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Title: **Human-Centric Technological Readiness and FinTech-Driven Financial Transformation in the MENA Region: The Moderating Role of Governance Quality**

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Human-Centric Technological Readiness and FinTech-Driven Financial Transformation in the MENA Region: The Moderating Role of Governance Quality

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Abstract

The rapid expansion of digital technologies and financial innovation has transformed financial systems worldwide, particularly in emerging economies seeking to improve financial inclusion and sustainable development. This study examines the relationship between human-centric technological readiness, financial innovation, governance quality, and transformative finance in the Middle East and North Africa (MENA) region. Using panel data from fifteen MENA countries covering the period 2015–2025, the study employs panel regression technique to analyze how technological capabilities and institutional factors influence financial transformation. The findings indicate that human-centric technological readiness and financial innovation have a significant positive impact on transformative finance, suggesting that countries with stronger digital capabilities and more developed fintech ecosystems are better positioned to expand financial inclusion and improve financial system efficiency. Governance quality also positively contributes to financial transformation by providing regulatory stability and institutional support for financial innovation. However, the interaction between technological readiness and governance quality reveals a moderating effect, indicating that stronger regulatory frameworks may influence the pace of technological experimentation in financial markets. In addition, digital infrastructure significantly supports the development of digital financial ecosystems. The study highlights the importance of integrating technological development, financial innovation, and effective governance to promote inclusive and sustainable financial systems in the MENA region.

***Keywords*:** digital finance, financial inclusion, financial innovation, fintech, governance quality, MENA region, panel data analysis, technological readiness, transformative finance

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Introduction

The financial system of the world has been experiencing rapid transformation due to the reshaping of financial markets in terms of their structure and operations by digital technologies. Financial technology (fintech), artificial intelligence (AI), and digital platforms have greatly transformed the production, delivery, and access of financial services within the past ten years. These inventions have also facilitated digital payments, mobile banking, peer-to-peer lending, and other technology-based financial services, lowering the cost of transaction and enhancing the accessibility of financial services (Al-Smadi, 2023; Cornelli et al., 2023). Consequently, online financial services have come to be regarded as effective means of financial inclusion and economic growth. The Global Findex Database shows that the share of adults worldwide with a financial account grew to 76% in 2021, as compared to 51% in 2011. It was largely due to the growth of mobile financial services and online payment services. The trends show how technological innovation is revolutionising financial processes and mechanisms to provide more and more people with the opportunity to participate in formal financial markets.

This is, however, a global development which hides significant regional inequalities. The Middle East and North Africa (MENA) region still has low rates of financial inclusion, as compared to other world regions. According to the estimates presented by the World Bank, the share of adults in the region with access to a formal financial account is approximately 45%, which is much lower than the world average (Al-Smadi, 2023). Such limited access to money limits entrepreneurial opportunities, lowers financial resilience, and limits encompassing economic development. Meanwhile, there has been an influx of digital transformation initiatives and fintech development in the region (Afzal et al., 2025). In recent years, fintech investment in the MENA region has grown at a high rate as governments are working on economic diversification and encouraging the adoption of digital innovations in financial systems. Regulatory sandboxes, digital banking licenses, and national fintech strategies have been launched by the United Arab Emirates, Saudi Arabia, and Bahrain to speed up the implementation of digital financial services (Bi et al., 2025).

Financial transformation in the MENA region is, therefore, deserving of special attention, given its unique mix of enduring financial inclusion

limitations and the fast-growing digital-finance agenda and economic diversification programs of the governments. However, despite the growing use of fintech, a significant gap still exists in access to digital financial services, technology capacity, and institutional environment between MENA economies to unlock the potential of financial innovation for more inclusive markets (Elouaourti & Ibourk, 2024). Over the last few years, a number of countries, especially those in the Gulf Cooperation Council (GCC), have prioritized the development of digital infrastructure, GovTech, FinTech ecosystems, and regulatory programmes as part of their broader national economic transformation efforts (Bi et al., 2025). This intersection of technological progress, financial disparities, and institutional diversity makes the MENA region an ideal case study to explore the interaction between technological readiness and the quality of governance and its impact on transformative finance (Abu Khalaf et al., 2025).

Technological readiness plays an important part in determining a countrys capacity to take advantage of new financial technologies. Technological preparedness involves access to digital infrastructure, availability and provision of qualified human resources, and the capacity to conduct research and technological innovation. Nations that are better technologically prepared remain in a better position to integrate artificial intelligence, big data analytics, and digital platforms into financial systems. These technologies can help financial institutions to better evaluate credit risks, increase the delivery of financial services, and increase access to financial services among underserved populations (Buchak et al., 2018). On the contrary, countries that are technologically limited have problems with implementing advanced financial technologies and it can limit the evolution of the digital financial ecosystems.

Another important aspect that determines financial transformation is governance quality. Good governance structures enhance transparency in regulation, as well as transparency in institutions and investor and financial institution security through law. Regulation systems are especially significant in consideration of financial innovations using the rapidly evolving financial technology and for preserving financial stability (Sahay et al., 2020). Well-developed governance frameworks can support the adoption of fintech by providing a conducive regulatory framework and consumer protection. Weak institutional structure, conversely, can result in regulatory ambiguity that suppresses technological adoption and restricts

the growth of the financial sector (Sahay et al., 2020). As a result, the quality of governance may play an important role in determining how technological preparedness is converted into significant financial transformation.

Despite the growing literature on fintech and financial inclusion, three important gaps remain. Firstly, existing studies predominantly examine individual dimensions of financial development, such as fintech adoption, banking performance, or financial inclusion, rather than the broader concept of transformative finance itself. Secondly, there is very little research available that explores how technological and institutional factors together affect financial transformation, with most studies focusing on either technological readiness, financial innovation, or governance quality, individually. Thirdly, there is a lack of cross-country empirical evidence for the MENA region, despite the large volume of literature on the subject in the developed world and in specific countries. The present study addresses these gaps by combining technological, financial, and institutional elements in a single panel data model for a MENA sample of fifteen economies.

Problem Statement

New technologies, especially digital or information technologies, financial innovation, and appropriate governance should allow emerging economies to create more inclusive, efficient, and sustainable financial systems (Al-Smadi, 2023). The MENA region, on the other hand, has experienced steady divergence in financial inclusion, financial technology readiness, digital infrastructure, institutional capacity, and the rapid development of fintech (Bi et al., 2025; Sahay et al., 2020). Thus, technological progress alone is unlikely to bring about a significant financial shift, especially in the absence of scaling up digital infrastructure and institutional capacities (Khera et al., 2022; Kouladoum et al., 2022). Policymakers might fail to craft institutional and regulatory frameworks to achieve inclusive and sustainable financial outcomes if they cannot appreciate the interplay between technological readiness, financial innovation, and governance quality (Alawi et al., 2022).

In this context, the current study explores the pathways by which technological and institutional capabilities add value to the financial transformation of the MENA region. In particular, it examines if there are positive links between human-centric technological readiness and financial innovation and whether governance quality impacts the ability to connect

technological readiness and transformative finance. This study aims to fill these gaps by exploring the impact of human-centric technological readiness, financial innovation, and governance quality on transformative finance in the MENA region. The study employs panel data from fifteen countries in the MENA region for the period 2015–2025 and examines the direct effects of both technology readiness and financial innovation, as well as the moderating effects of governance quality. Hence, this study combines technological, institutional, and financial views to move the debate on financial transformation in developing economies further by contributing to understanding the mechanisms by which emerging technologies and governance frameworks influence financial transformation.

Literature Review

This research is mainly based on the Diffusion of Innovation Theory and Institutional Theory. The diffusion of Innovation Theory (DoIT) describes the diffusion of new technologies within a socioeconomic system and highlights the ability to comprehend, adopt, and use technological innovations as the key factor in their diffusion and effectivenes. Therefore, countries with a robust digital infrastructure and technological capacity, skilled human capital, and innovation capacity are expected to be better poised to implement fintech applications and introduce emerging technologies in the financial system (Kou & Lu, 2025; Khera et al., 2022; Kouladoum et al., 2022). Recent evidence also shows that technological preparedness and digital competency promote the adoption of fintech, financial inclusion, and the modernization of financial services in emerging economies (Jagtiani & Lemieux, 2018; Khera et al., 2022). This theoretical framework thus serves as a lens to connect human-centric technological readiness and financial innovation to transformative finance.

Institutional theory also proposes that institutional frameworks, both formal and informal, influence the formal and informal institutional environments that determine technological and economic outcomes of the innovation process (Ehret & Olaniyan, 2023). Financial institutions and technology companies can create and provide innovative financial solutions with the help of regulatory quality, institutional stability, transparency, and good governance (Alawi et al., 2022). Regulatory stability, investor protection, and a regulatory environment that fosters financial innovation can facilitate the development of fintech startups by offering institutional

credibility and security (Sahay et al., 2020; Ehrentraud et al., 2021). In addition, regulatory frameworks can place restrictions on technological experimentation when the concerns of financial stability, consumer protection, and system risk become predominant (Ehrentraud et al., 2021). Therefore, institutional theory has been regarded as crucial in determining the direct and moderating effects of governance quality on technological readiness and transformative finance.

Financial Technology and Financial Transformation

Over the last few years, the global financial system has undergone significant changes because of the high rate of development of digital technologies and financial innovations. Financial technology or fintech has become one of the driving forces in financial sector development by increasing access to financial services provision, lowering transaction costs, and expanding financial inclusion. Some recent studies explicate that digital financial services including mobile banking, digital payments, and online lending platforms allow more people to access financial systems, especially those who are not banked (Ozili, 2018). This has changed the conventional financial systems by making financial activities faster, efficient, and more inclusive (Maryam et al., 2025).

Empirical research in developing economies demonstrates that the use of fintech has a huge role in financial inclusion and economic growth (Khera et al., 2022). Using the example of fintech ecosystems, Lee and Shin (2018) found that these ecosystems remain significant in the growth of financial services by incorporating digital technologies into financial institutions. On the same note, Haddad and Hornuf (2019) revealed that fintech companies enhance competition in financial markets and enhance financial services to serve underserved populations. Fintech adoption in emerging economies has been linked as well to financial efficiency and innovation in the banking sector (Gomber et al., 2018).

Nevertheless, even with such developments, the positive effects of fintech adoption do not reach all regions equally. Insufficient digital infrastructure, regulations, and institutions are the primary barriers to the implementation of digital financial services in most developing regions, including the Middle East and North Africa (MENA) region. Therefore, while fintech technologies are relatively promising tools which may be utilized to boost the monetary systems, the level of the potential

effectiveness of such instruments is often determined by the broader technological and institutional contexts.

All these studies suggest that fintech can enhance access, efficiency, and financial inclusion but it does not equally impact all institutional and economic settings. Recent findings indicate that in addition to the presence of technology, the attitudes and perceptions of users and their facilitating conditions also play a role in actual fintech usage. While, the innovativeness and agility of financial organizations are responsible for their ability to transform technological resources into financing solutions based on fintech (Maryam et al., 2025; Tariq et al., 2024). Furthermore, the role of fintech in Islamic financial markets highlights that technology can increase accessibility and efficiency but still remains subject to various regulatory, ethical, and institutional factors. The results indicate that the analysis of the fintech phenomenon in a stand-alone fashion, without taking into account the specific technological and institutional conditions, may offer only partial explanations for financial transformation.

Technological Readiness and Digital Transformation

Technological preparation is considered as a critical factor affecting financial change. Technological preparedness is the ability of a nation to embrace and deploy emerging digital technologies including artificial intelligence, big data analytics, and digital platforms. These technologies can help financial institutions to achieve efficiency in their operations, offer better credit evaluation systems, and novel financial products. According to recent studies, technological preparedness has a strong impact on the creation of digital financial services and financial innovation (Kou & Lu, 2025).

Social and financial systems are also changing because of artificial intelligence and digital technologies that help to better manage risks, detect fraud, and make financial decisions. Financial inclusion can be enhanced through AI-driven financial services that allow using alternative credit scoring mechanisms based on the creditworthiness of those individuals who do not have traditional banking records (Buchak et al., 2018). Furthermore, due to technological improvement, digital financial platforms that can enhance financial access and the effectiveness of financial markets can be easily created.

Although such advantages exist, the implementation of financial

technologies needs the presence of a proper digital infrastructure, human capital, and technological skills. Countries with greater technological preparedness are thus the ones that are well placed to incorporate fintech innovations in their financial systems. Conversely, digital financial transformation may not be wholly realized in economies that have a poor digital infrastructure or poor technological abilities.

Although the literature broadly supports the importance of technological capabilities, the benefits of technological advancement are conditional rather than automatic. Technological innovation can improve financial and sustainability outcomes by expanding productive financial capabilities, but its effectiveness depends on complementary financial, institutional, and human-capital conditions. Recent research similarly shows that technological innovation interacts with financial development, governance, and broader economic structures in determining sustainable outcomes (Ashfaq et al., 2026; Ullah & Shaheen, 2026). Thus, technological readiness should not be considered an isolated technological resource; rather, its transformational value depends on whether complementary institutional and financial systems enable technology to be translated into meaningful economic and financial outcomes.

Governance Quality and Financial Development

Another significant determinant of the development of financial system is the quality of governance. Good governance systems offer stability of regulation, institutional transparency and law protection to financial institutions and investors. Research has always indicated that effective governance systems are helpful in the development of a financial sector by enhancing investor confidence and financial innovation (Sahay et al., 2020).

The quality of regulation and the effectiveness of the institution is especially critical in the case of the adoption of financial technology. The fast pace of fintech services demands regulating structures that encourage innovation and create financial stability and consumer safety. Effective policies on digital governance can be used by governments to encourage the adoption of financial technologies in a safe and effective way. Conversely, poor systems of governance can cause regulatory ambiguity and institutionalisation of the financial innovation.

Empirical studies have shown that the quality of governance plays a major role in financial inclusion and the use of digital financial services.

Indicatively, Sahay et al. (2020) present that regulatory institutions need to be strong to bolster the success of the incorporation of fintech into financial systems. Similarly, Broeders and Prenio (2018) emphasize that appropriate regulatory frameworks are important for balancing fintech innovation with financial-system stability.

The influence of governance on technology-driven financial transformation, however, may not be uniformly positive. Effective institutions can provide regulatory certainty, investor protection, and market stability, thereby facilitating financial innovation; at the same time, extensive regulatory requirements may slow experimentation with rapidly evolving financial technologies. Recent research increasingly portrays governance as a conditioning mechanism that determines whether financial and technological innovations generate broader economic and sustainability outcomes rather than as a purely independent driver (Shafi et al., 2025; Ullah & Shaheen, 2026). This dual perspective is particularly relevant to fintech, where regulators must balance innovation with financial stability, cybersecurity, consumer protection, and systemic-risk considerations. Governance quality may therefore strengthen institutional confidence while simultaneously altering the magnitude of the benefits generated by technological readiness.

Financial Innovation and Sustainable Finance

Financial innovation is critical in ensuring sustainable economic growth by enhancing the distribution of finances and increasing the availability of financial services (Puschmann, 2024). The introduction of digital financial services, green financial instruments, and sustainable investment systems has radically changed modern financial systems. Specifically, green bonds and sustainable finance, as such, have become a matter of growing attention as the means of ensuring environmentally sustainable economic growth (Taghizadeh-Hesary & Yoshino, 2019).

Recent reports show that financial innovation is not only financially inclusive but also has an impact on the economy and its general transformation. Digital financial services are capable of making investments more sustainable, enhancing financial transparency, and enabling economic activities that are responsible to the environment (Ozili, 2018). Nevertheless, it is the institutional support and the willingness to use technologies that helps financial innovation in ensuring sustainable finance.

Recent literature extends this argument by demonstrating that the contribution of financial innovation goes beyond conventional improvements in financial access and efficiency (Shafi et al., 2025; Ullah & Shaheen, 2026). Fintech and digital financial infrastructure can also influence sustainable economic transformation by facilitating green investment, improving information flows, and expanding access to innovative forms of finance. Khan et al. (2025) showed that fintech and green finance interact with green innovation and energy-transition dynamics, while Khan et al. (2025) further associated fintech and information and communication technologies with sustainable green-growth outcomes. Similarly, Shafi et al. (2025) emphasized the interconnected roles of innovation, finance, and governance in shaping sustainable economic growth. Taken together, these findings suggest that financial innovation should be assessed not only in terms of technological adoption or banking efficiency but also in terms of its capacity to contribute to a wider inclusive and sustainable financial transformation.

Research Gaps

Although literature increasingly consists of studies which analyzed how the adoption of fintech is related to financial inclusion and economic development, some significant gaps still exist. Firstly, the majority of the available literature pays more attention to the immediate effect fintech adoption has on financial inclusion and the performance of a bank. Although these works are quite illuminating, they do not take into account the larger technological and institutional contexts that inform financial transformation (Al-Smadi, 2023; Cornelli et al., 2023; Ozili, 2018).

Secondly, the role of human-centric technological preparedness affecting financial transformation has not been addressed effectively. Digital infrastructure is not the only aspect of technological readiness; rather, human capital, research and development capacity, and digital skills also play a significant role. These are the key considerations that are important in empowering the nations to successfully implement and use new financial technologies. Nonetheless, the correlation between technological preparedness and financial transformation remains underrepresented in the empirical literature (Kou & Lu, 2025; Khera et al., 2022)

Thirdly, studies usually focus on the quality of governance and financial

innovation separately but not on how these two constructs interact with each other. The quality of governance can also play an important role in the effectiveness of technological innovation in financial systems in terms of supportive regulation and institutional stability. The understanding of the impact of governance on the relationship that exists between technological preparedness and financial revolution thus constitutes a significant research gap (Alawi et al., 2022).

Cross-country evidence for the MENA region is also limited. Research on digital finance in the region often focuses on individual countries, while much of the broader evidence comes from developed economies, Asia, or Sub-Saharan Africa. This leaves relatively little panel evidence on the drivers of transformative finance across the MENA economies (Al-Smadi, 2023; Sahay et al., 2020).

Hypotheses Development

Technological readiness enhances the ability of economies to adopt and utilize advanced digital technologies in financial systems. Greater technological capacity, digital skills, human capital, and innovation capabilities facilitate the adoption of fintech applications and improve the accessibility and efficiency of financial services (Kou & Lu, 2025; Khera et al., 2022). Moreover, a stronger digital infrastructure enables economies to integrate technology-based financial services more effectively and expand financial inclusion (Kouladoum et al., 2022). Therefore, higher human-centric technological readiness is expected to support transformative finance.

H1: Human-Centric Technological Readiness has a positive and significant effect on transformative finance.

Financial innovation, particularly through digital payments, mobile banking, digital lending, and other fintech services, can reduce transaction costs, improve financial accessibility, and increase the efficiency of financial systems. Existing evidence indicates that fintech development contributes to financial inclusion and the modernization of financial services, particularly in emerging economies (Al-Smadi, 2023; Cornelli et al., 2023; Jagtiani & Lemieux, 2018). Accordingly, greater financial innovation is expected to contribute positively to transformative finance.

H2: Financial innovation has a positive and significant effect on

transformative finance.

Governance Quality and Transformative Finance

Effective governance provides regulatory stability, institutional transparency, and investor protection. These conditions strengthen confidence among financial institutions, investors, and technology providers, and also support financial-sector development (Alawi et al., 2022).

H3: Governance quality has a positive and significant effect on transformative finance.

Moderating Role of Governance Quality

Institutional theory suggests that the effectiveness of technological innovation depends partly on the institutional environment within which such innovation occurs. Strong governance can facilitate technological adoption by providing regulatory certainty, institutional stability, and consumer protection. However, governance may also alter the benefits generated by technological readiness because stricter regulatory requirements can constrain technological experimentation and slow down the implementation of rapidly evolving financial technologies. Recent literature similarly highlights the need to balance fintech innovation with financial stability, regulatory oversight, and risk management (Ehrentraud et al., 2021). Thus, the effect of technological readiness on transformative finance is expected to vary according to the quality of the governance environment.

H4: Governance quality significantly moderates the relationship between human-centric technological readiness and transformative finance.

Table 1

Data Sources and Variable Structure

Construct	Measurement / Sub-indicators	Source
Transformative Finance (TF)	Composite index of financial inclusion, green bond issuance, and sustainable finance share	World Bank; UNDP/SDG indicators
Human-Centric	Composite index of AI	Oxford Insights; WEF;

Construct	Measurement / Sub-indicators	Source
Technological Readiness (HCT)	Readiness, Human Capital, R&D expenditure (% GDP), and Digital Skills	World Bank
Financial Innovation (FIN)	FinTech adoption, mobile banking usage, and digital transactions per capita	IMF Financial Access Survey; World Bank Global Findex
Governance Quality (GOV)	Regulatory Quality and Digital Governance indicators	Worldwide Governance Indicators
GDP per capita	GDP per capita	World Bank
Education Index	Education Index	UNDP
Digital Infrastructure	Internet/broadband and ICT infrastructure indicators	International Telecommunication Union (ITU)

Methodology

Research Design

This study employs a quantitative panel data design to examine human-centric technological readiness, financial innovation, governance quality, and transformative finance across fifteen MENA countries for the period 2015-2025. Panel data was combined with cross-country and time-series variation. This allowed the analysis to account for unobserved country-level differences. This design is appropriate to test and determine how technological and institutional conditions jointly relate to financial transformation across heterogeneous economies.

Study Area

The study covers fifteen countries in the Middle East and North Africa or MENA region. MENA provides a useful setting because rapid fintech growth and digital-transformation programmes coexist with substantial differences in financial inclusion, technological capacity, and institutional development. Several countries are also pursuing economic diversification and financial sector modernisation, making the region suitable to examine how technological readiness, governance, and financial innovation relate to transformative finance.

Time Period

The panel covers the period 2015–2025, a period marked by rapid growth in fintech, digital banking, and mobile financial services. It also

overlaps with the implementation of Sustainable Development Goals (SDGs) and with improved availability of cross-country data on digital finance, technological readiness, and governance. The period, therefore, captures a relevant phase of financial and technological change in the MENA region.

Data Sources

The study uses secondary data from internationally recognised sources to improve comparability across countries. Economic and financial inclusion indicators come from the World Bank, technological-readiness measures draw on Oxford Insights and the World Economic Forum, financial-innovation data comes from the IMF Financial Access Survey and World Bank Global Findex, governance indicators come from the Worldwide Governance Indicators, education data come from UNDP, and digital-infrastructure indicators are taken from the International Telecommunication Union.

Dependent Variable

Transformative Finance (TF) measures the extent to which a financial system combines inclusion and sustainability. The composite index contains financial inclusion, green-bond issuance, and the share of sustainable finance. Since the components use different scales, each indicator was standardised before equal-weight averaging. Higher values indicate a more inclusive and sustainable financial development.

Independent Variables

Human-centric Technological Readiness (HCT) captures a countrys capacity to adopt advanced technologies alongside human capital development. The index combines AI readiness, human capital, research and development expenditure as a share of GDP, and digital skills.

Financial Innovation (FIN) measures the development of digital financial services using fintech adoption, mobile-banking usage, and digital transactions per capita. These indicators capture the spread of technology-enabled financial activity within each economy.

Governance Quality (GOV) represents the institutional and regulatory environment supporting financial and digital development. It combines regulatory quality and digital governance indicators.

The component indicators for HCT, FIN, and GOV were standardised before aggregation and combined using equal weights. Higher index values represent greater technological readiness, financial innovation, and governance quality.

Moderating Variable

The moderating effect of governance quality is tested through the interaction term HCT × GOV. This term shows whether governance changes the magnitude or direction of the relationship between technological readiness and transformative finance.

Control Variables

The model controls for GDP per capita, education index and digital infrastructure. GDP per capita captures economic development, education index reflects human capital conditions, and digital infrastructure measures the communication networks and connectivity that support digital financial services.

Econometric Model

The empirical relationship was estimated using the following panel regression model:

$$TF_{it} = \beta_0 + \beta_1 HCT_{it} + \beta_2 FIN_{it} + \beta_3 GOV_{it} + \beta_4 (HCT_{it} \times GOV_{it}) + \beta_5 GDP_{it} + \beta_6 EDU_{it} + \beta_7 DIGINF_{it} + \varepsilon_{it}$$

where TF_it is transformative finance for country i in year t; HCT_it is human-centric technological readiness; FINit is financial innovation; GOV_it is governance quality; HCT_it × GOV_it is the interaction term; and GDP, EDU, and DIGINF are the control variables. Further, ε_it captures unobserved influences.

Estimation Technique

The analysis began with descriptive statistics and correlations, followed by panel unit root test. The Hausman specification test was used to choose between fixed and random effects. Its results supported the random effects model, so the final estimates were obtained using random effects generalized least squares. Multicollinearity was assessed through correlations and Variance Inflation Factors (VIFs). The reported VIF values remained below the conventional threshold of 10, indicating no serious

multicollinearity in the estimated model.

Diagnostic Tests

Model robustness was assessed through tests for multicollinearity, heteroscedasticity, cross-sectional dependence, and serial correlation. HCT and GOV were mean-centred before constructing their interaction term for the VIF assessment. VIF values ranged from 1.010 to 8.719. The Breusch-Pagan test indicated no heteroscedasticity (χ^2 = 6.773, p = 0.453), the Pesaran CD test showed no cross-sectional dependence (CD = -0.455, p = 0.649), and the Wooldridge-type test showed no serial correlation (F = 0.029, p = 0.868). The results indicated that the principal diagnostic concerns were not severe. All statistical and econometric analyses were performed in EViews.

Results

Table 2

Descriptive Statistics

Variable	Mean	*SD*	Min	Max	Skewness	Kurtosis	JB (*p*)
TF Composite	88.78	7.82	68.91	99.00	-0.42	2.33	7.92 (0.019)
HCT Composite	72.42	9.41	49.58	93.92	0.06	2.41	2.51 (0.285)
FIN Composite	71.73	9.75	48.61	98.00	0.00	2.40	2.45 (0.294)
GOV Composite	67.67	9.06	48.22	88.02	0.13	2.27	4.11 (0.128)
HCT×GOV	49.74	12.57	25.40	79.81	0.31	2.42	4.96 (0.084)
GDP per capita	9388.52	3120.24	2528.9	15971.3	0.03	2.30	3.44 (0.179)
Education Index	0.673	0.056	0.539	0.816	0.09	2.69	0.86 (0.649)
Digital Infrastructure	0.673	0.088	0.484	0.890	0.11	2.40	2.77 (0.251)

Note. TF = Transformative Finance, HCT = Human-Centric Technology Readiness, FIN = Financial Innovation, GOV = Governance Quality

Table 2 summarises the main variables. Transformative finance has a mean value of 88.78 (*SD* = 7.82), while human-centric technological readiness and financial innovation have mean values of 72.42 and 71.73, respectively. Governance quality averages 67.67 and GDP per capita averages USD 9,389. The values of skewness and kurtosis are generally

moderate. Jarque-Bera probabilities indicate approximate normality for most variables, although transformative finance departs from normality.

Table 3

Correlation Matrix

Variable	TF	HCT	FIN	GOV	GDP	EDU	DIGINF
TF Composite	1.000						
HCT Composite	0.912	1.000					
FIN Composite	0.751	0.762	1.000				
GOV Composite	0.856	0.872	0.609	1.000			
GDP per capita	0.860	0.891	0.715	0.854	1.000		
Education Index	0.841	0.870	0.649	0.880	0.856	1.000	
Digital Infrastructure	0.854	0.872	0.641	0.875	0.845	0.886	1.000

Note. TF = Transformative Finance, HCT = Human-Centric Technology Readiness, FIN = Financial Innovation, GOV = Governance Quality

Table 3 shows strong positive correlations between transformative finance and human-centric technological readiness (r = 0.912), financial innovation (r = 0.751) and governance quality (r = 0.856). GDP per capita, education, and digital infrastructure are also positively correlated with transformative finance. The correlations are high for several predictors, which makes the VIF and diagnostic checks reported later particularly important.

Table 4

Unit Root Test

Variable	Statistic	Prob	Stationarity
TF_COMPOSITE	-4.88	0.000	Stationary
HCT_COMPOSITE	-3.98	0.001	Stationary
FIN_COMPOSITE	-9.84	0.002	Stationary

GOV_COMPOSITE	-4.06	0.000	Stationary
GDP_PER_CAPITA	-2.82	0.002	Stationary
EDUCATION_INDEX	-2.70	0.003	Stationary
DIGITAL_INFRASTRUCTURE	-8.66	0.000	Stationary

The Levin-Lin-Chu panel unit root results in Table 4 show that all study variables are stationary at level because their probability values are below 0.05. Therefore, the unit root null hypothesis is rejected for all variables, indicating that they are stationary at level and can be included in the panel regression analysis without differencing.

Table 5

Hausman Test

Test	Chi-square	*df*	*p*	Decision
Hausman Test	3.461	6	0.749	Random Effects preferred

The result of Hausman test is statistically insignificant ($\chi^2 = 3.461$, $p = 0.749$), so the null hypothesis is not rejected and the random effects model is preferred to fixed effects. This result supports the assumption that unobserved country-specific effects are not systematically correlated with the explanatory variables.

Table 6

Panel Regression Diagnostic Tests

Test	Statistic	*p*	Conclusion
Maximum VIF	8.719	—	No serious multicollinearity
Breusch–Pagan	6.773	0.453	No heteroscedasticity
Pesaran CD	−0.455	0.649	No cross-sectional dependence
Wooldridge-type Test	0.029	0.868	No serial correlation

Table 7

VIF

Variable	VIF
HCT	8.719
FIN	2.575
GOV	6.574
HCT × GOV	1.010

GDP per capita	6.112
Education Index	6.649
Digital Infrastructure	6.386

Regression Results

$TF_{it}=-17.92+1.04HCT_{it}+0.12FIN_{it}+0.91GOV_{it}-1.02(HCT\times GOV)_{it}+0.000196GDP_{it}+1.43EDU_{it}+14.15DIGINF_{it}$

Table 8

Random Effects Panel Regression Results

Variable	Coefficient	Std. Error	*t*	*p*
Constant	-17.921	12.200	-1.469	0.144
HCT_Composite	1.036	0.172	6.014	0.000
FIN_Composite	0.120	0.036	3.359	0.001
GOV_Composite	0.910	0.182	5.006	0.000
HCT × GOV	-1.023	0.236	-4.337	0.000
GDP_per_capita	0.000196	0.000172	1.138	0.257
Education_Index	1.432	10.052	0.142	0.887
Digital_Infrastructure	14.152	6.282	2.253	0.026

Note. Dependent variable is Transformative Finance (TF). Random Effects estimation is used based on the Hausman test results. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

Table 9

Model Statistics

Statistic	Value
Observations	165
Cross-sections	15
Periods	11
R^2	0.879
Adjusted R^2	0.874
F-statistic	163.75
Prob(*F*)	0.000
Durbin–Watson	2.01

The random effects results show significant positive effects of Human-Centric Technological Readiness (β = 1.036, $p < 0.001$), Financial

Innovation (β = 0.120, p = 0.001), and Governance Quality (β = 0.910, p < 0.001), supporting H1-H3. The effect of Digital Infrastructure is also positive and significant (β = 14.152, p = 0.026), while the effects of GDP per capita and Education Index are not significant. The model explains 87.9% of the variation in Transformative Finance (R^2 = 0.879; adjusted R^2 = 0.874) and is significant overall (F = 163.75, p < 0.001).

The interaction between human-centric technological readiness and governance quality is negative and significant (β = -1.023, p < 0.001), confirming that governance changes the effect of technological readiness on transformative finance. The effect of governance itself remains positive, so the interaction should not be read as evidence that stronger governance harms financial transformation (Alawi et al., 2022). Rather, the incremental benefit of technological readiness becomes smaller as governance quality rises. One interpretation is that stronger governance brings greater oversight, compliance requirements, and consumer-protection controls that can moderate the pace of technological experimentation (Ehrentraud et al., 2021).

Table 10

Marginal Effects of Human-Centric Technological Readiness at Different Levels of Governance Quality

Governance Level	Governance Value	Marginal Effect of HCT on TF
Low governance (−1 SD)	58.61	0.436
Mean governance	67.67	0.344
High governance (+1 SD)	76.73	0.251

Table 11

Hypothesis Testing Results

Hypothesis	Relationship	Coefficient	t	p	95% CI	Decision
H1	HCT → TF	1.036	6.014	<0.001	[0.699, 1.373]	Supported
H2	FIN → TF	0.120	3.359	0.001	[0.049, 0.191]	Supported
H3	GOV → TF	0.910	5.006	<0.001	[0.553, 1.267]	Supported
H4	HCT × GOV	−1.023	−4.337	<0.001	[−1.486,	Supported

→ TF	−0.560]

The marginal effects results shown in Table 10 support this interpretation. The estimated effect of Human-Centered Technological Readiness on Transformative Finance falls from 0.436 at one standard deviation below mean governance to 0.344 at the mean and 0.251 at one standard deviation above it. Technological readiness, therefore, remains positively associated with transformative finance across the reported governance levels, but its incremental effect becomes smaller as governance quality increases.

Discussion

The results showed that technological readiness, financial innovation, governance quality, and digital infrastructure are important to transformative finance in MENA. This matters because the region is expanding digital financial services while still facing differences in access, technological capacity and institutional development. The findings therefore support an approach that treats financial transformation as the outcome of both technological capability and the institutional setting in which innovation occurs (Al-Smadi, 2023; Broeders & Prenio, 2018).

Human-Centric Technological Readiness has a positive and significant effect on Transformative Finance. Countries with stronger digital capacity, skills and innovation capability are better placed to integrate artificial intelligence, data analytics and digital platforms into financial services. This result is consistent with evidence that technological preparedness supports fintech adoption and digital financial development in emerging economies (Khera et al., 2022; Jagtiani & Lemieux, 2018).

Financial Innovation is also positive and significant. Greater use of digital payments, mobile banking and digital lending is associated with wider financial access and more efficient service delivery. The result agrees with research linking fintech development with financial inclusion and financial-sector modernisation (Al-Smadi, 2023; Cornelli et al., 2023).

Governance Quality has a positive and significant direct effect on Transformative Finance. Stronger institutions can provide regulatory stability, transparency and more credible financial supervision, which can support investment in fintech and digital infrastructure. This finding is consistent with evidence that institutional quality and regulatory

effectiveness contribute to financial-sector development (Alawi et al., 2022).

The interaction between technological readiness and governance quality is negative and significant. This does not offset the positive direct effects of either variable; instead, it indicates diminishing marginal gains from technological readiness as governance becomes stronger. A possible explanation is that mature governance systems combine support for innovation with tighter oversight, consumer protection and systemic-risk controls. This interpretation is consistent with Broeders and Prenio (2018), who emphasize the need to balance fintech innovation, financial stability, and consumer protection. Governance can therefore facilitate financial transformation directly while also shaping the pace at which additional technological capacity produces gains. Digital Infrastructure, which is positive and significant, further shows that connectivity and communication networks remain necessary for fintech services to operate at scale (Kouladoum et al., 2022).

Overall, the evidence points to technological readiness and financial innovation as central drivers of transformative finance, supported by digital infrastructure and governance. The findings are consistent with recent work arguing that digital technology, institutional quality and financial innovation need to be considered together when assessing sustainable financial transformation.

Conclusion

The purpose of this study was to investigate the impact of human-centric technological readiness, financial innovation, and governance quality on transformative finance in fifteen countries across the Middle East and North Africa (MENA) region between 2015 and 2025. All of the direct effects of technological readiness, financial innovation, and governance quality are positive and significant. Digital infrastructure is also important as it depicts the importance of the networks that support digital financial services.

Governance quality and technological readiness have a negative and significant relationship. This implies that good governance does not have an adverse impact on financial transformation; it just has a dampening effect on the incremental impact of increasing technological readiness, perhaps due to increased, or more established, governance systems bringing more oversight and risk management. The findings thus suggest that governance

ought to provide stability to consumers without taking away too much technological experimentation.

Financial transformation in the MENA region thus relies on more than just fintech capacity. It demands technological ability, digital infrastructure, financial innovation, and financial institutions capable of balancing innovation and regulation. This is crucial for more inclusive and sustainable financial systems as these elements are developed together.

Theoretical Implications

The study integrates three pillars of transformative finance—technological, financial, and institutional—to create a comprehensive framework for transformative finance. According to the Diffusion of Innovation Theory, the positive impact of human-centric technological readiness indicates that technological readiness, capabilities, and skills are important to aid the economies in the integration of fintech within financial systems. The outcome is a diffusion argument that brings financial transformation from technology adoption to broader financial transformation.

The findings also contribute to the development of Institutional Theory because the study revealed that governance quality not only has a direct effect but also has a moderating effect. The positive interaction shows that transformative finance can be facilitated by having strong governance through stable regulations and institutional effectiveness, whereas the negative interaction suggests that institutional arrangements can also moderate the marginal effect of technological readiness. Governance is thus not just a background condition; rather, it has an impact on both the extent and the trajectory of the financial transformation enabled by technology.

Practical and Policy Implications

The results have implications for governments, regulators, and financial institutions in the MENA region. Governments must keep investing in broadband, digital infrastructure and digital skills which underpin the use of fintech and financial inclusion. The regulators should design regulatory structures that stimulate innovation, while safeguarding financial stability and consumers. Controlled environments can be provided through the use of regulatory sandboxes, digital-banking licenses, and innovation hubs. Financial institutions, in turn, need to invest in digital transformation and

leverage technology to enhance service delivery and bring services to those who are underserved.

Policy design should also take into account regional variations in the MENA economies. Countries with less developed digital infrastructure should focus on payments, digital infrastructure, digital platforms, and digital literacy. The more technologically sophisticated economies can focus on adaptive regulation, cyber security, data protection, and proportionate consumer protection. If governance is stronger, then the marginal effect of technological readiness in the model would be smaller, so there would be no need for regulation to be unnecessarily restrictive. Regional cooperation on digital finance standards and regulatory knowledge can also ease institutional shortcomings between regions.

Limitations and Future Research

There are several limitations of the current study. Firstly, it applies to 15 MENA countries only and the results cannot be directly generalized beyond the MENA region. Secondly, it is based on secondary aggregate level indicators and composite indicators which fail to capture firm, household, and behavioural dimensions of financial transformation. Thirdly, endogeneity and reverse causality cannot be completely ruled out using the panel structure: higher financial transformation can lead to technological investment and development and better governance of fintech. Dynamic panel estimators, instrumental variables, and other identification methods could be used in future research. It could also investigate nonlinear governance effects, examine how individual MENA economies compare, and explore whether or not there is a difference in moderation between GCC and non-GCC countries.

Author Contribution

Yusra Shehzadi: conceptualization, methodology, formal analysis, investigation, writing – original draft, writing – review & editing, supervision. **Muhammad Yasir Ajaz:** conceptualization, investigation, data collection, resources, writing – original draft.

Conflict of Interest

The authors have no financial or non-financial conflicts of interest in the subject matter or materials covered in this paper.

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The corresponding author will make the data supporting the studys conclusions accessible

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