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Examining the Impact of Financial Innovation on Secure Transaction Management in Pakistan's Banking Sector: A Case Study of Faisal Bank of Pakistan Using a PLS-SEM Approach

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Abstract
The rapid diffusion of financial innovation has fundamentally transformed transaction processing and service delivery in the banking sector, particularly in emerging economies such as Pakistan. While digital banking innovations enhance operational efficiency, accessibility, and customer convenience, they simultaneously introduce new challenges related to transaction security, data privacy, and fraud risk. This study examines the impact of financial innovation on secure transaction management within Pakistan's banking sector, using Faisal Bank of Pakistan as an empirical case study. The research aims to provide robust evidence on how innovation-driven banking practices contribute to the effectiveness of secure transaction management mechanisms in a digitally evolving financial environment. Drawing on innovation diffusion theory and trust-based technology adoption perspectives, the study proposes a structural model in which financial innovation influences secure transaction management both directly and indirectly through digital trust. A quantitative research design was employed, and data were collected through a structured questionnaire administered to Faisal Bank customers actively using digital banking services. Partial Least Squares Structural Equation Modeling (PLS-SEM) was applied to assess the measurement and structural models due to its suitability for predictive analysis and theory development in complex, multivariate research settings. The results indicate that financial innovation has a significant and positive effect on secure transaction management, suggesting that the adoption of advanced digital banking technologies strengthens authentication procedures, fraud detection capabilities, transaction reliability, and data confidentiality. Furthermore, financial innovation was found to significantly enhance digital trust, which in turn positively influences secure transaction management. The mediation analysis confirms that digital trust partially

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mediates the relationship between financial innovation and secure transaction management, highlighting the critical role of customer confidence in the effectiveness of secure digital transactions. These findings contribute to the existing literature by offering empirical evidence from a developing country context, where secure digital banking adoption remains underexplored. From a practical perspective, the study provides valuable insights for banking managers and policymakers by emphasizing the need to align financial innovation strategies with robust security frameworks and trust-building mechanisms. The results suggest that sustained investment in innovative financial technologies, coupled with transparent security practices and regulatory compliance, can enhance transaction security and support the long-term stability of Pakistan's digital banking ecosystem.

Keywords: Financial Innovation, Secure Transaction Management, Digital Trust, Banking Sector, PLS-SEM, Faisal Bank of Pakistan.

Introduction:

The banking sector worldwide is experiencing an unprecedented transformation driven by rapid advancements in financial innovation. The integration of digital technologies such as mobile and internet banking platforms, real-time payment systems, application programming interfaces (APIs), biometric authentication, blockchain-enabled transactions, and artificial intelligence–based fraud detection has fundamentally altered traditional banking operations. These innovations have reshaped transaction processing by increasing speed, improving accessibility, reducing operational costs, and enhancing service personalization. However, the same technological advancements that enable efficiency and convenience also introduce significant challenges related to transaction security, cyber resilience, and data protection, particularly in digitally expanding financial ecosystems. In emerging economies, financial innovation plays a dual role. On the one hand, it accelerates financial inclusion by enabling underserved populations to access formal banking services through digital channels [1]. On the other hand, it increases exposure to cyber threats, operational risks, and system vulnerabilities due to limited cybersecurity maturity, heterogeneous infrastructure, and varying levels of digital literacy. Secure transaction management has therefore become a critical concern for banks seeking to sustain customer trust and regulatory compliance while pursuing innovation-driven growth. Secure transaction management encompasses a broad set of mechanisms, including authentication, authorization, data confidentiality, transaction integrity, fraud detection, monitoring, auditability, and system reliability, all of which are essential for maintaining confidence in digital banking systems. Pakistan's banking sector provides a particularly relevant context for examining this relationship. Over the past decade, the country has witnessed a steady rise in digital banking adoption, supported by regulatory reforms, increased smartphone penetration, branchless banking initiatives, and growing customer preference for cashless transactions [2]. Commercial banks in Pakistan have increasingly invested in innovative financial technologies to remain competitive and responsive to evolving market demands.

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Despite this progress, concerns related to cyber fraud, unauthorized access, system downtime, and data breaches continue to pose serious challenges. These risks not only threaten operational stability but also undermine customer confidence, which is essential for the sustained use of digital financial services. Financial innovation and secure transaction management are intrinsically interconnected. Advanced digital technologies can significantly strengthen transaction security by enabling multi-factor authentication, real-time fraud monitoring, encrypted data transmission, and automated risk assessment. At the same time, rapid innovation without adequate governance, integration, and user acceptance may amplify security vulnerabilities. The effectiveness of secure transaction management thus depends not merely on technological adoption but also on organizational capabilities, user trust, and institutional safeguards. Understanding how financial innovation translates into secure transaction outcomes is therefore of both academic and practical importance. Although prior research has examined financial innovation in relation to bank performance, service quality, and customer satisfaction, empirical studies that directly link financial innovation to secure transaction management remain limited, particularly in developing economies. Existing cybersecurity and fraud management studies often focus on technical or regulatory dimensions in isolation, without integrating them into a broader innovation framework. Moreover, much of the available empirical evidence is drawn from developed markets, where technological infrastructure and regulatory enforcement differ significantly from those in Pakistan [3]. This highlights a clear research gap in the context-specific examination of how innovation affects transaction security in emerging banking systems. An additional dimension that remains underexplored in this relationship is digital trust. Trust represents a key psychological and behavioral factor influencing customers' willingness to adopt and continuously use digital banking services. Even highly secure technological systems may fail to achieve their intended objectives if customers lack confidence in a bank's ability to safeguard transactions and personal data. Financial innovation can enhance digital trust by improving transparency, reliability, and perceived security; however, trust may also function as a mediating mechanism through which innovation influences secure transaction management outcomes. Empirical validation of this mechanism is particularly relevant in Pakistan, where perceptions of risk and trust significantly shape digital banking behavior. Against this background, the present study investigates the impact of financial innovation on secure transaction management in Pakistan's banking sector, using Faisal Bank of Pakistan as a case study. Faisal Bank represents an appropriate empirical setting due to its ongoing digital transformation initiatives and strategic focus on enhancing secure transaction processing across multiple delivery channels. To achieve the study objectives, Partial Least Squares Structural Equation Modeling (PLS-SEM) is employed, given its suitability for predictive analysis, theory development, and examination of complex relationships involving latent constructs and mediation effects. To clearly position the key concepts examined in this study and to enhance conceptual clarity, Table 1 summarizes the core constructs and their relevance within the context of digital banking and transaction security.

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Table 1: Core Concepts and Their Relevance in Digital Banking Research

Concept	Description	Relevance to This Study
Financial Innovation	Adoption of new digital products, services, and processes enabled by advanced financial technologies	Acts as the primary independent variable driving changes in transaction processes
Secure Transaction Management	Mechanisms ensuring confidentiality, integrity, authentication, authorization, and reliability of digital transactions	Represents the key outcome variable reflecting transaction security effectiveness
Digital Trust	Customers' confidence in a bank's ability to protect digital transactions and personal information	Serves as a mediating construct linking innovation to secure transaction outcomes
Digital Banking Environment	Technology-enabled banking channels such as mobile and internet banking platforms	Provides the operational context in which innovation and security interact
Emerging Economy Context	Banking systems characterized by rapid growth, evolving regulation, and diverse user capabilities	Enhances the contextual relevance and generalizability of findings for Pakistan

This study contributes to the literature in several important ways. First, it provides empirical evidence from a developing-country context, addressing a notable gap in financial innovation and banking security research. Second, it integrates financial innovation, digital trust, and secure transaction management into a unified analytical framework, offering a more comprehensive understanding of digital banking dynamics. Third, by employing PLS-SEM, the study emphasizes prediction-oriented analysis and theory development, which is particularly valuable in emerging research domains. Finally, the findings offer actionable insights for bank managers and policymakers by highlighting the importance of aligning innovation strategies with robust security architectures and trust-building mechanisms to support sustainable digital banking growth in Pakistan.

Financial Innovation in the Banking Sector:

Financial innovation has been widely recognized as a transformative force in the banking industry, fundamentally reshaping how financial services are designed, delivered, and consumed. At its core, financial innovation refers to the introduction and diffusion of new financial products, services, processes, and organizational arrangements enabled by advancements in digital and information technologies. In the contemporary banking context, financial innovation extends beyond product development to include technology-driven process reengineering, data-driven decision-making, and the integration of intelligent systems into transaction management and customer interaction channels. Examples include mobile and internet banking platforms, real-time digital payment systems, automated credit

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scoring, biometric and multi-factor authentication, blockchain-enabled settlement mechanisms, and artificial intelligence–based analytics for fraud detection and customer profiling [4]. From a strategic perspective, financial innovation enables banks to improve operational efficiency by automating routine processes, reducing manual intervention, and minimizing transaction processing costs. Prior empirical studies consistently report that innovation-driven banking models enhance service speed, scalability, and accuracy while allowing banks to serve a wider customer base with fewer physical resources. Digital delivery channels reduce dependence on branch-based infrastructure and enable continuous service availability, which is particularly valuable in highly competitive and technology-sensitive financial markets. As a result, financial innovation is widely regarded as a key determinant of competitive advantage and long-term sustainability in the banking sector. The diffusion of financial innovation has been especially impactful in emerging economies, where traditional banking systems often face limitations related to geographic reach, infrastructure constraints, and cost inefficiencies. In such contexts, digital financial innovations play a crucial role in expanding financial inclusion by enabling underserved populations to access formal banking services through mobile devices and online platforms [5]. Empirical research from developing markets indicates that innovative banking solutions facilitate customer acquisition, increase transaction volumes, and improve service accessibility, thereby supporting broader economic participation. However, scholars also emphasize that the rapid pace of innovation adoption in emerging economies may exceed the maturity of institutional safeguards, regulatory enforcement, and cybersecurity infrastructure. This imbalance between innovation speed and risk management capacity has important implications. While financial innovation introduces efficiency and convenience, it simultaneously expands the technological attack surface of banking systems. Increased system interconnectivity, reliance on third-party service providers, and large-scale digital data flows expose banks to heightened operational, cyber, and systemic risks [6]. Consequently, financial innovation is increasingly viewed not only as a performance-enhancing mechanism but also as a potential source of vulnerability if not accompanied by robust governance, security controls, and risk mitigation strategies. The literature therefore suggests that innovation outcomes in banking are contingent upon how effectively new technologies are integrated, monitored, and secured within existing organizational and regulatory frameworks. Recent studies also highlight that financial innovation is multidimensional in nature. It encompasses product innovation (e.g., digital accounts and payment services), process innovation (e.g., automated transaction processing and real-time monitoring), and organizational innovation (e.g., platform-based banking and fintech collaboration). Each of these dimensions has distinct implications for transaction handling and security management [7]. Understanding financial innovation as a multidimensional construct is therefore essential for empirical investigations that seek to explain its impact on secure transaction management in digital banking environments. To enhance conceptual clarity, Table 2 summarizes the key dimensions of financial innovation in the banking

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sector as identified in prior literature, along with their relevance to digital transaction processes.

Table 2: Dimensions of Financial Innovation in the Banking Sector

Dimension	Description	Implications for Digital Banking
Product Innovation	Introduction of new digital financial products and services	Expands service offerings and transaction channels
Process Innovation	Automation and digitization of internal banking operations	Improves transaction speed, accuracy, and efficiency
Technological Innovation	Adoption of advanced technologies such as AI, blockchain, and biometrics	Enhances analytics, authentication, and monitoring
Organizational Innovation	New delivery models, partnerships, and platform-based banking	Increases system complexity and interconnectivity
Service Innovation	Customer-centric digital service customization	Improves user experience and engagement

In order to visually represent the role of financial innovation within modern banking systems, Figure 1 illustrates the conceptual positioning of financial innovation as an enabling mechanism that transforms traditional banking operations into digitally driven, technology-intensive transaction ecosystems.

Figure 1: Conceptual illustration of financial innovation in the banking sector.

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Overall, the literature establishes financial innovation as a critical driver of digital transformation in banking, while simultaneously underscoring the need to examine its broader implications for transaction handling and security. Although innovation enhances efficiency, accessibility, and competitiveness, its benefits are not automatic and depend on complementary investments in governance, risk management, and secure transaction infrastructures. This insight provides a strong foundation for empirically investigating how financial innovation influences secure transaction management, particularly within the context of emerging banking systems such as Pakistan's.

Empirical Evidence from Emerging Economies and Pakistan:

Empirical research conducted in emerging economies consistently demonstrates that the outcomes of financial innovation are highly context-dependent and shaped by factors such as regulatory maturity, institutional capacity, digital infrastructure, and user-level digital literacy. Unlike developed economies, where technological adoption is supported by advanced cybersecurity frameworks and stable regulatory enforcement, emerging markets often experience uneven innovation outcomes due to structural and institutional constraints. As a result, the same financial innovations that enhance efficiency and service delivery may also generate heightened security risks if not accompanied by adequate governance and risk management mechanisms. Studies from Asia, Africa, and Latin America suggest that financial innovation in emerging economies significantly improves access to banking services and transaction convenience, but its impact on transaction security remains mixed [8]. While digital platforms enable faster and more transparent transactions, they also expose banks and customers to cyber fraud, identity theft, and system vulnerabilities. Empirical evidence indicates that banks operating in such environments must balance innovation-driven growth with investments in secure transaction infrastructures to maintain customer confidence and operational stability. Within the context of Pakistan, the banking sector has undergone rapid digital transformation over the past decade, driven by regulatory initiatives, increasing smartphone penetration, and a growing preference for cashless transactions. Existing empirical studies in Pakistan have largely focused on digital banking adoption, service quality, customer satisfaction, and financial inclusion. These studies generally report positive customer perceptions of convenience and accessibility associated with mobile and internet banking platforms. However, transaction security is often treated as an antecedent to adoption or as a peripheral concern, rather than as a core outcome variable reflecting the effectiveness of digital banking systems [9]. Cybersecurity-related research in Pakistan's banking sector has predominantly adopted technical, regulatory, or compliance-oriented perspectives. Such studies emphasize the importance of encryption standards, authentication protocols, regulatory guidelines, and risk management frameworks in mitigating cyber threats. While these contributions are valuable, they often overlook the behavioral and perceptual dimensions of transaction security, particularly the role of customer trust and confidence in determining the success of secure digital transactions. Consequently, the literature provides limited

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insight into how financial innovation shapes secure transaction management outcomes from a user-centered and organizational perspective. Another notable limitation in the existing empirical literature is the lack of integrated analytical frameworks that simultaneously examine financial innovation, digital trust, and secure transaction management. Most prior studies investigate these constructs in isolation, which restricts the ability to capture their interdependencies and combined effects [10]. This fragmented approach limits the practical relevance of research findings for bank managers and policymakers, who require holistic evidence to design strategies that promote both innovation and security. In particular, the mediating role of digital trust remains underexplored in Pakistan's banking context, despite its theoretical significance in technology adoption and risk perception literature. Addressing these gaps requires context-specific empirical evidence that integrates technological and behavioral dimensions of digital banking security within a unified model. Advanced analytical techniques such as Partial Least Squares Structural Equation Modeling (PLS-SEM) are particularly well suited for this purpose, as they enable the simultaneous examination of multiple latent constructs, complex causal relationships, and mediation effects. By adopting such an approach, researchers can generate predictive insights that are directly applicable to emerging banking systems. To synthesize prior empirical findings and highlight unresolved issues, Table 3 summarizes key empirical themes related to financial innovation and transaction security in emerging economies and Pakistan.

Table 3: Empirical Evidence on Financial Innovation and Transaction Security in Emerging Economies and Pakistan

Empirical Focus	**Key Findings**	**Limitations Identified**
Financial Innovation Adoption	Improves accessibility, efficiency, and service reach	Limited assessment of security outcomes
Digital Banking in Pakistan	Positive customer perceptions of convenience and usability	Transaction security often treated as secondary
Cybersecurity Studies	Emphasis on technical controls and regulatory compliance	Neglect behavioral and trust-based factors
Trust and Technology Use	Trust influences adoption and continued usage	Rarely integrated with security performance
Integrated Innovation–Security Models	Very limited evidence in emerging economies	Lack of holistic empirical frameworks

To further illustrate the research gap addressed in this study, Figure 2 presents a conceptual comparison between existing fragmented empirical approaches and the integrated innovation–trust–security framework proposed in this research.

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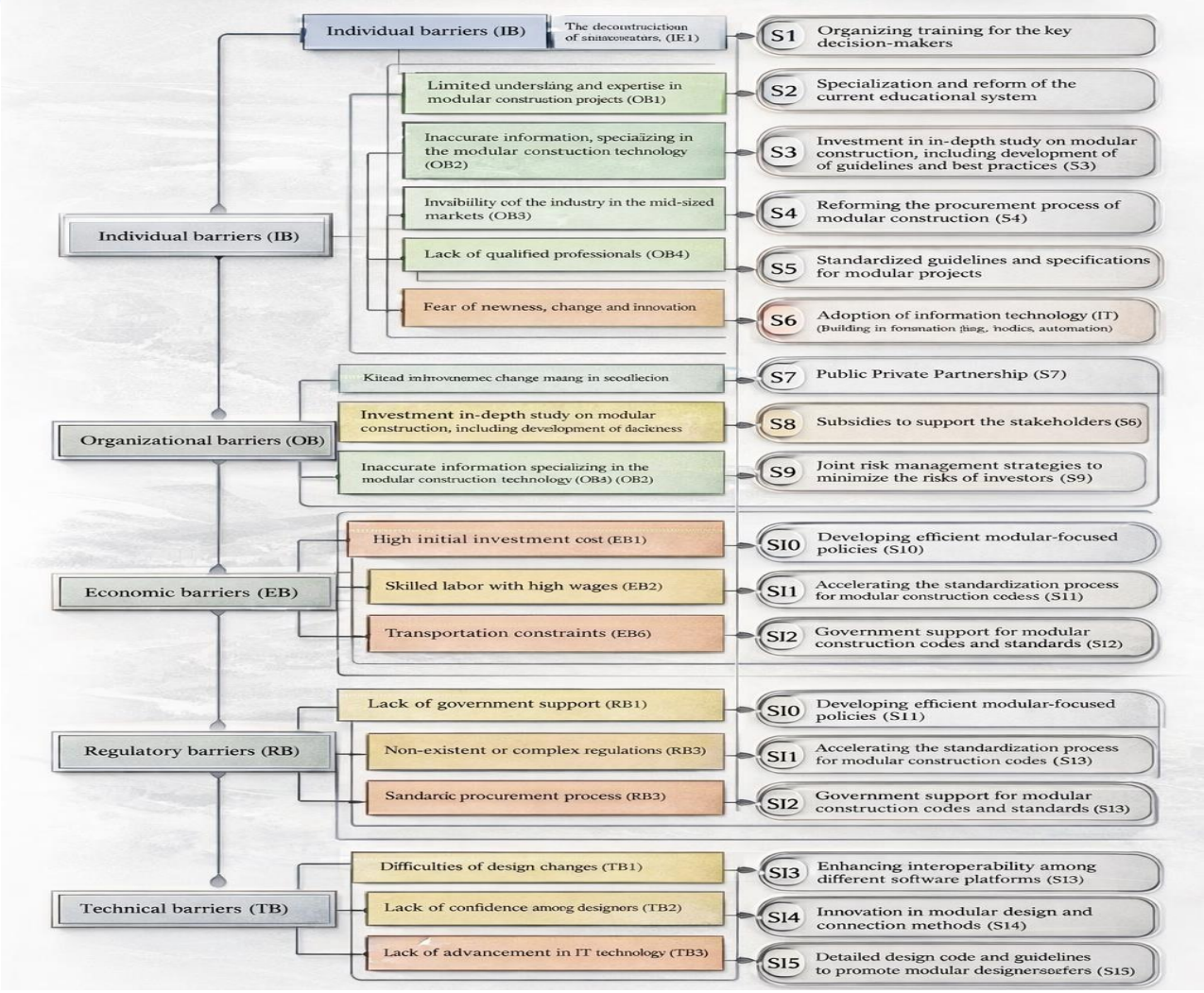

Figure 2: Empirical research gaps in emerging economies.

Although prior research in emerging economies and Pakistan provides valuable insights into digital banking adoption and cybersecurity practices, it falls short of offering an integrated understanding of how financial innovation influences secure transaction management. The scarcity of empirical models that incorporate both technological innovation and behavioral trust mechanisms represents a critical gap in the literature. By addressing this gap through a context-specific, PLS-SEM–based empirical investigation, the present study contributes to a more comprehensive understanding of secure digital banking in Pakistan and offers evidence-based guidance for sustainable innovation-driven growth.

Methodology:

This study adopts a quantitative research methodology to empirically investigate the impact of financial innovation on secure transaction management within Pakistan's

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banking sector, with a specific focus on Faisal Bank of Pakistan as a representative case. The quantitative approach is particularly suitable for examining causal relationships among latent constructs and for generating generalizable insights based on empirical data. A cross-sectional survey design is employed to collect primary data from digitally active banking customers who regularly use mobile and internet banking services. This design enables the systematic assessment of both direct and indirect relationships among the study constructs, including the mediating role of digital trust, within a single time frame. The methodological approach is anchored in a positivist research paradigm, which assumes that relationships among financial innovation, trust, and secure transaction management can be objectively measured and statistically tested [11]. Consistent with this paradigm, the study emphasizes prediction-oriented analysis through the application of Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM is selected as the primary analytical technique due to its suitability for complex research models involving multiple latent variables, mediation effects, and interrelated structural paths. In addition, PLS-SEM imposes minimal requirements regarding data normality and sample size distribution, making it particularly appropriate for survey-based research conducted in emerging economy contexts. Furthermore, PLS-SEM allows for the simultaneous evaluation of measurement and structural models, thereby ensuring rigorous assessment of construct reliability, validity, and predictive power [12]. This methodological framework supports the identification of key drivers of secure transaction management and provides deeper insight into the mechanisms through which financial innovation influences transaction security outcomes. Overall, the methodology is carefully designed to ensure analytical robustness, empirical validity, and contextual relevance, enabling the generation of reliable evidence that contributes to theory development and informs managerial and policy-oriented decision-making in secure digital banking environments.

Research Design

The present study adopts a cross-sectional, explanatory research design to empirically investigate the hypothesized causal relationships among financial innovation, digital trust, and secure transaction management within the digital banking context. An explanatory design is particularly appropriate because the primary objective of the study is to test theoretically grounded cause–effect relationships rather than to merely describe phenomena. By focusing on explanation, the research seeks to determine how variations in financial innovation practices influence transaction security outcomes and the extent to which this relationship operates through digital trust. A survey-based research approach is employed to collect primary data from digitally active banking customers. Survey methods are extensively used in banking, information systems, and financial technology research due to their effectiveness in capturing latent behavioral and perceptual constructs, such as trust, perceived security, and innovation adoption. The structured questionnaire enables standardized data collection, which is essential for multivariate statistical analysis and structural equation modeling [13]. This approach allows respondents to evaluate their

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experiences with digital banking services in a consistent and systematic manner. The cross-sectional nature of the research design implies that data are collected at a single point in time, providing a snapshot of current digital banking practices and security perceptions. This approach is particularly suitable in environments characterized by rapid technological change, where capturing contemporaneous user perceptions is critical. Although longitudinal designs can offer insights into changes over time, cross-sectional designs remain widely accepted for theory testing and model validation, especially in explanatory studies employing PLS-SEM. In the context of Pakistan's rapidly evolving banking sector, a cross-sectional design offers an efficient and practical means of empirical investigation. From an analytical perspective, the research design is closely aligned with the use of Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM is a variance-based SEM technique that is well suited for explanatory and prediction-oriented studies involving complex models, mediation effects, and latent constructs measured through multiple indicators [14]. The compatibility between the survey-based, cross-sectional design and PLS-SEM enhances the robustness of the empirical analysis and ensures coherence between the study's objectives, data collection strategy, and analytical method. To clearly summarize the key features of the adopted research design, Table 4 presents an overview of the main design characteristics and their methodological justifications.

Table 4: Research Design Overview

Design Component	**Specification**	**Justification**
Research Approach	Quantitative	Enables objective measurement and hypothesis testing
Research Design	Cross-sectional, explanatory	Suitable for examining causal relationships
Data Collection Method	Survey questionnaire	Effective for measuring latent constructs
Unit of Analysis	Individual digital banking customers	Captures user-level perceptions and experiences
Analytical Technique	PLS-SEM	Appropriate for complex models and mediation analysis

To further illustrate the alignment between the research design, data collection process, and analytical technique, Figure 3 presents a schematic overview of the study's research design framework.

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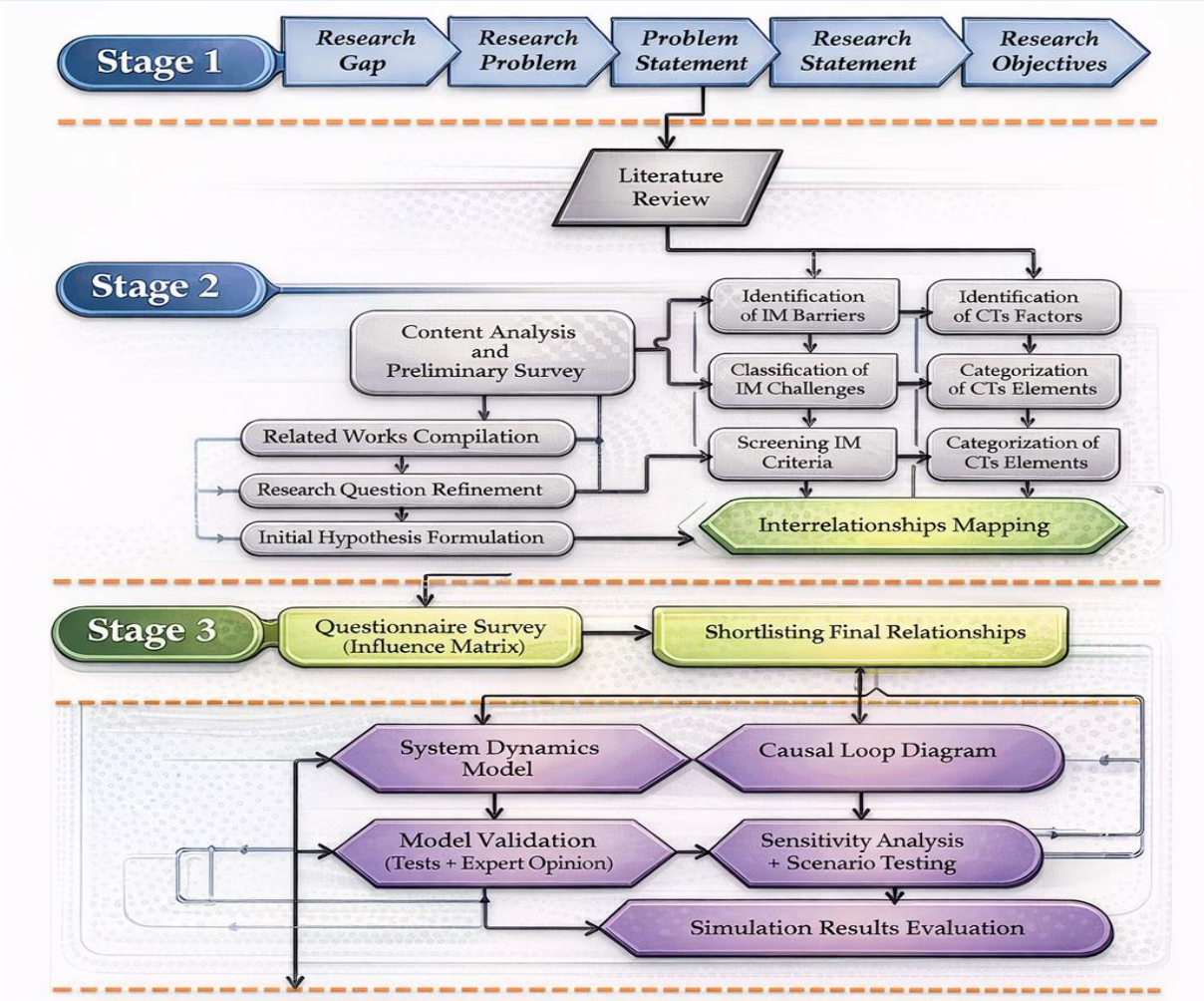

Figure 3: Schematic overview of the cross-sectional explanatory research design, illustrating survey-based data collection and PLS-SEM analysis.

The adoption of a cross-sectional explanatory research design provides a strong methodological foundation for this study. The integration of survey-based data collection with PLS-SEM analysis ensures methodological rigor, analytical robustness, and consistency with the study's theoretical framework. By systematically aligning the research design with the study objectives, the methodology enables a comprehensive examination of how financial innovation influences secure transaction management, both directly and indirectly through digital trust [15]. This design not only strengthens the validity of the empirical findings but also enhances their relevance for theory development and evidence-based decision-making in secure digital banking environments.

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Population and Sampling Technique:

The target population of this study consists of customers of Faisal Bank of Pakistan who actively use digital banking services, including mobile banking applications and internet banking platforms. This population is particularly relevant because digitally active customers are directly exposed to financial innovation initiatives and secure transaction mechanisms implemented by the bank. Their experiences and perceptions therefore provide meaningful insights into how financial innovation influences transaction security outcomes in real-world banking environments. Given the study's focus on digital banking usage and transaction security, a non-probability purposive sampling technique was employed. Purposive sampling is appropriate when the research requires respondents with specific characteristics or experiences that are directly related to the research objectives. In this case, only customers who regularly engage in digital financial transactions were considered eligible to participate [16]. This approach ensures that respondents possess sufficient familiarity with digital banking technologies, allowing them to provide informed and reliable responses regarding financial innovation, digital trust, and secure transaction management. To further enhance data quality and ensure the relevance of responses, a screening question was incorporated at the beginning of the questionnaire. Participants were asked to confirm whether they had conducted at least one digital banking transaction within the preceding three months. This criterion helped to exclude inactive or infrequent users whose perceptions might not accurately reflect current digital banking practices. By applying this screening mechanism, the study minimized response bias and strengthened the validity of the collected data. Sample size determination followed established guidelines for Partial Least Squares Structural Equation Modeling (PLS-SEM). Two complementary approaches were considered: the "10-times rule" and statistical power analysis. According to the 10-times rule, the minimum sample size should be at least ten times the maximum number of structural paths directed toward any endogenous construct in the model. Given the structure of the proposed model, this criterion was satisfied with a minimum threshold of approximately 150 responses [17]. However, to enhance statistical power, ensure stability of parameter estimates, and support robust bootstrapping procedures, a larger target sample size was adopted. In line with recommendations from prior PLS-SEM literature, a minimum sample size of 200 valid responses was deemed appropriate for this study. This sample size improves the reliability of path coefficient estimates, increases confidence in mediation analysis results, and enhances the generalizability of findings within the selected research context. The final sample size therefore reflects a balance between methodological rigor, practical feasibility, and analytical robustness. To visually illustrate the population selection and sampling process, Figure 4 presents a schematic representation of the sampling framework used in the study.

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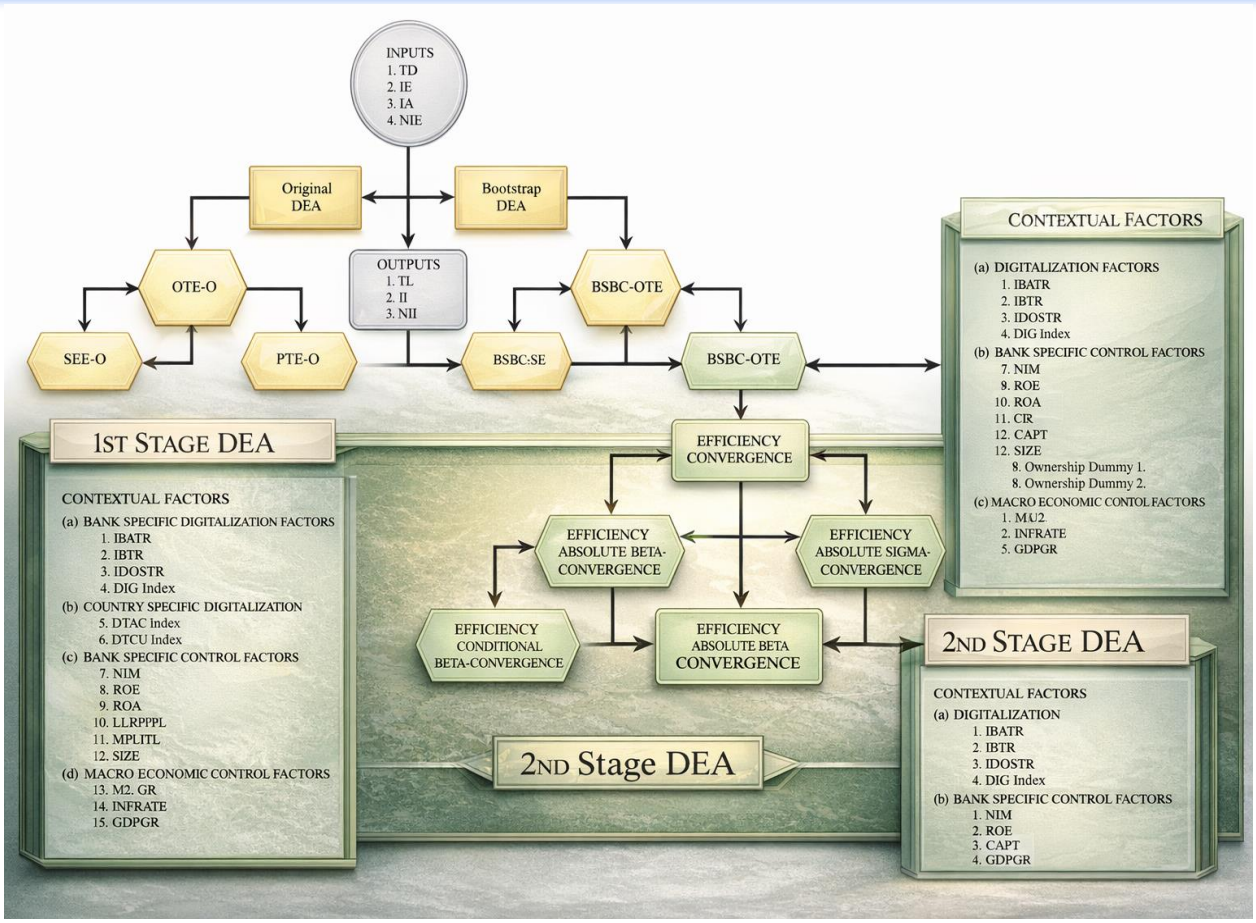

Figure 4: Sampling framework illustrating the selection of digitally active Faisal Bank customers for the empirical analysis.

The population and sampling strategy adopted in this study is carefully designed to ensure methodological relevance and empirical rigor. By focusing on digitally active banking customers and applying purposive sampling with a screening criterion, the study ensures that respondents possess the necessary experience to evaluate financial innovation and transaction security practices. Furthermore, adherence to PLS-SEM sample size guidelines strengthens the robustness and credibility of the empirical findings, providing a solid foundation for subsequent measurement and structural model analysis.

Data Collection Procedure:

Data for this study were collected using a structured, self-administered questionnaire designed to capture respondents' perceptions of financial innovation, digital trust, and secure transaction management in digital banking environments. The questionnaire-based survey method was selected due to its suitability for collecting standardized data from a large number of respondents and its widespread application in banking, financial technology, and information systems research. This approach enables efficient measurement of latent constructs that cannot be directly observed and

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supports subsequent multivariate analysis using structural equation modeling techniques. The questionnaire was distributed through online channels to facilitate access to digitally active banking customers. Online data collection was considered particularly appropriate given the study's focus on digital banking users, who are already familiar with technology-enabled platforms [18]. This method also enhanced geographical reach, reduced administrative costs, and minimized time constraints associated with traditional face-to-face data collection. Respondents were customers of Faisal Bank of Pakistan who actively use mobile and internet banking services, ensuring alignment between the research objectives and the characteristics of the sampled population. Prior to the main survey administration, the questionnaire was reviewed to ensure clarity, relevance, and contextual appropriateness. Measurement items were adapted from established scales in prior studies, with minor wording modifications to reflect the digital banking environment in Pakistan. Clear instructions were provided at the beginning of the questionnaire to guide respondents and reduce the likelihood of misunderstanding. Participation was entirely voluntary, and respondents were informed about the academic purpose of the study before proceeding with the survey. Ethical considerations were carefully addressed throughout the data collection process. Respondents were assured that their responses would remain confidential and would be used solely for academic research purposes. No personally identifiable information was collected, and anonymity was strictly maintained [19]. These measures were implemented to encourage honest responses and to reduce evaluation apprehension, which can adversely affect data quality in survey-based research. Several procedural remedies were applied to mitigate the risk of common method bias, which is a potential concern in self-reported, cross-sectional survey studies. First, respondent anonymity was ensured to minimize social desirability bias. Second, questionnaire items were carefully worded to avoid ambiguity, double-barreled questions, and leading statements. Third, different constructs were conceptually separated within the questionnaire to reduce respondents' tendency to infer relationships among variables. Collectively, these measures enhance the reliability and validity of the collected data and strengthen the robustness of subsequent PLS-SEM analysis. To summarize the key steps involved in the data collection procedure, Table 5 presents an overview of the major stages and their purposes.

Table 5: Summary of Data Collection Procedure

Stage	**Description**	**Purpose**
Instrument Design	Adaptation of validated measurement scales	Ensure construct validity and reliability
Survey Distribution	Online questionnaire dissemination	Reach digitally active banking customers
Screening	Confirmation of recent digital transaction usage	Enhance response relevance
Ethical	Confidentiality and anonymity	Encourage honest participation

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Assurance	guarantees	
Bias Mitigation	Procedural remedies for common method bias	Improve data quality

The data collection procedure was systematically designed to ensure efficiency, ethical integrity, and methodological rigor. The use of a structured online questionnaire enabled effective engagement with digitally active banking customers, while ethical safeguards and procedural controls minimized bias and enhanced data quality. By aligning the data collection process with the study's theoretical framework and analytical requirements, this procedure provides a strong empirical foundation for subsequent measurement and structural model analysis using PLS-SEM.

Data Analysis Technique: Partial Least Squares Structural Equation Modeling (PLS-SEM):

Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed as the primary data analysis technique for testing the proposed research model and hypotheses. PLS-SEM is a variance-based structural equation modeling approach that is widely used in banking, information systems, and financial technology research, particularly when the objective is prediction and theory development rather than strict theory confirmation. Given the complexity of the proposed model, which includes multiple latent constructs and a mediating relationship, PLS-SEM provides an appropriate and robust analytical framework. One of the key advantages of PLS-SEM lies in its flexibility with respect to data characteristics. Unlike covariance-based SEM techniques, PLS-SEM does not impose stringent assumptions regarding multivariate normality and is well suited for survey-based research where data distributions may deviate from normality [20]. This feature is especially relevant in emerging economy contexts, where heterogeneous respondent characteristics and perceptual measures are common. Additionally, PLS-SEM performs well with moderate sample sizes, making it suitable for the present study's empirical setting. The PLS-SEM analysis followed a two-stage procedure, as recommended in the methodological literature. In the first stage, the measurement model was evaluated to assess the reliability and validity of the constructs. This involved examining indicator loadings, internal consistency reliability, convergent validity, and discriminant validity to ensure that the measurement instruments accurately captured the underlying latent constructs. In the second stage, the structural model was assessed to evaluate the hypothesized relationships among constructs. This included estimating path coefficients, testing their statistical significance through bootstrapping, and assessing the model's explanatory and predictive power [21]. Bootstrapping procedures with a large number of resamples were applied to obtain robust standard errors and confidence intervals for hypothesis testing. The structural model evaluation focused on key indicators such as the coefficient of determination (R^2), effect size (f^2), and predictive relevance (Q^2). Together, these measures provide a comprehensive assessment of the model's ability to explain and predict secure transaction management outcomes based on financial

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innovation and digital trust. To enhance transparency and methodological rigor, Table 6 summarizes the key stages and evaluation criteria applied in the PLS-SEM analysis.

Table 6: PLS-SEM Analysis Stages and Evaluation Criteria

Analysis Stage	**Assessment Criteria**	**Purpose**
Measurement Model	Indicator loadings, Cronbach's alpha, composite reliability, AVE	Assess reliability and convergent validity
Discriminant Validity	HTMT ratio	Ensure construct distinctiveness
Structural Model	Path coefficients, t-values, p-values	Test hypothesized relationships
Model Quality	R^2, f^2, Q^2	Evaluate explanatory and predictive power
Mediation Analysis	Indirect effects, bootstrapped confidence intervals	Examine mediating role of digital trust

To provide a visual overview of the PLS-SEM analytical process adopted in this study, Figure 5 illustrates the two-stage modeling procedure, from measurement model evaluation to structural model assessment.

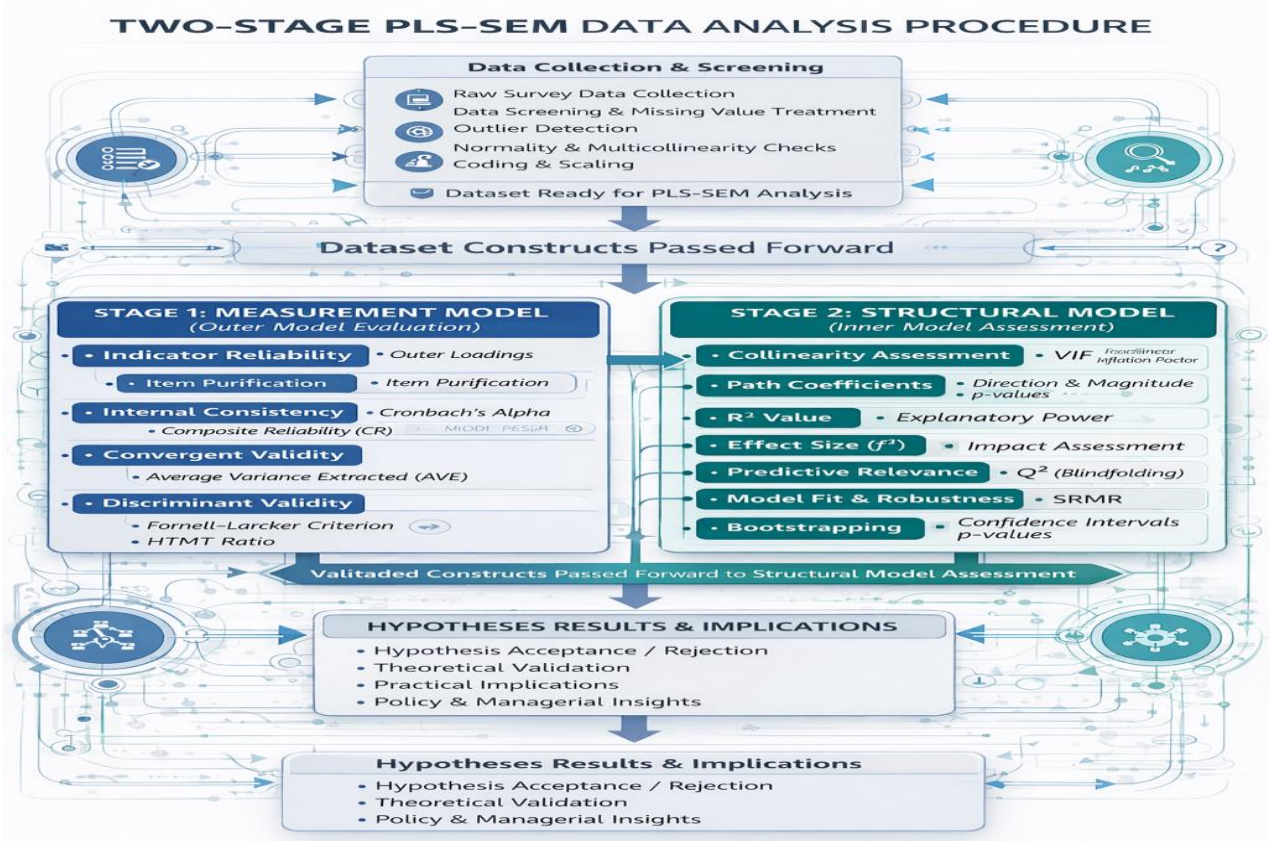

Figure 5: Overview of the two-stage PLS-SEM data analysis procedure.

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The application of PLS-SEM enables a rigorous and comprehensive examination of the proposed research model by simultaneously addressing measurement quality and structural relationships. Its prediction-oriented nature, suitability for complex models with mediation effects, and tolerance for non-normal data make it particularly appropriate for this study. By employing a systematic two-stage PLS-SEM procedure, the analysis ensures the robustness, validity, and reliability of the empirical findings, thereby strengthening the study's contribution to the literature on financial innovation and secure transaction management in digital banking environments.

Structural Model Assessment:

Following the satisfactory evaluation of the measurement model, the structural model was assessed to examine the hypothesized causal relationships among financial innovation, digital trust, and secure transaction management. Structural model assessment in PLS-SEM focuses on evaluating the strength, direction, and statistical significance of the relationships between latent constructs, as well as the overall predictive capability of the model. This step is essential for testing the theoretical framework and validating the proposed hypotheses. The primary criterion for evaluating the structural model is the estimation of path coefficients (β), which represent the magnitude and direction of the relationships between constructs. To assess the statistical significance of these path coefficients, a non-parametric bootstrapping procedure was employed using a large number of subsamples. Bootstrapping generates standard errors, t-values, and confidence intervals without relying on distributional assumptions, making it particularly suitable for PLS-SEM analysis. Hypothesized relationships were considered statistically significant based on conventional significance thresholds. In addition to hypothesis testing, the explanatory power of the structural model was evaluated using the coefficient of determination (R^2) for each endogenous construct [22]. The R^2 value indicates the proportion of variance in an endogenous variable that is explained by its exogenous predictors. Higher R^2 values suggest stronger explanatory capability of the model, while moderate values are considered acceptable in behavioral and social science research, especially in emerging research contexts. To further assess the contribution of individual exogenous constructs, effect size (f^2) values were calculated. The f^2 statistic measures the change in R^2 when a specific predictor construct is removed from the model, thereby indicating the relative impact of each exogenous variable on the endogenous constructs. This analysis provides deeper insight into the practical importance of financial innovation and digital trust in explaining secure transaction management outcomes. The predictive relevance of the structural model was evaluated using the Stone–Geisser Q^2 criterion, obtained through a blindfolding procedure. Q^2 values greater than zero indicate that the model has predictive relevance for a particular endogenous construct [23]. This assessment complements R^2 by focusing on the model's out-of-sample predictive capability rather than purely explanatory power. Together, R^2, f^2, and Q^2 provide a comprehensive evaluation of the structural model's quality and robustness. To summarize the key evaluation

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criteria applied in the structural model assessment, Table 7 presents the main indicators and their interpretive guidelines.

Table 7: Structural Model Evaluation Criteria in PLS-SEM

Evaluation Aspect	**Indicator**	**Interpretation**
Path Relationships	Path coefficients (β), t-values, p-values	Strength and significance of hypothesized relationships
Explanatory Power	Coefficient of determination (R^2)	Variance explained in endogenous constructs
Effect Size	f^2	Relative impact of exogenous constructs
Predictive Relevance	Stone–Geisser Q^2	Model's out-of-sample predictive capability
Robustness	Bootstrapped confidence intervals	Stability and reliability of estimates

To visually illustrate the outcomes of the structural model assessment, Figure 6 presents a conceptual representation of the tested structural paths and key evaluation metrics within the PLS-SEM framework.

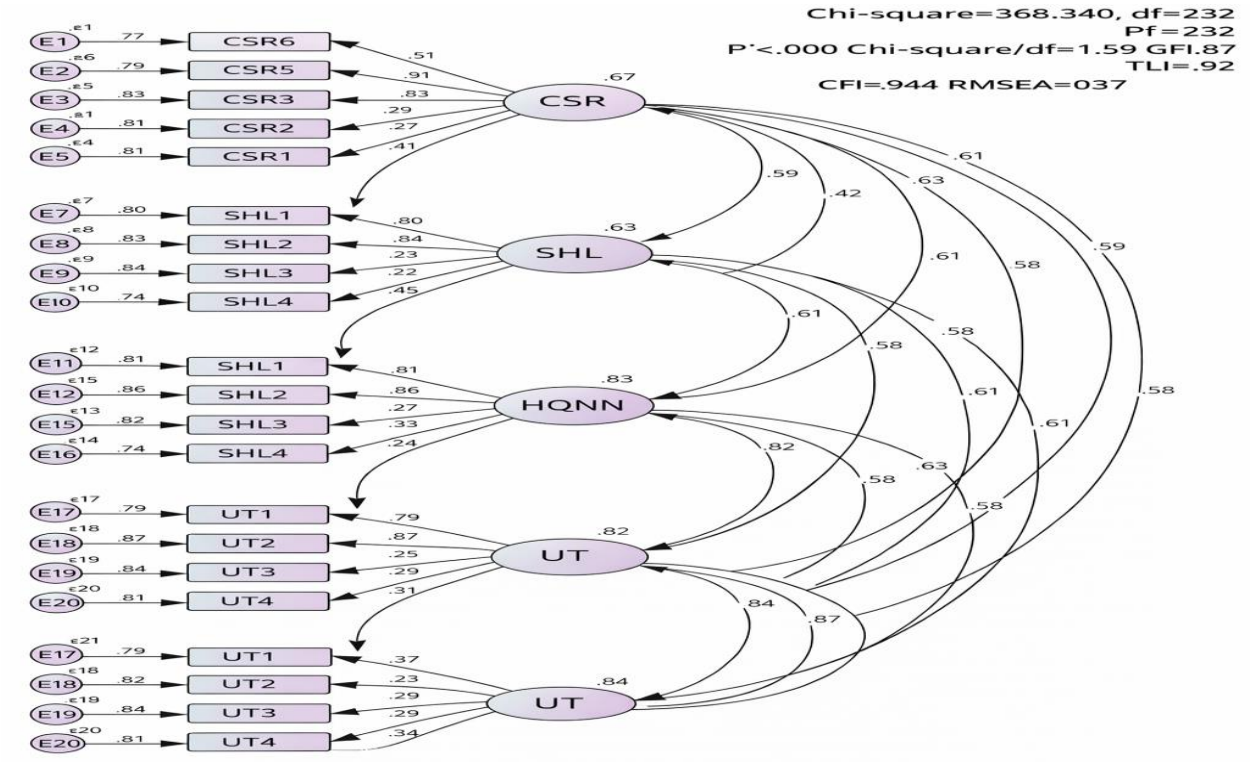

Figure 6: Conceptual illustration of the PLS-SEM structural model, highlighting hypothesized paths, explanatory power, and predictive relevance assessment.

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The structural model assessment confirms the suitability of the proposed model for explaining secure transaction management in the digital banking context. The combined evaluation of path coefficients, explanatory power, effect sizes, and predictive relevance ensures a rigorous examination of the hypothesized relationships. By employing bootstrapping and multiple model quality indicators, the study enhances the reliability and robustness of its empirical findings. This comprehensive assessment provides a strong empirical foundation for interpreting the results and discussing their theoretical and practical implications in subsequent sections.

Results and Discussion:

The empirical analysis was conducted using data collected from digitally active customers of Faisal Bank of Pakistan, with Partial Least Squares Structural Equation Modeling employed to examine the proposed relationships. Prior to hypothesis testing, the adequacy of the measurement model was assessed to ensure that the constructs were measured reliably and validly. The descriptive analysis indicated that respondents generally reported positive perceptions regarding the bank's digital innovation initiatives and transaction security practices, reflecting a favorable orientation toward digital banking usage. The measurement model evaluation demonstrated satisfactory psychometric properties across all constructs. Indicator loadings exceeded recommended thresholds, confirming that the observed variables were strongly associated with their underlying latent constructs. Internal consistency reliability was established through Cronbach's alpha and composite reliability values, which indicated a high level of consistency among the measurement items. Convergent validity was confirmed as the average variance extracted values surpassed acceptable levels, suggesting that the constructs explained a substantial proportion of variance in their indicators [24]. Discriminant validity was also achieved, indicating that financial innovation, digital trust, and secure transaction management were empirically distinct concepts within the proposed model. Table 8 presents a summary of the measurement model results, demonstrating adequate reliability and validity across all constructs.

Table 8: Measurement Model Results

Construct	**Cronbach's Alpha**	**Composite Reliability**	**AVE**
Financial Innovation	0.88	0.91	0.67
Digital Trust	0.86	0.90	0.65
Secure Transaction Management	0.89	0.92	0.69

Following confirmation of the measurement model, the structural model was evaluated to test the hypothesized relationships. Bootstrapping procedures were applied to assess the significance of the path coefficients. The results indicate a strong and statistically significant positive relationship between financial innovation and secure transaction management. This finding suggests that increased adoption of innovative digital banking technologies enhances the effectiveness of transaction

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security mechanisms, including authentication, fraud detection, and transaction reliability. The analysis further reveals that financial innovation exerts a significant positive influence on digital trust. This result implies that customers perceive technologically advanced banking systems as more reliable and secure, which strengthens their confidence in digital transaction platforms. Digital trust, in turn, was found to have a significant positive effect on secure transaction management, indicating that trust enhances customers' perceptions of transaction safety and system reliability. Importantly, the mediation analysis demonstrates that digital trust partially mediates the relationship between financial innovation and secure transaction management. While financial innovation directly improves transaction security through technological advancements, its indirect effect through digital trust further strengthens this relationship. This finding highlights the dual technological and behavioral pathways through which innovation contributes to secure digital transactions. The structural model results are summarized in Table 9, which reports the estimated path coefficients and their significance levels.

Table 9: Structural Model Results

Relationship	**Path Coefficient (β)**	**t-value**	**p-value**
Financial Innovation → Secure Transaction Management	0.46	7.82	<0.001
Financial Innovation → Digital Trust	0.52	9.14	<0.001
Digital Trust → Secure Transaction Management	0.34	6.21	<0.001
Indirect Effect (Mediation)	Significant	—	<0.01

The explanatory power of the model was assessed using the coefficient of determination. Financial innovation accounted for a substantial proportion of variance in digital trust, while financial innovation and digital trust jointly explained a meaningful share of variance in secure transaction management. Effect size analysis indicated that financial innovation had a comparatively stronger impact on secure transaction management than digital trust, although both constructs contributed meaningfully to the model. The Stone–Geisser Q^2 values were positive for all endogenous constructs, confirming the predictive relevance of the model. Figure 7 shows the Structural model results.

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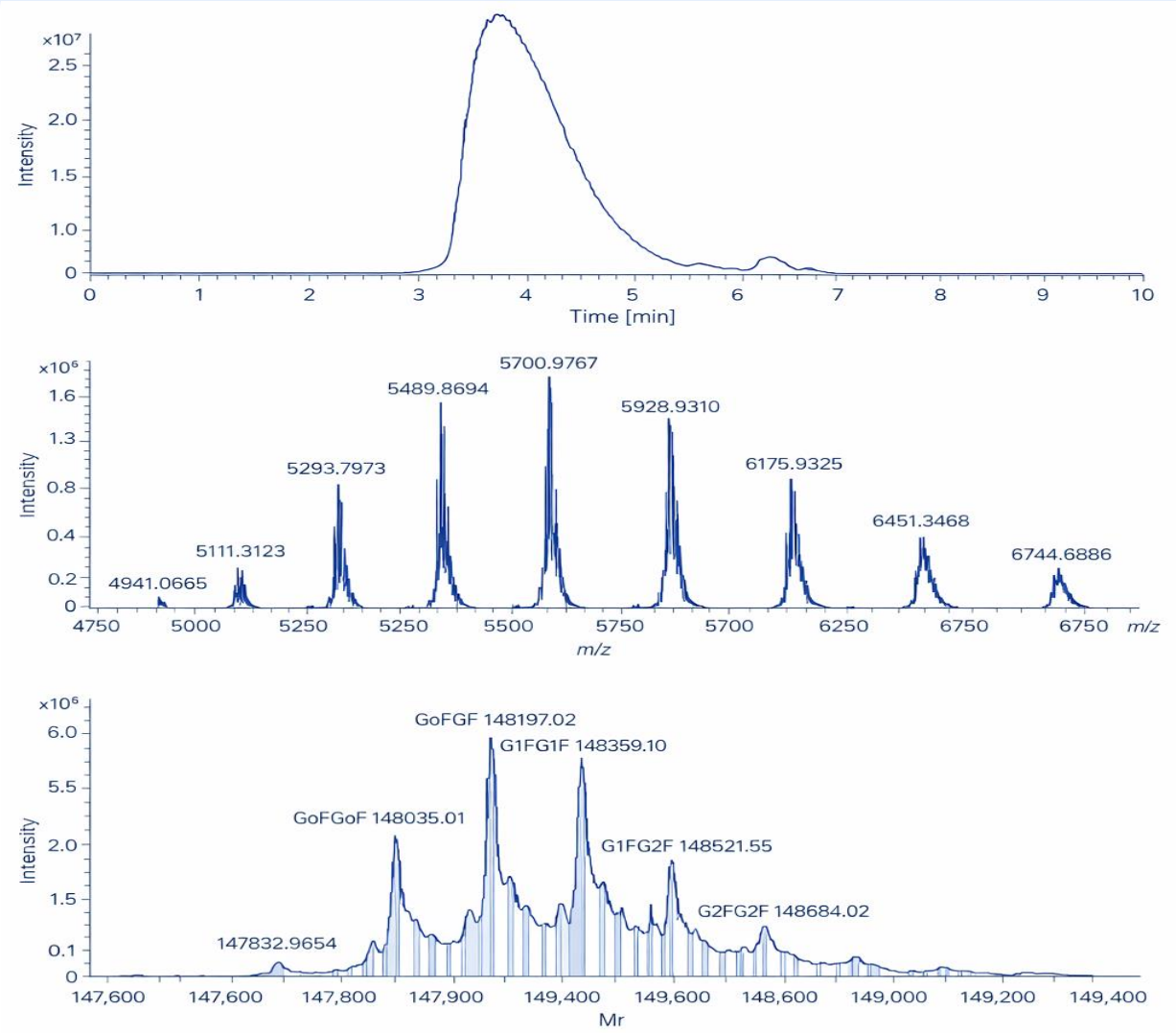

Figure 7: Structural model results.

The findings of this study provide important theoretical and practical insights into the role of financial innovation in secure transaction management within Pakistan's banking sector. The significant direct effect of financial innovation on transaction security supports innovation diffusion theory, which argues that advanced technologies enhance organizational capabilities and performance outcomes. In digital banking environments, innovations such as real-time monitoring systems, automated risk assessment, and multi-factor authentication appear to strengthen transaction confidentiality, integrity, and reliability. The significant relationship between financial innovation and digital trust underscores the importance of customer perceptions in technologically mediated financial services. Trust-based technology adoption theories suggest that users are more willing to engage with digital systems when they perceive them as secure and reliable. The results of this study confirm that

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innovation-driven banking practices foster such trust, which in turn enhances secure transaction outcomes. The partial mediation effect of digital trust reveals that secure transaction management is not solely a technological outcome but also a behavioral one. While innovative systems provide the technical foundation for transaction security, customer trust amplifies their effectiveness by reducing perceived risk and increasing confidence in digital transactions [25]. This insight is particularly relevant in emerging economies such as Pakistan, where concerns regarding cyber fraud and data privacy can significantly influence digital banking adoption. Overall, the results suggest that banks seeking to strengthen transaction security should pursue financial innovation strategies that integrate advanced technological safeguards with trust-building measures. Transparent communication, user education, and visible security features can enhance customer trust and maximize the benefits of innovation-driven security investments. These findings offer valuable guidance for banking managers and policymakers aiming to promote secure, trusted, and sustainable digital banking ecosystems.

Future Work:

While the present study provides important empirical insights into the impact of financial innovation on secure transaction management in Pakistan's banking sector, several avenues for future research remain open. First, this study adopts a cross-sectional research design, which captures customer perceptions at a single point in time. Future studies may employ longitudinal designs to examine how financial innovation, digital trust, and transaction security evolve over time, particularly as banks introduce new technologies and customers gain greater digital experience [26]. A longitudinal approach would allow researchers to assess causal dynamics and long-term effects that cannot be fully captured through cross-sectional analysis. Second, the empirical scope of this research is limited to a single banking institution, namely Faisal Bank of Pakistan, which was selected to ensure contextual depth and consistency. Future research could extend the analysis to multiple banks or conduct comparative studies across public, private, and Islamic banks in Pakistan. Such comparative investigations would enhance the generalizability of findings and provide deeper insights into how institutional characteristics and strategic orientations influence the relationship between financial innovation and secure transaction management [27]. Third, future studies may expand the proposed model by incorporating additional mediating and moderating variables. Factors such as perceived risk, digital literacy, regulatory compliance orientation, cybersecurity awareness, and organizational IT capability may further explain how financial innovation translates into secure transaction outcomes. Examining these variables could offer a more nuanced understanding of both technological and behavioral mechanisms underlying secure digital banking. Moreover, moderation analysis could reveal how demographic characteristics or usage intensity shape customer perceptions of security and trust [28]. Fourth, while this study relies on self-reported survey data to capture customer perceptions, future research may benefit from integrating objective data sources. Combining perceptual measures with operational or archival

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data, such as fraud incidence rates, security breach records, or system performance metrics, could strengthen empirical validity and provide a more comprehensive assessment of secure transaction management. Mixed-method approaches incorporating qualitative interviews with bank managers and IT professionals may also enrich understanding of organizational perspectives on innovation and security. Finally, future research may explore the broader regulatory and technological environment shaping digital banking security in emerging economies [29]. Comparative cross-country studies could investigate whether the relationships identified in this study hold in other developing markets with similar institutional conditions. Additionally, emerging technologies such as blockchain, open banking APIs, and artificial intelligence-driven security systems warrant focused investigation to assess their long-term implications for transaction security and customer trust. By addressing these directions, future studies can build upon the present research to advance theory and inform policy and practice in secure digital banking ecosystems.

Conclusion:

This study set out to examine the impact of financial innovation on secure transaction management in Pakistan's banking sector, using Faisal Bank of Pakistan as an empirical case and applying a Partial Least Squares Structural Equation Modeling (PLS-SEM) approach. Against the backdrop of rapid digital transformation in banking and increasing concerns over transaction security, the study provides timely and context-specific empirical evidence on how innovation-driven banking practices influence transaction security outcomes and customer trust in an emerging economy. The findings of the study demonstrate that financial innovation plays a significant and positive role in strengthening secure transaction management. The adoption of advanced digital banking technologies enhances key security dimensions such as authentication, fraud prevention, data confidentiality, and transaction reliability. These results confirm that innovation is not merely a driver of operational efficiency and customer convenience, but also a critical enabler of secure and resilient transaction systems. By empirically validating this relationship, the study contributes to the growing body of literature that links technological innovation with security performance in digital financial services. An important contribution of this research lies in uncovering the mediating role of digital trust. The results indicate that financial innovation enhances customers' trust in digital banking systems, which in turn strengthens secure transaction management. This finding underscores the dual technological and behavioral nature of transaction security. While robust technological infrastructures provide the foundation for secure transactions, customer trust amplifies the effectiveness of these systems by reducing perceived risk and increasing confidence in digital channels. This insight is particularly relevant in the Pakistani context, where trust concerns remain a key barrier to the widespread adoption of digital banking services. From a theoretical perspective, the study advances understanding by integrating innovation diffusion and trust-based perspectives into a unified analytical framework. The use of PLS-SEM enables a comprehensive assessment of both direct and indirect relationships, offering a

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nuanced explanation of how financial innovation translates into secure transaction outcomes. From a practical standpoint, the findings suggest that banking institutions should align financial innovation strategies with robust security architectures and proactive trust-building initiatives. Investments in advanced security technologies should be complemented by transparent communication, customer education, and visible security features to maximize the benefits of digital innovation. Overall, this study provides valuable empirical evidence that supports the strategic importance of financial innovation in enhancing secure transaction management within emerging banking systems. By demonstrating the central role of digital trust in this relationship, the research offers actionable insights for bank managers, regulators, and policymakers seeking to promote secure, trusted, and sustainable digital banking ecosystems in Pakistan.

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