Assessing the Impact of Open Banking Initiatives on E-Service Quality in Saudi Arabia: A Quantitative Study

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ABSTRACT:

This study investigates the impact of open banking initiatives on e-service quality in Saudi Arabian banks. Using a quantitative approach, we surveyed 513 bank customers to assess changes in perceived e-service quality following the implementation of open banking. The study employs an extended E-S-QUAL model, incorporating dimensions specific to open banking. Results indicate that open banking initiatives significantly enhance e-service quality, particularly in the areas of efficiency, system availability, and innovation. However, challenges remain in privacy and security perceptions. This research contributes to the understanding of technology-driven banking innovations in emerging markets and provides practical implications for banks and regulators in Saudi Arabia and similar contexts.

1. Introduction

The global financial landscape is undergoing rapid transformation, driven by technological advancements and evolving consumer expectations. Open banking, a model enabling third-party financial service providers to access consumer banking data through APIs (Application Programming Interfaces), stands at the forefront of this revolution. This innovative approach promises to reshape the banking sector by fostering innovation, enhancing competition, and elevating customer experiences (Brodsky & Oakes, 2017; Omarini, 2018).

In Saudi Arabia, the adoption of open banking aligns strategically with Vision 2030, the country's ambitious plan to diversify its economy and cultivate a thriving financial sector (Saudi Vision 2030, 2016). The Saudi Central Bank (SAMA) has demonstrated proactive leadership by issuing a comprehensive Open Banking Policy in 2021, signaling a significant step towards transforming the Kingdom's electronic banking services (SAMA, 2021).

The concept of open banking is fundamentally rooted in the democratization of financial data and services. By empowering customers to share their financial information with third-party providers, open banking aims to foster a more competitive and innovative financial ecosystem (Zachariadis & Ozcan, 2017). Furthermore, data ownership in open banking requires careful consideration of both customer empowerment and privacy protection (Chiu et al., 2019). While customers gain the ability to share their financial data, this raises important questions about trust and control mechanisms (Gozman et al., 2018).

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Banks could implement enhanced privacy measures such as granular consent management, real-time data access notifications, and transparent data usage tracking (Borgogno & Colangelo, 2020). These measures would reinforce customer ownership without compromising the operational efficiency of open banking services. Additionally, implementing time-limited data access permissions and regular consent renewal requirements could help maintain customer control over their financial information, as recommended by Mansfield-Devine (2016) in their analysis of open banking security frameworks. This paradigm shift towards open finance has the potential to redefine traditional banking models and reshape the intricate relationships between banks, fintech companies, and customers (Remolina, 2019).

Despite the growing global interest in open banking, there remains a significant gap in understanding its impact on e-service quality, particularly within the Saudi Arabian context. While existing studies have explored the technical aspects of open banking implementation (e.g., Gozman et al., 2018) and its potential economic ramifications (e.g., Borgogno & Colangelo, 2020), there is a dearth of research specifically addressing how open banking influences the quality of electronic banking services in emerging markets like Saudi Arabia. This study aims to address several critical aspects of this research gap. It provides a context-specific analysis of open banking implementation within Saudi Arabia's unique cultural and regulatory environment, characterized by Islamic banking principles and rapid digital transformation (Chiu et al., 2019). The research focuses on e-service quality in open banking, an area often overlooked by studies primarily examining technical implementation or economic impacts (Gozman et al., 2018; Borgogno & Colangelo, 2020). Additionally, it addresses the crucial customer perspective, which Omarini (2018) highlighted as essential for successful open banking implementation, in contrast to the predominant focus on regulatory and technological aspects in existing research.

Furthermore, this study offers much-needed quantitative evidence on open banking's impact in the Middle East, complementing existing conceptual and qualitative studies (e.g., Remolina, 2019). It presents a holistic assessment of e-service quality dimensions in open banking, moving beyond the narrow focus on specific aspects like security (Mansfield-Devine, 2016) or competition (Zachariadis & Ozcan, 2017) found in many existing studies. By addressing these gaps, this research contributes to a comprehensive understanding of open banking's impact on e-service quality in Saudi Arabia's unique banking sector. It offers valuable insights for both academics studying financial innovation and practitioners implementing open banking initiatives. Furthermore, it addresses the scarcity of empirical research on fintech innovations in Gulf Cooperation Council countries, as noted by Almazrooie et al. (2020).

The study also explores customer perceptions of open banking, including privacy and security concerns, which Mansfield-Devine (2016) emphasized as crucial for banks to understand. Moreover, as Remolina (2019) pointed out, the findings can inform policy decisions in other countries considering open banking initiatives, given the varied implementation across jurisdictions. Lastly, by extending e-service quality models to the open banking context, this research contributes to theoretical development in the field, addressing Marimon et al.'s (2012) call for context-specific adaptations of these models.

Given these considerations, the primary objectives of this research are to assess the impact of open banking initiatives on different dimensions of e-service quality in Saudi Arabian

banks, examine the relationship between open banking adoption and overall customer satisfaction, and investigate the moderating effects of demographic factors on these relationships.

To achieve these objectives, this study addresses the following research questions: How do open banking initiatives affect the dimensions of e-service quality in Saudi Arabian banks? What is the relationship between open banking adoption and customer satisfaction in Saudi banks? How do demographic factors moderate the impact of open banking on perceived e-service quality?

By addressing these questions, this study aims to provide a comprehensive understanding of open banking's impact on e-service quality in the unique context of Saudi Arabia's banking sector, offering valuable insights for both academics and practitioners in the field of financial innovation.

2. Literature Review
2.1 Open Banking: Concept and Global Trends

Open banking refers to a collaborative model in which banking data is shared through APIs with third-party providers (TPPs) to build applications and services for banking customers (Brodsky & Oakes, 2017). It aims to increase competition, foster innovation, and enhance customer experiences in the financial sector. The concept of open banking is rooted in the broader trend of digital transformation in the financial services industry and the growing emphasis on customer-centric banking models (Omarini, 2018).

At its core, open banking is about data sharing and interoperability. It enables customers to securely share their financial data with authorized third parties, allowing for the development of new financial products and services. This data sharing is typically facilitated through standardized APIs, which provide a secure and efficient means of exchanging information between banks and TPPs (Zachariadis & Ozcan, 2017).

Globally, open banking has gained traction, with various countries implementing regulatory frameworks to facilitate its adoption. The United Kingdom has been at the forefront of this movement, implementing the Open Banking Standard in 2018 (Open Banking Implementation Entity, 2018). This initiative, mandated by the Competition and Markets Authority (CMA), required the nine largest banks in the UK to make their data available through standardized APIs.

The European Union followed suit with the revised Payment Services Directive (PSD2), which came into effect in 2018 (European Commission, 2015). PSD2 aims to create a more integrated and efficient European payments market, enhance competition, and improve consumer protection. It requires banks to provide third-party providers with access to customer account data and payment initiation services, subject to customer consent.

In Asia, countries like Singapore and Hong Kong have also made significant strides in open banking implementation. The Monetary Authority of Singapore (MAS) has adopted a market-driven approach, encouraging banks to develop their own APIs and collaborate with fintech companies (Monetary Authority of Singapore, 2019). Hong Kong has implemented a phased approach to open banking, starting with product and service information and gradually moving towards transactional APIs (Hong Kong Monetary Authority, 2018).

The global trend towards open banking reflects a broader shift in the financial services industry towards greater openness, collaboration, and customer-centricity. As noted by Remolina (2019), open banking is part of a larger movement towards "open finance," which extends the principles of data sharing and interoperability beyond traditional banking services to include areas such as insurance, investments, and pensions.

However, the implementation of open banking is not without challenges. Concerns about data privacy and security have been raised by various stakeholders (Mansfield-Devine, 2016). There are also technical challenges related to API standardization and system integration (Gozman et al., 2018). Moreover, the success of open banking initiatives depends on factors such as consumer awareness and trust, as well as the readiness of banks and fintech companies to collaborate effectively (Omarini, 2018).

Despite these challenges, the potential benefits of open banking are significant. It has the potential to enhance financial inclusion by making financial services more accessible and affordable (Jekwa et al., 2021). It can also lead to more personalized financial products and services, improved customer experiences, and increased competition in the financial sector (Brodsky & Oakes, 2017). As open banking continues to evolve globally, it is crucial to understand its impacts in different contexts.

2.2 Open Banking in Saudi Arabia

Saudi Arabia's journey towards open banking began in earnest with the announcement of its Open Banking Policy by the Saudi Central Bank (SAMA) in 2021. This policy outlines the regulatory framework for open banking in the Kingdom, aiming to create a secure and innovative financial ecosystem (SAMA, 2021). The initiative aligns with the broader goals of Saudi Vision 2030, which seeks to develop a diverse and thriving economy, including a sophisticated digital infrastructure (Saudi Vision 2030, 2016).

The Saudi approach to open banking is characterized by a phased implementation strategy. The first phase, which began in 2022, focuses on account information services. This allows third-party providers to access customer account information, with customer consent, to provide services such as financial management tools and credit assessments. The second phase, planned for subsequent years, will extend to payment initiation services, enabling third parties to initiate payments on behalf of customers (SAMA, 2021).

A critical consideration in open banking implementation is ensuring inclusivity for less technologically adept customers (Jekwa et al., 2021). Banks need to develop comprehensive, stratified support systems, reflecting the findings of Remolina (2019) on digital inclusion in financial services. These support systems should encompass simplified user interfaces for basic banking functions, complemented by integrated multi-channel customer support that effectively combines digital and traditional assistance methods. Furthermore, banks should provide detailed, step-by-step guidance for new feature adoption, ensuring that customers can gradually build confidence in using advanced banking functionalities. The provision of educational resources, carefully tailored to different technological literacy levels, is equally essential. This balanced approach, as suggested by Almazrooie et al. (2020), would help bridge the digital divide while maintaining the innovative benefits of open banking.

SAMA's open banking policy establishes several key principles guiding its implementation in Saudi Arabia. Customer protection stands at the forefront, ensuring the security and

privacy of customer data as a paramount concern. This principle is intrinsically linked to the emphasis on cybersecurity, involving the implementation of robust security measures to safeguard against potential cyber threats. The policy strongly affirms the concept of data ownership, acknowledging customers' rights to own and share their financial data. Supporting this principle, consent management emerges as a critical component, mandating explicit customer consent for all data sharing activities. The policy further aims to foster innovation in the financial sector by encouraging the development of new financial products and services. These interconnected principles form a comprehensive framework that carefully balances customer rights, security concerns, and innovation potential within the open banking ecosystem.

The implementation of open banking in Saudi Arabia is expected to have significant impacts on the banking sector. As noted by Almazrooie et al. (2020), it has the potential to transform traditional banking models and foster collaboration between banks and fintech companies. This could lead to increased competition, improved customer experiences, and the development of innovative financial products tailored to the Saudi market.

However, the implementation of open banking in Saudi Arabia also faces unique challenges. The Kingdom's banking sector is characterized by a strong emphasis on Islamic banking principles, which may require specific considerations in the development of open banking services (Lone & Bhat, 2019). Additionally, concerns about data privacy and security in the context of open banking have been raised by both customers and industry stakeholders (Mansfield-Devine, 2016).

Despite these challenges, the move towards open banking in Saudi Arabia represents a significant step in the Kingdom's financial sector development. It aligns with broader trends of digital transformation and financial innovation in the country, as outlined in Saudi Vision 2030 (Saudi Vision 2030, 2016).

The impact of open banking on e-service quality in Saudi banks is a crucial area of study. As banks and fintech companies begin to leverage open banking APIs, it is expected to affect various aspects of electronic banking services, from the range of available services to the speed and efficiency of transactions. Understanding these impacts is essential for both banks and regulators as they navigate the implementation of open banking in the Kingdom.

2.3 E-Service Quality in Banking

E-service quality refers to the extent to which a website facilitates efficient and effective shopping, purchasing, and delivery of products and services (Parasuraman et al., 2005). In the context of banking, e-service quality encompasses various dimensions of online and mobile banking services, reflecting the overall customer experience in digital banking channels.

The concept of e-service quality has gained increasing importance in the banking sector as more customers shift towards digital banking channels. As noted by Amin (2016), high-quality electronic banking services can lead to increased customer satisfaction, loyalty, and ultimately, improved financial performance for banks.

Several models have been developed to measure e-service quality in various contexts. One of the most widely used in the banking sector is the E-S-QUAL model, developed by Parasuraman et al. (2005). This model comprises four dimensions:

1. Efficiency: The ease and speed of accessing and using the site.
2. Fulfillment: The extent to which the site's promises about order delivery and item availability are fulfilled.
3. System Availability: The correct technical functioning of the site.
4. Privacy: The degree to which the site is safe and protects customer information.

While the E-S-QUAL model provides a solid foundation for assessing e-service quality, researchers have argued for the need to adapt this model to specific contexts and incorporate additional dimensions relevant to particular industries or technological innovations (Marimon et al., 2012).

In the banking context, several studies have extended or adapted the E-S-QUAL model. For example, Amin (2016) proposed an Islamic banking e-service quality model that included dimensions such as reliability, responsiveness, and Islamic ethical dimension. Hammoud et al. (2018) developed a model for e-banking service quality in Lebanon, incorporating dimensions such as ease of use, security/privacy, reliability, and responsiveness.

The importance of e-service quality in banking has been underscored by numerous studies. George and Kumar (2014) found that e-service quality significantly influences customer satisfaction and loyalty in online banking. Similarly, Amin (2016) demonstrated that e-service quality dimensions have a significant impact on customer satisfaction in Islamic banking.

In the context of open banking, e-service quality takes on new dimensions. The integration of third-party services and the sharing of customer data introduce new considerations in areas such as interoperability, data security, and service innovation. As noted by Omarini (2018), open banking has the potential to significantly enhance the quality of digital banking services by enabling more personalized and innovative offerings.

However, the relationship between open banking and e-service quality is complex. While open banking can potentially enhance certain aspects of e-service quality, such as the range and personalization of services, it also introduces new challenges, particularly in areas such as privacy and security (Mansfield-Devine, 2016).

Understanding the impact of open banking on e-service quality is crucial for banks as they navigate the shift towards more open and collaborative banking models. It can inform strategies for service design, customer communication, and technology implementation.

Moreover, from a regulatory perspective, insights into how open banking affects e-service quality can help in developing policies that balance innovation with customer protection.

In the Saudi Arabian context, where open banking is in its early stages of implementation, studying its impact on e-service quality is particularly relevant. The unique characteristics of the Saudi banking sector including the rapid pace of digital transformation, make it an interesting case study for examining the relationship between open banking and e-service quality.

2.4 Open Banking and E-Service Quality

The relationship between open banking and e-service quality is an emerging area of research. As open banking initiatives are implemented globally, there is growing interest in understanding how they affect the quality of electronic banking services and, by extension, customer experiences and satisfaction.

Studies have suggested that open banking can enhance various aspects of e-service quality, including:

1. Efficiency: By allowing seamless data sharing, open banking can streamline processes and reduce transaction times (Zachariadis & Ozcan, 2017). For example, account aggregation services enabled by open banking can provide customers with a comprehensive view of their finances across multiple institutions, potentially improving the efficiency of financial management.

2. Personalization: Access to a broader range of customer data enables banks and third-party providers to offer more tailored services and products (Borgogno & Colangelo, 2020). This could lead to more personalized financial advice, product recommendations, and user experiences, potentially enhancing the overall quality of electronic banking services.

3. Innovation: Open banking fosters the development of new financial products and services, potentially enhancing the overall quality of banking services (Omarini, 2018). By allowing third-party providers to access banking data and functionality, open banking can spur innovation in areas such as personal financial management, credit scoring, and payment services.

4. Accessibility: By enabling third-party providers to offer financial services, open banking can increase the accessibility of banking services to underserved populations (Jekwa et al., 2021). This could potentially improve the inclusivity dimension of e-service quality, making financial services more accessible to a broader range of customers.

5. Interoperability: Open banking promotes interoperability between different financial services and institutions. As noted by Gozman et al. (2018), this can lead to more seamless customer experiences across different financial platforms and services.

However, the impact of open banking on e-service quality is not uniformly positive. Concerns have also been raised about potential negative impacts, particularly in the areas of privacy and security. Mansfield-Devine (2016) highlighted that the sharing of customer data inherent in open banking models raises significant privacy concerns. These concerns could potentially negatively impact customers' perceptions of the privacy and security dimensions of e-service quality.

Moreover, the implementation of open banking can introduce new complexities into banking systems, potentially affecting system reliability and availability. Gozman et al. (2018) noted that the integration of third-party services through APIs introduces new points of potential failure, which could impact the system availability dimension of e-service quality if not properly managed.

The relationship between open banking and e-service quality is also likely to be influenced by factors such as customer awareness and understanding of open banking concepts. Brear and Bouvier (2019) found that customer understanding of open banking varies

significantly, which could affect how they perceive and evaluate the quality of open banking-enabled services.

Furthermore, the rapid pace of digital transformation in Saudi Arabia, as outlined in Vision 2030 (Saudi Vision 2030, 2016), may create a conducive environment for open banking to enhance e-service quality. However, it also raises questions about digital readiness and potential digital divides, which could affect the accessibility and efficiency dimensions of e-service quality.

The insights gained from this study can also be instrumental in shaping customer education initiatives, aligning customer expectations with the realities of open banking-enabled services. This study contributes to the broader understanding of how financial innovations impact service quality in emerging markets, providing valuable lessons that extend beyond the Saudi context. Collectively, these aspects underscore the importance of this study in shaping the future of open banking implementation and its effects on e-service quality.

This study aims to address these issues by empirically examining the impact of open banking initiatives on various dimensions of e-service quality in Saudi Arabian banks.

2.5 Theoretical Framework

This study employs an extended version of the E-S-QUAL model (Parasuraman et al., 2005) as its theoretical framework. The E-S-QUAL model has been widely used and validated in various e-service contexts, including online banking (George & Kumar, 2014; Amin, 2016). However, given the unique characteristics of open banking and the Saudi Arabian context, we propose an extended model that incorporates additional dimensions relevant to open banking.

The original E-S-QUAL dimensions are retained:

This study employs an extended version of the E-S-QUAL model, incorporating both traditional dimensions and those specific to open banking contexts. The original E-S-QUAL dimensions include Efficiency, which refers to the ease and speed of accessing and using the site; System Availability, concerning the correct technical functioning of the site; Fulfillment, measuring the extent to which the site's promises about order delivery and item availability are met; and Privacy, assessing the degree to which the site is safe and protects customer information. To address the unique aspects of open banking, three additional dimensions are incorporated: Innovation, based on Omarini's (2018) work, which measures the degree to which open banking enables new and improved services; Interoperability, informed by Gozman et al.'s (2018) research, which evaluates the ease with which customers can use services across different providers; and Control, drawing on Brear and Bouvier's (2019) findings, which assesses the level of control customers perceive over their financial data. This extended model provides a comprehensive framework for evaluating e-service quality in the context of open banking, encompassing both traditional e-service quality aspects and those specifically relevant to the open banking paradigm.

This extended model provides a comprehensive framework for assessing the impact of open banking on e-service quality in the Saudi Arabian context. It allows for the examination of both traditional e-service quality dimensions and aspects specifically relevant to open banking.

The proposed relationships in our model are as follows:

1. Open banking adoption is hypothesized to have a positive relationship with the following e-service quality dimensions: Efficiency (H1a). System Availability (H1b). Fulfillment (H1c). Innovation (H1e). Interoperability (H1f). Control (H1g)
2. Open banking adoption is hypothesized to have a potentially negative relationship with Privacy (H1d), based on the concerns raised in previous literature.
3. All e-service quality dimensions are hypothesized to have a positive relationship with overall customer satisfaction: Efficiency → Customer Satisfaction (H2a) System Availability → Customer Satisfaction (H2b) Fulfillment → Customer Satisfaction (H2c). Privacy → Customer Satisfaction (H2d). Innovation → Customer Satisfaction (H2e). Interoperability → Customer Satisfaction (H2f). Control → Customer Satisfaction (H2g)
4. Demographic factors (age, education level, income) are hypothesized to moderate the relationship between open banking adoption and e-service quality dimensions.

3. Methodology
3.1 Research Design
This study employs a quantitative research design, utilizing a cross-sectional survey method. This approach allows for the collection of data from a large sample at a single point in time, enabling the examination of relationships between variables (Creswell & Creswell, 2017). The quantitative approach is appropriate for this study as it allows for the statistical testing of hypotheses derived from our theoretical framework.
The cross-sectional design is chosen due to its efficiency in capturing a snapshot of current perceptions and experiences with open banking and e-service quality. While a longitudinal design could provide insights into changes over time, the relatively recent implementation of open banking in Saudi Arabia makes a cross-sectional approach more suitable at this stage.

3.2 Population and Sampling
The target population for this study is Saudi Arabian bank customers who have experience with digital banking services. This population is chosen because they are most likely to have exposure to and opinions about open banking initiatives and e-service quality in online banking.
A stratified random sampling technique was used to ensure representation across different demographic groups and banks. This approach helps to mitigate potential bias and increase the generalizability of the findings (Taherdoost, 2016). The strata were defined based on age, gender, education level, and bank affiliation.
A total of 650 survey questionnaires were distributed. After data cleaning and removing incomplete responses, we obtained 513 valid responses, representing a response rate of 78.92%.
Sample size: Based on a population of approximately 20 million bank customers in Saudi Arabia (assuming adult population), our sample size of 513 provides a confidence level of 95% with a margin of error of ±4.33%. This sample size is determined using Cochran's formula for sample size calculation (Cochran, 1977):
$n = Z^2 * p * (1-p) / e^2$
Where:

n = sample size
Z = z-score (1.96 for 95% confidence level)
p = population proportion (0.5 used for maximum variability)
e = margin of error (0.0438 or 4.38%)
This sample size is deemed sufficient for the statistical analyses planned, including structural equation modeling, which typically requires a minimum of 200 respondents (Kline, 2015).

3.3 Data Collection

Data is collected through an online survey distributed via email and social media platforms. The online approach is chosen due to its efficiency, cost-effectiveness, and ability to reach a geographically dispersed sample (Evans & Mathur, 2018). Moreover, given that the study focuses on digital banking services, an online survey is appropriate for reaching customers who are likely to use these services.
The survey is conducted in both Arabic and English to ensure accessibility to all participants. The Arabic version is back-translated to English to ensure equivalence between the two versions (Brislin, 1970).
To mitigate potential biases associated with online surveys, such as self-selection bias, we employ several strategies:
1. Using multiple distribution channels to reach a diverse range of respondents
2. Employing quota sampling to ensure representation across different demographic groups
3. Offering incentives (e.g., entry into a prize draw) to encourage participation from a broad range of respondents
The data collection period spans four weeks to allow sufficient time for responses while maintaining the cross-sectional nature of the study.

3.4 Measurement Instrument

The survey questionnaire is developed based on the extended E-S-QUAL model discussed in the theoretical framework. It consists of the following sections:
The study collects a range of information from respondents, beginning with demographic details such as age, gender, education level, income, and bank affiliation. It then explores participants' banking habits, specifically focusing on the frequency of digital banking use and their awareness of open banking concepts. Additionally, the research assesses e-service quality using 35 items spread across seven dimensions: efficiency, system availability, fulfillment, privacy, innovation, interoperability, and control. Each dimension contains a set number of items to measure specific aspects, such as efficiency with five items and system availability with four. Lastly, the study gauges overall satisfaction with banking services through three targeted items.
Responses for e-service quality items are measured on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). The items are adapted from previous studies (Parasuraman et al., 2005; Amin, 2016; Gozman et al., 2018) and modified to fit the context of open banking in Saudi Arabia.

To ensure content validity, the questionnaire is reviewed by a panel of experts including academics in the fields of banking and e-service quality, and practitioners from Saudi banks. Their feedback is incorporated to refine the questionnaire items.

A pilot study is conducted with a sample of 50 respondents to test the clarity of the questions, the reliability of the scales, and the overall structure of the questionnaire. Based on the pilot study results, necessary adjustments are made to improve the instrument's reliability and validity.

4. Results

4.1 Demographic Profile of Respondents

A total of 513 valid responses were received. The demographic breakdown of the respondents is as follows:

- Gender: 54.8% male (281), 45.2% female (232)
- Age: 18-25 (19.9%, 102), 26-35 (35.1%, 180), 36-45 (25.3%, 130), 46-55 (14.8%, 76), 56+ (4.9%, 25)
- Education: High school or less (10.1%, 52), Bachelor's degree (59.8%, 307), Postgraduate degree (30.1%, 154)
- Monthly Income (SAR): <5000 (15.2%, 78), 5000-10000 (29.8%, 153), 10001-20000 (35.3%, 181), >20000 (19.7%, 101)

This demographic profile suggests a relatively young, well-educated sample, which is consistent with the target population of digital banking users in Saudi Arabia.

4.2 Descriptive Statistics

Table 1 presents the means and standard deviations for each e-service quality dimension:

Dimension	Mean	SD
Efficiency	3.86	0.75
System Availability	3.93	0.67
Fulfillment	3.79	0.81
Privacy	3.57	0.94
Innovation	3.90	0.70
Interoperability	3.72	0.78
Control	3.63	0.87

The results indicate generally positive perceptions of e-service quality across all dimensions, with System Availability and Innovation receiving the highest ratings. Privacy received the lowest rating, which aligns with previous research highlighting privacy concerns in open banking contexts (Mansfield-Devine, 2016).

4.3 Reliability Analysis

Cronbach's alpha was calculated for each scale to assess internal consistency. All scales demonstrated good reliability, with Cronbach's alpha values ranging from 0.79 to 0.93, exceeding the recommended threshold of 0.7 (Nunnally, 1978).

4.4 Confirmatory Factor Analysis

CFA was conducted to validate the measurement model. The initial model showed adequate but not optimal fit: $\chi2/df$ = 2.76, CFI = 0.92, TLI = 0.91, RMSEA = 0.058. After removing three items with low factor loadings and allowing for theoretically justified covariances between error terms, the model fit improved significantly: $\chi2/df$ = 2.32, CFI = 0.95, TLI = 0.94, RMSEA = 0.051. All factor loadings were significant ($p < 0.001$) and above 0.62, indicating good convergent validity.

Discriminant validity was assessed by comparing the square root of the average variance extracted (AVE) for each construct with its correlations with other constructs. The square root of AVE for each construct was greater than its correlations with other constructs, supporting discriminant validity (Fornell & Larcker, 1981).

4.5 Structural Equation Modeling

To test our hypotheses and evaluate the relationships between open banking adoption, e-service quality dimensions, and customer satisfaction, we conducted Structural Equation Modeling (SEM). The results of the hypothesis testing are presented in Table 2, and the model fit indices are reported below.

Table 2: Summary of Hypothesis Testing Results

Hypothesis	Path	Standardized Coefficient	Path t-value	p-value	Result
H1a	Open Banking → Efficiency	0.43	7.92	<0.001	Supported
H1b	Open Banking → System Availability	0.39	7.01	<0.001	Supported
H1c	Open Banking → Fulfillment	0.32	5.83	<0.001	Supported
H1d	Open Banking → Privacy	-0.14	-2.31	0.02	Supported (negative)
H1e	Open Banking → Innovation	0.57	10.35	<0.001	Supported
H1f	Open Banking → Interoperability	0.50	9.24	<0.001	Supported
H1g	Open Banking → Control	0.29	5.28	<0.001	Supported
H2a	Efficiency → Customer Satisfaction	0.25	4.63	<0.001	Supported
H2b	System Availability → Customer Satisfaction	0.20	3.09	0.002	Supported
H2c	Fulfillment → Customer Satisfaction	0.23	4.25	<0.001	Supported
H2d	Privacy → Customer Satisfaction	0.32	5.95	<0.001	Supported

Hypothesis	Path	Standardized Coefficient	Path t-value	p-value	Result
H2e	Innovation → Customer Satisfaction	0.36	6.52	<0.001	Supported
H2f	Interoperability → Customer Satisfaction	0.30	5.41	<0.001	Supported
H2g	Control → Customer Satisfaction	0.27	4.96	<0.001	Supported

Model Fit Indices

The structural model demonstrated good fit with the data:
- Chi-square/df = 2.39 (recommended < 3)
- Comparative Fit Index (CFI) = 0.94 (recommended > 0.90)
- Tucker-Lewis Index (TLI) = 0.93 (recommended > 0.90)
- Root Mean Square Error of Approximation (RMSEA) = 0.052 (recommended < 0.08)

These fit indices suggest that our proposed model adequately represents the relationships in the data.

All e-service quality dimensions showed significant positive relationships with overall customer satisfaction, with innovation having the strongest impact.

4.6 Moderation Analysis

Moderation analysis revealed that age and education level significantly moderated the relationship between open banking adoption and certain e-service quality dimensions. For age, multi-group analysis showed that the relationship between open banking adoption and innovation was stronger for younger customers (18-35 years) compared to older customers (36+ years) ($\Delta\chi2 = 8.05$, $p < 0.01$). Similarly, the relationship between open banking adoption and interoperability was stronger for younger customers ($\Delta\chi2 = 6.73$, $p < 0.05$).

For education level, the relationship between open banking adoption and efficiency was stronger for customers with higher education levels (bachelor's degree or above) compared to those with lower education levels ($\Delta\chi2 = 8.41$, $p < 0.01$).

4.7 Mediation Analysis

Mediation analysis was conducted to examine whether e-service quality dimensions mediated the relationship between open banking adoption and overall customer satisfaction. Bootstrap analysis with 5000 samples revealed significant indirect effects of open banking adoption on satisfaction through all e-service quality dimensions except privacy.

The strongest mediating effects were observed for innovation (standardized indirect effect = 0.205, 95% CI [0.149, 0.269]) and interoperability (standardized indirect effect = 0.150, 95% CI [0.100, 0.208]).

5. Discussion

The results of this study provide valuable insights into the impact of open banking initiatives on e-service quality in Saudi Arabian banks. The findings suggest that open banking has a significant positive impact on most dimensions of e-service quality, particularly efficiency, system availability, innovation, and interoperability.

The strong positive relationships between open banking and both efficiency ($\beta = 0.43$, $p < 0.001$) and system availability ($\beta = 0.39$, $p < 0.001$) suggest that open banking initiatives are enhancing the speed and reliability of banking services. This aligns with previous research indicating that open banking can streamline processes and reduce transaction times (Zachariadis & Ozcan, 2017).

The improvement in efficiency could be attributed to the seamless data sharing enabled by open banking APIs, which allows for faster and more automated processes. For example, account aggregation services enabled by open banking can provide customers with a comprehensive view of their finances across multiple institutions, potentially improving the efficiency of financial management.

The positive impact on system availability suggests that despite the increased complexity introduced by open banking systems, banks in Saudi Arabia have been successful in maintaining and even improving the reliability of their digital services. This is crucial for building customer trust in open banking-enabled services.

The strongest positive relationship was observed between open banking and innovation ($\beta = 0.57$, $p < 0.001$), followed closely by interoperability ($\beta = 0.50$, $p < 0.001$). This supports the notion that open banking is fostering the development of new and improved financial services (Omarini, 2018) and enhancing the ease with which customers can use services across different providers.

The strong relationship with innovation suggests that open banking is indeed driving the creation of new financial products and services in the Saudi market. This could include personalized financial management tools, innovative payment solutions, or new credit products leveraging open banking data.

The high score for interoperability indicates that open banking is successfully breaking down silos between different financial services and institutions, creating a more integrated financial ecosystem. This aligns with the findings of Gozman et al. (2018) on the importance of interoperability in open banking ecosystems.

Interestingly, A small negative relationship was found between open banking and privacy ($\beta = -0.14$, $p = 0.02$). This suggests that while open banking is improving many aspects of e-service quality, it may be raising concerns about data privacy among some customers. This finding echoes previous research highlighting privacy and security as potential challenges in open banking implementation (Mansfield-Devine, 2016).

The privacy concerns could be attributed to the increased data sharing inherent in open banking models. Customers may be worried about how their financial data is being used and shared across different entities. This highlights the need for banks and regulators to address privacy concerns proactively through robust data protection measures and transparent communication about data usage.

All e-service quality dimensions showed significant positive relationships with overall customer satisfaction, with innovation having the strongest impact ($\beta = 0.36$, $p < 0.001$). This suggests that customers value the new and improved services enabled by open banking, and that these innovations are contributing significantly to overall satisfaction with banking services.

The mediation analysis revealed that e-service quality dimensions, particularly innovation and interoperability, significantly mediate the relationship between open banking adoption and customer satisfaction. This underscores the importance of focusing on these aspects of e-service quality when implementing open banking initiatives.

The moderation analysis revealed that younger and more educated customers tend to perceive greater benefits from open banking in terms of innovation, interoperability, and efficiency. This could be due to greater digital literacy and openness to new technologies among these demographic groups.

These findings suggest that banks may need to tailor their open banking strategies and communication to different demographic groups. For example, they might focus on highlighting innovative features when targeting younger customers, while emphasizing security and privacy measures when communicating with older customers.

This study contributes to the literature by validating an extended E-S-QUAL model in the context of open banking. The addition of innovation, interoperability, and control dimensions to the original model provides a more comprehensive framework for assessing e-service quality in the era of open banking.

The findings support the theoretical proposition that open banking can enhance various aspects of e-service quality, particularly in areas related to innovation and interoperability. However, they also highlight the complex relationship between open banking and privacy perceptions, suggesting a need for further theoretical development in this area.

For banks and financial institutions in Saudi Arabia, these findings highlight the importance of leveraging open banking to enhance e-service quality, particularly in areas of innovation and interoperability. Banks should focus on developing new, innovative services that take advantage of open banking capabilities, while also ensuring seamless integration with other financial services.

However, the results also underscore the need to address privacy concerns proactively. Banks should invest in robust data protection measures and communicate clearly with customers about how their data is being used and protected in the open banking ecosystem.

For policymakers, the results support the potential benefits of open banking initiatives while highlighting areas that may require additional attention, such as data privacy regulations and consumer education. Regulators might consider developing guidelines for privacy protection in open banking contexts and implementing public awareness campaigns to educate consumers about the benefits and risks of open banking.

6. Conclusion

This study provides empirical evidence of the significant impact of open banking initiatives on e-service quality in Saudi Arabian banks. The findings reveal that open

banking enhances multiple aspects of e-service quality, notably efficiency, innovation, and interoperability, which collectively contribute to increased customer satisfaction.

The strong positive relationship between open banking and innovation is particularly significant, demonstrating that open banking effectively fosters the development of new and improved financial services in the Saudi market. This finding aligns seamlessly with Saudi Vision 2030's objectives of developing a thriving and innovative financial sector.

However, the research also illuminates potential challenges, particularly regarding privacy concerns. The observed negative relationship between open banking and privacy perceptions emphasizes the necessity for careful management of data sharing practices and transparent communication with customers regarding data usage and protection protocols.

A significant limitation of this research lies in its cross-sectional design, which captures perceptions at a single temporal point. As suggested by Parasuraman et al. (2005) and reinforced by George and Kumar (2014), longitudinal research would provide valuable insights into the evolution of customer attitudes, the impact of sustained exposure to open banking on trust and satisfaction, the progression of privacy concerns and adoption patterns, and the long-term effectiveness of customer education initiatives.

The research reveals differential impacts across demographic groups, suggesting that a uniform approach to open banking implementation may be suboptimal. This finding indicates that banks and policymakers should consider developing tailored strategies and communication approaches for different customer segments to maximize open banking benefits.

As Saudi Arabia progresses with its open banking policy implementation, banks and regulators must focus on optimizing the benefits while addressing privacy concerns. This balanced approach is crucial for enhancing e-service quality and fostering innovation in the Saudi banking sector.

The successful implementation of open banking necessitates a robust customer-centric approach that carefully balances innovation with user needs. Financial institutions should prioritize implementing comprehensive data protection measures, maintaining transparent communication about data usage, developing innovative yet accessible digital services, and aligning open banking practices with Saudi Vision 2030's modernization goals while ensuring inclusivity. This balanced approach, as emphasized by Remolina (2019), is fundamental for building and maintaining customer confidence in the open banking ecosystem.

Future research directions could extend to exploring open banking's impact on e-service quality across different cultural contexts, facilitating valuable cross-cultural comparisons. Further investigation into the perspectives of bank employees and fintech companies would contribute to a more comprehensive understanding of the open banking ecosystem. Additionally, examining the relationship between digital literacy and open banking adoption would provide insights into how varying levels of digital readiness influence the effectiveness of open banking initiatives.

Moreover, future research should address the development and evaluation of customer education initiatives that align expectations with open banking practices. This research direction could encompass the examination of effective communication strategies for diverse customer segments, assessment of educational programs' impact on privacy concerns, evaluation of the relationship between customer education and adoption rates,

and the development of best practices for building trust in open banking services. Through these comprehensive research efforts, a deeper understanding of open banking's role in transforming the banking sector can be achieved, ultimately contributing to the development of more effective implementation strategies and improved customer experiences.

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