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Analysis of effectiveness of information process management in banking institutions

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Abstract: A key aspect affecting the competitiveness of banks is the management of IT processes. Effective management of IT processes ensures the reliability, security, scalability of banking services, and fosters innovation implementation. Key issues include uneven load on computing power and personnel, complexities of software integration, and insufficient detailing of technological processes. The use of architectural patterns has been proposed to enhance the efficiency and flexibility of IT infrastructure. Architectural patterns can serve as an effective tool to achieve stable and reliable operation of banking system.

Keywords: management efficiency, financial transactions, IT processes, architectural patterns, domain driven design (DDD), distributed patterns.

1. Introduction

Banks play a significant role in the implementation of monetary policy, participate in the efficient redistribution of savings and investments in market economy conditions, and ensure the stability of the entire financial system of the country as a whole [1]. In the era of digital transformation, the banking sector is facing the need to adapt rapidly to changing market conditions and customer demands. One of the key aspects influencing the competitiveness and resilience of banks is the management of IT processes [2]. Effective management of IT processes allows for ensuring the reliability, security, scalability of banking services, and facilitates the timely implementation of innovations [3].

This study examines methods for analyzing the effectiveness of managing IT processes in banks and discusses the application of architectural patterns to enhance the efficiency and flexibility of IT infrastructure.

2. Problem Statement

IT processes in a bank encompass all aspects of the development, implementation, operation, and support of information systems and technologies [4]. They ensure the smooth operation of core business processes, such as transaction processing, customer data management, compliance with regulatory requirements, and provision of digital services to clients.

Effective management of IT processes enables banks to achieve the following objectives:

- Ensuring high availability and reliability of IT services.
- Reducing operational risks and ensuring information security.
- Optimizing costs related to IT infrastructure and resources.

- Accelerating the implementation of innovations and new products in the market.
- Enhancing customer service quality through the adoption of modern digital solutions.

3. The main part

In the life cycle of a financial institution, during its creation, development, growth, capitalization, technology infrastructure construction, and service implementation, a combination of methods and tools for achieving successful operational outcomes faces several structural problems related to establishing IT processes and building the right IT infrastructure [5].

One of the main issues encountered by banks is the uneven distribution of technological workload on computing resources and personnel. This can lead to overloading some systems and underutilizing others, negatively impacting the efficiency of the institution. The use of diverse software that does not always integrate well with each other creates additional management difficulties for the IT system of the institution. Inconsistencies in software components can result in data loss, calculation errors, and other issues [6].

Even in the software development stage, owners of business processes in banking institutions may not always pay enough attention to detailing technological processes. This can lead to inconsistencies and errors that adversely affect the overall efficiency of the bank's operations [7, 8]. The lack of middle managers with appropriate skills complicates the management of technological processes.

One of the primary issues is the suboptimal distribution of computational tasks at different times, leading to peak server loads, thus reducing system efficiency. This is related to complex computational tasks that may be rigidly tied to specific times or servers, limiting the flexibility of the IT system and complicating its scalability.

Excessive abstraction, insufficient detailing, and detachment from the reality of technological maps, positions, and other regulatory documents are often tailored solely to meet legislative requirements rather than practical use. This detachment from real needs diminishes operational efficiency. Restrictions on software usage based on legislative norms, licenses, contracts, regulatory requirements, and parent institution requirements can create additional constraints and challenges for banks.

Analysis of IT Process Management Effectiveness.

Key performance indicators characterizing the efficiency of IT processes include [9]:

1. Service Availability: This indicator reflects the amount of time IT services are available to users as a ratio of the total time.
2. Mean Time to Restore (MTTR): The average time required to restore IT service functionality after an incident, including detection, diagnosis, and recovery.
3. Mean Time Between Failures (MTBF): The average time between incidents leading to IT service failures. Higher MTBF indicates a more reliable service.
4. Change Success Rate: The proportion of changes introduced without incidents or issues, assessing change management effectiveness.
5. Change Implementation Time: The average time required for developing, testing, and implementing changes in the IT infrastructure.

Each of these key indicators is vital for monitoring and improving the IT department's performance, ensuring the stability and efficiency of services provided.

Methods used for analyzing the efficiency of managing IT processes include monitoring and log analysis, incident and problem analysis, IT action audit, and user satisfaction assessment [10].

Monitoring and log analysis involve continuous data collection on IT system operations and their analysis. Logs contain information on system actions, errors, warnings, and other events. This method helps identify problematic areas, monitor system performance, prevent potential failures, and optimize processes. Real-time log monitoring allows for prompt responses to system issues, anticipating potential incidents.

Incident and problem analysis entails investigating incidents (unplanned events) and problems (events that may lead to incidents). This method analyzes the causes and consequences of incidents to prevent their reoccurrence, enhancing system stability and reliability, and reducing incident frequency.

IT process audit is a regular check to ensure compliance with IT processes with best practices and regulatory requirements, improving risk management and enhancing IT efficiency[11, 12]. Regular audits help uncover vulnerabilities in processes, non-compliance with security standards, or legal requirements. User satisfaction assessment involves collecting feedback from IT service users to evaluate their satisfaction and identify service-related issues. This method allows for improving service quality, increasing user satisfaction, and adapting services to user needs. Each of these methods plays a crucial role in ensuring the effectiveness of IT process management, providing control, analysis, and continuous system improvement.

Financial Transaction.

A financial transaction is the foundation of any banking activity, being a key element in the functioning of banks and financial institutions [6, 13]. Whether it is a simple cash withdrawal, fund transfer between accounts, or complex credit operations, transactions facilitate the circulation of money and the execution of financial obligations. Each day, the number of electronic payments, transfers, and other operations related to financial institutions is increasing. This growth poses new challenges for bank servers, ensuring fast and reliable transaction processing.

Financial transactions are a critical element of banking systems. To ensure the stable and reliable operation of servers, regular load analysis and appropriate optimization measures are necessary. Analyzing server load becomes a key aspect in ensuring their stable operation.

Bank servers must process thousands or even millions of transactions per second. High load can arise due to various factors such as:

Peak hours: For example, during payday, interest accrual schemes, sales, tax deadlines.

Seasonal variations: Holiday periods or the beginning of the academic year.

Attacks: Cyberattacks or fraudulent activities.

Banking Institution Load Analysis.

From January to May 2024, an analysis of the operations of Bank "A" and the effectiveness of IT process management (the bank name is not disclosed due to commercial secrecy) was conducted.

The load on the bank's server system can be evaluated using various metrics, including the volume and number of transactions processed during specific time periods. Peak transaction volumes contribute to uneven distribution of technological workload on computing resources and personnel, reducing the provision of high availability and reliability of IT services, operational risks, and ensuring information security.

Charts provided for January to May 2024 illustrate the dynamics of the number of transactions for each day of these months (Fig. 1 – 5).

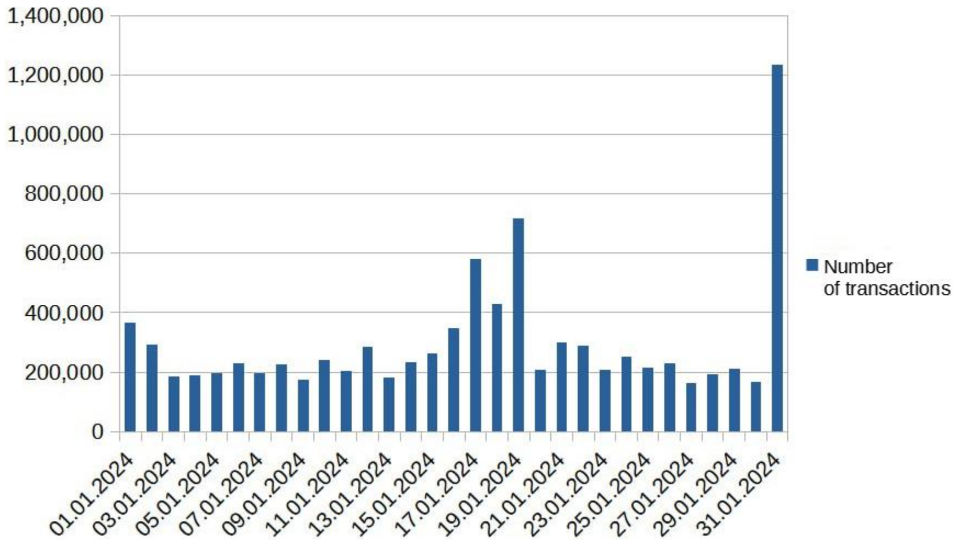

Fig. 1 Number of transactions for each day of January 2024.

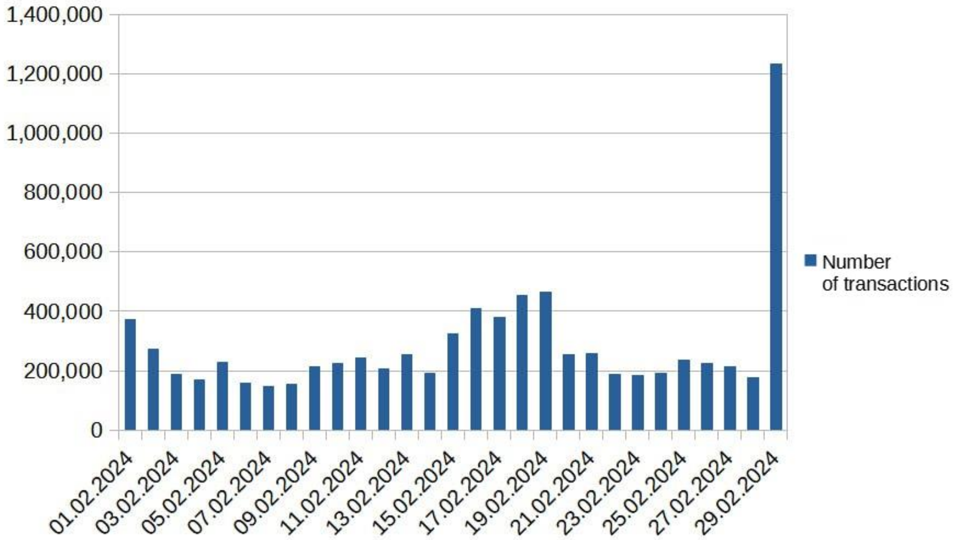

Fig. 2 Number of transactions for each day of February 2024.

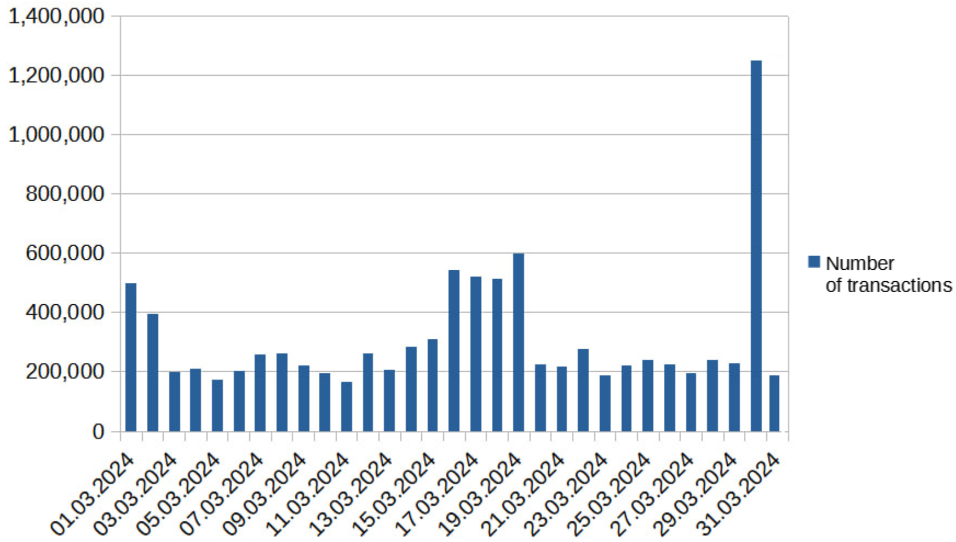

Fig. 3 Number of transactions for each day of March 2024.

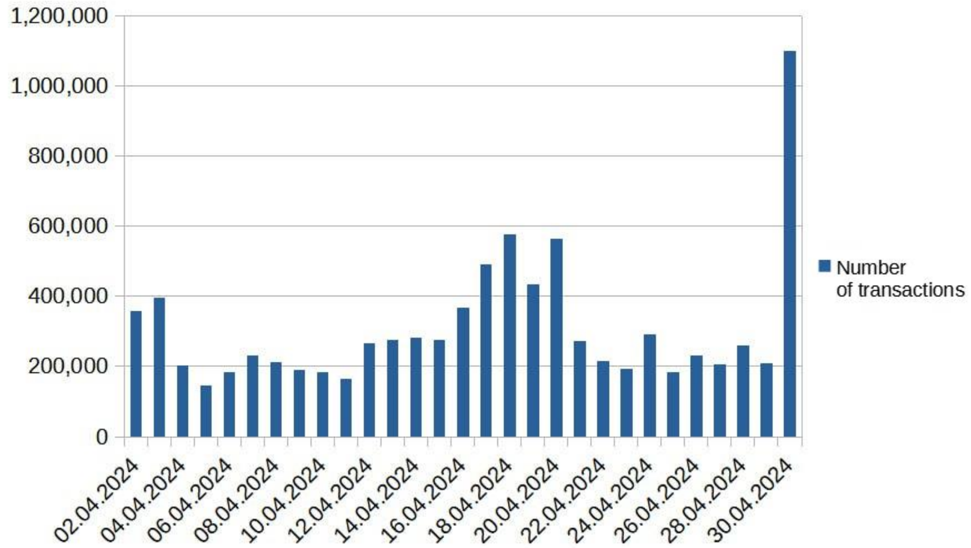

Fig. 4 Number of transactions for each day of April 2024.

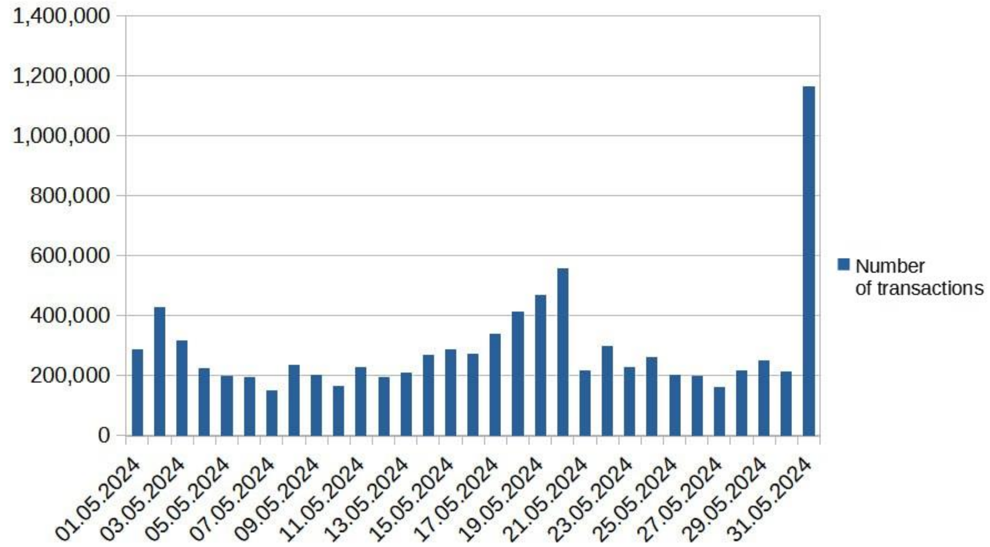

Fig. 5 Number of transactions for each day of May 2024.

Based on the analysis provided, we can observe the following trends and possible reasons for changes in transactional activity:

January 2024:

The graph for January 2024 shows fluctuations in the number of transactions ranging from 100,000 to 1,200,000 per day.

Key observations include:

Beginning of the month: Transactions in the first few days range from 200,000 to 300,000 per day.

Mid-month: Stable growth in transactions, peaking around the 20th with approximately 700,000 transactions.

End of the month: The highest peak of activity is on January 31st with approximately 1,200,000 transactions.

Possible reasons for these peak loads could include financial reporting periods, increased business activity after the New Year holidays, and transaction spikes related to month-end activities such as interest accruals.

February 2024:

The analysis for February 2024 also shows significant variability in transaction volumes, ranging from 100,000 to 1,200,000 per day.

Key points include:

Beginning of the month: Similar transaction volumes to January, around 200,000 to 300,000 per day.

Mid-month: Activity increases with peaks around the 17th and 21st, reaching about 600,000 transactions.

End of the month: Similar to January, the highest activity is on February 29th, with around 1,200,000 transactions.

Reasons for increased activity at month-end may be similar to those in January, such as financial reporting periods and regular payments like salaries and financial instrument-related transactions.

March, April, May:

Similar patterns of increased activity in mid-month and peak loads on the last working day are observed in March, April, and May.

Notably, March shows peak activity on the last working day, indicating executing financial instrument interest accruals and closing the current period by bank's responsible executives and other bulk operations running.

Comparative Analysis:

Activity Peaks: Peaks of business activity occur around mid-month in all months, with maximum activity at month-end likely linked to financial reporting closures and regular payments.

Seasonal Variances: Spring months show a slight increase in business activity and sharper fluctuations at the start and middle of the month, possibly due to retail resurgence in the spring.

Average Transaction Levels: The average transaction levels are consistent across all months, suggesting stable transactional activity in the banking system.

The graphs indicate that the banking system experiences peak loads at the end of each month, particularly on the last working day. This is likely due to interest accruals, financial reporting closures, and mass payouts. Understanding these processes allows for better resource planning and management to ensure stable and efficient operations even during high-load periods.

Usage of Architectural Patterns.

To address the mentioned challenges of financial institutions, the use of architectural patterns in the development, implementation, and modernization of software is proposed to enhance the efficiency of managing IT processes [14, 15]. This will help evenly distribute computational tasks in space and time, saving costs on proprietary server hardware and cloud resource rentals. It will also optimize the work of enterprise staff, particularly DevOps personnel, improve communication between departments, and make technological processes more integrated, manageable, controllable, predictable, reliable, and secure.

Architectural patterns are proven solutions for typical design and development tasks of IT systems [16]. Applying architectural patterns can enhance the flexibility, scalability, and reliability of a bank's IT infrastructure. Let's consider some of the most common architectural patterns [17, 18].

The Microservices pattern involves dividing the system into independent services, each performing a specific function and interacting with other services through well-defined interfaces. The primary benefits of microservices architecture are flexibility and scalability of individual services based on load. Implementing microservices architecture increases resilience - the failure of one service does not lead to a system-wide failure.

The Event-Driven Architecture pattern involves using events for component interaction within the system. Components react to events and perform specific actions. The advantages of event-driven interaction include reducing dependencies between components, improving performance, and enabling parallel event processing.

The CQRS (Command Query Responsibility Segregation) pattern separates read and write operations of data into two separate interfaces. This optimizes the system's performance and scalability. Key benefits of CQRS include improved performance - optimizing read and write data operations, scalability - independently scaling read and write operations, and simplifying development - separating read and write logic simplifies development and testing.

The Message Queues pattern allows system components to communicate asynchronously by sending and receiving messages through a queue. Message queues help offload the main system threads, evenly distribute computational resources, and prevent overload. Message queue-based systems are easily scalable, adapting to changing loads.

The Caching pattern enables storing frequently requested data in memory for fast access, reducing the burden on the database.

The Database Sharding pattern splits the database into smaller parts (shards) to distribute load and speed up data access.

Let's consider the possibility of using these patterns in a banking system.

Dividing the system into microservices such as Transaction Processing, Interest Accrual, Account Management allows scaling specific services that experience the highest load during peak periods.

Using the Event-Driven pattern is advisable for managing interest accruals and bulk transactions. For example, the `End of month` event triggers the interest accrual process, which is processed asynchronously.

Implementing message queues is effective for managing the flow of transactions and interest accruals. Using tools like RabbitMQ or Apache Kafka helps smooth out peak loads.

The CQRS pattern can be used for developing data management and reporting systems where high performance and scalability of read and write operations are required.

Caching calculation results of interests and frequently requested data such as account balances helps reduce the system load.

Segmenting the database by regions, client groups, and other segments can be applied to distribute the load on databases and independent computation streams.

These patterns enable the creation of flexible and scalable systems capable of adapting to changing conditions and providing high-quality customer service. Regular monitoring and optimizing the system will help maintain its efficiency and resilience in the long term.

4. Conclusions

Solving information process management issues in banking institutions is a relevant task that requires a comprehensive approach and the application of modern technologies.

Using architectural patterns for distributing computational power and managing peak loads in a banking system ensures stable and reliable operation even during periods of high activity. Microservices architecture, event-driven architecture, CQRS, message queues, caching, and database sharding are effective tools for achieving this goal.

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