



## **Is Sustainable Performance Affected by Digital Transformation in the Main Centers of Egyptian Governmental Banks? The Mediating Role of Innovation Capabilities**

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### **Abstract**

The examination of the impact of digital transformation (DT) on generating value within governmental banking institutions has captivated the attention of scholars over an extended period, particularly in a dynamic and unpredictable context. Despite the extensive exploration of DT by various governmental banks, both researchers and practitioners have encountered numerous challenges in assessing the integration of DT with SP. This study aims to assess influence of digital transformation (DT) on sustainable performance (SP) of governmental banks-main centers in Egypt, with a focus on the mediating function of innovation capabilities (IC) rooted in dynamic capability (DC) theory. The analysis of quantitative data was conducted using PLS-SEM. The sample comprised of 378 respondents from governmental banks-main centers including the National Bank of Egypt, Banque du Caire, and Banque Misr in Egypt. The results indicated that DT positively influences IC and SP. Furthermore, IC positively impacts SP. Additionally, IC serve as a partial mediator between DT and SP.

**Keywords:** Digital transformation, Innovation Capabilities, Sustainable performance, Dynamic Capability Theory, Governmental Banks.

### **Introduction**

Banks exhibit a substantial reliance on emerging digital technologies as they incorporate both information and financial technologies (**Pramanik et al., 2019**). Not surprisingly, the current legislations promote the heightened transparency of a bank's infrastructure, compelling the availability of systems and account transaction data to be accessible to account-to-account payment systems, cardless payment systems, and

aggregation services (Cziesla, 2014). In addition, the rapid expansion of technologies such as cyber-physical systems, Internet of things, smart factories, and big data, along with the emergence of new competitors in the form of financial technology startups (FinTech), and shifts in customer attitudes and behaviors, serve as catalysts for banks to undergo a transformation and foster innovation (Imran et al., 2018; Pramanik et al., 2019). This has led to a shift in focus from all sectors towards the process of digital transformation (Later denoted as DT), Moreover, DT is ingrained within the framework of the fourth industrial revolution, commonly denoted as Industry 4.0 (Imran et al., 2018).

As a consequence, various industries currently perceive digital transformation as a pivotal approach to augmenting sustainability (Ghobakhloo et al., 2021; Mendez-Picazo et al., 2024). Whereas, the recognition of innovation capabilities as a significant determinant of business performance and outcomes is widely accepted (Nguyen et al., 2023a). Additionally, the effective implementation of digital transformation and the incorporation of innovative methods have a crucial impact on enhancing the competitive standing and financial accomplishments of organizations (Grooss, 2024).

The significance of DT further underscores the importance of innovation capabilities (Later denoted as IC). This capability denotes to the ability to generate or employ innovation activities, enhance or cultivate services or products, introduce novel services or products to the marketplace, and enhance or establish management or production procedures (Zhang et al., 2023). Moreover, Enterprises possessing advanced innovation capabilities can effectively address swift technological changes, consumer preferences, and unforeseen opportunities, while actively conforming to the competitive market and surrounding circumstances (Um, 2017). Moreover, in the financial services sector, the concept of innovation is perceived as the process of originating and promoting novel financial tools, technologies, establishments, and markets. These innovations serve to enhance the availability of information, facilitate trading activities, and provide various methods of payment (Harsono & Suprapti, 2024; Solans, 2003). When organizations have the capabilities and assets to introduce innovations to the market, they can sustain a competitive advantage and improve their capability for innovation, both of which directly impact their overall performance (Alghamdi & Agag, 2024; Zheng et al., 2022).

As the importance of environmental issues increases, organizations and banks are encountered with the requirement to actively participate in the effective mitigation of environmental burdens. While the financial sector is typically not viewed as enough environmentally conscious, banks have the potentiality to make a significant and profitable contribution by undertaking initiatives aimed at minimizing the effects of climate change, thereby achieving sustainability (Grijalvo & García-Wang, 2023). The issue of sustainability in the banking sector and its influence on performance has gained significance in contemporary society, as the primary distinguishing element lies in the capacity of banks to fulfill sustainability or community reinvestment requirements (Bhaskaran et al., 2023).

Moreover, According to the study conducted by Lizarelli et al. (2023), various service industries such as banking, healthcare, utilities, and maintenance act a crucial part in the economic growth and progress of a nation. Further, The study of Do et al. (2022) observed the positive role of DT on performance was more pronounced in larger banks. Hence, it can be inferred that the effectiveness of digital transformation is contingent upon the scale of the

bank. And so, the current study was executed on the main centers of governmental banks in Egypt due to their large scale and significance, as they assume responsibility for formulating policies, procedures, and directives, and incorporate the most recent technological advancements, which will facilitate the researcher in implementing her study.

A limited number of studies utilize IC as a mediator, as evidenced by the works of **Bamfo and Kraa (2019)**, **Borah et al. (2022)**, and **Al Koliby et al. (2024)**, among others. Similarly, innovation capabilities have also been examined as a moderator, as demonstrated by the studies conducted by **(Odoom & Mensah, 2019)**, **(Fan et al., 2021)**, and **(Zhang et al., 2023)**. Likewise, several studies have explored the link between DT and its positive consequences on SP, as exemplified by the research conducted by **(Li, 2022)**, **(Acosta-Prado & Tafur-Mendoza, 2024)**, and **(Xu et al., 2023)**. Additionally, other studies showed an interest in investigating the relationship amidst IC and their positive effects on SP, as observed in studies of **(Borah et al., 2022)**, and **(Al Koliby et al., 2024)**. Moreover, certain studies have focused on the nexus between DT and IC, as evidenced by the works of **(Zhang et al., 2023)**. Furthermore, several studies have utilized DT as an independent variable, highlighting its importance and positive impact in various sectors such as the textile and logistics industry **(Imran et al., 2018)**, commercial banks **(Do et al., 2022)**, and manufacturing industries **(Frank et al., 2019)**. This analysis existing in the literature review confirms the novelty of the study and identifies the existing study gap. Thus, this study endeavor purposes to examine the correlation between the above various factors in Egyptian governmental banks-Main centers (Later denoted as EGB-MCs). Consequently, the study questions can be framed as follows:

1. Does DT impact employees' IC in the EGB-MCs?
2. Do employees' IC impact SP in the EGB-MCs?
3. Does DT impact SP in the EGB-MCs?
4. Does IC play a mediating role in the link between DT and SP in the EGB-MCs?

Through an analysis of the connections among DT, IC, and SP, scholarly investigation within this domain can furnish governmental banks-main centers with practical perspectives to establish a more conducive work atmosphere, boost sustainable performance, and enhance overall business results.

## **Literature Review**

### **Theoretical background**

This study, which is based on dynamic capability (DC) theory, examines how DT contributes to SP by employing IC as a mediating function. DC theory is perceived as a continuation of the resource-based view (RBV) **(Teece, 2007)**, and DC is commonly referred to as “the firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments” **(Teece et al., 1997, p. 516)**, which evaluate the ability of the organization to reform existing skills and acquire new ones, and facilitate the advancement of the overarching goal of gaining a competitive edge **(Teece, 2020)**.

Moreover, a DC theory is regarded as one of the most significant theories in the subject of business and technology management study **(Al-Omush et al., 2023)**, and has been commonly applied in the body of existing literature on digital transformation **(Al-Omush et al., 2023; Kokshagina, 2021; Li, 2022; Martínez-Peláez et al., 2023; Papadopoulos et al.,**

2022; Su et al., 2023). Additionally, DC theory used in previous studies related to IC (Alghamdi & Agag, 2024; Blaique et al., 2024).

### **Digital transformation**

The process of digital transformation (DT) is deemed essential for all enterprises and communities, with the banking sector standing out as one of the industries experiencing significant repercussions from its effects (Buck et al., 2023; Porfirio et al., 2024). DT is associated with the transformations that digital technologies occur in the business model, culture, products, processes, and structures of an organization (Porfirio et al., 2024). To achieve outcomes and thrive, DT must engage the expertise of skilled employees and leaders through the utilization of technology, thereby fostering the creation of new products and services (Mergel et al., 2019; Nadkarni & Prügl, 2021).

Moreover, DT defined as “a Fundamental change process enabled by digital technologies that aims to bring radical improvement and innovation to an entity [e.g., an organization, a business network, an industry, or society] to create value for its stakeholders by strategically leveraging its key resources and capabilities” (Gong & Ribiere, 2021, p. 10). The researchers concluded that DT can be characterized as “the utilization of digital technologies, such as Big Data (BD), Cyber-Physical Systems (CPS), and Internet of Things (IoT), in both the public and private sectors. The purpose of this application is to serve to the needs and desires of shareholders and stakeholders while simultaneously generating value for the entities, placing them in a favorable position relative to their competitors”.

The historical progression of DT encompasses the stages of digitization, digitalization, and digital optimization (DO). The process of transitioning from digitization to DT is predicated on the existing level of technology (Lozic, 2019). In the meantime, digitization is defined as the conversion from analog to digital format, which is an inevitable, irreversible, rapid, and ubiquitous process (Schreckling & Steiger, 2017). Digitalization, on the other hand, denotes to the utilization of digital technologies to alter business model and generate new sources of revenue and value. It constitutes the shift towards a digital business (Gartner n.d.). Additionally, DO denotes the employment of digital technology to enhance current operational processes and business models (Patel, 2019). Finally, DT involves the incorporation of digital technology into all facets of a business, necessitating vital changes in culture, operations, technology, and value delivery (Lozic, 2019). Consequently, when and how a business progresses from digitization to digitalization to DO to DT is aptly referred to as "The Digital Journey" of said business (Gagre, 2018).

### **Innovation Capabilities**

In the realm of banking, banks have been making significant strides in enhancing and broadening their array of services through the incorporation of cutting-edge technologies. This integration serves to expedite service delivery processes, enhance the quality of services offered, and provide customers with tailored experiences (Ngo et al., 2022). Moreover, in the financial services sector, the concept of innovation is perceived as the process of originating and promoting novel financial tools, technologies, establishments, and markets. These innovations serve to enhance the availability of information, facilitate trading activities, and provide various methods of payment (Harsono & Suprpti, 2024; Solans,

2003). According to **Frishammar et al. (2012)**, to achieve effective innovation, banks must strengthen their innovation capability (IC).

Furthermore, IC is deemed as the indispensable component of organizational performance (**Le & Lei, 2019; Mone et al., 1998**). On one hand, sustained corporate growth is intricately linked to innovation capability (**Yang, 2012**). The occurrence of innovation is contingent upon the organizational capability to innovate. Hence, innovation is regarded as an outcome, while IC is considered as an input (**Aas & Breunig, 2017; Blaique et al., 2024; Hill et al., 2015; Kamal et al., 2023; Laforet, 2011; Rajapathirana & Hui, 2018**). The concept of innovation capability is distinguished from performance, as it pertains to the readiness and capacity of a firm, often referred to as its "muscles for innovation" (**Börjesson & Elmquist, 2011**). Innovation capability refers to resources' availability, collaborative structures, and processes to tackle challenges (**Laforet, 2011**).

### **Sustainable Performance**

It is widely acknowledged that the contemporary concept of sustainability originated from the UN Stockholm Conference on the Environment in 1972, as well as subsequent discussions in the 1970s regarding the limitations of growth (**Al-Shihri, 2013; Choy, 2015; Warhurst, 2002**). Furthermore, the Stockholm International Conference had a singular focus on environmental matters and saw the participation of 113 governments and officials from 19 international organizations (**Paul, 2008; Vogler, 2014**). The World Commission on Environment and Development, established in 1983, performed a significant role in promoting the notion of sustainable development. Sustainable development, as defined by the Commission (commonly known as the Brundtland Commission), is attributed as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (**MacNeill, 1987**).

Furthermore, numerous banks, in response to the imminent perils posed by rapid climate change, have made steadfast commitments to incorporate environmental considerations into their decision-making processes (**Mirza et al., 2023**). A prevalent risk encountered by banks is the environmental hazard engendered by factors such as emerging environmental regulations or shifting consumer preferences, which possess the capacity to exert a detrimental impact on the performance of borrowing enterprises, ultimately propelling them toward default if they engage in environmentally harmful activities (**Mirza et al., 2023**).

However, to persistently generate value, enterprises are compelled to allocate resources for the pursuit of sustainability (**El Hilali et al., 2020**). Therefore, it is imperative for organizations that are dedicated to the concept of sustainable development to shift their attention toward a triple bottom line strategy that emphasizes sustainable performance (**Hollos et al., 2012**). This particular approach encompasses the convergence of economic, environmental, and social performance (**Ding et al., 2023; Fok et al., 2023; Geng et al., 2017; Shoab et al., 2022**).



## Hypothesis Development

### *Digital Transformation and Innovation Capabilities Studies*

Moreover, the study of **Sánchez Ramírez et al. (2022)** examined influence of digitalization on IC. The study sampled 78 companies operating in the IT, programming sectors, technology, consulting in Spain. The study's findings revealed that digitalization positively impact both IC. Further, **Suwanto et al. (2022)** inspected effects of DT, on IC. Moreover, the study sample comprised 380 SMEs located in Tangerang City. Results revealed that digital transformation does not positively impact IC.

The research by **Nguyen et al. (2023b)** investigated the influence of DT on IC. The data for this research was collected from a sample of 306 responses, specifically from SMEs in Vietnam. The study's findings indicated that DT positively impact IC. The research executed by **Jiang and Wang (2024)** examined the influence of DT on innovation capability. The participants of this study were companies listed in China from the year 2012 to 2022. The findings indicated DT, as well as IC plays a positive role in improving the link between DT and speed of internationalization.

**Yang et al. (2023)** conducted an examination into the influence of DT on IC. Information was collected from manufacturing firms listed on the A-share market in China spanning the years 2011 to 2019. The results indicated a positive relationship between DT and IC. The research conducted by **Jin and Wu (2024)** delved into examining the impact of DT on IC. Information was gathered from the publicly traded companies in the manufacturing sector in Shanghai and Shenzhen A-shares during the period from 2016 to 2021. The findings revealed that there exists a positive relationship between DT and IC.

Further, the integration of novel technologies can simultaneously present lucrative prospects and intricate obstacles to enterprises endeavoring to foster novelty; thus, it will be crucial to assess the ramifications of DT on the capabilities for innovation (**Sánchez Ramírez et al., 2022**). Therefore, the researcher hypothesizes:

**H1:** DT positively impacts IC in EGB-MCs.

### *Innovation Capabilities and Sustainable performance Studies*

As per DC theory, IC is frequently regarded as a fundamental element of DC (**Acosta-Prado & Tafur-Mendoza, 2024; Parashar & Singh, 2005**). Innovation capability emphasizes the acquisition, investigation, and execution of novel prospects and undertakings both within and beyond the confines of the organizations. Dynamic and innovation capabilities are distinct to each firm and exhibit variability, seeking to modify, arrange, and embrace new procedures to improve performance of the organization (**Hudnurkar et al., 2023**).

Nonetheless, **Borah et al. (2022)** conducted a study that delved into the correlation IC and SP. The study involved a sample of 549 individuals comprising CEOs, managers, and executives from various sectors including construction, manufacturing, services, and high-tech SMEs in China. The findings highlighted that IC positively impact performance of sustainable SMEs.

The study of **Hudnurkar et al. (2023)** explored the correlation between IC, measured by process, product, and managerial innovation on sustainability of corporations, encompassing economic, environmental, and social sustainability. The sample was 155 managers from top and mid-levels within the micro, small, and medium enterprises (MSME) sector in the manufacturing industries of India. The study's results indicated that IC positively impact corporate sustainability.

In addition, **Mukhtar et al. (2024)** assessed impact of green technology innovation (GTI) on SP employing IC as a moderator within 204 manufacturing companies in Malaysia. The findings indicate that the extensive implementation of GTI positively influence SP, encompassing environmental, economic, and social aspects. Furthermore, the relationship between GTI and SP is positively moderated by IC. Thus, the researcher proposes:

**H2:** IC positively impacts SP in EGB-MCs.

### ***Digital Transformation and Sustainable Performance Studies***

The study of **Li (2022)** investigated influence of DT on SP (specifically economic and environmental aspects). With a sample size consisting of 223 individuals holding positions as CEOs, operations managers, or IT managers within Chinese companies, it was revealed that DT exerts a positive influence on economic performance. Conversely, DT negatively affect environmental performance in Chinese companies.

Additionally, **Xu et al. (2023)** assessed influence of DT, encompassing digital capability and strategy, on SP, encompassing environmental, social, and economic aspects. The study consisted of a sample of 210 middle and senior managers employed within Chinese manufacturing companies. The findings revealed a significant enhancement in SP as a result of DT.

The study of **Alathamneh and Al-Hawary (2023)** identified the influence of DT, encompassing CPS, smart factories, BD, and IoTs, on sustainable performance, with regards to social, economic, and environmental factors. A total of 397 managers from diverse levels of industrial enterprises within the Amman stock exchange were surveyed. It was deduced that the various dimensions of DT positively influence on SP, with big data proving to have the most significant impact.

**Chen et al. (2024)** examined the correlation between DT and SP. The study involved a sample of 440 managerial staff in various industries in China. It was observed that DT had a positive effect on SP. Furthermore, **Sun et al. (2024)** delved into the examination of influence of DT on SP. A total of 3947 Chinese firms listed in the sample. The findings of the research underscored a noteworthy correlation between DT and SP. Consequently, the researcher posits:

**H3:** DT positively impacts SP in EGB-MCs.

### ***The mediating role of innovation capabilities***

The investigation carried out by **(Ylijoki et al., 2018)** scrutinized the concept of IC as a mediator in the linkage between big data and business model. A total of 430 buses operating in urban and suburban regions of Finland were included in the sample. The findings provided

evidence supporting the role of IC as a mediating factor in the association between big data attributes and the business model.

The investigation conducted by **Taleb et al. (2023)** scrutinized the mediating function of IC in the association amid entrepreneurial resources (ER) and micro business performance (MBP). The sample was 455 female entrepreneurs in Malaysia. The findings divulge that innovation capability acts as an intermediary in the relationship between ER and MBP.

**Alaskar (2023)** examined the role of IC as an intermediary factor in the relationship between business analytics and firm performance. A total of 386 surveys were collected from business analytics specialists working in Saudi Arabian companies. The findings provided empirical evidence supporting the mediating effect of IC in the linkage between business analytics utilization and firm performance.

Furthermore, **Yang et al. (2023)** conducted an examination on the intermediary function of dynamic capabilities and its various components (particularly absorption capacity, innovation capability, and adaptive capacity) in the relationship between DT and the innovation of low-carbon technologies (LCTI). The study focused on A-share Chinese manufacturing companies from 2011 to 2019. The results demonstrated that dynamic capabilities act as a mediation within enterprises, which subsequently foster the advancement of low-carbon technology innovation. Hence, the researcher suggests:

**H4:** IC mediates the link between DT and SP in EGB-MCs.

### ***Research Conceptual model***

The evaluation of Innovation Capabilities (IC) as an intermediary in the correlation between Digital Transformation (DT) and Sustainable Performance (SP) grounded on dynamic capability theory distinguishes this research due to the absence of any previous examination of the proposed framework. The suggested theoretical model is depicted in Figure 2.3.

### **Methodology**

#### **Data Collection**

The current research employed a survey methodology to gather information from both Mid and Top-level management in EGB-MCs through structured questionnaire endorsed by previous researchers. The survey was designed using Google forms, then distributed to the targeted respondents. The study employed the PLS-SEM methodology for quantitative examination through implementation of SmartPLS 4.0 version 4.9.6. Furthermore, the sample was 378 and the response rate is 94.5%.

The questionnaire adopted from prior research in English before being rendered into the Arabic language, which is the common linguistic medium for all participants, employing the back-translation method by the researcher. The translated version was further scrutinized by a proficient translator. The significance of utilizing the native language cannot be overstated as it is crucial for the participants to comprehend and fulfill the questionnaire requirements (**Bulmer & Warwick, 1993**).



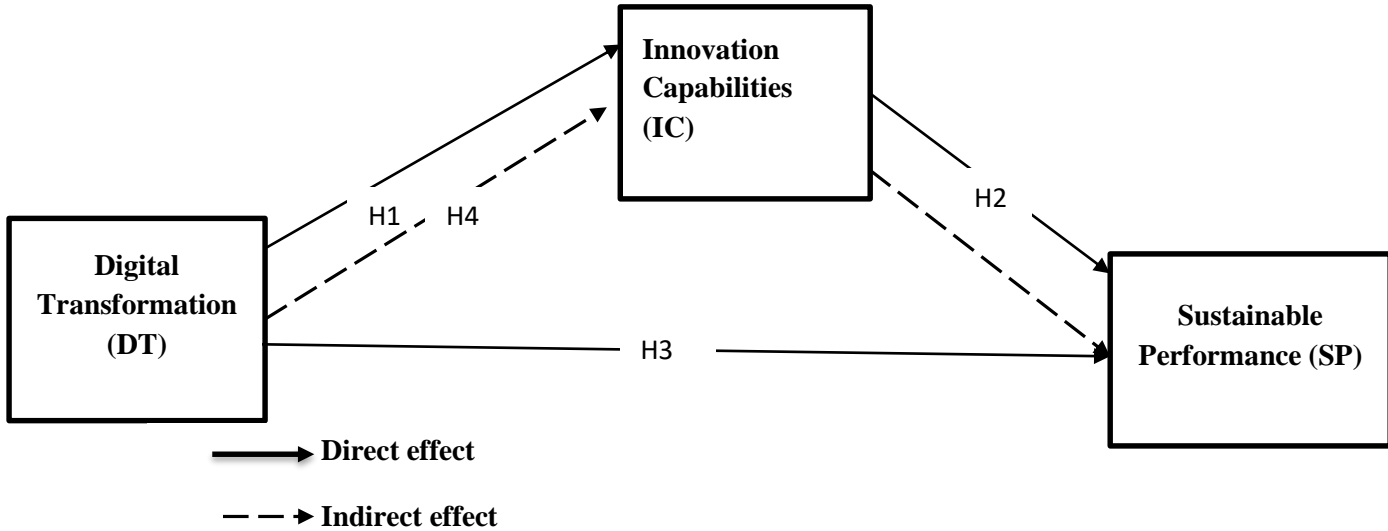


Fig. 1. Study's theoretical framework.

### Measurements

Digital transformation was assessed using 13-item scale adapted from (Imran et al., 2018). Concerning sustainable performance, the construct was evaluated using 13 items adopted from Al Koliby et al. (2024). Moreover, innovation capabilities was measured using 5 items adopted from (Odoom & Mensah, 2019), which is used also by (Fan et al., 2021).

### Data Analysis

In this study, SmartPLS version 4.9.6 was employed for data analysis, encompassing the scrutiny of both the measurement model and structural model of the constructs being studied. Nevertheless, it is crucial to acknowledge that the concurrent gathering of data for all variables from a single source introduces the possibility of common method bias (CMB) influencing the findings (Rehman et al., 2021).

The current investigation employed Harman's single-factor test to ensure data integrity, revealing that a single factor accounted for merely 45.59% of the overall variance, falling short of the accepted threshold of 50.0% (Podsakoff et al., 2003). According to Hair et al. (2019), researchers can utilize the inner variance inflation factor (VIF), referred to as the full collinearity method, through the SmartPLS 4.0 software tool.

The methodology utilized for the CMB results demonstrated the absence of data CMB due to VIF values being maintained at  $\leq 3$ , as indicated in Table II. According to Bagozzi et al. (1991), the correlation matrix can also be utilized to identify potential bias, which becomes apparent when correlations between constructs exceed 0.9, as suggested by Tehseen et al. (2020). However, no correlations were found to be equal to or greater than 0.9, as shown in Table III.

## Results

### Demographics

Table 1 demonstrates that among 378 participants, the preponderance of individuals identified as male, totaling 224 (59.3%), while the female participants accounted for 154 (40.7%). Furthermore, the bulk of the survey respondents belong to the demographic of relatively youthful managers, particularly falling within the age bracket of 30 to under 40 years old (39.4%). Moreover, a substantial portion of these participants possess between 5 to above 15 years of experience (48.9% and 44.7%, respectively), thereby enhancing the reliability of their answers. It deserves noting that the highest proportion of participants, accounting for 238 (63%), hold mid-level positions, while 140 (37%) are in top-level management. Additionally, the National Bank of Egypt stands out with the largest representation of participants at 227 (60.1%), followed by Banque Misr with 90 (23.8%), and the least number of participants hails from Banque du Caire, totaling 61 (61.1%).

### Measurement Model Assessment

According to the assertion made by **Hair et al. (2019)**, the utilization of SmartPLS 4.0 for confirmatory factor analysis was examined by means of a measurement model. This model encompasses various aspects such as individual item reliability, internal consistency, content, convergent, and discriminant validity. The assessment of individual item reliability was conducted by analyzing the outer loadings of items associated with a specific dimension as proposed by **Hair et al. (2019)**. It was recently suggested by **Hair et al. (2019)** that the factor loading should be equal to or greater than 0.7; the values obtained in this particular study ranged from 0.706 to 0.873, all of which exceeded the threshold of 0.7 (Table 2). As per the findings of **Hair et al. (2019)**, it is recommended that CA values surpass the 0.7 threshold. The specified threshold values within this study varied from 0.809 to 0.887. In terms of Internal consistency reliability, **Hair et al. (2019)** stipulates that the composite reliability (CR) should be equal to or greater than 0.7. The CR coefficient values in this particular study were reported to range from 0.867 to 0.930, as indicated in Table II. Concerning convergent validity, **Fornell and Larcker (1981)** suggested that AVE should exceed 0.5. The AVE figures for the lower-order constructs examined in this research ranged from 0.538 to 0.815, thereby validating a satisfactory degree of convergent validity (see Table 2).

Regarding the concept of discriminant validity, as highlighted by **Fornell and Larcker (1981)**, it is essential that the square root of the AVE for each construct surpasses the inter-correlations between the construct and other constructs within the model. The discriminant validity of the findings is illustrated in Table 3. The investigation evaluated discriminant validity through the comparison of the square root of AVE with the corresponding inter-correlation coefficients. In order to establish discriminant validity, it is necessary for the AVE to exceed the respective inter-correlation coefficients, as demonstrated in Table 3.

Table 1. Demographic information of respondents.

	<b>Item</b>	<b>Frequency</b>	<b>Percent (%)</b>
<b>Gender</b>	Male	224	59.3
	Female	154	40.7
<b>Age</b>	Below 30 years	23	6.1
	from 30-40 years	149	39.4
	from 41-50 years	138	36.5
	Above 51 Years	68	18
<b>Experience</b>	Below 5 years	24	6.3
	From 5-15 years	185	48.9
	Above 15 years	169	44.7
<b>Job Level</b>	Mid	238	63
	Top	140	37
<b>Bank Name</b>	National Bank of Egypt	227	60.1
	Banque Misr	90	23.8
	Banque du Caire	61	16.1

Table 2. Measurement model.

<b>Constructs</b>	<b>Item Code</b>	<b>Factor Loading</b>	<b>CA</b>	<b>CR</b>	<b>AVE</b>	<b>Inner VIF</b>
Digital Transformation (DT)	DT1: We consistently analyze the innovative opportunities for the strategic application of big data analytics.	0.776	0.887	0.930	0.815	2.437
	DT2: When considering investments in big data analytics, we engage in estimating the impact of such investments on the employees' productivity.	0.814				
	DT3: In our bank, business analysts and line people meet continually to discuss important matters.	0.828				
	DT4: In our bank, the responsibility for developing big data analytics is clear.	0.834				
	DT5: Cyber Physical system offers substantial computational resources that supports services and operations.	0.797				

	DT6: Cyber Physical system improves local storage and processing capacity.	0.868				
	DT7: Cyber Physical system offers unparalleled opportunities for innovation.	0.84				
	DT8: Cyber Physical system offers means to deal with issues, problems, and threats.	0.873				
	DT9: The Internet of Things offers quick access for customers and reduces overall costs.	0.738				
	DT10: The Internet of Things assists in enhancing production capacity.	0.749				
	DT11: The Internet of Things enables the connection of all devices to the internet which assists in production procedures.	0.782				
	DT12: The Internet of Things enables better communication among employees.	0.783				
	DT13: The Internet of Things offers a connection between customers and the bank and leverages the level of customer satisfaction.	0.706				
Innovation Capabilities (IC)	IC1: There is a generation of novel product ideas constantly in this bank.	0.706	0.814	0.871	0.574	2.450
	IC2: We are always searching for novel approaches to do things.	0.727				
	IC3: Our operational procedures are creative.	0.82				
	IC4: This bank is in usual a pioneer in the marketplace.	0.75				
	IC5: This bank is capable of introducing new services/products every five years.	0.781				
Sustainable Performance (SP)	SP1: Our bank has enhanced compliance with ecological standards.	0.751	0.928	0.938	0.538	
	SP2: Our bank has lowered energy consumption.	0.704				
	SP3: Our bank has lowered CO2 emissions.	0.756				

	SP4: Our bank has lowered the hazardous materials' consumption.	0.745				
	SP5: Our bank has designed products and services to be reused, repaired or recycled.	0.74				
	SP6: Our bank has improved the overall welfare of stakeholders.	0.762				
	SP7: Our bank has lowered environmental effects and dangers to the general public.	0.77				
	SP8: Our bank has enhanced occupational health and safety of employees.	0.709				
	SP9: Our bank has developed the awareness and safeguard of the rights and claims of the served community.	0.731				
	SP10: Our bank has enhanced its market share.	0.709				
	SP11: Our bank has enhanced its market position.	0.707				
	SP12: Our bank has boosts its profits.	0.74				
	SP13: Our bank has boosts its return on investment	0.706				

Table 3. Discriminant validity.

<b>Constructs</b>	<b>DT</b>	<b>IC</b>	<b>SP</b>
DT	<b>0.854</b>		
IC	0.758	<b>0.758</b>	
SP	0.731	0.730	<b>0.733</b>

AVE is bold

### Structural Model Assessment

As previously mentioned, the current investigation employed the PLS-Algorithm and bootstrapping methodology with 5,000 bootstraps as suggested by (Hair et al., 2019) to calculate the path coefficient value and their corresponding significance level. The outcomes presented in Table 4 demonstrate that the R<sup>2</sup> for in this particular research stands at 0.590 for IC. This finding indicates that 59% of the variations in IC can be due to DT, while 65.3% of the variances in banks' sustainable performance can be ascribed to DT and IC. Cohen (1998) postulated that R<sup>2</sup> values of 0.60, 0.33, and 0.19 are deemed to be substantial, moderate, and



weak, respectively. In accordance with **Cohen (1998)** guidelines, this study demonstrated that it possesses considerable predictive capability for the sustainable performance of banks in emerging economies.

In addition to  $R^2$  metric, the current research also employed the cross-validated redundancy measure along with effect sizes ( $f^2$ ) and ( $q^2$ ) to evaluate the proposed model and confirm the outcomes (**Ringle et al., 2012**). The model proposed by (**Hair et al., 2019**) indicated predictive relevance when the effect size  $q^2 > 0$  was observed (Table 4). Analysis of the effect sizes for DT, IC, and SP in this study revealed there is a predictive relevance for some variables and not for another, given that values of 0.02, 0.15, and 0.35 are classified as small, medium, and large respectively (**Cohen, 1998**). Furthermore, SRMR is commonly utilized as "a definitive measure of fit: a score of zero signifies an ideal fit, while a score below 0.08 is deemed satisfactory" (**Hu & Bentler, 1999**). Table 4 demonstrates that the current study exhibits sufficient goodness of fit.

Table 5 and Figures II illustrate the study’s findings, indicating that DT has a notable impact on IC of banks’ employees. Specifically, the analysis indicated that DT positively affect IC ( $\beta = 0.768, p = 0.000$ ), thereby confirming the support for H1 as depicted in Figure II. This implies that the transition of banks from conventional to digital approach could potentially enhance the IC of their employees.

The hypothesis testing’s results reveal a significant finding indicating a positive correlation between innovation capabilities and sustainable performance ( $\beta = 0.430, p < 0.000$ ). This suggests that enhancing the innovation capabilities of employees by governmental banks leads to an improvement in their sustainable performance. Consequently, H2 receives empirical support.

Table 4. Model strength.

Construct	Determination Coefficient ( $R^2$ )		Effect Size				SRMR
	$R^2$	Adj. $R^2$	SSO	SSE	$Q^2 (= 1 - \frac{SSE}{SSO})$	$F^2$	
Digital transformation			1860	1134.000	0.390	0.219	0.063
Innovation capabilities	0.590	0.589	1890	1270.213	0.328	0.218	
Sustainable performance	0.653	0.651	4914	3221.151	0.344		

Table 5. Direct Hypotheses testing.

Hypothesis	Relationship	Path coefficient	Std.deviation	t-value	P-value	Result
H1	DT→IC	0.768	0.024	31.955	0	Confirmed
H2	IC→SP	0.430	0.056	7.624	0	Confirmed
H3	DT→SP	0.430	0.058	7.428	0	Confirmed

The findings indicate that DT positively influence SP ( $\beta = 0.430, p < 0.000$ ), thereby confirming H3 as depicted in Figure 3.2. This means that transforming the processes and business models of banks from conventional to digital will leverage the level of SP for governmental banks in Egypt.

The fourth aim of the research is to ascertain the intermediary function of IC in the correlation between DT comprising its three facets and the SP of governmental banks. The results suggest that IC serves as a partial mediator in the association between DT and SP ( $\beta = 0.330, p\text{-value} = 0.000$ ), thereby corroborating hypothesis H4.

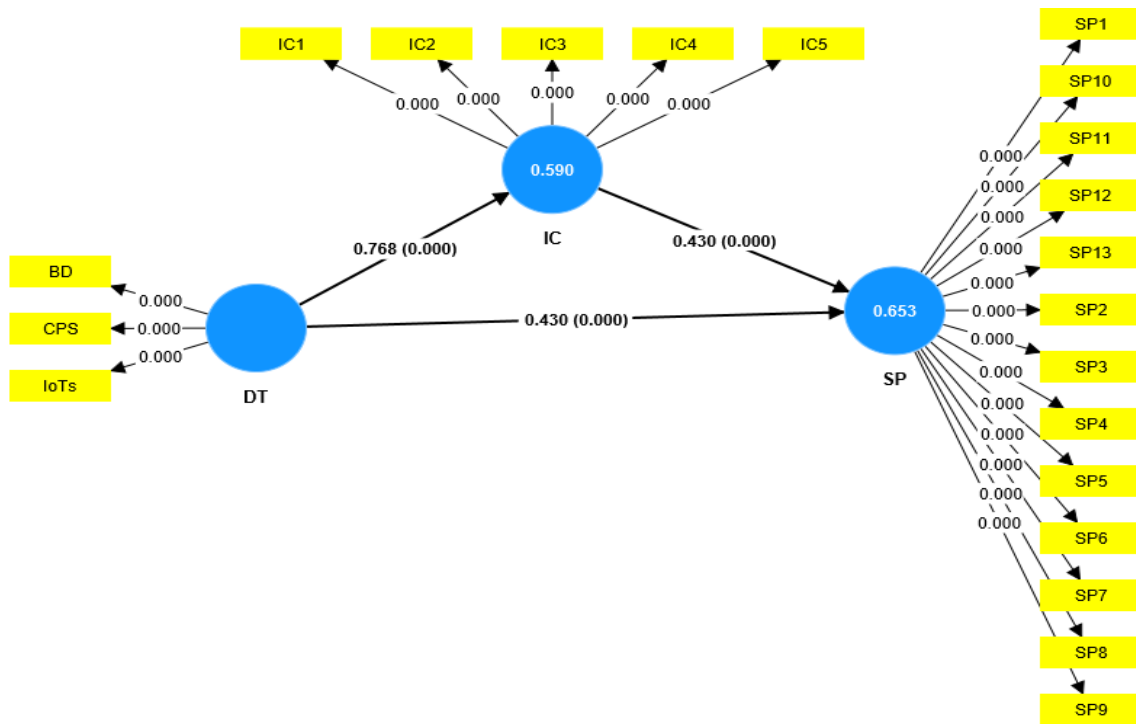


Fig. 2. Structural equation modeling.

Table 6. The results of mediation effect.

Hypothesis	Relationship	Path coefficient	Std.deviation	t-value	p-value	Decision
H4	DT -> IC -> SP	0.330	0.043	7.591	0.000	Partial Mediation

## Discussion and Conclusion

This research aimed to explore impact of DT on IC and SP. Furthermore, it sought to investigate influence of IC on SP and to analyze the intermediary role of IC in the relationship amid DT and SP specifically within the Egyptian governmental banking sector. The subsequent section provides a detailed discussion of the hypotheses' outcomes.

Concerning the direct relationship between DT and IC, the findings of this study reveal a substantial impact of DT on IC within the context of governmental banks ( $\beta = 0.768$ ,  $t = 31.955$ ,  $p\text{-value}=0.000$ ), thereby confirming Hypothesis 1. This outcome suggests that as banks increasingly focus on digital transformation, their employees' innovative capabilities will also improve. Furthermore, The DT of business processes exhibits a positive correlation with IC, leading to developing innovative approaches, as well as novel products and services. The DT of business processes plays a crucial role in streamlining production, overseeing management, executing operations, and managing customer interactions, consequently resulting in time and cost reductions. This optimization further contributes to heightened operational effectiveness and amplified productivity levels. Furthermore, banks have the potentiality to leverage their competitive edge through the provision of superior, expedited, and competitively priced goods and services in comparison to their rivals. This improvement can be achieved by streamlining operational, managerial, production, and promotional expenses, utilizing modern digital technologies like BD, CPS, and IoTs. This finding is in line with previous research conducted by **Sánchez Ramírez et al. (2022)**; **Zhang et al. (2023)**; **Nguyen et al. (2023b)**; and **Jiang and Wang (2024)**, all of whom have recognized DT as a key driver of innovation capabilities. However, these results differ from those of **Suwanto et al. (2022)**, who revealed insignificant correlation between DT and IC in SMEs in Tangerang City.

A noteworthy association was observed between the relationship of IC–SP ( $\beta = 0.430$ ,  $t = 7.624$ ,  $p = 0.000$ ), hence, confirming H2. This outcome implies that the continuous generation of newly products and services plays a crucial role for banks in emerging economies to enhance their sustainable performance. This finding aligns with prior studies indicating that IC significantly impacts SP (**Borah et al., 2022**; **Hudnurkar et al., 2023**; **Jum'a et al., 2023**; **Mukhtar et al., 2024**).

From the perspective of DT, the present study revealed a noteworthy impact of DT on SP ( $\beta = 0.430$ ,  $t = 7.428$ ,  $p = 0.000$ ), thus providing support for Hypothesis 3. This outcome may stem from the backing of governmental entities in the complete digitalization of their

establishments. Consequently, banks in emerging economies are embracing DT as a strategy to navigate through unpredictable circumstances and dynamic market environments. Moreover, the organization might experience pressure as a result of competitors within their industry adopting a particular technology, leading them to also implement it to enhance competitiveness and ensure sustainability in the market, ultimately achieving long-term performance and preserving resources for future generations. This finding is consistent with previous studies by **El Hilali et al. (2020)**; **Li (2022)**; **Xu et al. (2023)**; **Alathamneh and Al-Hawary (2023)**; as well as **Sun et al. (2024)**, all of which highlighted the beneficial impact of DT on Sustainable Performance.

Several studies have established a direct correlation between DT–SP (**Alathamneh & Al-Hawary, 2023**; **El Hilali et al., 2020**; **Feroz et al., 2021**; **Li, 2022**; **Sun et al., 2024**; **Xu et al., 2023**), as well as between IC–SP (**Borah et al., 2022**; **Hudnurkar et al., 2023**; **Jum'a et al., 2023**; **Mukhtar et al., 2024**). Nevertheless, only limited studies have delved into the intermediary function of IC within the Egyptian banking institutions. The current study's empirical findings have demonstrated the presence of partial mediation for IC between the relationship of DT-SP ( $\beta = 0.330$ ,  $t = 7.591$ ,  $p = 0.010$ ). As a result, the main hypothesis H4 proposed that IC acts as a mediator in the link between DT and SP.

### **Theoretical Implication**

This study makes several theoretical contributions to the current body of literature on DT adoption and SP framework. *First of all*, the current study further contributes to the limited body of literature on the adoption of DT by main centers of governmental banks operating in developing nations. By examining the factors influencing DT in emerging countries, specifically the case of Egypt, this research enhances our incomplete understanding of digital transformation adoption within the main centers of governmental banks in emerging economies. Fundamentally, this study is a response to the appeals made by various authors such as (**Siddik et al., 2023**) who advocated for the necessity of advancing the comprehensive comprehension of DT adoption within the main centers of governmental banks framework operating in emerging nations.

*Secondly*, the current research is grounded in the DC theory to investigate the multitude of factors that influence DT adoption within the main centers of governmental banks. Furthermore, this research extends the DC theory, which originates from the RBV theory, in the realm of SP. It makes a valuable contribution to existing academic literature by delving into the strategic enhancement of resources and capabilities within banks to achieve competitive edge and ensure long-term financial viability through the integration of sustainable business strategies. This study reveals the importance of incorporating sustainability into the frameworks of DC and RBV theories. It emphasizes the significance of value creation in comprehending the intricate relationship amidst sustainability strategies and financial performance. Consequently, the investigation provides insights into the economic drivers influencing organizations' decisions to engage in sustainable practices and offers guidance on the reasons why banking executives may choose to embrace such initiatives.

*Thirdly*, it can be argued that this research has presented a parsimonious model and enhanced comprehension of the factors that impact IC and the SP of banks in emerging

economies, particularly in Egypt. Similarly, **Lizarelli et al. (2023)** have provided evidence to support the notion that sustainability holds considerable significance as a determinant for decision-making within service-oriented organizations. Moreover, the banking sector holds significant importance due to its role as the central financial institution of a nation, assuming a crucial function in the allocation of funds to various economic actors (**Bukhari et al., 2023**).

Finally, this study further demonstrated the direct and indirect positive impacts of IC on enhancing banks' SP. The study's contribution lies in expanding the current body of knowledge on IC, as many banks in emerging economies grapple with uncertainty regarding the implications of IC, whether positive or negative (**YuSheng & Ibrahim, 2020**). Nevertheless, the present study offers a coherent comprehension of IC, elucidating its significance and advantages. Moreover, the recognition of the indirect or mediating function of IC in the relationship amidst DT and banks' SP adds value to the current body of knowledge; limited researchers have demonstrated the mediating function of IC (**YuSheng & Ibrahim, 2020**). The presence of continual and demanding environmental transformations may prompt organizations to revise their strategies in harnessing and leveraging IC as a means to achieve sustainable performance. Furthermore, the current study's findings indicate that solely utilizing DT to enhance banks' SP is inadequate, thus lending confirmation to the theory that DT impact on banks' SP can be heightened through an increase in IC. Moreover, this investigation made a significant contribution by exploring the mediating function of IC. The study revealed that IC serves as a partial mediator between DT and banks' SP (refer to Table 6 and Figure 2).

### **Practical Implication**

This study's findings may hold practical significance for stakeholders in the banking sector, such as managers and owners. Primarily, the ongoing investigation yields an in-depth comprehension of variables, enabling managers and owners to grasp the true impact of DT and IC on SP. This manuscript facilitates their comprehension of how the efficient management of DT and IC can enhance the overall sustainable performance of banks (covering environmental, social, and economic aspects) in developing economies. For instance, the results demonstrate that DT positively impact SP of banks by enhancing the efficiency of service and product delivery, as well as reducing costs associated with both internal and external operations. Additionally, DT aids banks in the introduction of innovative products and services, facilitating the reach of a substantial customer base, and improving the speed at which customers can access necessary information.

*Secondly*, the study's results have highlighted the importance of managerial support in decision-making process concerning IC adoption. Managers and owners of banks who actively address the barriers to IC among employees are likely to witness a boost in their overall performance sustainability. It is crucial for banks to prioritize investments in digitalization and cutting-edge solutions, including the automation of services, development of new payment systems, and the utilization of BD analysis. To foster creativity and innovation, banks should update their innovation labs within their premises and seek novel ideas beyond their organizational boundaries. Furthermore, banks are encouraged to thoroughly examine and leverage the data at their disposal regarding clients and their financial activities. This practice should extend beyond simply adhering to know-your-



customer protocols, encompassing a more comprehensive approach. The utilization of this data is anticipated to enhance the comprehension of customer requirements and behaviors, while concurrently enhancing operational efficiency and efficacy across the entire entity.

*Thirdly*, banks ought to migrate novel operational procedures concerning client assistance to the digital realm. As evidenced in our study, the utilization of online banking and applications of mobile banking is on the rise within the banking clientele. If banks opt to implement online validation of agreements through the utilization of a mobile banking application, it could result in advantages for both the banks and their clients. The primary suggestion in this context would involve examining these business opportunities and putting them into practice to maintain and attract a larger customer base through easily reachable and effective services.

*Fourthly*, in order to advance sustainable development, it is advisable for banks to utilize the aforementioned digital technologies to bolster their environmental, social, and economic sustainability. It is imperative to acknowledge that processes and environmental management practices in today's business landscape heavily rely on information. Banks that acquire precise and up-to-date information can consequently gain competitive edge. The usage of digital technologies in Industry 4.0 is predominantly aimed at gathering and analyzing data pertaining to goods and services, thus facilitating efficient and effective decision-making. An electronically empowered technological framework will be a vital decision for banks to achieve operational and environmental management success.

*Finally*, in order to effectively implement DT and IC for the enhancement of sustainable performance, it is recommended that owners and representatives of banks assign accountability to specialized team or personnel to oversee DT and IC accounts. Additionally, they should prioritize addressing all stakeholders and evaluating the most suitable demands through the results of analyzing big data. Furthermore, the current study's findings indicate that it is imperative for bank representatives not only to adhere to existing digital technologies but also to anticipate forthcoming technologies and effectively address them to stay competitive and thrive in the ever-evolving markets.

### **Limitations and Upcoming Research**

This investigation is not devoid of limitations, indicating pathways for prospective research. *Primarily*, all the banks surveyed are situated in Egypt, a factor that may impact any attempt to generalize our outcomes. Subsequent researchers could contemplate expanding the breadth of this inquiry by enlarging the focal research areas to encompass additional regions like European and American nations for comparing results in developing and developed economies, thereby enhancing generalizability. *Secondly*, the analysis was limited to governmental banks in Egypt; hence, there is a need for future investigations to encompass both governmental and private banking institutions for comparative purposes. Additionally, forthcoming research endeavors could explore various sectors like healthcare, tourism, or other manufacturing industries. Furthermore, there is potential for future studies to delve into comparative analyses between banks and health sectors, areas that have received limited attention in Egypt.

*Thirdly*, the usage of the questionnaire technique was employed for the acquisition of cross-sectional data. Consequently, forthcoming investigations could consider the utilization

of panel data or a blend of qualitative and quantitative research methodologies. Lastly, the present study employs IC as an intermediary construct in the relationship amidst DT and SP. Therefore, forthcoming research ought to concentrate on further variables influencing meditation, such as technological turbulence, governmental support, and competition while potentially incorporating moderators akin to the scale of the banks. Moreover, this investigation proposes that upcoming academicians might evaluate DT and its relationships, as well as its effects on SP within banking institutions in a developing market, and explore any disparities in outcomes across varying time periods.

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