Evaluating innovation performance for financial technology within the national innovation system: A case study of the Kingdom of Bahrain

Mohammed Al-Mannaei, Odeh Al-Jayyousi, Asif Mahmood, Utz Dornberger, Noor Al-Jayousi

A B S T R A C T

Objective: This article aims to identify the role of ICT infrastructure and knowledge creation on innovation outcomes based on the technology innovation system (TIS) framework to stimulate innovation in financial technology (fintech) in Bahrain.

Research Design & Methods: This study employed the framework of the technology innovation system (as a subset of the national innovation system (NIS)) as a theoretical framework, with variables that were extracted from four major innovation theories. The study evaluated the fintech innovation sector in several commercial banks and government institutions in the Kingdom of Bahrain using a survey questionnaire. The data were collected from 119 respondents, and analyzed through partial least squares structural equation modelling(PLS-SEM).

Findings: The results showed that knowledge creation, ICT infrastructure, and knowledge diffusion impacted innovation outputs through knowledge impact. Moreover, knowledge creation did not affect innovation outputs directly but through knowledge creation.

Implications & Recommendations: The study would be invaluable for the financial managers of fintech industries in implementing strategies as well as for the policymakers in integrating financial technology innovations into the financial system.

Contribution & Value Added: The study uniquely explains the role of knowledge impact between knowledge creation, ICT infrastructure, knowledge diffusion, and innovation outputs.

INTRODUCTION

Researchers have been interested in the national innovation systems (NIS), because of their importance in promoting knowledge-based economies and their impact on economic growth and sustainable development. The NIS concept was developed to better understand and improve countries' innovation performance and competitiveness by analyzing and improving sectoral connections and information flows. Moreover, NIS emphasizes how the right initiatives, incentives, and regulations may help progress technology (Bengt-Åke Lundvall, 1992). Nelson (1993) describes the NIS concept as a group of organizations whose relationships impact the innovative performance of national systems. Raffaelli and Ann Glynn (2015) define NIS as 'institution-enshrined knowledge.' It is

a term that refers to an integrated innovation system that is all-encompassing, innovative, realistic, practical, and valuable (Al-Jayyousi, 2017).

Afterwards, the NIS concept was changed into the technology innovation system (TIS), which describes the nature and pace of technological developments. The TIS is a dynamic network of actors creating, diffusing, and applying technology in a given economy with the help of institutional infrastructure (Fabra, 2019). The central tenet of this approach is that factors affecting technological change can also be found in a larger societal framework beyond the boundaries of specific businesses and research institutes. Importantly, the current study considers TIS as a subset of NIS and uses the latter as a substitute. Building an enabling environment for NIS was a priority for many nations to harness human potential and innovative capabilities (Wang *et al.*, 2019). The NIS comprises several indicators, including innovation outputs, ICT infrastructure, and knowledge creation, dissemination, and its impact. The relationships between these factors have become more critical with the growth of the knowledge economy, in which knowledge is the key element in driving innovation and economic development. The literature has identified knowledge creation and diffusion as two of the main drivers of innovation. Knowledge creation is acquiring and generating new knowledge and diffusing it within the organization (Andreeva, & Kianto, 2011). Meanwhile, ICT infrastructure enables organizations to access and share information and facilitate communication and collaboration (Cai, 2011). While considering these NIS indicators, several research questions arise, including: what is the relationship among knowledge creation, ICT infrastructure, and knowledge diffusion and how does this affect innovation outputs? To what extent does knowledge impact play a role in the relationship between knowledge creation, ICT infrastructure, and innovation outputs?

The purpose of assessing innovation outputs through the lens of the technology innovation system is to examine and evaluate how financial technology (fintech) has developed concerning knowledge and infrastructure. The suspension of daily life due to the outbreak of the Covid-19 pandemic disrupted the financial and banking system in particular. However, fintech proved that it offers ideal solutions for payments and online transactions to meet the needs of customers during disruptions and to comply with new standards for public health (Varea & González-Calvo, 2021). fintech is the use of technology to enhance the delivery of financial services. It uses specialized algorithms and software to assist businesses in better managing their operations. Fintech can range from back-end systems and consumer-oriented services such as robo-advisor, peer-to-peer (P2P) lending, and investment and crypto apps. The emerging platforms and business models in financial technology offer new perspectives and paradigms for researchers and policymakers to transform organizations (Mahmood, 2021). The interplay between fintech and economic performance is underpinned by good governance, human capital, and innovation policy to foster effective NIS (Al-Jayyousi, 2017; Al-Jayyousi *et al.*, 2022).

In this context, the current research contributes to the existing literature by providing a comprehensive understanding of the factors that influence innovation outputs and the role of knowledge impact in this relationship within the non-oil sectors for sustainable development in Bahrain, a member of the Gulf Cooperation Council (GCC). In particular, this article aims to identify the role of ICT infrastructure and knowledge creation on innovation outcomes based on the TIS framework to stimulate innovation fintech in Bahrain. The context of Bahrain provides a unique perspective for understanding the relationship between knowledge creation, ICT infrastructure, knowledge diffusion, and innovation outputs. Bahrain is a small island nation in the Arab region that has made significant efforts to diversify its economy from oil and gas industries to knowledge-based industries, such as finance, ICT, and services. As a result, Bahrain has invested heavily in ICT infrastructure, innovation programs, education, and training initiatives, making it an interesting case study for examining the impact of these factors on innovation outputs. Furthermore, we utilized partial least squares structural equation modelling (PLS-SEM) through SmartPLS to investigate the relationships among the variables. The results of this research will help public and private financial sector managers identify and develop new future strategies for fintech.

The remainder of the article comprises the following sections. The following literature review and hypotheses development sections will provide a critical analysis of previous research on the topic and present testable hypotheses based on the literature review and research problem. The next section

will describe the research methodology, including the data collection and analysis procedures. The results and discussion section will present data analyzed using PLS-SEM in SmartPLS, including the interpretation of results, comparing them with previous research, and offering insights into the implications of the findings. Next, the conclusions will summarize the major findings of the study, their significance, and the contributions of the research to the existing knowledge. Finally, the last section will discuss the research limitations and outline the directions for future research.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Knowledge Creation and Innovation Outputs

Knowledge creation, referred to as knowledge generation, is widely recognized as a key construct of the innovation process (Cepeda-Carrion, 2022; Faccin *et al.*, 2019; Khaksar *et al.*, 2020), with close ties to innovative outputs. Andreeva and Kianto (2011, p. 1010) define knowledge creation as the 'ability to develop new and useful ideas and solutions relating to organizational activities, new products or services, technological processes, and managerial procedures. As a focal part of the innovation process (Quintane *et al.*, 2011), thriving innovation ecosystems create innovative knowledge that leads to innovative outputs (Bramwell *et al.*, 2012). Nonaka and Takeuchi (1995) describe the creation of knowledge as the means that flows between tacit and explicit knowledge. Knowledge creation is a complex process involving the interaction of multiple actors in the fintech innovation ecosystem and optimizing different types of tacit or explicit knowledge at different levels of knowledge (Schniederjan *et al.*, 2020).

Knowledge creation has four indicators reflecting innovative activities to create the knowledge necessary for fintech and to spread as an innovation in the financial and banking field. Knowledge creation encompasses all the determinants considered to be the core of fintech industry innovations. Studies have shown that the creation of innovation and technical knowledge through knowledge diffusion has positively contributed to the economic growth of the countries (Asongu & Tchamyou, 2018).

The outputs of knowledge and technology are also very important. Many studies have indicated that the more clients and the company's employees are aware of the latest innovations as fintech innovation, the more they appear to be ready to use them efficiently (*e.g.*, Chang *et al.*, 2020; Wiseman, & Anderson, 2012). The more knowledge they have, the more tacit knowledge is translated into innovation (Cai, 2011).

Based on these arguments, we hypothesised:

H1: Knowledge Creation has a positive impact on Innovation Outputs.

Knowledge Creation and Knowledge Impact

Knowledge impact includes most of the reports and statistics that represent the impact of innovation activities on the NIS from the micro and macroeconomic levels. This effect can be considered an increase in labour productivity, the intensity of entry of new companies, spending on modern technology programs such as fintech, and industrial production measurement. While knowledge creation is concerned with the continuous transfer, collection and transfer of different types of knowledge as users practice, interact, and learn (Bag *et al.*, 2021). Knowledge creation abilities encourage innovative thinking and competencies in complex situations (Nonaka *et al.*, 2000). It enables the flow of knowledge from outside to create an internal knowledge repository or by utilizing existing knowledge in an innovative and advanced way internally (Robertson, 2020).

The shift in fintech's condition between the possession of technological knowledge and the act of knowing something comes through practice, action, and interaction, which is the driving force in creating new fintech knowledge. Furthermore, for this interaction to be highly productive for innovation in fintech, it is important to support unregulated work environments where creativity and innovation are essential in the fintech ecosystem. Moreover, research conducted by Ravichandran and Rai (2003) showed that knowledge creation has a direct and positive impact on knowledge impact by increasing the rate of innovation, optimizing fintech operations, improving organizational speed, and making better and faster decisions. Therefore, we developed the following hypothesis:

H2: Knowledge creation has a positive impact on knowledge impact.

ICT Infrastructure and Knowledge Creation

The ICT infrastructure includes three sub-variables, that is, information and communication technologies (ICTs), general infrastructure, and ecological sustainability as major components for the success and sustainability of any national innovation system (Cai, 2011). In this regard, ecological sustainability can play a role in the sustainability of the national innovation system. Ecological systems develop a relationship between innovation and social systems because some innovations can potentially lead the world in the wrong direction. Similarly, the better the infrastructure, the easier the means of communication and the environment-friendly means of transportation that would help produce and exchange ideas, services, and goods. Moreover, it will create an ideal environment for the innovation system to work more flexibly through increased productivity and efficiency, lower transaction costs, improved market access, and sustainable growth (Skoczkowski *et al.*, 2020). Thus, the NIS system will have access to information and communication technology, online service by governments, and citizen participation via the Internet. Therefore, the effect of ICTs on the economy through technological and non-technological innovations in a country is influenced by the number of different applications and the development of new products, processes, and organizational models (Andrijauskiene, Dumciuviene, & Stundziene, 2021).

The ICT infrastructure creates a shared knowledge base and best practices across a fintech network in which ICT provides the strength, security, and ease of use of fintech operations (Haddad & Hornuf, 2019). The analysis of the study presents the central role of ICT that plays through the strength of interrelationships with knowledge creation in the accuracy of implementing and supporting financial technology. Furthermore, ICT tools enable knowledge creation to provide best practices by using the areas that are enabled and contribute to their knowledge. It highlights the challenge of improving ICT skills in fintech so that those in charge of fintech programs can expand their ability to transact through the ICT system and maximize its benefits comfortably. Thus, we hypothesised:

H3: ICT infrastructure has a positive impact on knowledge creation.

ICT Infrastructure and Knowledge Diffusion

Knowledge diffusion and integration include four dimensions, all related to the fintech sector in this case and with high-tech content or a key to innovation (Gomber *et al.*, 2018). Knowledge diffusion includes intellectual property (IP) revenue as a percentage of total trade of fintech products and services provided, net high-tech exports as a percentage of total exports, exports of information and communication technology services as a percentage of total trade, and net outflows of foreign direct investment as a percentage of GDP.

The results of statistical analysis and data charts confirmed the significant positive impact of ICT on knowledge diffusion, specifically during the COVID-19 pandemic. It has highlighted the many unconventional benefits of ICT infrastructure, such as cloud infrastructure with its resilience and accessibility to enable a better response to digital customers and increasingly remote workforces (Saqib *et al.*, 2015). This indicates the clear positive relationship between ICT infrastructures and knowledge diffusion. The existence of a new ICT infrastructure, such as the 'information cloud' is considered a model to better respond to the requirements of the growing digital customers, such as the diffusion of knowledge, which contributes to increasing efficiency and expanding the use of the fintech technology sector among customers (Wonglimpiyarat, 2017). Based on these arguments, the following hypothesis was proposed:

H4: ICT infrastructure has a positive impact on knowledge diffusion.

ICT Infrastructure and Knowledge Impact

The results of a study by Bankole and Mimbi (2017) support the dynamics and the main and sub-indicators of the Global Innovation Index, as the data show that they have positive effects and statistical significance in terms of the impact of ICT on the impact of knowledge.

Regarding the impact of ICT, the assessment results generally align with expectations and show that ICT is critical for knowledge creation and that it directly affects customers internally and positively impacts knowledge diffusion (Ode, & Ayavoo, 2020).

H5:　ICT infrastructure has a positive impact on knowledge impact.

Knowledge Impact and Innovation Outputs

The research results by Chang *et al*. (2020) indicate that a reliable knowledge impact can improve productivity, increase efficiency, and reduce costs in the financial sector, leading to effective, innovative outputs. Knowledge impact places combined and integrated effects on knowledge-based innovation at micro and macro levels (Robertson, Caruana, & Ferreira, 2023). It is also confirmed that integrating ICT infrastructure with knowledge increases innovation competitiveness.

Hence, it reduces the risks of fraud in financial technology and financial transactions between users of financial technology (Romānova & Kudinska, 2016). Thus, the following hypothesis was proposed:

H6:　Knowledge impact has a positive impact on innovation outputs.

Knowledge Diffusion and Innovation Outputs

The study by Braunerhjelm, Ding, and Thulin (2020) accepted the hypothesis that the diffusion of knowledge has a direct and positive impact on innovation outcomes, as knowledge creates a culture conducive to innovation and creativity in the financial technology ecosystem. On the other hand, knowledge dissemination activities profoundly impact the specific outputs of the innovation processes that create tacit knowledge. The experience of participation affects the financial technology ecosystem, and these effects play an important role in the knowledge dissemination process. Furthermore, creating sustainable competitive advantage depends upon knowledge diffusion, indicating that the latter is essential to accelerate innovation and maintain competitiveness (Tang *et al*., 2020). It is because knowledge diffusion indicates an inside-out management strategy that depends on inner capabilities to identify and respond to market fluctuations (Day, 2020). Thus, we hypothesiesed:

**H7:**　Knowledge diffusion has a positive impact on innovation outputs.

Knowledge Diffusion and Knowledge Impact

The results of the study by Perez-Trujillo and Lacalle-Calderon (2020) show that the diffusion of knowledge looks at how to diffuse financial technology as new knowledge and its spread in society. Most of the survey and interview data showed how fintech is disseminated as new knowledge in the form of ideas, innovations, technology, products or practices, influencing users, customers and adopters to increase the ability to understand the potential of the transformed knowledge. The presence of gadgets such as smartphones and many other devices managed in the digital computing system helped diffuse knowledge quickly and impressively regarding fintech technology, so it was able to penetrate all aspects of work and daily activities, to meet the needs of daily life (Nakashima, 2018).

Furthermore, the data showed that knowledge diffusion has a direct and positive impact the diffusion of knowledge as an export product of financial technology and ICT infrastructure (Skare & Soriano, 2021), which is measured as a percentage and indicator of the non-oil income of the national economy. Moreover, the data showed that the diffusion of knowledge has a direct and positive impact on the diffusion of knowledge with its impact as the export product of fintech and ICT infrastructure (Chien, Cheng, & Kurniawati, 2020), which is measured as a percentage and an indicator of non-oil income for the national economy.

H8:　Knowledge diffusion has a positive impact on knowledge impact.

Based on these arguments, we formulated a theoretical framework as depicted in Figure 1.
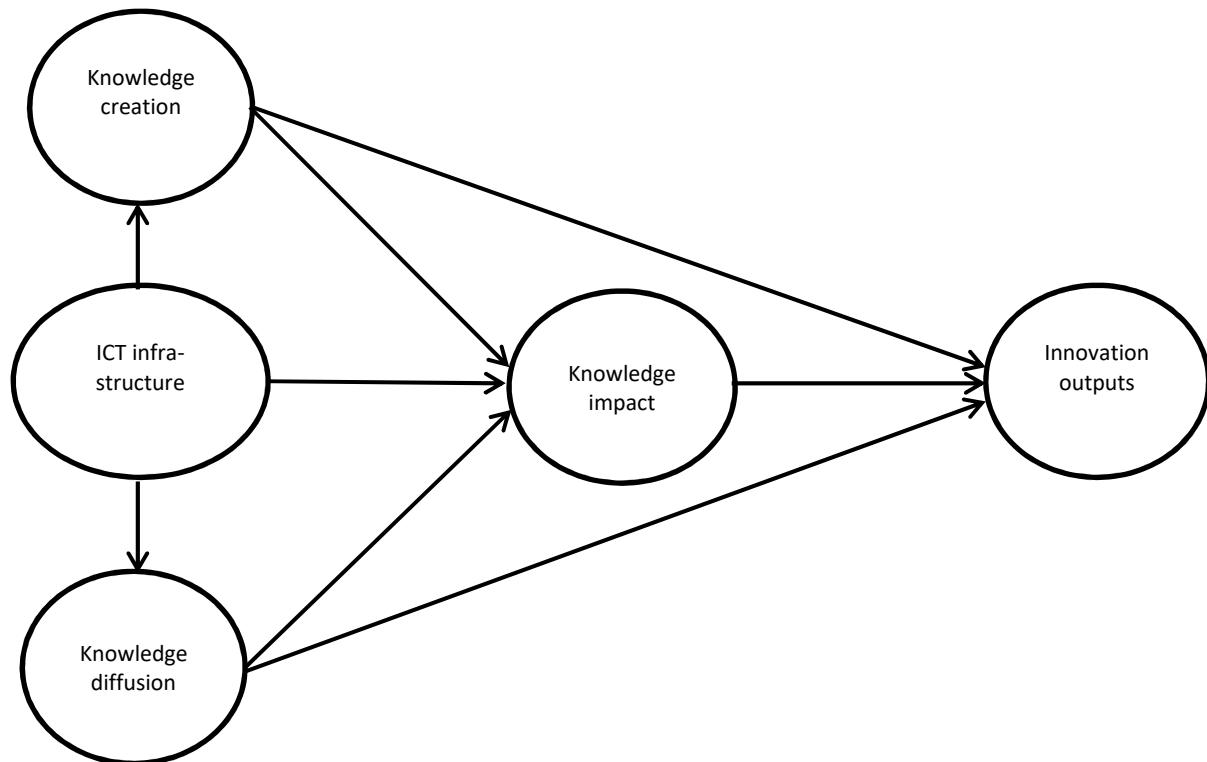
Figure 1. Theoretical framework of the study
Source: own elaboration.

RESEARCH METHODOLOGY

The study adopted the framework based on the NIS. Bahrain was selected for this study, because it is classified as a financial centre in the Middle East in terms of best practices and business environment. Regarding the digital and knowledge economy, Bahrain is the only Arab country that developed fintech legislation. Besides, the Central Bank of Bahrain has allocated a specialized financial technology unit to foster innovation. This makes the Kingdom of Bahrain a suitable candidate for the case study.

Since this research is limited to a specific time frame, a cross-sectional time horizon was used to cover the research objectives. Furthermore, non-probability-based purposive sampling was adopted and the sample members were selected based on their expertise and the nature of their relevant profession. The survey was distributed digitally through the website survey tool (Google Forms) using three digital communication mediums, namely direct email address, contact via instant messaging service (WhatsApp), and posts on social media groups (Twitter and Instagram) that include a number of experts in the field of financial services and the financial technology industry in Bahrain. The data were collected during the research period between 15 January and 15 February 2022. The target population consisted of nine categories representing the public and private sectors in Bahrain. These were the Ministry of Finance (MoF), Economic Development Board (EDB), Central Bank of Bahrain (CBB), and four leading banks providing innovative services in financial technology technologies, in addition to companies emerging in fintech applications and bank customers who use this service. A sum of 98 complete responses was retained out of 119 received. The demographics of the respondents, such as age, gender, and educational level have been shown in Table 1.

The instrument to measure the variables was adopted from the previous studies. The measures containing four items for knowledge creation were adopted from Eisenhardt and Martin (2000). The reported reliability was found to be 0.84. Similarly, knowledge impact was measured through three items adopted from Ravichandran and Rai (2003) with a reported reliability of 0.87. The four items of knowledge diffusion were adopted from Asongu and Tchamyou (2018). The reported Cronbach's alpha is 0.81. Likewise, ICT infrastructure was adopted from Cai (2020). The measure comprises 10 items

with a reliability of 0.88. Lastly, innovation outputs having six items were adopted from Wiseman and Anderson (2012), and the reported reliability is 0.79.

Table 1. Demographics of the respondents

Characteristics	Categories	Frequency	Percentage
Gender	Male	59	50
	Female	60	50
Age	20-29 years	7	6
	30-39 years	59	49
	40-50 years	32	27
	50 years and above	21	18
Education Level	Diploma	4	4
	Bachelor	25	21
	Master	40	34
	PhD	48	41
Experience	less than 5 years	18	15
	5 to 10 years	17	14
	11 to 20 years	48	41
	21 to 30 years	18	15
	Above 30 years	18	15
Position (fintech)	Start-up founders or app developers	8	16
	Heads of dept	17	14
	Software development supervisors	3	30
	CRM assistants	7	40

Source: own elaboration of collected data.

RESULTS AND DISCUSSION

The PLS-SEM measurement model was evaluated in different stages (Figure 2). Table 2 indicates that Cronbach's alpha values for all measures were above 0.7, confirming their reliability (Taber, 2018). The construct validity was evaluated through convergent and discriminant validity. The convergent validity measures how closely are the items of a construct. Table 2 also shows that AVE and indicator reliability (factor loadings) values were above 0.5, thus establishing convergent validity.

Table 2. The construct of reliability and validity

Variables	Cronbach's alpha	rho_A	Composite reliability	Average variance extracted (AVE)	Factor loading range
ICT	0.937	0.941	0.947	0.599	0.707-0.873
IO	0.873	0.878	0.902	0.571	0.737-0.840
KC	0.801	0.805	0.863	0.558	0.732-0.800
KD	0.713	0.715	0.821	0.534	0.720-0.763
KI	0.654	0.660	0.794	0.491	0.713-0.789

Source: own study.

Similarly, discriminant validity measures the extent to which a variable's items differ from other constructs. It was evaluated through a heterotrait-monotrait (HTMT) ratio of correlations. Since HTMT values in Table 3 are less than 0.9, the discriminant validity was established (Hair *et al*., 2021).

To test hypotheses with PLS-SEM, bootstrapping was performed to generate t-values to get significance for the hypotheses. Table 4 shows the path coefficients and the corresponding significance values related to each hypothesis.

The results presented in Table 4 reveal that all significant research hypotheses (H2 to H8) derived from NIS indicators were accepted except H1, which describes the direct effect of knowledge creation on innovation outputs (β=0.015, p>0.5). Hence, it signifies that knowledge creation influences innovation outputs through knowledge impact only. These hypotheses suggest that organizations

investing in knowledge creation, ICT infrastructure, and knowledge diffusion will likely experience higher innovation outputs through knowledge impact. Consistent with the present study, numerous past studies (*e.g.*, Kim *et al.*, 2018; Ben-Akiva, McFadden, & Train, 2019; Haggag *et al.*, 2019) demonstrated that knowledge creation, ICT infrastructure, and knowledge diffusion have a positive influence on knowledge impact and innovation outputs. For example, Asongu and Tchamyou (2018) found that knowledge creation, ICT infrastructure, and knowledge diffusion positively affected innovation outputs in the telecommunications industry in Sub-Saharan Africa.
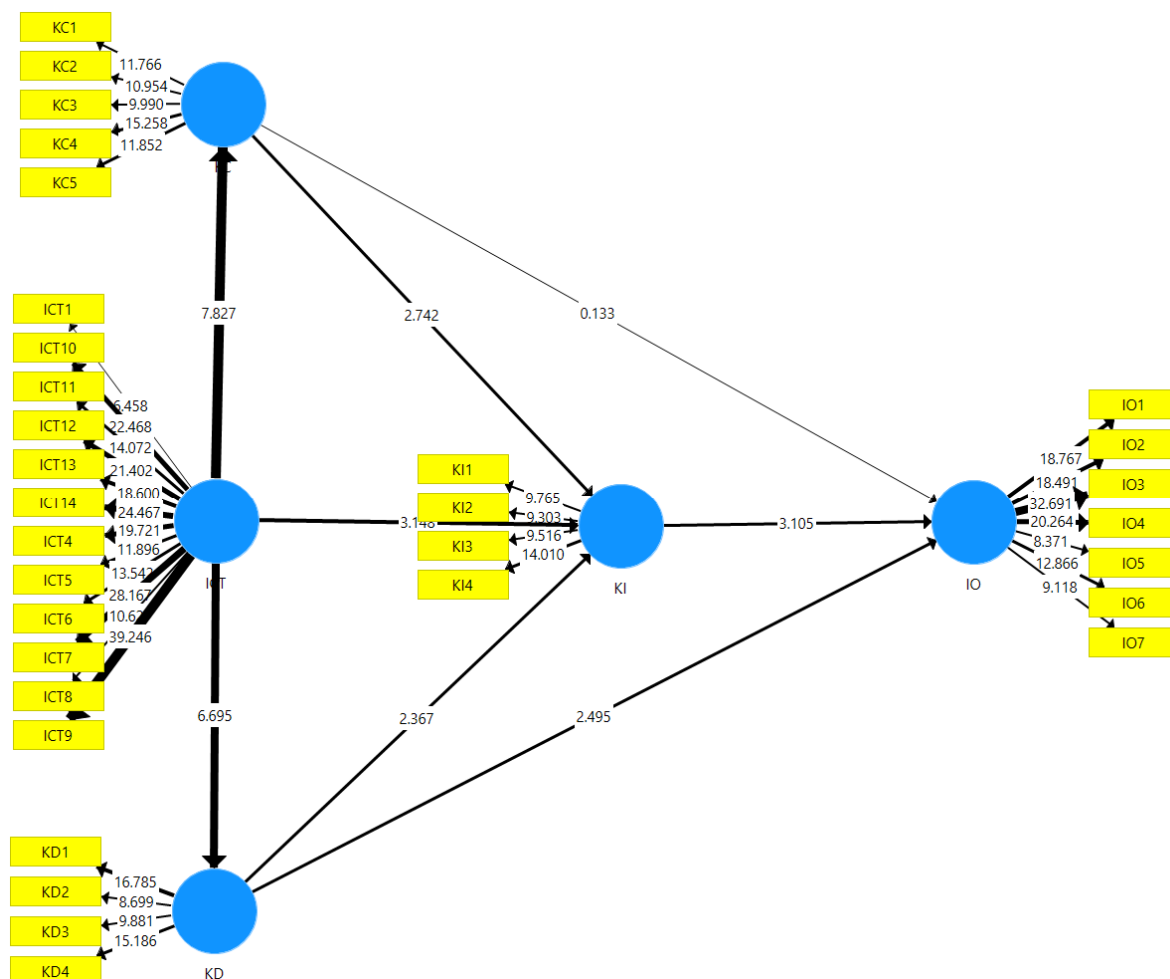
Figure 2. Research model in SmartPLS 3 software
Source: own elaboration in SmartPLS 3.

Table 3. Heterotrait-monotrait ratio (HTMT)

Variables	ICT	IO	KC	KD	KI
ICT					
IO	0.807				
KC	0.669	0.546			
KD	0.676	0.668	0.964		
KI	0.740	0.715	0.871	0.861	

Source: own elaboration.

Similarly, a study by Tuladhar *et al.* (2015) found that knowledge creation, ICT infrastructure, and knowledge diffusion positively affected innovation outputs in the manufacturing industry in Nepal. Additionally, a study by Rahman *et al.* (2019) found that knowledge creation, ICT infrastructure, and knowledge diffusion positively affected innovation outputs in the banking sector in Bangladesh. These

studies provide evidence that knowledge creation, ICT infrastructure, and knowledge diffusion positively affect innovation outputs, which is reflected in this study's findings.

Table 4. Path analysis (hypotheses testing)

Hypotheses	Relations	Coefficient	Standard deviation	T statistics	P values
H1	KC -> IO	0.015	0.112	0.133	0.894
H2	KC -> KI	0.311	0.113	2.742	0.006
H3	ICT -> KC	0.586	0.075	7.827	0.000
H4	ICT -> KD	0.569	0.085	6.695	0.000
H5	ICT -> KI	0.265	0.084	3.148	0.002
H6	KI -> IO	0.323	0.104	3.105	0.002
H7	KD -> IO	0.335	0.134	2.495	0.013
H8	KD -> KI	0.239	0.101	2.367	0.018

Source: own study.

Theoretical Implications

This study contributes to the literature by providing empirical evidence that links knowledge creation, diffusion, ICT infrastructure, innovation performance and knowledge impact. It includes the analysis of Bahrain's NIS framework and fintech ecosystem using empirical data. The national innovation system framework has shifted the emphasis from a quantity-based economy to a quality-based economy for innovation in the banking and financial sector following international standards. Moreover, the research introduces the knowledge impact between ICT infrastructure, knowledge creation, dissemination, and innovation outputs in fintech to improve the delivery of financial services.

This has enabled Bahrain to use fintech as a payment and purchase platform for various financial transactions. It also significantly impacts some customers' willingness to integrate financial technology, and Bahrain's willingness to update legislation in the national innovation system and economic vision to keep pace with digital technologies in general and the financial sector in particular. In this sense, when technological and legal limits are minimal, clients have fewer reservations about utilizing and integrating fintech into financial activities. When technological and regulatory restrictions are high, signalling that most constraints have been overcome, customers are generally willing to incorporate fintech into their daily life, resulting in economic growth and increased GDP. Additionally, when technological restrictions are high and regulatory constraints are low, customers require increased confidence and security to incorporate this technology into their daily lives. On the other hand, if technological constraints are minimal but regulatory limitations are severe, new inventions and alternative solutions will be required to promote integration.

Practical Implications

The results of this study have significant implications for managers and business leaders looking to foster innovation in their organizations. Firstly, it is clear that knowledge creation, diffusion, and ICT infrastructure are all essential factors in driving innovation performance. Managers should create an environment where knowledge is continuously developed, shared, and utilized. Additionally, they should ensure that the necessary ICT infrastructure is in place to facilitate knowledge transfer.

Furthermore, the results reveal that knowledge impact plays an important role between knowledge creation, diffusion, and ICT infrastructure in innovation performance. Therefore, managers must understand that developed and shared knowledge may be challenging to use if it has no impact. Thus, they should make sure that knowledge is meaningful, pertinent, and applicable to the business processes and goals to maximize its benefits. They should also think about creating policies that promote knowledge sharing and collaboration among staff to ensure that the information produced is effectively shared and distributed. They should take into account these findings when developing strategies to promote innovation in their organizations.

Policy Implications

Bahrain provides a unique perspective for understanding the relationships among knowledge creation, ICT infrastructure, knowledge diffusion and innovation outputs. The Kingdom of Bahrain is a small island nation in the Arabian Gulf that has diversified its economy from oil and gas industries to a knowledge-based economy, such as ICT, fintech, and services. In this regard, Bahrain has invested heavily in ICT infrastructure, innovation programs, and education and training initiatives. This makes it an interesting case study for examining the impact of the mentioned factors on innovation outputs.

Since the Kingdom of Bahrain is rapidly embracing fintech as part of Bahrain Economic Vision 2030, the government must evaluate its innovation performance and streams to ensure maximum success. This research highlighted several critical policy implications when assessing fintech in the kingdom. Firstly, the government must create a conducive environment for fintech to thrive in the Kingdom. It can involve establishing knowledge impact by encouraging knowledge creation and sharing. The government can enhance the potential for success with fintech within the Kingdom by creating a benign environment. Secondly, the government should invest in talented people to improve knowledge management and ensure fintech success. This can be accomplished through sponsoring training programs, scholarships, and other incentives to attract the biggest talents from local and global markets.

Thirdly, the government should ensure that the required ICT infrastructure is available for fintech to succeed. It can be achieved through cloud computing, artificial intelligence, blockchain technologies, and secure payment networks. Finally, the government should encourage stakeholders to collaborate to ensure that fintech is successful. It can be guaranteed by setting up industry-wide standards and regulations, as well as creating fora for the exchange of ideas. By following these research implications, the Kingdom of Bahrain can warrant the successful implementation of fintech within the national innovation system. Consequently, it will help drive innovation and develop a more robust and secure financial system.

CONCLUSIONS

This research investigated and assessed the performance of innovation in financial technology concerning ICT infrastructure and knowledge management in the Kingdom of Bahrain, a member of GCC countries. The research contributes to the literature on financial technology by assessing the performance outputs of ICT infrastructure and knowledge management within the framework of the national innovation system by providing insights into financial technology as a contemporary innovation literature for the countries of the Gulf Cooperation Council. Managers of fintech can devise strategies to enhance innovation outputs by making use of ICT infrastructure and managing the knowledge attributes. The research suggests a dire need to integrate financial technology innovations into the financial system, guided by Bahrain Economic Vision 2030. Thus, findings suggest that organizations should focus on creating a conducive environment for knowledge creation and diffusion and invest in ICT infrastructure to enhance innovation outputs.

The research results are consistent with previous studies (*e.g.*, Cai, 2011; Ravichandran & Rai, 2003; Haddad, & Hornuf, 2019). However, the present research has limitations, such as being limited to one country. Therefore, it is recommended for future research to increase the scope of the study by replicating it in other nations across regions and to undertake comparison research between different economic samples.

Despite the novelty and relevance of the research in this article, some limitations should be noted. Firstly, the study focused solely on the impact of knowledge creation, diffusion, and ICT infrastructure on innovation performance in Bahrain. While the results obtained from Bahrain could be generalized to other countries in the Gulf region, future research should include other countries and areas to understand better the impact of knowledge creation, diffusion, and ICT infrastructure on innovation performance across a wider geographical range.

Secondly, the data used were only from recent surveys and archival records. Although a variety of data sources supported the results of the study, future research should utilize additional data sources

to gain more accurate and comprehensive results. Finally, while the study was able to examine the role of knowledge impact in the context of Bahrain, it did not take into consideration the broader implications of knowledge impact in a global context. Future studies could further explore the mechanisms and processes by which knowledge impact mediates the relationship between knowledge creation and diffusion, ICT infrastructure and innovation performance. Future researchers may also survey a bigger group of people as a part of their research. In addition, cross- and in-case analyses should be considered to uncover possible exogenous states in future studies. Further studies could also investigate the influence of other factors, such as organizational culture, on this relationship.

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Authors

The contribution of the authors is equal. MAHAM, OAJ, & UD – conceptualization, literature writing, AM, & NAJ – methodology, calculations, discussion.

Mohammed Al-Mannaei

PhD in Innovation Technology and Innovation Management, a graduate of the College of Graduate Studies, Arabian Gulf University, Bahrain. His research includes research on national innovation systems, disruptive innovation for fintech, innovation and entrepreneurship, innovation and economic growth, innovation and sustainable development, service sector innovation, and public sector innovation.
Correspondence to: Dr Mohammad Al-Mannai, e-mail: mannai2266@gmail.com or mohamedahm@agu.edu.bh
ORCID http://orcid.org/0000-0003-0419-8352

Odeh Al-Jayyousi

PhD, Professor of Innovation Policy, College of Graduate Studies, Arabian Gulf University, Bahrain. His research includes innovation systems, disruptive innovation, green innovation, sustainability, public sector innovation, innovation policy, smart cities, and higher education strategy.
Correspondence to: Prof. Odeh Al-Jayyousi- College of Graduate Studies, Department of Innovation and Technology Management, Arabian Gulf University, Bahrain. e-mail: Odehaj@agu.edu.bh or odjayousi@gmail.com
ORCID http://orcid.org/0000-0002-5137-6628

Asif Mahmood

PhD, Associate Professor of Operations Management, College of Graduate Studies, Arabian Gulf University, Bahrain. His research includes data analytics, machine learning, operations management, and project management involving qualitative and quantitative analyses.
Correspondence to: Dr Asif Mahmood, College of Graduate Studies, Department of Innovation and technology management, Arabian Gulf University, Bahrain. e-mail: asifnm@agu.edu.bh
ORCID http://orcid.org/0000-0003-1416-0390

Utz Dornberger

PhD, Utz Dornberger is a Professor of Development Economics at Leipzig University, Germany. His research includes innovation management in SMEs, innovation policies, the promotion of entrepreneurship, and the internationalization process of businesses. Currently, he is the Director of the International SEPT Competence Center (SME Promotion and Training) at Leipzig University. He is also the founder of in4in-Network (intelligence for innovation) promoting cooperation between universities worldwide in the fields of technology transfer and entrepreneurship promotion.
Correspondence to: Prof. Utz Dornberger, Entwicklungsökonomie/Kleinerer und Mittlerer Unternehmen, Mietobjekt, Ritterstraße, 9-13, Raum 1.5, 04109 Leipzig, e-mail: dornberg@uni-leipzig.de
ORCID http://orcid.org/0000-0002-0267-0310

Noor Al-Jayousi

MSc, Lecturer in digital marketing at the School of Business Technology, Princess Sumaya University for Technology, Jordan. Her research interests include green marketing, ethical marketing, CSR, international marketing, and marketing innovation.
Correspondence to: Ms Noor Al-Jayousi, School of Business Technology, Princess Sumaya University for Technology, Al-Jubaiha 11941 P.O. Box 1438. Amman, Jordan, e-mail: n.aljayyousi@psut.edu.jo
ORCID http://orcid.org/0009-0002-4607-0082

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.