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Validation of the Banking Services Redundancy Model in Sepah Bank

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Abstract

This study aims to validate a banking service redundancy model for Sepah Bank to assess the impact of redundant banking services on operational efficiency, customer experience, and technological integration. The research employs a mixed-methods approach, integrating both qualitative and quantitative analyses. The qualitative phase involves a meta-synthesis of existing literature on banking service redundancy, digital banking optimization, and financial risk management. The quantitative phase utilizes survey data collected from 384 Sepah Bank customers and experts in banking service management. Structural equation modeling (SEM) and statistical validation techniques, including Cronbach's Alpha, composite reliability, average variance extracted (AVE), and Fornell-Larcker criteria, are used to measure construct validity and reliability. Additionally, R^2 values, effect size (f^2), and predictive relevance (Q^2) are analyzed to assess the structural model's fit. The results indicate that excessive banking service redundancy leads to operational inefficiencies, increased costs, and diminished customer satisfaction. The structural model analysis revealed a strong R^2 value (0.996) for banking service redundancy, confirming the robustness of the validation model. The impact of redundancy on customer experience was found to be significant, aligning with prior studies on digital banking efficiency. Moreover, security redundancies, though necessary for regulatory compliance, were identified as a source of usability challenges. The study also highlights the role of AI and data analytics in optimizing banking service redundancy while maintaining regulatory and operational requirements. The study underscores the necessity of a structured validation framework to manage banking service redundancy effectively. Financial institutions must differentiate between operational redundancies that hinder efficiency and regulatory redundancies that are required for compliance. Leveraging AI-driven automation and predictive analytics can help banks streamline redundant services while maintaining security and customer satisfaction. The findings contribute to the broader discourse on digital banking optimization and offer practical insights for financial institutions seeking to enhance operational resilience and service efficiency.

Keywords: Banking service redundancy, digital banking, customer experience, operational efficiency, AI-driven optimization, regulatory compliance, financial institutions, banking automation.

1. Introduction

The increasing reliance on digital banking has accelerated the adoption of automation and artificial intelligence in financial transactions (Mohammad & Ismail, 2024). However, with this transition, banks often introduce overlapping functionalities that may not necessarily improve service quality but rather create inefficiencies in resource allocation (Tiwari, 2023). For example, multiple mobile banking applications offered by the same bank, each with similar functionalities, can lead to

confusion among customers while increasing operational costs (Tsobdjou et al., 2024). Similarly, redundant authentication mechanisms, while aimed at improving security, can sometimes compromise user convenience and deter transaction completion rates (Zu et al., 2023). These challenges highlight the need for a structured framework to assess and validate the necessity and effectiveness of redundant banking services.

From a customer perspective, service redundancy can have both positive and negative implications. While having multiple avenues for banking transactions can enhance accessibility and convenience, excessive service overlap can dilute the user experience (Muravskyi et al., 2023). The concept of digital banking has evolved to incorporate not only transactional functionalities but also personalized financial management tools, AI-driven customer assistance, and blockchain-based security enhancements (Rafiq, 2019). However, without a clear redundancy validation model, financial institutions risk overcomplicating their service structures, leading to dissatisfaction and potential attrition among customers (Banda & Fanny, 2023).

The theoretical foundation of service redundancy in banking is rooted in operational resilience and risk management strategies (Milkau, 2021). Operational resilience is a key component of financial sustainability, ensuring that banks can continue to provide services despite market fluctuations, cybersecurity threats, and regulatory changes (Lapidus & Topchiy, 2021). However, the presence of redundant services often results in fragmented infrastructure, increasing security vulnerabilities and system inefficiencies (Boyko & Василенко, 2020). In the context of cybersecurity, redundant services must be assessed not only for their functional necessity but also for their potential risks in data management and transaction security (Suzuki et al., 2021). A redundancy validation model should therefore incorporate risk assessment mechanisms to evaluate whether overlapping services contribute to resilience or merely introduce avoidable inefficiencies.

Another critical aspect of banking service redundancy is the economic and financial implications for financial institutions (Salhani & Mouselli, 2022). Redundant services often translate into increased operational costs due to additional infrastructure maintenance, software updates, and compliance monitoring (Watts, 2025). Financial institutions must strike a balance between service expansion and cost efficiency to ensure long-term profitability (Della et al., 2022). The optimization of service offerings through redundancy validation models allows banks to reallocate resources to high-impact areas such as fraud prevention, customer support, and product innovation (Pregnolato et al., 2020). By identifying and eliminating unnecessary service overlaps, banks can streamline their digital ecosystems, ultimately leading to improved financial performance and customer satisfaction (Nugroho et al., 2023).

The role of emerging technologies in redundancy validation cannot be overlooked. Artificial intelligence and machine learning models have been increasingly deployed to analyze customer interactions and identify redundant service features (Sam'an et al., 2024). For instance, predictive analytics can assess customer usage patterns to determine whether multiple authentication mechanisms or multiple digital wallets provide real utility or merely add to service complexity (Kumar et al., 2022). Furthermore, blockchain technology has been proposed as a means to consolidate redundant service elements while maintaining transparency and security (Yussof & Al-Harthy, 2020). The integration of such technologies can aid financial institutions in systematically evaluating the necessity of overlapping services and making data-driven decisions on service optimization (Kwant et al., 2023).

Regulatory compliance is another significant factor in the assessment of banking service redundancy (Lozanovska, 2023). Financial regulatory frameworks are continuously evolving to address consumer protection, data privacy, and financial stability. In some cases, redundancy in banking services is a regulatory requirement rather than an operational inefficiency (Vukov et al., 2023). For example, multi-factor authentication, while seemingly redundant from a usability perspective, is mandated under various cybersecurity laws to prevent unauthorized access to financial accounts (Zhang et al., 2019). Redundant banking services, if not systematically assessed, can lead to increased costs, cybersecurity risks, and customer dissatisfaction (Boyko & Василенко, 2020). This study will address these challenges by developing a comprehensive redundancy validation framework for Sepah Bank, incorporating technological, economic, and regulatory considerations

(Della et al., 2022). By leveraging advanced analytics and industry best practices, the research aims to provide financial institutions with a strategic approach to managing service redundancy and achieving sustainable banking operations (Pregnolato et al., 2020). Therefore, a redundancy validation model must distinguish between regulatory-driven redundancies and operational redundancies that may be streamlined or eliminated without violating compliance standards. The validation of a banking service redundancy model is critical in optimizing service offerings, improving customer satisfaction, and ensuring regulatory compliance. This study focuses on the validation of a redundancy model for Sepah Bank, one of Iran's leading financial institutions, to assess the impact of redundant banking services on operational efficiency, customer experience, and technological integration.

2. Methods and Materials

The present study is classified as applied research since its findings can be utilized to enhance and develop processes and mechanisms aimed at increasing revenue in online banking services. In terms of data collection and analysis, the research follows a descriptive-survey approach. The study employs both qualitative and quantitative methodologies. In the initial phase, library research and expert interviews were conducted to identify the key factors influencing service redundancy in the banking sector. After the qualitative analysis, structured questionnaires were distributed based on the findings from the first phase, and data were gathered from Sepah Bank customers. Therefore, this study adopts a mixed-methods research design.

For the qualitative component, the meta-synthesis method was applied using the seven-step model proposed by Sandelowski and Barroso. In the quantitative section, structural-interpretive modeling was utilized. According to the research onion model, this study is categorized as applied research in terms of its purpose and as descriptive-survey research regarding its data analysis method.

To collect the necessary information, several methods and tools were employed. Library research included reviewing domestic and international books, academic journals, and online databases to establish the theoretical foundations and incorporate prior research experiences. Keyword searches were conducted in academic databases to identify relevant literature, from which high-quality studies were selected. The literature review helped formulate the theoretical framework of the study. In the qualitative phase, open coding was employed to identify indicators, followed by categorizing components and subcomponents to analyze their relationships. To ensure research reliability, in addition to standard quality control measures, Cohen's Kappa coefficient was used. The identified characteristics of the study were later summarized in tables outlining dimensions and components.

Expert questionnaires were also utilized. The use of appropriate data collection tools allowed the researcher to systematically gather, extract, and categorize information related to the research problem. This ensured the accuracy of subsequent analyses. In the qualitative phase, the study population comprised all prior research on service redundancy in banking. In the structural equation modeling phase, experts familiar with service redundancy in the banking industry formed the study population. Initially, the research focused on articles, books, and dissertations that addressed service redundancy. A purposive sampling method, based on inclusion and exclusion criteria aligned with the PRISMA approach, was employed. In the second phase, the study population consisted of Sepah Bank customers. A simple random and convenience sampling approach was applied, and based on Morgan’s table for large populations, 384 customers were selected as the sample.

For data analysis, the study employed different methods for qualitative and quantitative sections. In the qualitative phase, the meta-synthesis method was used as a systematic and scientific approach to identify, summarize, and synthesize existing theoretical foundations. Meta-synthesis is increasingly utilized for evaluating prior research and is recognized as a form of research that systematically reviews previous studies. The study followed a structured seven-step process, beginning with defining the research question, searching the literature, selecting relevant studies, extracting data on banking services redundancy, analyzing and synthesizing findings, ensuring quality control, and finally presenting the results comprehensively. Open coding was applied to categorize and extract key findings.

In the quantitative phase, structural equation modeling was used. The data analysis included both descriptive and inferential statistics. SPSS and SmartPLS software were utilized for statistical analysis. In the descriptive analysis, demographic variables such as age, gender, and education were examined, and relevant charts were created. The descriptive statistics of variables,

including mean, standard deviation, skewness, and kurtosis, were assessed. For inferential analysis, various statistical tests were applied based on the nature and scale of variables to test the research hypotheses.

Partial least squares (PLS) structural equation modeling was employed, as it focuses on optimizing variance explanation in dependent constructs. The data analysis was conducted in two stages. The first phase involved content analysis after data collection, where qualitative findings were analyzed and a theoretical model was developed. Using the Delphi method, key factors, dimensions, consequences, and strategies related to service redundancy were identified. In the second phase, which followed a descriptive-survey approach, structural-interpretive modeling was conducted.

After each interview, transcripts were prepared for analysis. Data were coded in three stages: open coding, axial coding, and selective coding, to extract core, organizing, and comprehensive themes. Thematic analysis was applied to identify the key factors contributing to effective service redundancy. To determine the significance and prioritization of various factors, the Delphi technique was used. The final stage involved validating the proposed model. For statistical testing, SPSS version 23 was used for descriptive analysis, while SmartPLS version 3.3 was employed for structural equation modeling.

3. Findings and Results

Based on the results from Table 1, the management and improvement of banking services is recognized as one of the essential pillars in the financial industry, necessitating an in-depth understanding of the concepts related to service redundancy.

Table 1. Concepts and Codes

Research Concept	Codes
Customer Relationship Management (CRM)	Customer Relationship Management (CRM) – Electronic Customer Relationship Management – Customer Relationship Management Strategies – Customer Portfolio Management – Customer-Oriented Growth – Customer Retention – Customer Loyalty Programs – Creation of a Positive Customer Experience – Reputable Management Tools – Strategic Organizational Decision-Making – Hope Management – Customer Loyalty – Performance Analysis – Traditional Alignment Strategies – Supply Chain Management – Customer-Related Quality Management
Service Quality and Customer Satisfaction	Service Quality – Electronic Service Quality – Customer Satisfaction Coefficient – Customer Satisfaction Index – Kano Model – Quantitative Analysis of Customer Satisfaction – Dissatisfaction Index – Customer Satisfaction Index Model – Customer Expectations – Customer Satisfaction with Banking Services – Kano Model Questionnaire – Customer Satisfaction with Online Banking Services – Prediction of Customer Loyalty – Examination of the Impact of Brand and Corporate Image on Customer Loyalty – Customer Satisfaction Indices
Media and Information Literacy	Media Literacy – Digital Literacy – Information Literacy – New Media Literacy – Critical Thinking – News Consumption – Trust in News – Fake News Detection – Cognitive Model – Media Data Analysis – Media Information Management
Banking and Financial Services	Electronic Banking – Banking Services – Private Banks – State Banks – Bank Deposits – Credits – Current Account Operations – Security and Privacy in Banking – Customer Satisfaction with Online Banking Services – Deposit Interest Rates – Inflation Forecasting – Exchange Rate – Economic Growth – Banking Industry – Private Financial Institutions – Public Financial Institutions
Data Analysis and Modeling	Data Analysis – Structural Modeling – Machine Learning Algorithms – Data Mining – Classification and Regression Trees – Exploratory Factor Analysis – Confirmatory Factor Analysis – Path Analysis – Hierarchical Analysis – Logistic Regression – Naive Bayes – Predictive Modeling – Big Data Analysis – Hierarchical Regression Analysis – Importance-Performance Analysis – Linear Discriminant Analysis
Consumer Behavior and Digital Marketing	Consumer Behavior – Expectation Confirmation Theory – Consumer Behavior in Online Purchasing – Instrumental Consumerism – Hedonic Consumerism – Word-of-Mouth Advertising – Customer Behavior Analysis in Digital Space – Digital Marketing – Consumer Purchase Decisions – Customer Repurchase Behavior – Online Purchase Behavior Analysis – Consumer Purchase Behavior – Customer Data Analysis – Relationship Marketing – Customer Needs Analysis – Digital Marketing Strategies
Organizational Strategies and Innovation	Organizational Strategy – Innovation – Development of New Services – Alignment Strategies – Urban Service Production – Employee Behavior Analysis – Controlled Competition – Market Competition – Trend Analysis – Organizational Behavior Analysis – Crisis Management – Scale Development – Customer-Centric Organizational Transformation – Organizational Strategic Planning – Crisis Management Strategies – Innovation and Technology Management
Market Analysis and Consumer Behavior	Market Analysis – Relationship between Marketing and Long-Term Corporate Survival – Examination of the Impact of Brand and Corporate Image on Customer Loyalty – Factors Affecting Customer Visits – Willingness to Pay More – Market Competition Analysis – Market Segmentation – Marketing Strategies – Analysis of Competition in International Markets – Customer Behavior Analysis in the Market – Competition Analysis in Competitive Markets – Consumer Purchase Behavior – Analysis of Competitive Markets – Industry Competition Analysis – Inflation Rate – Deposit Interest Rate
Security and Privacy	Data Security – Privacy – Data Protection – Disaster Recovery – Malware – Prevention of Data Loss – Security Standards – Storage Array Protection – Information Security Management – NIST SP 800-53 Standard – Replication Systems – Cybersecurity Strategies – Cyberattack Analysis – Backup – Business Continuity
Information Technology and Systems	Information Systems – Big Data – Storage Systems – Storage Space – Backup – Virtual Machine – Business Impact Assessment – Computer Systems Management – Crisis Management Systems – Information Systems Analysis – Information Technology Management – Data Protection – Hardware Failure – Accounting Information Systems – Virtual Machine – Backup Version
Financial and Economic Analysis	Financial Analysis – Retail Banking – State Financial Institutions – Private Financial Institutions – Profitability – Financial Systems Analysis – Financial Markets Analysis – Financial Performance Analysis – Banking Systems – Economic Growth

	Analysis – Risk Aversion – Exchange Rate – Inflation Rate – Deposit Interest Rate – Financial Institutions Performance Analysis – Prediction of Customer Churn
Human Resource Management and Organizational Behavior	Organizational Behavior – Employee Behavior Analysis – Organizational Citizenship Behavior – Job Satisfaction – Service Provider Stress – Organizational Hierarchy – Psychosocial Well-Being – Human Resource Management – Employee Performance Enhancement – Gender Differences – Positive Employee Attitudes – Employee Behavior Analysis – Organizational Conflict Analysis – Workforce Reduction in the Organization – Organizational Conflict Management – Employee Performance Management
Knowledge Management and Organizational Improvement	Knowledge Management – Knowledge Transfer – Organizational Identification – Organizational Knowledge Improvement – Emergency Planning – Organizational Improvement – Customer Identification – Psychosocial Well-Being – Organizational Knowledge Management – Mobile Banking Service Quality – Effectiveness of Knowledge Management – Knowledge Management Strategies – Hope Management – Organizational Knowledge Analysis – Organizational Knowledge Performance Analysis – Knowledge Management Development
Statistical Analysis and Data Modeling	Statistical Analysis – Logistic Regression – Fuzzy Hierarchical Analysis – Online Data Analysis – Statistical Data Analysis – Linear Discriminant Analysis – Multidimensional Data Analysis – Multidimensional Data Modeling – Big Data Analysis – Predictive Modeling – Hierarchical Analysis – Importance-Performance Analysis – Advanced Statistical Analyses – Advanced Analyses – Hierarchical Regression Analysis – Path Analysis
Relationship Marketing and Customer Orientation	Relationship Marketing – Brand Image – Customer Relationship Management – Customer Needs Analysis – Brand Management – Brand Image Analysis – Relationship Marketing Strategies – Customer Loyalty Analysis – Customer Data Analysis – Customer Behavior Analysis – Customer-Based Market Analysis – Brand Image Management – Customer Loyalty Analysis – Customer-Based Marketing Strategies – Customer Behavior Analysis – Market Analysis and Customer Orientation
Sustainability and Social Responsibility	Sustainable Development – Corporate Social Responsibility – Psychosocial Well-Being – Social Responsibility in Organizations – Sustainable Profitability – Democratic Ethics – Social Responsibility Management – Service Sustainability – Citizenship Behavior Analysis – Development of Sustainability Strategies – Knowledge Management in Organizations – Sustainability in Management – Citizenship Behavior Analysis – Sustainability Strategy Analysis – Sustainability Performance Analysis – Social Responsibility in Organizations
Quality Management and Service Improvement	Quality Management – Service Improvement – Service Quality Analysis – Quality Management Tools – Quality Analysis in Services – Quality Assessment – Quality Analysis in Management – Service Quality Models – Public Service Quality Assessment – Service Quality Improvement – Citizen Evaluation of Public Service Quality – Organizational Quality Management – Quality Analysis in Organizations – Quality Improvement Models – Quality Analysis and Evaluation in Organizations – Organizational Quality Improvement
Management and Strategy Models	Structural Equation Modeling – Kano Model – Management Models – Business Models – Strategic Models – Decision-Making Models – Short-Term and Long-Term Models – Business Model Analysis – Management Model Analysis – Analysis of Managerial Strategies – Organizational Decision-Making Models – Financial Decision-Making Models – Strategic Model Analysis – Organizational Improvement Models – Management Models – Strategy Models
Organizational Behavior Analysis and Human Resource Management	Organizational Hierarchy – Organizational Behavior – Employee Behavior Analysis – Organizational Citizenship Behavior Analysis – Employee Performance Evaluation – Organizational Hierarchy – Workforce Reduction in the Organization – Human Resource Management – Gender Differences – Organizational Behavior Analysis – Psychosocial Well-Being – Employee Motivation Management – Organizational Conflict Analysis – Organizational Conflict Management – Employee Performance Analysis – Service Provider Stress – Organizational Behavior Management – Organizational Performance Management – Management of Organizational Citizenship Behavior – Human Resource Development in Organizations – Employee Performance Management – Human Resource Management Strategies – Organizational Citizenship Behavior – Positive Employee Attitudes
Surveys and Evaluations	Survey Questionnaires – Importance-Performance Analysis – Customer Needs Analysis – Survey Methods – Survey Data Analysis – Evaluation Tools – Test of Significant Differences – Survey Models – Design of Survey Questionnaires – Citizen Evaluation – Public Service Quality Evaluation – Survey Questionnaire Analysis – Statistical Analysis of Survey Data – Survey Methodology – Questionnaire Data Analysis
Research and Methodology	Research Design – Research Methods – Experimental Design – Research Statistical Analyses – Foundational Theories – Research Data Analysis – Research Trend Analysis – Comparative Analyses – Comparative Analysis – Research Methodology – Product Configuration Design – Statistical Trend Analysis – Statistical Analysis of Research Data – Survey Approach – Scale Development and Validation Methodology – Statistical Data Analysis
Innovation Management and Technology Development	Innovation – Technology Management – Technology Adoption – New Product Development – Innovation Analysis – New Technologies – Technology Development – Innovation Project Management – Product Life Cycle – Innovation in Service Management – Innovation Analysis – Innovation in Services – Innovation Strategies – Innovation Management – Innovation Development – Technology Efficiency – Innovation Management in Organizations
Quality Management and Service Improvement (Duplicate)	Quality Management – Service Improvement – Quality Management Tools – Quality Assessment – Service Quality Analysis – Service Quality Models – Quality Analysis in Services – Quality Analysis in Management – Service Quality Improvement – Public Service Quality Evaluation – Organizational Quality Management – Quality Improvement Models – Quality Analysis and Evaluation in Organizations – Organizational Quality Improvement – Citizen Evaluation of Public Service Quality – Improvement of Electronic Service Quality
Risk Analysis and Crisis Management	Organizational Risk Analysis – Risk Management – Risk Assessment – Disaster Recovery – Emergency Preparedness – Crisis Management Systems – Security Standards – Risk Analysis – Business Impact Assessment – Crisis Management – Impact Analysis – Risk and Crisis Analysis – FIPS 199 Standard – Security Standards – Information Systems – Information Security Standards – Crisis Management Planning – Crisis Management Strategies – Crisis Management Analysis – Organizational Risk Management – Risk and Crisis Management Analysis – Analysis of Organizational Crises – Risk Management Strategies – Risk Impact Analysis
Competition and Market	Market Competition – Market Analysis – Competitive Markets – Competition Analysis in Various Market Segments – International Competition – Competitiveness – Competitive Strategies in the Market – Competitive Advantage – Market Competition Analysis – Competitive Strategies – Competitive Environments – Controlled Competition – Inter-Firm Competition – Competition Analysis – Market Strategies – Analysis of Competition in International Markets – Competitive Strategy Analysis – Competition in Global Markets – Competition Analysis in Domestic Markets – Organizational Competition Analysis – Competition Strategy Analysis – Industry Competition Analysis – Analysis of Competitive Markets

The findings from Table 2 indicate three primary research categories that contribute to understanding service redundancy in banking.

Table 2. Categories and Concepts

Research Categories	Concepts
Business Management and Strategy	1. Customer Relationship Management (CRM) – 7. Organizational Strategies and Innovation – 12. Human Resource Management and Organizational Behavior – 13. Knowledge Management and Organizational Improvement – 15. Innovation Management and Technology Development – 19. Management and Strategy Models – 20. Risk Analysis and Crisis Management – 22. Organizational Behavior Analysis and Human Resource Management – 25. Quality Management and Service Improvement
Marketing and Customer Experience	2. Service Quality and Customer Satisfaction – 3. Media and Information Literacy – 6. Consumer Behavior and Digital Marketing – 8. Market Analysis and Consumer Behavior – 16. Relationship Marketing and Customer Orientation – 23. Surveys and Evaluations – 17. Sustainability and Social Responsibility – 21. Competition and Market
Data Analysis and Information Technology	5. Data Analysis and Modeling – 9. Security and Privacy – 10. Information Technology and Systems – 11. Financial and Economic Analysis – 14. Statistical Analysis and Data Modeling – 4. Banking and Financial Services – 24. Research and Methodology – 18. Quality Management and Service Improvement

The first category, Business Management and Strategy, highlights the importance of strategic management in achieving organizational goals and enhancing customer relationships. This includes CRM strategies that enable banks to identify customer needs and improve service delivery. Additionally, human resource management plays a crucial role in improving service quality and increasing customer satisfaction. Innovation management allows banks to introduce new and improved services, enhancing competitiveness and customer acquisition. Furthermore, risk analysis and crisis management are critical for mitigating financial risks and ensuring business continuity.

The second category, Marketing and Customer Experience, emphasizes the significance of customer-centric approaches in banking. Service quality and customer satisfaction are key drivers of success, and banks must analyze market trends and consumer behavior to tailor their services effectively. Relationship marketing helps build long-term connections with customers, encouraging loyalty and continuous service usage. Additionally, sustainability and corporate social responsibility contribute to customer trust and brand reputation. Competition analysis enables banks to develop strategic marketing initiatives that enhance their market position.

The third category, Data Analysis and Information Technology, underscores the role of data-driven decision-making in banking services. Data analysis and modeling help identify customer patterns and trends, leading to improved service delivery and satisfaction. Security and privacy remain essential considerations, as any breach could undermine customer trust. Financial and economic analysis enables banks to make informed investment decisions and optimize resource allocation. Moreover, the integration of statistical analysis and research methodologies supports evidence-based decision-making, ensuring the effectiveness of service enhancements.

The demographic analysis of the 384 respondents indicates a nearly equal distribution between genders, with 193 men (50.3%) and 191 women (49.7%). In terms of age distribution, 54 respondents (14.1%) were under 30 years old, 158 respondents (41.1%) fell within the 30 to 40-year age group, 98 respondents (25.5%) were in the 40 to 50-year age bracket, and 74 respondents (19.3%) were 50 years and older. The highest proportion of respondents belonged to the 30 to 40-year age group, while the lowest representation was observed in the under-30 category. Regarding work experience, 60 respondents (15.6%) had less than 5 years of experience, 136 respondents (35.4%) had between 6 to 10 years, 98 respondents (25.5%) had 11 to 15 years, and 90 respondents (23.4%) had more than 15 years of work experience. The findings indicate that the highest frequency of respondents fell within the 6 to 10 years of work experience category, whereas the lowest representation belonged to those with less than 5 years of experience.

Table 3. Cronbach's Alpha Values for Research Constructs

Research Constructs	Cronbach's Alpha
Business Management and Strategy	0.795
Data Analysis and Information Technology	0.846
Marketing and Customer Experience	0.832
Banking Service Redundancy	0.878

The Cronbach's Alpha values indicate acceptable internal consistency for all constructs, with values exceeding the recommended threshold of 0.7. However, due to the limitations of Cronbach's Alpha in assessing construct reliability,

composite reliability (CR) is also calculated. Composite reliability accounts for varying factor loadings of indicators and provides a more accurate measure of construct reliability.

Table 4. Composite Reliability (CR) Values for Research Constructs

Research Constructs	Composite Reliability (CR)
Business Management and Strategy	0.798
Data Analysis and Information Technology	0.875
Marketing and Customer Experience	0.842
Banking Service Redundancy	0.910

The composite reliability values are all above the acceptable threshold of 0.7, confirming adequate construct reliability.

To evaluate convergent validity at the factor level, the average variance extracted (AVE) index is used. According to Fornell and Larcker (1981), a minimum acceptable AVE value is 0.5, while Magner et al. (1996) suggest 0.4 as an alternative threshold.

Table 5. Average Variance Extracted (AVE) for Research Constructs

Research Constructs	AVE
Business Management and Strategy	0.579
Data Analysis and Information Technology	0.576
Marketing and Customer Experience	0.606
Banking Service Redundancy	0.653

Since all AVE values exceed 0.5, the results confirm strong convergent validity within the model.

Discriminant validity assesses whether a construct is unique and not overly influenced by other constructs. This is evaluated using two methods: cross-loadings and the Fornell-Larcker criterion.

Table 6. Fornell-Larcker Criterion for Discriminant Validity

	Business Management and Strategy	Data Analysis and Information Technology	Marketing and Customer Experience
Business Management and Strategy	0.840		
Data Analysis and Information Technology	0.752	0.793	
Marketing and Customer Experience	0.770	0.688	0.928

The diagonal values represent the square root of AVE for each construct, while the off-diagonal values indicate the correlations between constructs. Since each diagonal value is greater than the correlation values in the corresponding row and column, discriminant validity is confirmed.

After establishing measurement model validity and reliability, the structural model is evaluated. The most commonly used metric for assessing structural model fit is the coefficient of determination (R^2). R^2 values of 0.75, 0.50, and 0.25 are considered substantial, moderate, and weak, respectively. The R^2 value for banking service redundancy is 0.996, indicating excellent model fit.

Beyond R^2, the f^2 effect size measures the significance of an exogenous construct's effect on endogenous constructs when removed from the model. Values of 0.02, 0.15, and 0.35 indicate small, moderate, and large effects, respectively. The f^2 values for banking service redundancy on marketing and customer experience, data analysis and information technology, and business management and strategy are 14.190, 15.402, and 5.382, respectively, indicating strong effects.

Additionally, Stone-Geisser's Q^2 statistic evaluates predictive relevance, where values of 0.02, 0.15, and 0.35 indicate weak, moderate, and strong predictive power.

Table 7. Q^2 Values for Predictive Relevance of Endogenous Constructs

Construct	SSO	SSE	Q^2 (=1-SSE/SSO)
Marketing and Customer Experience	384.000	384.000	0.452
Data Analysis and Information Technology	7296.000	7296.000	0.358
Business Management and Strategy	1152.000	841.934	0.269

Since all Q^2 values are greater than zero, the model exhibits strong predictive relevance for endogenous constructs.

Finally, the standardized root mean square residual (SRMR) should be below 0.08 for a good model fit in PLS-SEM. In this study, SRMR = 0.062, confirming that the model fits well. The combined results of reliability, validity, R^2, f^2, and Q^2 suggest that the research model is well-structured and exhibits high predictive accuracy.

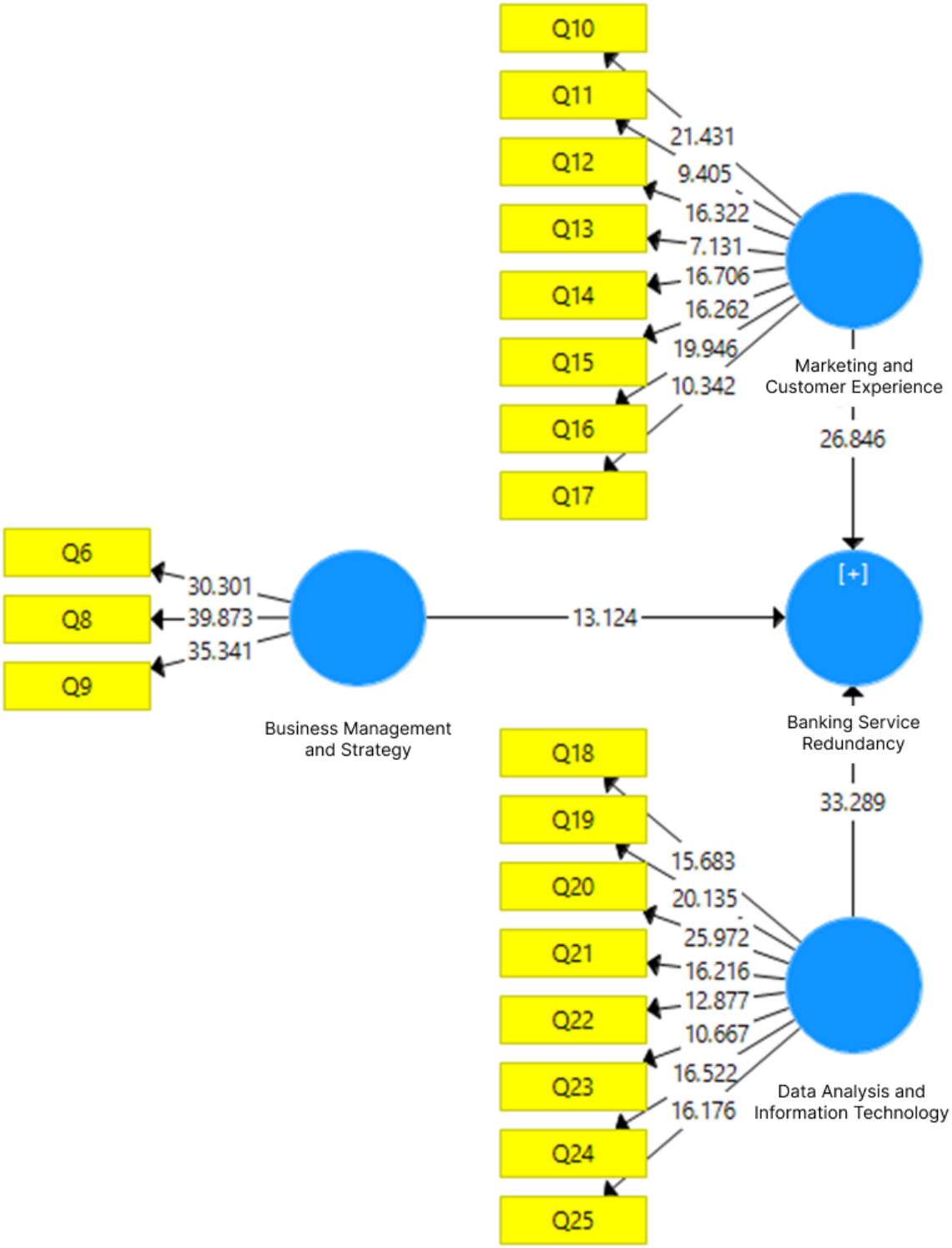

Figure 1. Model with t-values

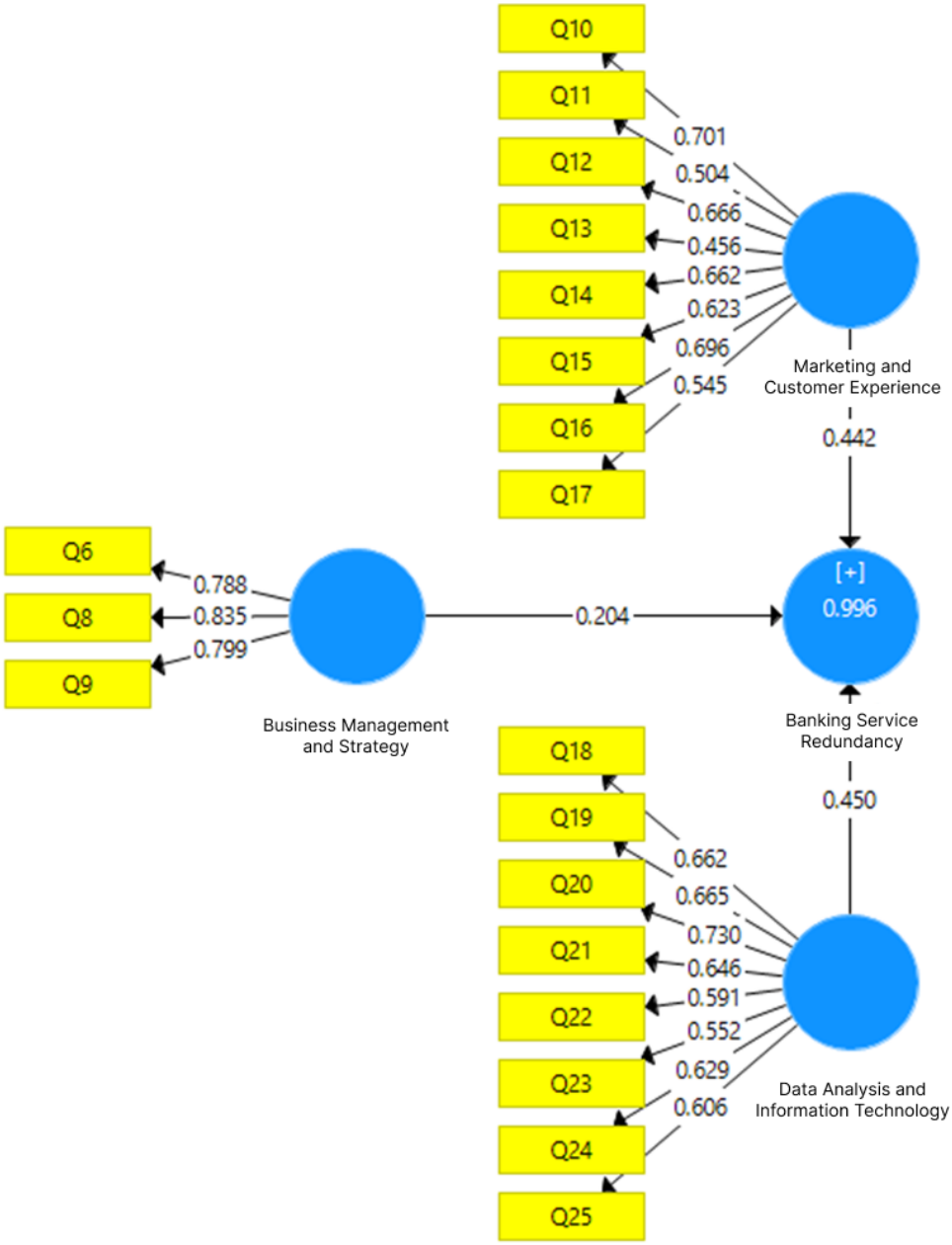

Figure 2. Model with Standard Coefficients

4. Discussion and Conclusion

The findings of this study highlight the complexities of service redundancy in the banking sector, particularly in the case of Sepah Bank. The results indicate that while redundancy in banking services can enhance accessibility and operational resilience, excessive service overlap often leads to inefficiencies, increased operational costs, and customer dissatisfaction. The Cronbach's Alpha and composite reliability values confirmed the internal consistency of the research constructs, demonstrating that business management and strategy, data analysis and information technology, marketing and customer experience, and banking service redundancy are interconnected elements that impact service optimization. Furthermore, the structural model assessment showed a strong R^2 value for banking service redundancy (0.996), indicating that the proposed redundancy validation model effectively explains service overlaps within Sepah Bank.

A key finding of this study was the significant impact of banking service redundancy on customer experience and operational efficiency. The results align with previous research suggesting that redundant services, while initially introduced to enhance convenience, may create a fragmented customer experience when not strategically managed (Mohammad & Ismail, 2024).

Customers often find themselves navigating multiple digital platforms with overlapping functionalities, leading to confusion and reduced engagement (Banda & Fanny, 2023). This aligns with the findings of Rafiq (2019), who emphasized that digital banking services must be streamlined to avoid unnecessary complexity (Rafiq, 2019). Similarly, Muravskyi et al. (2023) found that the implementation of redundant digital transaction processes without proper integration can lead to inefficiencies in electronic money transactions and an increased risk of security breaches (Muravskyi et al., 2023). The validation of a banking redundancy model is, therefore, essential to identifying which service overlaps contribute to value and which create operational burdens.

The study also found that data analysis and information technology play a central role in managing service redundancy. The results demonstrate that digital tools, such as AI-based analytics and predictive modeling, can assist financial institutions in identifying redundant service components and optimizing their digital portfolios. These findings support previous studies that have explored the role of AI in financial service efficiency. For example, Tsobdjou et al. (2024) proposed an AI-based framework for mobile banking security assessment, emphasizing the importance of using technology to mitigate redundancy while enhancing security (Tsobdjou et al., 2024). Similarly, Nugroho et al. (2023) found that machine learning algorithms can be effectively applied in peer-to-peer (P2P) lending to reduce service overlap and predict default risks, highlighting the potential for AI-driven service optimization in financial institutions (Nugroho et al., 2023).

Another critical aspect examined in this study is the economic impact of banking service redundancy. The results confirm that excessive service duplication increases operational costs, which in turn affects financial performance. These findings are consistent with prior research emphasizing the financial burden of redundant banking services. For instance, Pregnolato et al. (2020) highlighted how redundant operational infrastructures in financial institutions can lead to inflated costs and reduced profitability (Pregnolato et al., 2020). Della et al. (2022) also found that banks often invest in multiple service channels to enhance accessibility, but without proper redundancy management, these investments can become economically unsustainable (Della et al., 2022). In the context of Sepah Bank, service redundancy has led to increased expenditure on IT infrastructure and digital security, raising concerns about long-term financial sustainability. These findings underscore the need for financial institutions to implement redundancy validation models that balance service expansion with cost efficiency.

Regulatory compliance emerged as another significant factor influencing banking service redundancy. The study found that while some redundant services are operational inefficiencies, others are mandated by financial regulations to enhance security and consumer protection. These results are supported by previous studies highlighting the role of regulatory frameworks in shaping digital banking services. For example, Boyko et al. (2020) discussed how regulatory compliance requirements often necessitate the implementation of redundant cybersecurity measures in digital banking to protect against cyber threats (Boyko & Василенко, 2020). Similarly, Suzuki et al. (2021) found that disaster management regulations in financial institutions often require redundant security measures to ensure service continuity during cyberattacks or system failures (Suzuki et al., 2021). In the case of Sepah Bank, distinguishing between regulatory-driven redundancies and operational inefficiencies is essential for optimizing service offerings while maintaining compliance with banking regulations.

The study also explored customer perceptions of service redundancy. The findings indicate that customers value accessibility and multiple service options, but excessive redundancy without clear differentiation between services leads to dissatisfaction. These findings align with previous research on consumer behavior in digital banking. Kumar et al. (2022) found that consumers prefer streamlined digital banking experiences with minimal redundancy, particularly in mobile banking applications (Kumar et al., 2022). Similarly, Salhani and Mouselli (2022) observed that Islamic banking customers expressed frustration over redundant authentication mechanisms that, while enhancing security, hindered seamless transactions (Salhani & Mouselli, 2022). The results of this study reinforce the need for banks to adopt a customer-centric approach when managing service redundancy, ensuring that redundant features enhance rather than detract from the user experience.

Another significant finding was the impact of security and privacy concerns on service redundancy. The study revealed that while redundant security measures contribute to risk mitigation, they can also create usability challenges. These findings support research by Tsobdjou et al. (2024), who found that redundant security layers in mobile banking applications often result in lower adoption rates due to increased complexity (Tsobdjou et al., 2024). Likewise, Zu et al. (2023) explored how

overlapping encryption mechanisms in cloud banking services can create unnecessary processing delays, negatively affecting transaction speeds (Zu et al., 2023). These findings suggest that while security redundancies are necessary for regulatory compliance, banks must find a balance between security and user convenience.

Despite its contributions, this study has certain limitations. First, the research was conducted within the context of Sepah Bank, limiting the generalizability of the findings to other financial institutions with different operational models. Additionally, the study primarily relied on quantitative data, which, while useful for statistical validation, may not fully capture customer sentiment regarding service redundancy. Another limitation is the rapid evolution of digital banking technologies; as banking services continue to evolve, redundancy challenges and optimization strategies may shift, requiring ongoing research.

Future research should explore service redundancy across multiple banking institutions to provide a comparative analysis of redundancy validation strategies. A qualitative approach involving customer interviews and focus groups could provide deeper insights into consumer perceptions of redundant services. Additionally, further studies should investigate the role of emerging technologies such as blockchain and AI-driven automation in optimizing service redundancy. Future research could also explore the relationship between banking service redundancy and financial inclusion, assessing whether redundant services inadvertently exclude certain customer segments from digital banking access.

Banking institutions should adopt redundancy validation models that incorporate both technological assessments and customer experience evaluations. Financial institutions must distinguish between operational redundancies that should be streamlined and regulatory-driven redundancies that must be maintained for compliance. Leveraging AI and machine learning for service redundancy detection can significantly enhance efficiency while minimizing unnecessary service overlap. Additionally, banks should prioritize customer education to ensure users understand the functionalities of different banking services, thereby improving digital banking adoption. Ultimately, service optimization should be a continuous process, integrating feedback from both operational metrics and customer satisfaction assessments to enhance banking efficiency and digital transformation strategies.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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