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Exploring the impact of total quality management on service quality in Dubai's housing sector: The moderating role of blockchain technology

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Abstract: This study critically examines the relationship between Total Quality Management (TQM) and Service Quality (SQ) within Dubai's housing sector, with a specific focus on the moderating influence of blockchain technology (BT) in this relationship. Employing a quantitative approach grounded in a deductive research strategy and positivist epistemology, data were gathered from a sample of industry professionals and subjected to rigorous analysis using Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings indicate that the deliberate deployment of TQM methodologies leads to significant improvements in SQ metrics, and the catalytic role of BT further enhances these service quality improvements. The study highlights the transformative potential of BT in recalibrating conventional paradigms of service delivery within the housing sector. Specifically, the analysis reveals that BT plays a pivotal moderating role in the relationship between TQM practices and SQ outcomes, thereby enriching our comprehension of the intricate interplay between these constructs. The study concludes by furnishing nuanced insights into the multifaceted dynamics shaping SQ within the housing sector, while also delineating avenues for future inquiry.

Keywords: total quality management; blockchain technology; service quality; survey; UAE housing sector

1. Introduction

Governments worldwide endeavor to meet the needs of their citizens through the provision of public services and the resolution of societal challenges (Basri et al., 2017). However, accessing these services can be cumbersome due to intricate processes and uncertainties surrounding costs and timelines (Khalid et al., 2016; Soltani et al., 2007). Recognizing the importance of improving service quality, particularly in public services, governments have turned to total quality management (TQM) methodologies (Mulyadi et al., 2012; Setyaningrum et al., 2017). Nevertheless, amidst the backdrop of a growing global population, ensuring the quality of public housing services has emerged as a pressing challenge for administrations worldwide.

To address the pressing need for enhanced public housing services, particularly within the context of Dubai's burgeoning population growth and increasing demand for housing, this study was conducted in Dubai, United Arab Emirates (UAE). With a population of 3.49 million, of which two-thirds are expatriates, Dubai has emerged as a global hub of opportunity, fueling significant population expansion over time (Global Media Insight, 2022). This growth has placed substantial strain on housing infrastructure and services. In response, the Mohammed Bin Rashid Housing Establishment (MBRHE), a key housing organization in Dubai, plays a pivotal role in providing essential housing services to residents. Specializing in constructing

affordable homes and offering landholdings and interest-free housing loans, MBRHE serves the majority of Dubai families, with additional services such as free landholdings and home improvements provided to qualified families (MBRHE, 2021). However, the high demand for housing has led to lengthy waitlists, with hundreds of families awaiting services that can take up to seven years to be fulfilled (MBRHE, 2021). This growing demand, particularly from young families, presents a significant challenge for government entities such as MBRHE and the Dubai Municipality, necessitating the allocation of substantial resources and the implementation of expedited delivery mechanisms to meet present and future housing needs (MBRHE, 2021).

Amidst the UAE government's ongoing efforts to enhance residents' quality of life, substantial investments, such as the AED 10 billion allocation by MBRHE towards bolstering Dubai's housing market, underscore the significance placed on addressing housing challenges (Agrawal et al., 2020). However, studies have illuminated significant hurdles within Dubai's housing sector. Real estate priorities have often favored high-end developments catering to the affluent, neglecting the pressing need for affordable housing for the working class (Alawadi et al., 2018). Contributing factors to Dubai's housing crisis include the city's subsidized residential programs and the operational autonomy of private and semi-private real estate entities (Agrawal et al., 2020; Alawadi et al., 2018). The implementation of sustainable practices in housing infrastructure development is also hindered by challenging climatic conditions, impacting overall housing quality (Juaidi et al., 2019). Furthermore, concerns persist regarding poor indoor air quality in certain residential areas, further exacerbating housing standards in Dubai (Awad and Jung, 2021).

Given the multifaceted challenges confronting Dubai's housing market, scholars are increasingly drawn to TQM strategies as potential solutions to enhance overall SQ within the sector (Ansari, 2022; Liao et al., 2014). This burgeoning interest in TQM reflects a broader recognition within the government sector of the pivotal role SQ management plays in addressing housing sector challenges (Twum et al., 2022). Recent studies have underscored significant obstacles within Dubai's housing sector, including issues related to quality, sustainability, high costs, and other factors that directly influence customer satisfaction with service quality. Importantly, these challenges are intricately linked to TQM principles. For instance, TQM philosophy places a strong emphasis on continuous improvement and customer-centric approaches, directly addressing quality-related concerns (Oakland et al., 2020). Likewise, TQM principles advocate for efficiency, waste reduction, and cost-effectiveness, offering potential solutions to tackle unsustainable processes and high-cost developments (Soares et al., 2017; Soltani et al., 2008). These findings underscore the critical importance of further exploring TQM within the housing sector, revealing notable research gaps that merit investigation (Agrawal et al., 2020; Alawadi et al., 2018; Juaidi et al., 2019). Consequently, it becomes imperative to probe the following research question: What will be the impact of TQM implementation on SQ within Dubai's public housing sector?

TQM is increasingly recognized for its emphasis on leveraging new technology as a pivotal factor in enhancing the efficiency and effectiveness of governments worldwide. TQM is increasingly recognized for its emphasis on leveraging new

technology as a pivotal factor in enhancing the efficiency and effectiveness of governments worldwide (Ali AlShehail et al., 2021; Hung et al., 2011). This emphasis is particularly notable in endeavors to combat corruption and elevate service delivery, ultimately benefiting the general public and constituents (Farazmand, 2005; Mansour and Jakka, 2013; Vinni, 2007). TQM principles, when integrated with innovative technological solutions, offer governments potent tools to streamline processes, enhance transparency, and optimize resource allocation. Consequently, TQM's alignment with new technology holds significant promise for driving tangible improvements in governance, fostering trust, and advancing societal well-being. Blockchain technology (BT) is one of the most cutting-edge innovations developed recently to enhance the standards of business processes and customer services. Using BT for operational quality management and improvement has been considered by a number of studies (Li et al., 2020; Magd et al., 2023). BT has the capacity to improve both operational and informational quality (Zhong et al., 2020). It has the potential to make cities better by encouraging the growth of environmentally friendly neighbourhoods and paving the way for more accountable leadership (Khan et al., 2022). BT has recently received attention from researchers in the housing industry. For instance, BT holds significance in collaborative housing by reducing transaction costs for housing access and enhancing transparency in housing operations (Nasarre-Aznar, 2018). It's recognized as an important tool to address quality-related issues in the housing sector (Abu-Amara et al., 2022; Khan et al., 2022). Despite its potential, empirical evidence on the actual impact of BT implementation on SQ in Dubai's housing sector is lacking. Therefore, an additional research question arises: How does the integration of BT affect SQ within Dubai's public housing sector?

In light of the complex challenges facing the housing sector (Juaidi et al., 2019; Salim and Alabdouli, 2022), understanding the dynamics between TQM practices and SQ becomes imperative. Moreover, with the substantial investments made by the Dubai government in BT initiatives, particularly in the housing sector (Dubai Blockchain Strategy, n.d.; Emirates Blockchain Strategy, 2021), there arises a pressing need to investigate the potential of BT to complement TQM efforts and enhance SQ. Therefore, this study aims to bridge this gap by examining the moderating role of BT in the relationship between TQM implementation and SQ specifically within Dubai's public housing sector. This research endeavor holds significant implications for improving housing quality and addressing the diverse challenges faced by residents.

2. Theoretical background

To lay a solid groundwork for hypothesis development, we synthesize insights from existing literature and crafting hypotheses to deepen our understanding of how TQM practices, combined with the integration of BT, influence SQ outcomes. Our overarching aim with this review is to elucidate the nuanced dynamics at play in this relationship and pinpoint areas for further empirical scrutiny.

2.1. Total quality management

A review of extant literature reveals diverse interpretations of TQM (Chen et al., 2022; Oakland et al., 2020; Soltani et al., 2008). As a management philosophy, TQM's

core belief lies in continuous quality improvement (Deming, 1986; Hackman and Wageman, 1995). It serves as a company-wide initiative aimed at surpassing customer expectations and reducing costs associated with inferior quality by embracing innovative management approaches and cultural shifts (Berry, 1991). Moreover, TQM is seen as a method to enhance business efficiency, flexibility, and overall performance (Oakland et al., 2020), applicable to both service (Magd, 2021) and manufacturing sectors. Implementation of TQM necessitates alignment across organizational, operational, and personal levels, ensuring a cohesive integration of processes, objectives, and phases (Liao et al., 2014; Oakland et al., 2020; Sultana et al., 2024). This comprehensive approach extends to personnel management, training, organizational growth, and new product development, all essential for establishing a robust quality management system. The human element entails top-down support, employee development (Alenezi, 2024), client focus, and quality management in supplier relationships (Deming, 1986), while process management and interdisciplinary product development are central to product design. Organizational structure encompasses strategic planning, cross-departmental coordination, and information feedback control (Jabnoun, 2005). Altogether, these components and procedures of TQM significantly contribute to business success. Furthermore, TQM is extensively utilized in service industries to enhance SQ for consumers (Sitkin et al., 1994).

2.2. Service quality

A service is any action, benefit, or pleasure performed in exchange for money or in conjunction with the purchase of another good (Bordoloi et al., 2019; Cowell, 1988). To keep clients happy, businesses must conduct efficient operations and supply high-quality products. Services are individually recognized, and fundamentally intangible actions that supply want of fulfillment and that are not always related to the purchase of a commodity or the other service (Nicoulaud, 1989). Services also refer to discrete, generally immaterial acts that meet a need but are unrelated to the direct exchange of money for goods. The level of services provided must be unwavering (Gummesson, 1987; Liao et al., 2024; Soltani et al., 2010). Scholars often use the term '4Is' to refer to the four distinguishing features of services (Dotchin and Oakland, 1994; Hope and Muhlemann, 1997; Romero et al., 2019), which include intangibility; inconsistency; inseparability; and inventory. Services are intangible because they cannot be seen, touched, or held (Holdford, 2019). Service inconsistency is brought about by both overt and covert aspects of delivery, which are affected by individual consumer preferences and worldviews (Harimurti and Suryani, 2019). Even when consistently delivering the same service, different service providers within a company may produce varying outcomes over time. The inseparability of a service is indicative of its synchronicity, as it cannot exist separately from its main stakeholder (Zeithaml et al., 1996). Given that a client's existence is a precondition for offering services, these two events occur concurrently. Because services are produced and consumed simultaneously, they do not require inventory storage space (Holdford, 2019; for a review see Bordoloi et al. (2019)).

Various factors can influence customer satisfaction (Dimitriades and Maroudas,

2007), among which SQ plays a significant role (Helless and Liao, 2017). To ensure consistent evaluation of SQ across different contexts, providers, and clients, various assessment strategies have been identified (Abdullah, 2006). Among these strategies, SERVQUAL (Parasuraman et al., 1985) and its counterpart, SERVPERF (Cronin and Taylor, 1994), are widely used measurement tools in SQ research (Andronikidis and Bellou, 2010). SERVQUAL, for instance, compares customers' perceptions of the service they receive with their expectations to assess SQ (Parasuraman et al., 1985). Widely regarded as a versatile measurement tool, SERVQUAL is applicable to a diverse range of service providers in both public and commercial sectors (Faeni, 2023). Given the significance of improving SQ in the public sector, it's vital to highlight that TQM stands out as a key determinant for its enhancement.

2.3. Blockchain technology

Blockchain Technology (BT) revolutionizes the way data is stored and managed by distributing duplicate information across multiple servers, forming an immutable ledger of transactions (Pilkington, 2016). Each block in a blockchain contains a timestamped and encrypted record of a transaction, ensuring its permanence and preventing alteration (Pilkington, 2016). This decentralized design fosters transparency, reliability, accountability, and confidentiality (Christidis and Devetsikiotis, 2016). The flexibility and trustworthiness of BT have garnered significant attention, particularly from businesses, inspired by the rapid growth of cryptocurrency (Leible et al., 2019). While cryptocurrency is a prominent application, BT holds potential beyond this domain, extending to sectors like banking, supply chain, education, government, and healthcare.

BT finds diverse applications across various sectors, enhancing efficiency and security. In healthcare, it facilitates secure sharing of medical information, automated insurance evaluation, and digital clinical procedures (Juneja and Marefat, 2018; Shae and Tsai, 2017). For businesses, BT boosts e-commerce credibility and streamlines operations for Internet of Things enterprises (Tapscott and Tapscott, 2017). In the energy sector, BT enables peer-to-peer energy transactions and enhances distribution mechanisms for hybrid vehicles (Castellanos et al., 2017). Its potential extends to sustainable development, enhancing performance across various settings (Khaqqi et al., 2018).

The transformative impact of BT extends even to the housing industry, where it can facilitate financial transactions, legal contracts, and information dissemination, benefiting the community as a whole. Moreover, BT's value lies in its ability to enhance SQ by fostering trust in providers' sincerity and reliability (Jamthagen and Hell, 2016). As seen, BT's versatility and potential applications make it a pivotal technology in driving innovation and efficiency across multiple sectors, ultimately contributing to societal progress and development.

2.4. Conceptual framework and development of hypotheses

Our conceptual framework, as depicted in **Figure 1**, offers a systematic and structured approach to comprehensively examine the relationship between TQM and SQ, taking into account the potential moderating influence of BT. We delve into an

in-depth discussion of the hypotheses formulated based on this framework, synthesizing insights from existing literature and proposing avenues for empirical investigation. Through rigorous analysis and critical examination, we aim to elucidate the intricate dynamics underlying the interaction between TQM practices, BT, and SQ outcomes in the context of the UAE's housing sector.
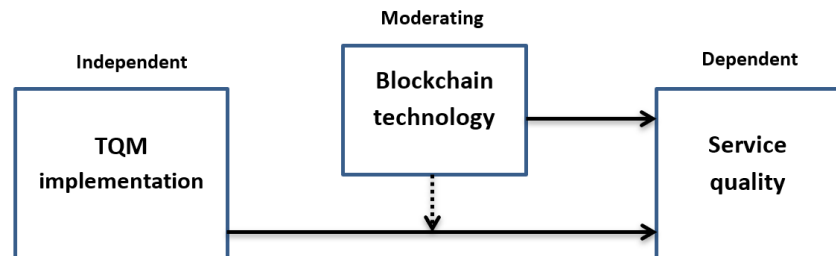
Figure 1. Conceptual framework.

2.5. Relationship between TQM and SQ

Research across various sectors has extensively examined the correlation between TQM and SQ. Notable studies by Aburayya et al. (2020) in healthcare, Al-Hawary and Abu-Laimon (2013) in the telecommunications sector, Gathoni and Van der Walt (2019) in libraries, and Talib et al. (2012) in banking have contributed valuable insights. Despite the housing sector's significant contribution to national economies, it remains a complex area of study. While numerous investigations underscore the critical role of SQ in housing, it's essential to note that the implementation of TQM methodologies alone does not guarantee its achievement. Streimikiene (2015) emphasized the increasing demand for improved housing quality and services as communities evolve. Effective management of housing estates, therefore, necessitates the expertise of professionals and experienced administrators capable of delivering comprehensive and competent services. This underscores the necessity of complementing TQM with specialized knowledge and skills tailored to the unique demands of the housing sector.

Ensuring the SQ of residential estates and buildings is paramount as it contributes significantly to maintaining a competitive edge (Forsythe, 2012; Kurian and Thampuran, 2011). The effective management of various resources, including financial, human, and physical assets, plays a crucial role in enhancing the performance of both commercial and governmental institutions. Assets from the housing sector often serve as vital sources for financing governmental responsibilities, acting as collateral for loans and facilitating the provision of essential services such as domestic security, education, and healthcare (Salim and Alabdouli, 2022). Recognizing the pivotal role of real estate in business successes and failures, its importance within the economic frameworks of the private sector, and its impact on the annual reports and capital structure of the public sector underscore the need for appropriate and efficient housing management (Forsythe, 2012; Kurian and Thampuran, 2011).

Achieving the highest levels of customer satisfaction and loyalty necessitates strong relationships between buyers and renters within the housing sector. It is imperative to integrate sector-specific expertise with commercial acumen (Baharum

et al., 2009). To meet the rising consumer expectations for high-quality services, the housing industry must embrace inclusivity and innovation, requiring an understanding of their perspectives, concerns, and needs (Baharum et al., 2009). Equally important, the integration of technical infrastructure into housing portfolios demands extensive maintenance and a high level of SQ (Baharum et al., 2009).

Recent years have seen a significant increase in consumer expectations regarding service quality, prompting stakeholders in the housing sector to raise the bar for management practices (Mottaeva and Borisova, 2019). Addressing the industry's weak management traits, developing strategies to boost operational effectiveness, and enhancing overall SQ outcomes are crucial imperatives. The evolution of housing and community services systems necessitates the adoption of new organizational structures and management strategies to improve managerial effectiveness. Providing substandard housing not only contributes to environmental problems but also leads to poor health outcomes for consumers (Habib et al., 2009). Previous research identified various problems that exacerbate the deterioration of crucial housing infrastructure, including subpar housing, overcrowding, and the likelihood of future disease outbreaks.

The full implementation of TQM remains ambiguous due to factors such as lack of uniformity, reliance on a temporary workforce, and involvement of multiple stakeholders (Adeoye, 2016). Temporary workers, often integral to construction projects, may pose logistical challenges due to their mobility and limited availability for consultation (Eniola et al., 2019; Zaid et al., 2020). However, despite these challenges, comprehensive TQM practices have the potential to mitigate these obstacles by fostering a culture of accountability, continual improvement, and stakeholder engagement (Hyun Park et al., 2017). By aligning TQM initiatives with local needs and preferences, stakeholders can optimize the effectiveness of quality management endeavors. Overall, TQM practices offer a viable pathway for enhancing SQ in Dubai's housing sector. By addressing industry-specific challenges and fostering a culture of excellence, TQM holds significant potential to drive sustainable improvements in service delivery and customer satisfaction. Therefore, based on the evidence and analysis presented, it is reasonable to posit:

H_1: TQM practices positively impact SQ in Dubai's housing sector.

2.6. Relationship between blockchain technology and SQ

Blockchain Technology (BT) plays a pivotal role in combating fraud within the housing industry by providing distinct digital property credentials for each property or owner involved in block records exchange. This includes addressing issues such as economic fraud, indirect costs, falsification, consumer safety, and rental scams (Nasarre-Aznar, 2018). BT ensures the secure verification of document details, such as time, date, and ownership, in a highly secure manner. As Nam and Yang (2017) pointed out, BT has streamlined the dissemination of smart contracts within the housing sector. Through encrypted information exchange facilitated by the blockchain network, various entities managing housing development financing share an identical distributed ledger via smart contracts. This innovative approach not only reduces expenses associated with complex housing development bond transactions but also

decreases networking consumption (Nam and Yang, 2017). The application of smart contracts through BT in the housing sector offers promising prospects for dispute resolution and transaction security. Kibet et al. (2019) propose a framework for creating and utilizing smart contracts, aiming to minimize disputes by enhancing transaction safety. Integrating BT into government-mandated business dealings databases enhances transparency and legitimizes commercial transactions by converting transactional data into rights records and providing buyers with ownership history proof (Geetha and Radhakumari, 2018). Furthermore, BT has found practical application in rental housing, enabling housing firms to conduct secure financial transactions. By eliminating the need for third-party intermediaries and employing identity access techniques based on zero-knowledge proofs and cryptographic technologies, BT ensures privacy protection throughout the entire home transaction process (Yu et al., 2021). This innovative approach not only addresses the drawbacks of traditional house rental platforms but also guarantees the safety of operations among stakeholders. Therefore, BT has the potential to significantly enhance the quality of service across a wide range of industries. Its effectiveness in preserving security, facilitating information exchange, and streamlining transactions in the housing industry underscores its positive impact. As a result, the following hypothesis is proposed:

H_2: Blockchain technology positively impacts SQ in Dubai's housing sector.

2.7. Moderating role of blockchain technology

BT has many potential uses in the housing market, including the reduction of legal concerns, exchange of secure information, reduction of legal costs, and rightful assignment of ownership rights and property to people (Pankratov et al., 2010). Furthermore, TQM techniques may not have a significant impact on SQ in terms of technological infrastructure if BT is not present. The adoption of BT will improve the connection between TQM procedures and SQ because technology has altered the trajectory of all businesses, including the housing industry (Muruganandham et al., 2023). This kind of relationship has never been established before, making it a unique addition to the housing sector, particularly in Dubai. BT presents a transformative opportunity in the housing market, addressing various challenges such as legal complexities, secure information exchange, cost reduction, and ensuring rightful property ownership (Geetha and Radhakumari, 2018; Nasarre-Aznar, 2018; Nam and Yang, 2017; Yu et al., 2021). However, while the industry grapples with these complexities, the adoption of TQM techniques emerges as a critical strategy (Christidis and Devetsikiotis, 2016; Kibet et al., 2019; Pilkington, 2016). Yet, without BT, the potential impact of TQM on SQ regarding technological infrastructure remains constrained. The integration of BT into TQM practices presents a compelling solution to bridge this gap and enhance alignment. Particularly in technologically progressive regions like Dubai, where innovation is highly prized, this integration holds significant promise. By leveraging BT's capabilities to streamline processes, ensure data integrity, and enhance transparency, housing businesses can better achieve the objectives of TQM and, in turn, improve service delivery standards and customer satisfaction levels. In essence, the symbiotic relationship between BT and TQM marks a new frontier in

the housing sector. Through this integration, housing businesses in Dubai can harness technological advancements to elevate SQ. Thus, the following hypothesis is proposed:

H_3: Blockchain technology moderates the relationship between TQM practices and SQ in Dubai's housing sector.

3. Methodology

This adopted methodology for current study is rooted in a positivist research philosophy, which lends itself well to hypothesis testing, precise generalizations, and thorough analyses (Benton and Craib, 2023). Employing a deductive research strategy, the study aims to comprehend the impact of TQM implementation on SQ and the pivotal role of BT within Dubai's housing market. This approach, guided by the positivist theory, allows for the quantification of relationships between constructs (Williams, 2007). To gather data, self-administered surveys were distributed via Google Forms, recognized for their efficiency and reliability in data collection (Bell et al., 2022).

3.1. Participants

A representative sample of MBRHE employees, totaling 1000 staff members, was randomly selected using basic random sampling techniques (Acharya et al., 2013; Lohr, 2021). Despite the large pool of potential participants, a response rate of 35% from the 1000 invites was achieved, ensuring a robust dataset for analysis (Pambreni et al., 2019). Data integrity was preserved by excluding outliers and confirming data normality (Seo, 2006).

3.2. Data collection

The data collection process involved two primary stages: questionnaire development and survey administration. Ethical clearance was secured, and participants were assured of the confidentiality of their responses (Boynton and Greenhalgh, 2004). Utilizing Google Forms, survey links were securely distributed through verified MBRHE mailing groups to prevent them from being erroneously marked as spam. The survey remained active for two months to afford participants ample time to respond. Rigorous analysis, employing PLS-SEM through SmartPLS 3 software, was conducted to examine constructs and draw meaningful conclusions (Hair et al., 2017).

4. Results

4.1. Exploratory factor analysis, reliability, and validity of constructs

Within the methodological framework, our approach commenced with the utilization of Exploratory Factor Analysis (EFA) to discern pivotal components for evaluation and unravel the interrelationships between variables, thereby affirming the dimensionality of our measures (Fabrigar and Wegener, 2011). Building upon this foundation, Principal Component Analysis (PCA), commonly referred to as component analysis, was subsequently embraced to delve further into the intricacies of our research (Abdi and Williams, 2010). The utilization of factor analysis in this

study aimed to condense a substantial amount of existing data (variance) into a smaller number of factors for interpretation. This necessitated the selection of the PCA approach for optimal results. Varimax rotation was selected for PCA because it simplifies and splits the components more accurately, with an emphasis on reducing the factor matrix components (Kaiser, 1958). **Table 1** shows that all items from each of the three variables (TQM, SQ, and BT) were loaded into the same component and that the values of the factor loadings were all larger than 0.5, indicating a very significant relationship. Owing to the positive results of the factor analysis, none of the TQM, SQ, or BT components were removed.

Composite reliability (CR) is equal to Cronbach's alpha for measuring the internal reliability of measurement items in terms of assessing the constructs' dependability (Cho, 2016; Netemeyer et al., 2003). It is the proportion of total score variance that can be accounted for by total outcome measure variance and an "acceptable" level for CR is 0.80 (Netemeyer et al., 2003). The following table shows that all components in this study had CR and Cronbach's alpha values greater than 0.8, indicating a high degree of internal consistency among items in each scale. The convergent validity of the composite variables as a whole can also be ensured using Rho_A values. The table also displays the Rho_A values for each variable, all of which are greater than 0.7, suggesting high validity. The average value was determined by squaring the loadings of each item on each variable and then averaging the results. A minimum AVE of 0.50 is required for acceptance. If a variable could explain at least half of the variation in the components of the construct, it was considered highly significant. There were no AVE values below 0.5, as shown in **Table 1**. When the AVE is high AVE suggests that the components of the construct explain at least half of the observed variation. More importantly, there were no problems with the structural model because all factor loadings were greater than 0.5.

Table 1. Exploratory factor analysis, construct reliability, and validity.

Item	Item Description	Factor Loadings	Cronbach's alpha	Rho_A	CR	AVE
Service Quality			0.891	0.893	0.917	0.650
SQ1	We are highly dedicated to solving our customers' problems and providing them with the right services in MBR's Housing Sector.	0.834				
SQ2	We always respond to our customers' inquiries and provide them with prompt responses in MBR's Housing Sector.	0.809				
SQ3	We always work hard to benefit our customers and keep their needs in mind in MBR's Housing Sector.	0.878				
SQ4	We ensure that our customers trust us, and we try our best to increase their confidence in us in MBR's Housing Sector.	0.846				
SQ5	We have convenient business hours in MBR's Housing Sector.	0.746				
SQ6	We have all the resources and equipment needed for providing the best services to our customers in MBR's Housing Sector.	0.714				

Table 1. (*Continued*).

Item	Item Description	Factor Loadings	Cronbach's alpha	Rho_A	CR	AVE
Total Quality Management			0.824	0.826	0.876	0.586
TQM1	We ensure that we maintain better employee relations in MBR Housing Sector by increasing participation and morale and reducing absenteeism and turnover intention.	0.729				
TQM2	We are focused on using improved operating procedures in the MBR Housing Sector by focusing on cost savings, processes, task productivity, decreasing the incidence of defects, and maintaining the overall operations efficiently.	0.778				
TQM3	We maintain high customer satisfaction in the MBR Housing Sector by providing our customers with on-time deliveries, addressing their complaints, and being complimentary.	0.779				
TQM4	We work diligently to engage in continuous improvement by eliminating flaws, improving the effectiveness of services, enhancing the quality of goods, and promoting staff enthusiasm in the MBR Housing Sector.	0.771				
TQM5	We ensure that we use the right types of tools and techniques in the MBR Housing Sector in the form of training and education, advanced technologies, and learning opportunities.	0.773				
Blockchain Technology			0.8	0.792	0.856	0.543
BT1	The technology used in MBR's housing sectors allows the customers to be in charge of their data.	0.704				
BT2	The technology used in MBR's housing sectors allows the customers to manage information and keep their data private and secure.	0.746				
BT3	The customer transactions are always safe, and none of the customer's personal information is shared or leaked to third parties.	0.739				
BT4	Customers in the MBR housing sector can structure their housing assets, prices, personal details, and other information.	0.783				
BT5	Customers in the MBR housing sector can use cryptocurrencies for making payments or making investments in any of the real-estate properties	0.712				

The obtained data exhibited satisfactory reliability and validity, as measured by Cronbach's alpha, Rho_A, CR, or AVE.

4.2. Hypothesis testing

The hypotheses presented in **Table 2** were examined as part of the current research study. These hypotheses sought to investigate the impact of TQM practices and BT application on SQ within Dubai's housing sector.

Table 2. Hypothesis and their structural path.

Hypothesis	Structural Path
H1: Implementation of TQM positively impacts SQ in Dubai's housing sector.	TQM → Service Quality
H2: Application of BT positively impacts SQ in Dubai's housing sector.	Blockchain Technology → Service Quality
H3: Blockchain technology moderates the relationship between TQM practices and SQ in Dubai's housing sector.	Moderating Effect → Service Quality

In this study, TQM was hypothesized to improve SQ in Dubai's housing market. The subsequent analysis, as shown in **Table 3**, revealed that the collected data supported this hypothesis. It suggested a significant positive influence of TQM on SQ within the Dubai housing industry ($\beta = 0.275$, $t = 4.678$, $p < 0.01$). Consequently, H1 was accepted, indicating that firms in Dubai's housing industry deliver high quality due to the widespread adoption of TQM practices. A favorable impact of BT on SQ in Dubai's housing industry was also postulated. As depicted in **Table 3**, the collected data aligns with the hypothesis, indicating that BT positively influences SQ in the Dubai housing industry ($\beta = 0.499$, $t = 9.309$, $p < 0.01$). Consequently, H2 was accepted, highlighting that firms within Dubai's housing sector can deliver high-quality services through the adoption of BT. This technology empowers customers by allowing them to control their data, enhances information security and safety, safeguards data from third parties, organizes customers' personal information, and facilitates payments using cryptocurrencies.

Furthermore, this study tested hypothesis (H3), examining whether the implementation of BT in the Dubai housing market strengthens the relationship between TQM practices and SQ. The results pertaining to H3 demonstrate that the effect of TQM on SQ is amplified with increasing levels of BT implementation due to the interaction effect of BT and TQM ($\beta = 0.07$, $t = 4.121$, $p < 0.01$). Therefore, H3 was also supported, suggesting a synergistic relationship between BT and TQM in enhancing service quality within the Dubai housing sector.

Table 3. Hypothesis testing results.

	Original sample [*O*]	Standardized value [*β*]	Standard deviation [STDEV]	*T* statistic [|O/STDEV|]	*P* value
Blockchain Technology → Service Quality	0.277	0.275	0.059	4.678	0.000
Total Quality Management → Service Quality	0.498	0.499	0.054	9.309	0.000
Moderating Effect → Service Quality	0.07	0.074	0.017	4.121	0.000

Based on the findings pertaining to H1, H2, and H3, all three hypotheses were substantiated—affirming the positive impact of TQM practices and BT on SQ within Dubai's housing sector.

5. Discussion

Our study reveals a positive link between TQM and SQ in the housing sector. We also explore the impact of BT on SQ, highlighting its moderating effect on the TQM-SQ relationship. Our findings suggest that broader BT adoption could amplify this connection, offering enhanced security and data integrity in housing transactions. In

the following discussion, we delve into the implications of these findings for both theory and practice.

5.1. Implications for theory

This study represents a contribution to our comprehension of the relationship between TQM and SQ, thereby advancing the knowledge base in this field. Building upon prior research by scholars such as Aburayya et al. (2020) and Gathoni and Van der Walt (2019), it reaffirms the positive association between TQM and SQ. In the housing sector, as in any other, effective leadership is crucial for quality management. This is not merely because leaders set the tone for organizational culture and prioritize quality standards, but also because their guidance and strategic decisions profoundly impact the implementation and success of quality initiatives throughout the sector (Arslan et al., 2024; Soltani et al., 2010, 2012). This involves a comprehensive exploration of quality-related concepts, drawing insights from successful case studies, and strategic implementation strategies (Nasarre-Aznar, 2018). These findings corroborate with existing literature, including works by Aburayya et al. (2020), Al-Hawary and Abu-Laimon (2013), Gathoni and Van der Walt (2019), and Talib et al. (2012), underscoring the significant impact of TQM processes on SQ.

The study highlights the significant impact of BT on enhancing SQ in the residential market, marking a noteworthy addition to the existing body of literature. While direct causal links between BT and service improvements remain elusive, the study's findings contribute fresh insights to this field. Our study aligns with and complements previous studies by Geetha and Radhakumari (2018), Kibet et al. (2019), and Yu et al. (2021), which also suggest a positive correlation between BT adoption and improved services across various industries. However, it's essential to note that most past research and the findings of these studies primarily rely on subjective assessments, lacking empirical validation. This discrepancy might arise due to the multifaceted evaluation criteria that integrate blockchain usability and service-related performance in the housing sector. Our study adds empirical insights to this debate, aiming to provide a more comprehensive understanding of the relationship between BT adoption and SQ outcomes in the housing sector.

Moreover, the study underscores BT's moderating effect on the relationship between TQM and SQ, suggesting that wider BT integration could amplify this connection (Chin et al., 2021; Ju et al., 2021; Muruganandham et al., 2023). Notably, the application of private blockchain networks for securing financial transactions and sensitive data in Dubai's housing market holds promise, despite challenges like smart contract vulnerabilities. Finally, the study introduces a new perspective regarding BT's potential to enhance the link between TQM procedures and SQ. It suggests that if customers perceive BT as enhancing security and efficiency in property transactions and housing sector employees adopt advanced TQM practices, significant operational improvements and heightened service quality can be expected. This underscores the transformative potential of BT integration in the housing sector, promising enhanced service delivery for customers (Li et al., 2019; Saari et al., 2022).

5.2. Implications for practicing managers and policymakers in the housing sector

The research findings elucidate pivotal implications for both practicing managers and policymakers within the housing sector. Specifically, for practicing managers, the study emphasizes the transformative potential of strategically adopting BT to augment SQ within their operations. This strategic integration of BT offers manifold benefits, including streamlined processes, heightened transparency, and enhanced security measures. By leveraging BT, managers can fortify their competitive positioning within the housing market landscape. The study also underscores the imperative of a renewed emphasis on TQM practices. Investing in comprehensive training programs and resources is paramount to equip employees with the requisite skills to proficiently implement advanced TQM strategies. This proactive approach ensures organizational readiness to adapt to evolving quality management standards and effectively meet customer expectations.

Policymakers also hold a pivotal role in shaping the regulatory landscape surrounding the adoption and implementation of BT, particularly within the housing sector. Clear and robust regulatory frameworks are indispensable to govern the integration of BT, addressing multifaceted concerns such as data privacy, security standards, and vulnerabilities inherent in smart contracts. By establishing comprehensive regulations, policymakers engender trust among stakeholders and mitigate potential risks associated with blockchain adoption. Furthermore, policymakers are urged to champion research and development initiatives aimed at elucidating blockchain's potential applications in enhancing service quality within the housing sector. This entails fostering a collaborative ecosystem wherein government agencies, research institutions, and industry stakeholders synergize efforts to explore and harness the transformative capabilities of blockchain technology. By providing financial support, incentives, and fostering collaborative partnerships, policymakers foster an environment conducive to innovation, ultimately driving advancements in housing service quality and fostering sustainable industry growth. In essence, the integration of BT presents a paradigm shift in housing sector operations, offering unprecedented opportunities for managers to enhance service quality through TQM and for policymakers to enact regulatory frameworks that encourage continuous quality improvement, foster innovation and mitigate risks. By aligning managerial strategies with regulatory frameworks that promote technological innovation, stakeholders can collectively navigate the evolving landscape of the housing sector, ensuring sustainable growth and enhanced service quality for all stakeholders involved.

5.3. Limitations and avenues for future research

Despite its contributions, the current study is not without limitations. Firstly, its exclusive focus on the housing industry raises concerns regarding the generalizability of its findings to other economic sectors within the UAE. The adoption of a cross-sectional research strategy also limits the study's ability to capture longitudinal trends and changes over time. Furthermore, the absence of descriptive data from managers within the housing industry limits the depth of understanding regarding how TQM and BT contribute to improvements in SQ.

To address these limitations, future research should consider employing case studies to provide in-depth insights into the practical implementation and effectiveness of TQM and BT initiatives within the housing sector (Soltani et al., 2014). Longitudinal studies (Ruspini, 2008) are also needed to observe trends and changes in the impact of TQM and BT on SQ over time. Finally, exploring individual components of the TQM-BT-SQ model and examining the transferability of the model to different regional contexts would enhance our understanding of the dynamics between TQM, BT, and SQ. By addressing these methodological limitations, scholars can provide more robust evidence to inform effective managerial practices and policymaking strategies in the UAE and beyond.

6. Conclusion

Drawing upon the foundational principles and assumptions of TQM and BT, our study advocates for deeper exploration into their combined impact on SQ within Dubai's housing sector. We contribute by reaffirming the positive correlation between TQM and SQ while highlighting BT's potential to further enhance SQ. Our findings suggest that BT may moderate the relationship between TQM and SQ, emphasizing the need for comprehensive exploration into their interaction. Overall, our study provides a foundation for strategic decision-making aimed at fostering innovation and enhancing service delivery within the sector.

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