of labor costs and increased efficiency of risk management.

Literature Review

The automation of business processes within financial companies has emerged as a critical area of focus, driven by the need for efficiency, cost reduction, and improved service delivery. The literature reveals a multifaceted approach to understanding how automation can be effectively integrated into financial services, highlighting both the benefits and challenges associated with its implementation.

Business Process Management (BPM) is a foundational concept in the automation of business processes, particularly in the financial sector. Duran emphasizes that BPM technologies can significantly enhance the efficiency and profitability of financial institutions by streamlining operations and reducing redundancies (Duran, 2012). This is corroborated by Nkurunziza, who notes that effective management of business processes through knowledge creation can lead to improved customer value and operational efficiency (Nkurunziza, 2023). The integration of BPM within financial services not only facilitates the automation of routine tasks but also supports strategic decision-making, enabling organizations to adapt to changing market conditions and customer needs.

Moreover, the role of information systems in automating business processes cannot be overstated. Mziray discusses how information systems facilitate the integration of disparate systems, allowing for the automation of various functions across departments (Mziray, 2023). This integration is crucial for financial institutions, which often deal with complex workflows that span multiple areas such as accounting, compliance, and customer service. The ability to automate these processes leads to reduced operational costs and enhanced service delivery, as employees can focus on higher-value tasks rather than repetitive manual processes.

The literature also addresses the challenges associated with implementing automation in financial services. For instance, while automation can lead to significant efficiency gains, it also requires careful management of change within organizations. As highlighted by Kvalnes, the ethical implications of automation, including potential job displacement and the need for employee retraining, must be considered (Kvalnes, 2019). This is particularly relevant in the financial sector, where the workforce is often required to adapt to new technologies and processes.

The article by Sembina et al. (2022) presents a comprehensive model for incident management, emphasizing the critical role of enhancing the efficiency of information technology infrastructures within enterprises. The authors argue that the increasing volume of technical support requests can lead to significant delays in incident resolution, which in turn results in system downtimes and financial losses for businesses. By developing a reference incident management model, the study aims to address these challenges and improve the overall effectiveness of incident management systems in organizations (Sembina et.al., 2022).

The literature on Business Process Automation (BPA) in the financial industry provides a comprehensive analysis of its potential and challenges. Markovitch and Willmott emphasize the importance of digitizing business processes to improve efficiency, though they note that high initial investment costs remain a significant barrier (Markovitch & Willmott, 2014). Kokina and Blanchette explore BPA's role in financial reporting, demonstrating its capacity to enhance accuracy and transparency (Kokina & Blanchette, 2019). Fernandez and Aman further highlight BPA's global impact, showcasing its ability to reduce operational costs and improve customer service delivery in financial services (Fernandez & Aman, 2018).

Chui et al. identify key areas where automation enhances productivity, particularly

in repetitive operational tasks (Chui et al., 2015). Extending this view, Milani et al. integrate blockchain technology into BPA to enhance transparency and reliability (Milani et al., 2016). Romao et al. present a banking industry case study that demonstrates BPA's ability to streamline workflows and significantly reduce processing times (Romao et al., 2019). Puschmann examines how fintech innovations drive BPA adoption, fostering both competition and operational efficiency (Puschmann, 2017).

Madakam et al. project the future directions of BPA in financial management, advocating for scalable and adaptable solutions in dynamic market conditions (Madakam et al., 2019). Schulte et al. emphasize the benefits of cloud-based BPA, particularly its scalability in handling variable workloads (Schulte et al., 2015). Ribeiro et al. connect BPA to Industry 4.0 advancements, illustrating its integration with emerging technologies to optimize operations (Ribeiro et al., 2021). Aguirre and Rodriguez provide insights into case studies where robotic process automation (RPA), a subset of BPA, has effectively reduced costs and improved efficiency (Aguirre & Rodriguez, 2017).

Tripathi discusses BPA implementation frameworks, offering practical insights for automating workflows using modern tools like UiPath (Tripathi, 2018). Lastly, Röglinger et al. introduce maturity models for BPA, underlining the importance of structured methodologies for sustained benefits (Röglinger et al., 2012).

Furthermore, the integration of automation technologies must be approached holistically. David et al. discuss the importance of enterprise resource planning (ERP) systems in monitoring and automating business processes across various functions, including finance and payroll (David et.al., 2019). This holistic approach ensures that automation initiatives are aligned with the overall strategic goals of the organization, thereby maximizing their impact on business performance.

Material and Methods

The object of research in this paper is the automation of business processes in the banking industry. In the context of growing transaction volumes and increasingly complex customer requirements, banks are striving to improve operational efficiency through the introduction of digital technologies and automation.

The subject of the study includes mathematical and computer models, as well as applied aspects of business process modeling using BPMN (Business Process Model and Notation). This methodology is widely used for visualization and optimization of processes, which allows banks to significantly improve the performance of their systems.

The hypothesis of the study is that automation of the main business processes in the bank using BPMN helps to improve operational efficiency, reduce transaction processing time, reduce costs and increase customer satisfaction. It is assumed that the introduction of BPMN in combination with modern information technologies will contribute to more flexible process management, reduce the risks of the human factor and improve the accuracy of operations.

BPMN allows you to create easily interpreted graphical models that help structure and simplify complex business processes. This methodology visualizes workflows in the form of diagrams, which allows you to identify bottlenecks, optimize resources and increase transparency of work. In the context of the banking sector, BPMN allows you to model processes such as credit transactions, payment processing, customer account management, as well as processes related to compliance with regulatory requirements(Fig.1).

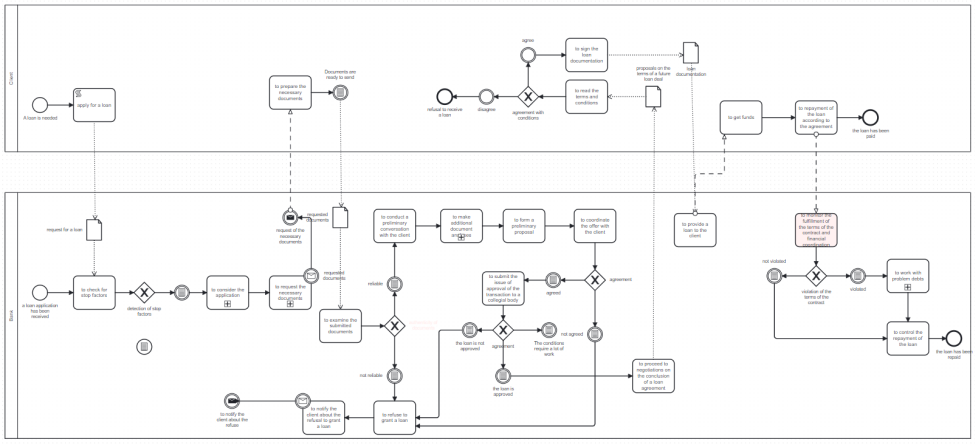

Figure 1 – The BPMN of the loan "AS-IS" process.

Let the bank have multiple processes that can be automated. These processes can be denoted as a set:

$$P = \{P_1, P_2, \ldots, P_n\} \tag{1}$$

where each P_i represents a distinct business process, such as account opening, loan processing, customer support, etc. Each process P_i requires inputs I_i and generates outputs O_i:

$$I_i = \{I_{i1}, I_{i2}, \ldots, I_{im}\} \quad (\text{Inputs for process } P_i)$$
$$O_i = \{O_{i1}, O_{i2}, \ldots, O_{io}\} \quad (\text{Outputs for process } P_i) \tag{2}$$

Examples of inputs might be customer information, transaction history, etc., and outputs can be loan approval decisions, account creation confirmations, etc.

Let's denote the degree of automation for each process as a variable x_i, where:

$x_i \in [0,1]$ where 0 represents no automation and 1 represents full automation.

where 0 represents no automation and 1 represents as a vector. So the automation configuration of the system can be represented as a vector:

$$\mathbf{x} = (x_1, x_2, \ldots, x_n) \tag{3}$$

The goal of automation is often to minimize the operational costs and maximize efficiency. Let the cost of automating process P_i be $C_i(x_i)$, which is a function of the degree of automation. We aim to minimize the total cost of automation across all processes:

$$C_{\text{total}} = \sum_{i=1}^{n} C_i(x_i) \tag{4}$$

Additionally, the bank may aim to maximize the performance or efficiency of these processes. Let the performance improvement of process P_i due to automation be $E_i(x_i)$. The overall performance can be maximized by:

$$E_{\text{total}} = \sum_{i=1}^{n} E_i(x_i) \tag{5}$$

The combined objective function can thus be:

$$f(\mathbf{x}) = \alpha \sum_{i=1}^{n} E_i(x_i) - \beta \sum_{i=1}^{n} C_i(x_i) \tag{6}$$

where α and β are weights reflecting the relative importance of performance and cost reduction.

Automation will likely face several constraints. Some typical ones include: there will be a maximum budget available for automation.

$$\sum_{i=1}^{n} C_i(x_i) \leq B \tag{7}$$

Certain processes may need to be automated to a minimum level for regulatory compliance or efficiency. Let this minimum automation level for process P_i be x_i.

$$x_i \geq x_{i,\min} \quad \forall i \tag{8}$$

Some processes may depend on the automation of others. For instance, process P_j can only be automated if process P_k is automated to a certain degree $x_{k,\min}$.

$$x_j \leq f(x_k) \tag{9}$$

Performance measures can be modeled as functions of time, accuracy, and customer satisfaction, for example:

• Time efficiency: Let $T_i(x_i)$ represent the time reduction achieved in process P_i due to automation. We want to minimize:

$$T_{\text{total}} = \sum_{i=1}^{n} T_i(x_i) \tag{10}$$

Error reduction: Let $E_{err,i}(x_i)$ represent the reduction in error rates due to automation in process P_i.

The final model, incorporating both cost and performance optimization, subject to constraints, would be:

$$f(\mathbf{x}) = \alpha \sum_{i=1}^{n} E_i(x_i) - \beta \sum_{i=1}^{n} C_i(x_i) \tag{11}$$

subject to

$$\sum_{i=1}^{n} C_i(x_i) \leq B$$

$$x_i \geq x_{i,\min} \quad \forall i \tag{12}$$

$$x_j \leq f(x_k)$$

The model leverages a process optimization framework, which includes defining the core components of business processes, such as inputs, outputs, decision variables, constraints, and objective functions (Madera, 2015). By representing each process mathematically, it becomes possible to evaluate the efficiency of different automation strategies, identify bottlenecks, and determine the optimal configuration for maximizing performance.

Results and Discussion

In the course of the research, mathematical modeling of business process automation in the banking sector was carried out, with the key goal of minimizing operational costs and maximizing process efficiency. The applied model considered parameters such as the degree of automation (x_i), the cost of automation ($C_i(x_i)$) and productivity improvement ($E_i(x_i)$).

1. Cost optimization: The model demonstrated that automating loan processes using machine learning algorithms and integration with external databases significantly reduced operational costs. In particular, the automation level (x_i) for loan application processing reached 0.8–0.9, minimizing human intervention and errors.
2. Reduction in processing time: The time for loan application processing decreased from 3–5 business days to one minute, reflecting an improvement in the $T_i(x_i)$ indicator. This optimization led to a significant increase in the number of customers, as their needs were met more quickly and transparently.
3. Improved accuracy: The introduction of automated systems reduced the error rate in calculations and creditworthiness checks. This improved decision quality and lowered the risk of defaults.
4. Resource savings: Through cost optimization ($C_i(x_i)$) and reallocation of labor, the

bank was able to reduce application processing expenses and increase overall profitability.

The table 1 highlights the transformative effects of automation business processes (BPA) on banking operations, showcasing significant improvements in efficiency and financial performance. For instance, the time required to process loan applications dropped from 3–5 business days to just 1 minute due to the implementation of BPA tools, such as real-time credit history verification integrated with external databases. This reduction enhanced customer satisfaction and significantly expanded the customer base, with active users increasing from 6 million in 2019 to 13 million in 2023, as seen in the case of Kaspi.kz. Financial indicators also saw notable improvements, with net profit rising from 175 billion KZT to 476 billion KZT in the same period. Although return on assets (ROA) and return on equity (ROE) experienced slight declines (from 9 % to 8.1 % and 77 % to 73 %, respectively), these changes reflect reinvestments and scaling efforts essential for sustaining long-term growth.

Table 1. Comparison of Kaspi.kz data before and after automation

Indicator	Before automation	After automation
Time to process loan applications	3–5 business days	1 minute
Number of active users	6 million (2019)	13 million (2023)
Net profit	175 billion KZT (2019)	476 billion KZT (2023)
Return on Assets (ROA)	9 % (2019)	8.1 % (2023)
Return on Equity (ROE)	77 % (2019)	73 % (2023)

BPA has also proven to be a vital tool in cost optimization and error reduction. Processes like loan processing, account opening, and customer support experienced substantial cost reductions, enabled by streamlined workflows and automated tools. Kaspi.kz, in particular, demonstrated the success of BPA by automating its credit application process, reducing the time to review applications to just 1 minute and processing around 80% of applications without human intervention. These advancements improved decision-making, reduced operational costs, and allowed the reallocation of resources to more complex tasks. This underscores the broader strategic importance of BPA in enhancing operational efficiency, reducing errors, and strengthening the market position of banks in an increasingly competitive financial environment.

Discussion

Automation has significantly reduced the time required for these processes, improving operational efficiency and customer satisfaction. The largest improvement is observed in loan processing, where automation eliminated bottlenecks and human intervention. These advancements not only enhance service speed but also free up resources for more complex tasks, contributing to overall operational excellence in the banking sector.

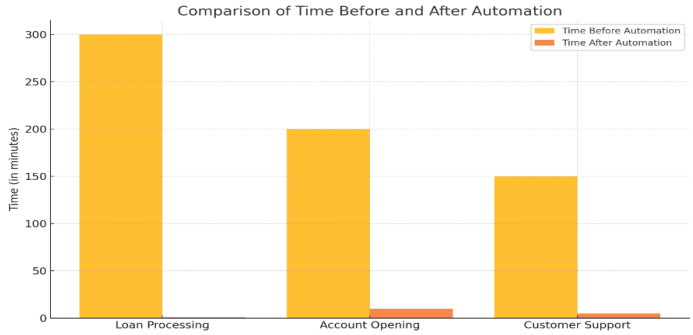

Figure 2 - Comparison time before and after automation

The diagram (Fig.2) illustrates the time efficiency achieved through automation in three key banking processes: loan processing, account opening, and customer support. For loan processing, the time required before automation was approximately 300 minutes (around 5 hours), reflecting the inefficiency of manual operations. After automation, this time was dramatically reduced to just 1 minute, showcasing the transformative impact of streamlined workflows and automated decision-making. Similarly, account opening, which previously took about 200 minutes due to extensive paperwork and manual verification, now requires only 10 minutes, highlighting the efficiency gains from process automation. Customer support also saw significant improvement, with average response times decreasing from 150 minutes to just 5 minutes after the implementation of automated systems for handling inquiries.

The diagram clearly demonstrates the profound reduction in processing times across all three processes, emphasizing the role of automation in enhancing operational efficiency and customer satisfaction. The improvements highlight how automation not only eliminates bottlenecks but also creates a more responsive and seamless banking experience, freeing resources for other strategic activities.

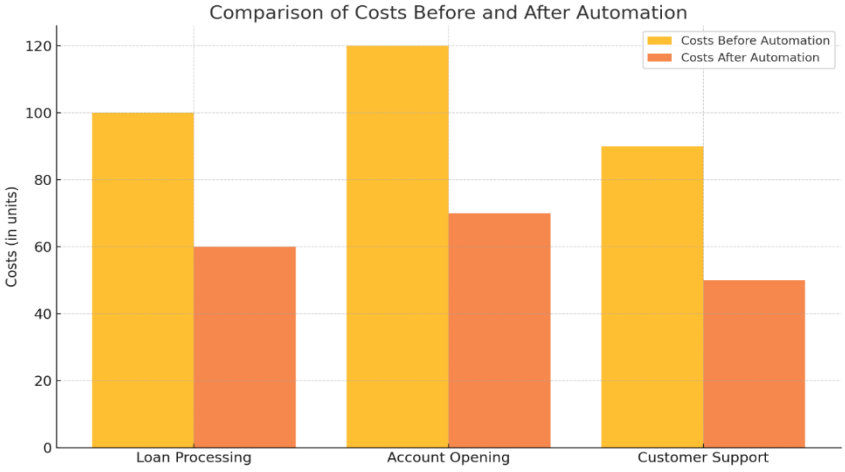

Figure 3 – Comparison costs before and after automation

The second diagram (Fig.3) presents a comparative analysis of costs incurred before and after the implementation of automation business processes (BPA) across three critical banking operations: loan processing, account opening, and customer support. For loan

processing, costs before automation were approximately 100 units, primarily due to reliance on manual labor and inefficiencies in workflow management. Post-automation, these costs decreased significantly to 60 units, reflecting the effectiveness of streamlined processes in reducing expenses. Similarly, the cost of account opening, which was around 120 units before automation due to the demands of paperwork, verification, and human resource management, dropped to 70 units after automation. This demonstrates enhanced cost efficiency and better resource utilization. In the case of customer support, costs reduced from 90 units to 50 units as automation replaced manual operations, contributing to faster and more reliable customer service.

According to the results, several key discussion points emerged:

1. Impact on efficiency: The presented results confirm the hypothesis that automating processes using the BPMN approach significantly enhances the operational efficiency of a bank. However, it is worth noting that high initial investments in the development and implementation of automated systems remain a barrier for many organizations.

2. Model adaptation: The successful application of the optimization model depends on properly configuring weight coefficients to balance costs and efficiency. For example, in this study, a greater emphasis was placed on productivity, which is justified in a competitive market environment.

3. Limitations: Although the presented model successfully demonstrated its advantages, its application is limited to specific scenarios. For complex operations, such as risk management or investments, the model may require further development and the integration of additional factors.

Future research should focus on expanding the existing model to incorporate factors that account for human interaction with automated systems, ensuring a more comprehensive understanding of their integration. It is also essential to consider the long-term risks associated with completely removing human involvement in critical processes, as this may pose challenges in maintaining oversight and adaptability. Additionally, evaluating the impact of automation on customer satisfaction, particularly from the perspective of varying levels of digital literacy among users, could provide valuable insights to guide inclusive and effective automation strategies.

The obtained results underscore the importance of a strategic approach to automation in the banking sector. Effective planning and process management will enable banks to achieve not only financial benefits but also strengthen their competitive position in the market.

Conclusion

In the context of automating business processes in banks, the study highlights the transformative impact and effectiveness of automation technologies. Despite the absence of large-scale industrial operations, automation has proven to be a critical tool for enhancing operational efficiency, reducing costs, and improving service quality within the banking sector.

The automation of business processes within the banking sector is no longer a mere trend but a strategic imperative. This study has delved into the intricate relationship between automation and the efficiency of banking operations. By leveraging mathematical modeling, we have demonstrated that the strategic implementation of automation can significantly enhance various aspects of banking.

The successful implementation of automation in banking requires an integrated approach that considers both technological and organizational factors. By carefully selecting the processes to be automated, developing robust models, and addressing potential challeng-

es, banks can harness the full potential of automation to achieve their strategic goals.

The automation of business processes is a powerful tool for transforming the banking industry. By optimizing operations, enhancing customer satisfaction, and driving innovation, banks can solidify their position in a rapidly evolving competitive landscape. As technology continues to advance, the possibilities for automation in banking are vast, and organizations that embrace this trend are poised to reap significant benefits.

In conclusion, automation of business processes in banks offers substantial benefits in terms of efficiency, cost savings, and service quality. However, addressing implementation challenges and ensuring a balanced approach that integrates automation with human oversight are essential for achieving long-term success. The findings underscore the importance of strategic planning and continuous improvement in leveraging automation technologies to enhance banking operations.

REFERENCES

Aguirre S. & Rodriguez A. (2017). «Automation of a business process using robotic process automation (RPA): A case study,» Springer Applied Computer Sciences. — 2017. doi: https://doi.org/10.1007/978-3-319-66963-2_7

Chui M., Manyika J. & Miremadi M. (2015). «Four fundamentals of workplace automation,» McKinsey Quarterly, 2015. [Online]. Available: https://roubler.com/wp-content/uploads/sites/60/2016/11/Four-fundamentals-of-workplace-automation.pdf

David J., Martikkala A., Lobov A. & Lanz M. (2019). «A unified ontology namespace for enterprise integration - a digital twin case study,» Future Generation Computing. — 2019. — Pp. 13–22. doi: https://doi.org/10.22213/2658-3658-2019-13-22

Duran R. (2012). «Business process management in financial services». — 2012. — Pp. 240–251. doi: https://doi.org/10.4018/978-1-4666-0249-6.ch013

Fernandez D. & Aman A. (2018). «Impacts of business process automation on global financial services,» Asian Journal of Accounting & Finance. — 2018. [Online]. Available: http://journalarticle.ukm.my/19713/1/25271-90574-1-PB.pdf

Kokina J. & Blanchette S. (2019). «Digital transformation through BPA in financial reporting,» International Journal of Financial Analytics. — 2019. doi: https://doi.org/10.1016/j.accinf.2019.05.001

Kvalnes Ø. (2019). «Automation and ethics». — 2019. — Pp. 69–77. doi: https://doi.org/10.1007/978-3-030-15191-1_8

Markovitch S. & Willmott P. (2014). «Accelerating the digitization of business processes,» McKinsey Corporate Finance Business. — — 2014. [Online]. Available: https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Accelerating%20the%20digitization%20of%20business%20processes/Accelerating%20the%20digitization%20of%20business%20processes.pdf

Madakam S., Holmukhe R.M. & Jaiswal D.K. (2019). «Future directions of BPA in financial management systems». — *Journal of Information Systems*. — 2019. [Online]. Available: https://www.scielo.br/j/jistm/a/m7cqFWJPsWSk8ZnWRN6fR5m/

Madera Alexander Georgievich (2015). «Mathematical modeling and optimization of business processes based on the complex criterion ‘chances - risks’,» Russian Journal of Management. — Vol. 13. — №. 4. — 2015. [Online]. Available: https://cyberleninka.ru/article/n/matematicheskoe-modelirovanie-i-optimizatsiya-biznes-protsessov-na-osnove-kompleksnogo-kriteriya-shansy-riski

Milani F., García-Bañuelos L. & Dumas M. (2016). «Blockchain and business process improvement». — BP Trends Journal. — 2016. [Online]. Available: https://bptrends.info/wp-content/uploads/10-04-2016-ART-Blockchain-and-Bus-Proc-Improvement-Milani-Garcia-Banuelos-Dumas.pdf

Mziray E. (2023). «Effectiveness of information systems on automation of business processes for nonprofit organizations in Arusha city». — *European Journal of Theoretical and Applied Sciences.* — Vol. 1. — №. 5. — 2023. — Pp. 1147–1154. doi: https://doi.org/10.59324/ejtas.2023.1(5).100

Nkurunziza G. (2023). «Knowledge creation and business process re-engineering outcomes of financial services». — *Seisense Journal of Management.* — Vol. 6. — №. 1. — 2023. — Pp. 141–158. doi: https://doi.org/10.33215/yae7kt49

Puschmann T. (2017). «Fintech and its impact on automating processes in financial services,» Business & Information Systems Engineering. — 2017. doi: https://doi.org/10.1007/s12599-017-0464-6

Ribeiro J., Lima R., Eckhardt T. & Paiva S. (2021). «Robotic process automation and artificial intelligence in industry 4.0 – a literature review,» Procedia Computer Science. — Vol. 181. — 2021. — Pp. 564–571. doi: https://doi.org/10.1016/j.procs.2021.02.020

Romao M., Costa J. & Costa C.J. (2019). «Business Process Automation: A Case Study in the Banking Industry,» IEEE Iberian Conference. — 2019. [Online]. Available: https://www.researchgate.net/profile/Carlos-Costa/publication/334482701_Robotic_Process_Automation_A_Case_Study_in_the_Banking_Industry/links/6034f0c2299bf1cc26e4c057/Robotic-Process-Automation-A-Case-Study-in-the-Banking-Industry.pdf

Röglinger M., Pöppelbuß J. & Becker J. (2012). «Maturity models in business process management». — *Business Process Management Journal.* — 2012. [Online]. Available: https://www.researchgate.net/profile/Jens-Poeppelbuss/publication/241509649_Maturity_Models_in_Business_Process_Management/links/565f108908aefe619b27f19e/Maturity-Models-in-Business-Process-Management.pdf

Schulte S., Janiesch C., Venugopal S. & Weber I. (2015). «Elastic Business Process Management in the cloud. «Future Generation Computing. — 2015. [Online]. Available: https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=e73cdeaeca8a5d0c3c200a8d97be2e2c7e3d6749

Sembina G., Mayandinova K., Naizabayeva L. & Sagnayeva S. (2022). «Development of reference incident management model». *Eastern-European Journal of Enterprise Technologies*. — Vol. 6. — №. 2 (120). — 2022. — Pp. 41–50. doi: https://doi.org/10.15587/1729-4061.2022.266387

Tripathi A.M. (2018). Learning Robotic Process Automation: Create Software Robots and Automate Business Processes with UiPath, Packt Publishing. — 2018. [Online]. Available: https://books.google.com/books?id=SLZTDwAAQBAJ

ХАЛЫҚАРАЛЫҚ АҚПАРАТТЫҚ ЖӘНЕ КОММУНИКАЦИЯЛЫҚ ТЕХНОЛОГИЯЛАР ЖУРНАЛЫ

МЕЖДУНАРОДНЫЙ ЖУРНАЛ ИНФОРМАЦИОННЫХ И КОММУНИКАЦИОННЫХ ТЕХНОЛОГИЙ

INTERNATIONAL JOURNAL OF INFORMATION AND COMMUNICATION TECHNOLOGIES

Правила оформления статьи для публикации в журнале на сайте:
https://journal.iitu.edu.kz
ISSN 2708–2032 (print)
ISSN 2708–2040 (online)
Собственник: АО «Международный университет информационных технологий» (Казахстан, Алматы)

ОТВЕТСТВЕННЫЙ РЕДАКТОР
Мрзабаева Раушан Жалиқызы

КОМПЬЮТЕРНАЯ ВЕРСТКА
Асанова Жадыра

Подписано в печать 15.12.2024.
Формат 60x881/8. Бумага офсетная. Печать - ризограф. 9,0 п.л. Тираж 100
050040 г. Алматы, ул. Манаса 34/1, каб. 709, тел: +7 (727) 244-51-09).

Издание Международного университета информационных технологий
Издательский центр КБТУ, Алматы, ул. Толе би, 59