



Digital Transformation in Financial Systems: Insights from Leading International Experiences

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Abstract:

this study aims to analyze the role of digital transformation in developing financial systems by examining leading international experiences, specifically those of Estonia, Singapore, and South Korea. The study adopted a descriptive-analytical approach to compare and examine the impact of digital transformation on the efficiency of public financial management, transparency, and financial sustainability.

The study's findings indicate that the success of digital transformation in financial systems relies on four fundamental pillars : a robust digital infrastructure, supportive legal frameworks, competent institutional leadership, and continuous investment in human capital. The analyzed international experiences further show that financial digitalization has contributed to accelerating financial processes, enhancing transparency, and reducing administrative corruption. The study concludes with a set of recommendations, most notably the adoption of a comprehensive national strategy for financial digitization, the development of electronic payment systems, the strengthening of data security, and the cultivation of competencies in fintech-related fields.

Keywords: Digital Financial Transformation; Financial Governance; Estonia; Singapore; South Korea.

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1. INTRODUCTION:

In recent decades, the rapid development of information and communication technologies has brought about wide-ranging changes in the economic and financial environment. This technological shift has had a noticeable impact on public financial management practices, on the functioning of financial and banking systems, and on the tools used in monetary and fiscal policymaking. With these developments, digital transformation has become a central driver of greater efficiency, transparency, and financial sustainability. It has also contributed to lowering costs, speeding up financial transactions, improving the management of public resources, and limiting various forms of administrative and financial corruption (OECD, 2022).

Both advanced and developing countries have recognized that digital transformation is no longer optional but has become a strategic requirement for strengthening competitiveness in the global economy. International experiences, however, differ in the scope of digital reforms and in the extent to which they have succeeded in modernizing financial systems. Estonia represents a comprehensive digital state that has integrated technology across all components of public financial management. Singapore has adopted an approach centered on smart financial innovation, while South Korea has focused on institutional transformation and the development of an integrated digital infrastructure (World Bank, 2023).

In this context, analyzing leading international experiences becomes essential for identifying lessons that can inform the trajectory of digital transformation in developing countries, particularly in light of challenges related to cybersecurity, infrastructure, and human capital.

1.1. Statement of the Problem:

Despite the widespread global adoption of digital transformation, many countries still face challenges in integrating technology into their financial systems in a manner that ensures the desired efficiency and transparency. International experiences vary in terms of digital maturity, raising the following question:

How has digital transformation contributed to the development of financial systems in leading international cases, and what lessons can be drawn to guide financial policies in developing countries?

1.2. Research Questions:

From the main research question, the Following sub-questions are derived :

- What Is the conceptual Framework of digital transformation in Financial systems ?
- What are the key features of Estonia, Singapore, and South Korea's experiences in modernising their Financial systems ?

What lessons and policies can developing countries draw upon to build effective and sustainable digital Financial systems ?

1.3. Hypothesis/ hypotheses:

- Digital transformation contributes effectively to improving the efficiency of public Financial management by accelerating transaction processes and reducing Financial waste.
- The success of digital transformation in Financial systems depends on digital infrastructure, governance, and the overall Policy Framework.
- Leading international experiences represent a model that can be adapted in developing countries, provided there is political will and technical capacity. What are the key features.

1.4. Significance of the Study:

The significance of this study lies in its focus on the fundamental role of digital transformation in modernising and reforming financial systems, particularly in the context of global economic challenges and the rapid advancement of artificial intelligence technologies. By analysing leading international experiences, such as those of Estonia, Singapore, and South Korea, the study provides a foundational framework that can be utilised to enhance and develop effective and sustainable digital financial systems in developing countries, with Algeria as a primary example. This aims to improve the efficiency of public financial management, strengthen transparency, and support sustainable financial governance.

1.5. Objectives of the Study:

This study aims to achieve a set of main objectives, including :

- To analyse the pivotal role of digital transformation in modernising and reforming Financial systems.
- To review leading international experiences in financial digitalisation.
- To derive lessons and actionable recommendations for developing countries to enhance financial efficiency and transparency.
- To identify the institutional and technological factors that have contributed to the success of digital transformation in financial systems.

1.6. methodology of the Study:

This study adopts a comparative descriptive-analytical approach, based on the analysis of data and information from international reports (World Bank, IMF, OECD, UNCTAD, BIS) and a comparison of the experiences of three leading countries in financial digital transformation :

- **Estonia** : a model of an integrated digital state.

- **Singapore** : a model of smart financial innovation.
- **South Korea** : a model of digital governance and technology investment.

An analytical approach was employed to identify similarities, differences, and lessons learned, relying on academic references and official reports covering the period 2015–2024.

1.7. previous researches :(literature review)

The studies most relevant to the topic of this research are as follow :

Research on **E-Estonia : The e-government cases of Estonia, Singapore, and Curaçao** shows that the study by **Goede (2019)** is an early contribution to the field. It can be seen that the author examined government digitalization through a comparative analysis of Estonia, Singapore, and Curaçao. As shown in the study, Estonia was able to build a leading model of digital governance by relying on an advanced data-exchange infrastructure. The X-Road platform is an example of this, as it brought together hundreds of databases and enabled the delivery of thousands of digital services.

According to the findings, Estonia's success was not only the result of technology. It has been shown that this progress came from the combination of public–private cooperation, a clear strategic vision, and early investment in digital human capital. In some cases, as the study suggests, the path of digital transformation differs across countries. Even so, the general principles observed in the Estonian case provide support for designing national models elsewhere. As we shall see, the value of this work lies in offering a comparative framework that can inform later research on digital governance and institutional transformation supported by information technologies.

According to **Diener & Spacek (2021)**, banks face a range of managerial and regulatory barriers during digital transformation, which negatively affect the comprehensive digitalisation of the banking sector. The study indicates that digital transformation requires fundamental changes in the institutional structure, organisational culture, as well as the IT infrastructure and data protection environment.

(Shanti & al, 2023) employed panel ARDL data from digital banks in Indonesia covering the period from 2016 to February 2023. The study found that the relationship between investment in digital transformation and bank profitability follows a U-shaped pattern. In the short term, high expenditure on information technology leads to a decline in profits due to the significant investment costs. However, in the long term, profitability improves markedly as a result of increased efficiency, customer base growth, and reduced operational costs.

The significance of this study for our research lies in providing empirical evidence that, despite high short-term costs, digital transformation can achieve sustainable profitability. This issue is especially important for developing countries that are

digitalising their financial and banking systems. Indeed, these countries must consider the initial financial costs and the need for gradual implementation. Only then can they achieve meaningful benefits in the medium term.

Edo (2025) investigates the relationship between digital transformation and financial development across emerging economies ; The study utilised data spanning 2000–2023 for 99 countries across major emerging economic regions, including the Middle East and North Africa (MENA), Latin America and the Caribbean (LAC), and Sub-Saharan Africa (SSA). It employed advanced econometric techniques such as the Generalised Method of Moments (GMM) and the Panel Vector Error-Correction Model (Panel VECM) to ensure robust and reliable empirical results.

The findings indicate that digital transformation plays a significant and positive role in advancing financial systems by promoting financial inclusion, reducing transaction costs, and narrowing information asymmetries. The impact of digitalisation on financial development, however, varies across regions: the strongest effects were observed in the MENA region, followed by Latin America, and then Sub-Saharan Africa. This suggests that regional context and institutional conditions play a critical role in determining the extent to which countries benefit from digital transformation.

The study E-government, inclusive growth, and the legitimacy of capitalism: Lessons from Estonia (Espinosa & Pino, 2025), examines how e-government can reinforce the legitimacy of the capitalist system by embedding principles of transparency, trust, and security (TTS) within public governance. Drawing on Estonia's post-Soviet experience as a case study, the research demonstrates that digital governance grounded in TTS principles effectively reduced corruption and rent-seeking practices, promoted inclusive growth, and rebuilt citizens' trust in state institutions.

1.8. Organization of the Study:

The study is divided into five main sections; The first section is an introduction, as it presents the problem statement, the research questions, the hypotheses, and the importance of the study. It also outlines the objectives, the methodology, and a brief review of previous research, as shown in typical academic studies; The second section examines the theoretical framework of digital transformation in financial systems, It can be seen that this part explains the concept, the historical evolution, the main theories, and the key dimensions of digital financial transformation. It also shows the importance of digital transformation, its link with financial governance, and the challenges faced in this field; The third section discusses leading international experiences in Digital Financial Transformation, for instance those of Estonia, Singapore, and South Korea. Each case is an example of how digital tools have been used to improve public finance; The fourth section highlights the lessons learned from these experiences, As we have seen, this includes the need for a clear digital vision, strong institutions, solid digital infrastructure,

appropriate legal frameworks, investment in digital skills, and effective cybersecurity. The fifth and final section presents the main conclusion of the study, followed by the list of references. It can be shown that this structure provides a clear and coherent path for understanding digital transformation in financial systems.

2. Theoretical Framework of Digital Transformation in Financial Systems:

2.1 The Concept of Digital Financial Transformation:

Digital transformation in financial systems refers to the process of integrating artificial intelligence technologies into the various stages of public financial management and banking services. This process aims to improve operational efficiency, strengthen transparency, and support data-driven financial decision-making (OECD, 2021).

Moreover, this transformation involves the use of financial technologies (FinTech), artificial intelligence (AI), blockchain, big data analytics, cloud computing, and analytical intelligence across different phases of budget preparation and execution, public procurement, public spending, oversight, and banking services.

The International Monetary Fund (IMF, 2022) affirms that digital financial transformation is no longer a simple technical automation. Instead, it has become a strategic shift in the philosophy of financial management. Thus, digital financial transformation is now considered one of the key drivers of sound financial governance, as it improves the management of revenues and expenditures, facilitates internal control, and reduces the risks of financial and administrative corruption.

2.2. The historical evolution of the concept of digital transformation in public finance:

The development of this concept has passed through three main stages, which can be summarised as follows:

➤ First Phase: Administrative Computerisation (1980-2000)

This phase was marked by the introduction of computers and basic software into financial operations such as accounting and budgeting. However, the use of these tools remained limited to administrative tasks and did not achieve institutional integration.

➤ Second Phase: E-Government (2000-2015)

During this period, financial systems were incorporated into national electronic portals. This shift helped simplify transactions, including electronic tax payments and salary transfers.

➤ Third Phase: Smart Digital Government (2015-Present)

In this stage, institutions moved from partial digitisation to smart integration. They began using artificial intelligence and blockchain to support financial decision-making and to analyse risks in a proactive manner (OECD, 2022).

Therefore, digital financial transformation has become a structural shift that reshapes the tools of financial policymaking, the mechanisms of implementation, and the

methods of oversight.

2.3 Theoretical Foundations of Digital Financial Transformation:

The concept of digital financial transformation can be linked to several contemporary economic and financial theories. As shown in recent literature, these theories provide a clear foundation for understanding how digital tools reshape financial systems.

❖ Efficient Market Hypothesis (EMH):

According to this hypothesis, the flow of accurate and immediate information improves the efficiency of financial markets. It can be seen that digital transformation, for instance through enhanced data exchange, reduces information gaps. Evidence shows that this process supports transparency in pricing and financial transactions (OECD, 2022).

❖ Fiscal Transparency and Accountability Theory:

This theory suggests that digital transparency strengthens financial accountability; Digital systems allow oversight bodies to track public spending and tax flows in real time. As in recent IMF reports, digital tools have been shown to improve monitoring and reduce opacity in public finance (IMF, 2021).

❖ New Public Management Theory (NPM):

Research on public administration has shown that modern management techniques help increase the efficiency of public institutions. Digital transformation is an example of how NPM principles are applied, as it automates procedures and simplifies financial services (Pollitt & Bouckaert, 2017). It can be shown that this approach encourages flexibility and improves service delivery.

2.4 Key Dimensions of Digital Transformation in Financial Systems:

According to OECD (2021), four main dimensions shape digital transformation in financial systems. Evidence for this classification can be seen in comparative studies across advanced and emerging economies.

❖ Technical dimension:

This includes digital infrastructure, interconnected financial platforms, and electronic payment systems.

❖ Institutional dimension:

This dimension relates to restructuring financial institutions so they become more flexible and capable of adopting digital solutions. As we have seen in several countries, institutional readiness is a critical factor.

❖ Regulatory dimension:

This includes legal frameworks governing digital transactions, data protection rules, and cybersecurity standards. It has been argued that strong regulation increases trust in digital financial systems.

❖ **Human dimension:**

This dimension focuses on building digital skills among financial and administrative personnel. As shown in various capacity-building programs, human capital plays a central role in sustaining digital reforms.

It can be seen that modern studies consistently indicate that successful digital financial transformation depends on the interaction of these four dimensions. In some cases, failure in one dimension weakens progress in the others, which provides support for adopting an integrated and coordinated digital strategy.

2.5 The Importance of Digital Transformation in Financial Systems:

According to official IMF reports (IMF, 2022), digital transformation in public financial management provides three key gains, First, it enhances efficiency and transparency, as shown in the automation of procedures and the reduction of human intervention. Second, it strengthens financial fairness by improving the tracking of public expenditure and ensuring that resources reach the targeted groups. Third, it supports financial sustainability, since digital systems have been shown to identify and manage risks in a timely manner.

2.6 The Relationship Between Digital Transformation and Financial Governance:

Digital transformation is a good example of a tool that promotes transparency and financial accountability. As can be seen in several cases, digital systems make it possible to track financial operations across all stages, which reduces opportunities for financial and administrative misconduct (Transparency International, 2023). It also contributes to stronger financial governance by, for instance, expanding the use of open financial data. These systems also make parliamentary and public oversight easier, and they reduce the time between expenditure and financial reporting.

2.7 Digital Transformation as a Driver of Financial Efficiency and Sustainability:

It has been shown by empirical analyses that digital transformation helps reduce the cost of financial operations by an estimated 15% to 30% of administrative spending (OECD, 2021). As shown in recent applications, digital tools also improve public debt management through forecasting systems that rely on artificial intelligence to analyse economic data in a short time.

It can be seen that digitalization supports financial sustainability as well. It does so by strengthening the capacity to mobilize public resources, improving tax collection, and ensuring a better allocation of public spending according to sustainable development priorities.

2.8 Challenges Facing Digital Transformation in Financial Systems:

As we have seen, digital transformation offers several advantages. However, evidence shows that it also faces a set of structural and institutional constraints. Among the most common challenges are:

- weak technological infrastructure in some developing countries, which limits the effectiveness of digital systems;
- shortages in skilled human resources able to manage smart financial platforms;
- cyber risks that threaten the confidentiality and safety of financial data and transactions;
- institutional resistance to organizational change within public financial bodies;
- and legal and regulatory gaps that, in some cases, do not fully support digital transformation (IMF, 2021).

According to available research, these challenges require gradual and comprehensive policies. Such policies should combine institutional reform, technical investment, and the development of human capabilities to ensure long-term success in digital financial transformation.

3. Leading International Experiences in Digital Financial Transformation:

3.1. Estonia's Experiences: A Model of Integrated Digital State:

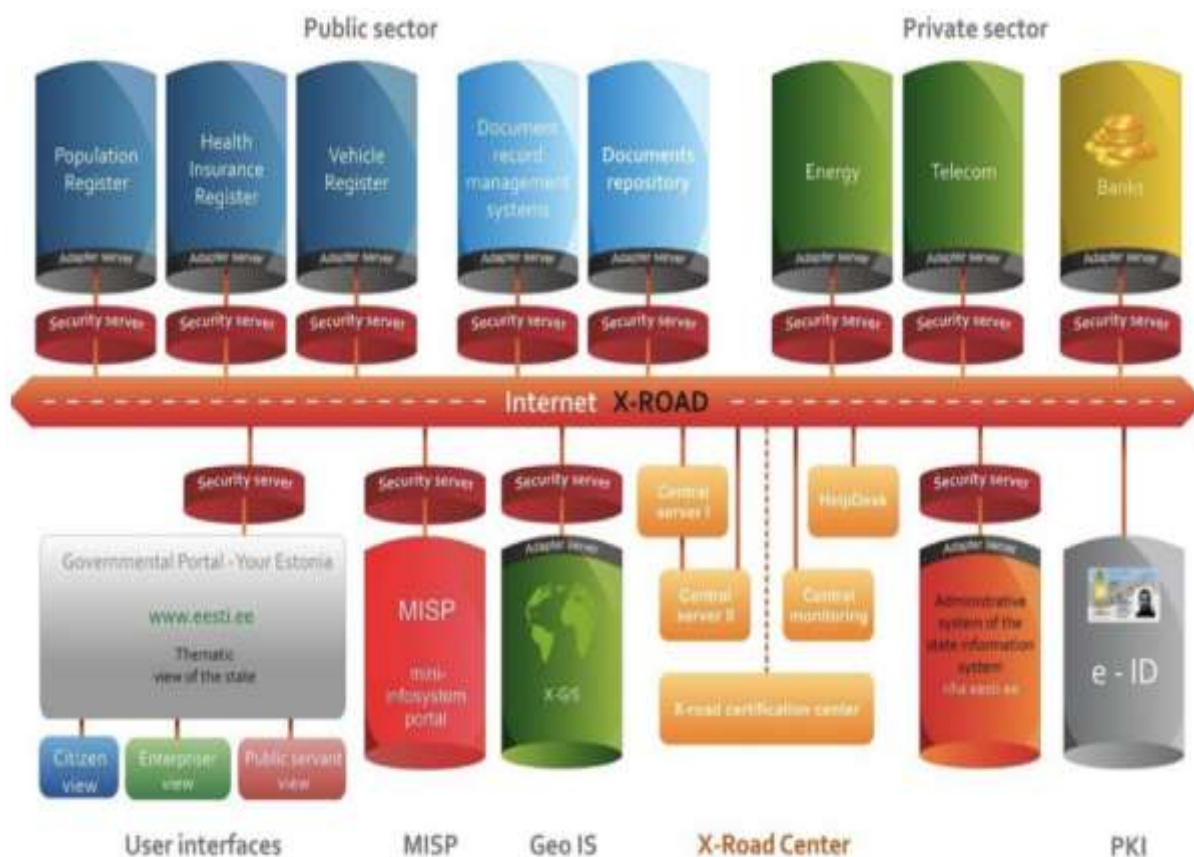
Estonia is one of the most advanced countries in integrated digital financial transformation. Since the early 2000s, it adopted a comprehensive e-government policy that allowed citizens to access all financial and administrative services through a single platform known as e-Estonia.

Estonia relied on a universal Digital ID system. It enables citizens and companies to carry out all financial and administrative transactions online, including banking services, tax payments, and public procurement; Consequently, this system reduced government transaction costs by nearly 15% each year and increased trust between citizens and public institutions. It also led to a significant decline in financial corruption and generated annual savings of more than 2% of GDP (OECD, 2022).

Estonia also developed the **X-Road government payment system**, which connects all public institutions through a secure network for real-time financial data exchange. This system enabled fast and safe data sharing. As a result, the United Nations ranked Estonia among the top ten countries worldwide in the e-government index (UN, 2022). The X-Road platform offers a clear example of an integrated digital infrastructure; It can be seen that the system brings together more than 360 different databases into a unified environment. As shown in official reports, it supports nearly 2,000 electronic services used by citizens and institutions. Data on institutional adoption indicate that around

d 500 organizations have already connected their systems to X-Road; In some cases, as in 2009, the platform recorded more than 420 million service requests per year, which is evidence of its large-scale use and high reliability (Goede, 2019, P 220).

Figure N°01: X-Road



Source: Geode, M, 2019, P 220.

❖ Key Lessons from Estonia's experience:

- Establish a unified digital identity for all citizens and institutions;
- Centralise financial data in a secure digital platform;
- Invest heavily in cybersecurity to build digital trust.

In sum, Estonia provides an example of how political commitment and institutional integration can turn digitalisation into a main pillar of sound financial governance.

3.2. Singapore's Experience: A Model of Smart Financial Innovation

Singapore is a global leader in integrating technological innovation into its financial system. Its national strategy, Smart Nation, launched in 2014, aims to position the country as a major hub for financial technologies (FinTech).

The Monetary Authority of Singapore (MAS) led the digital financial transformation through several initiatives, including:

- Creating financial innovation labs in partnership with banks and technology firms.
- Launching the national instant payment platform (FAST), which enables bank-to-bank transfers in less than one second.

- Developing a regulatory test framework for central bank digital currencies (CBDC Sandbox) to reduce cross-border transfer costs (World Bank, 2023).

Institutionally, Singapore adopted a “smart regulation” approach. It balances the encouragement of financial innovation with the need to maintain systemic stability. As a result, financial inclusion reached 98% of the population, and Singapore became a global centre for digital finance.

Thus, Singapore’s experience shows that strong leadership from the central bank helps achieve balance between innovation and financial risk.

❖ **Key Lessons from Singapore’s experience:**

- Engage the central bank as a primary driver of digital transformation;
- Strengthen cooperation between government and the private sector in financial innovation;
- Invest in instant payment systems and digital currencies.

3.3. South Korea’s Experience: A Model of Digital Governance in Public Finance

South Korea integrated digital transformation into its financial institutions at an early stage. In 2017, it launched the Digital Government Innovation Plan to improve coordination between financial and tax institutions.

One of its major achievements is the development of the KONEPS system for electronic public procurement. The system covers more than 95% of public tenders, which reduced processing time by 75% and cut government costs by about USD 8 billion annually (OECD, 2021).

South Korea also adopted artificial intelligence to forecast revenues and estimate fiscal deficits. This approach improved the accuracy of budget preparation and medium-term financing plans (IMF, 2022).

4. Lessons Learned from International Experiences in Digital Financial Transformation:

International experiences in Estonia, Singapore, and South Korea show that digital transformation in financial systems cannot be achieved simply by introducing technology into financial operations; Instead, it requires a clear strategic vision, a coherent institutional and legal framework, and continuous investment in human and technological capabilities. By analysing these experiences, several essential lessons can be drawn, the most important of which are:

4.1 Building an Integrated Digital Strategic Vision:

The three countries share the view that digital financial transformation is not a temporary technical project. Instead, it is a long-term national policy that spans multiple sectors.

In Estonia, digital transformation was incorporated into the economic development model under the **e-Estonia Vision 2030**; In South Korea, it was part of the Digital

Government Innovation plan; In Singapore, it was included in **the Smart Nation Master Plan** (World Bank, 2023).

This shows that the success of digital financial transformation depends on having a comprehensive national vision. Such a vision aligns financial, technical, and regulatory objectives. Thus, digitalisation becomes a tool to achieve efficiency and financial sustainability, rather than an end in itself.

4.2 Digital Governance and Strong Institutional Leadership:

A main lesson from international experiences is that digital transformation needs clear leadership. This leadership must coordinate the work of all financial actors, including ministries, the treasury, central banks, and regulatory agencies.

In Singapore, the Monetary Authority of Singapore (MAS) played a key role in guiding the digitalisation of the financial system.

In Estonia, the Ministry of Economic Affairs and Communications led the process. In South Korea, the Ministry of the Interior and Public Administration managed the transformation under a single strategic vision (OECD, 2022).

These examples show that poor coordination can cause duplicated systems, conflicting data, and weak financial results; Therefore, a central digital body should direct and manage financial transformation within the overall government framework.

4.3 Digital Infrastructure as a Foundation for Modern Financial Systems:

The success of digital transformation in financial systems largely depends on strong infrastructure. This includes both information systems and communication networks.

For example, Estonia invested in the X-Road system, which allowed government institutions to share data securely. South Korea implemented a comprehensive national network for exchanging financial and administrative data. Singapore relies on the FAST platform as the backbone of its instant payment system (IMF, 2022).

This structural integration helps reduce costs and fight corruption. It also enables faster and more transparent money flows within public and private institutions. These examples show that digital transformation without a solid infrastructure remains weak and unsustainable.

4.4 The Legal and Regulatory Framework as a Condition for Digital Trust:

International experiences show that the move toward digitalizing financial systems requires an advanced legal and regulatory framework. Such a framework protects data, combats cybercrime, and governs digital financial transactions with speed and precision. As shown in several leading cases, Estonia adopted its Digital Identity Law in 2002,

which made digital financial transactions legally binding. In Singapore, the government introduced the Personal Data Protection Act (PDPA), which strengthened trust in electronic transactions. South Korea, as we have seen, implemented strict security standards under its Cybersecurity Act (OECD, 2021).

It can be seen that these strong legal frameworks helped these countries establish an environment of digital trust. This trust is essential for citizens and institutions to adopt digital systems in financial operations.

4.5 Investment in Digital Human Capital

Despite rapid technological progress, the human factor remains at the core of successful digital transformation in finance. For instance, Singapore allocated more than 2% of its GDP to train public-sector employees in digital skills (World Bank, 2023). Estonia, as in many pioneering cases, created a National Academy for Digital Governance to build expertise in financial and administrative fields. South Korea integrated digital education into its public university programs, as we shall see in other policy areas.

These experiences show that digitalization is not only about tools. It is, rather, a new institutional culture that requires a comprehensive re-skilling of human resources in the financial sector.

4.6 Cybersecurity as a Guarantee for the Sustainability of the Digital Financial System

The three international experiences show the strategic role of cybersecurity in safeguarding digital financial transactions. As shown in Estonia, the government established a National Cybersecurity Center following the cyberattacks of 2007, and it was later integrated into the national defense system (UN, 2022); Singapore, for instance, created the National Cybersecurity Agency as part of a broader plan to secure its digital financial environment. In South Korea, cybersecurity systems in public institutions are updated regularly through unified protocols, as we have seen in other sectors.

It can be seen that these examples highlight a clear conclusion: sustainable digital financial transformation cannot be achieved without a strong system that protects data and digital platforms from cyber risks.

5. CONCLUSION:

The review of leading international experiences shows that digital transformation in financial systems is one of the main pillars of modern financial reform. It can be seen that this shift supports efficiency, transparency, and sustainability in managing public resources. Yet, its success depends on the integration of technical, legal, and institutional dimensions within a comprehensive national vision.

As shown in the cases of Estonia, Singapore, and South Korea, digitalization is not simply a technical option. It has been shown to be a structural transformation of the

state's financial model. In some cases, evidence from these countries indicates that adopting a combined approach—one that develops digital infrastructure, builds trust, and strengthens human capacities—is a good path for developing countries seeking to modernize their financial systems and establish advanced digital financial governance.

As we have seen, drawing lessons from these leading experiences offers both challenges and opportunities for policymakers in the Arab world. The data on these reforms show that such lessons can support efforts to build financial systems that are more transparent, efficient, and sustainable. It can be shown that these systems will be better equipped to meet the demands of the digital age and the effects of a rapidly changing global economy.

Based on the lessons learned from previous experiences, it can be suggested that developing countries adopt a set of practical policies to build effective and sustainable digital financial systems. For instance, the following measures can be considered:

- ✔ It is a good practice to establish a unified national strategy for digital financial transformation, with clear objectives and measurable performance indicators;
- ✔ Evidence from leading countries shows that creating a central authority for digital financial governance can coordinate efforts across ministries, banks, and public institutions;
- ✔ As shown in international cases, strengthening digital infrastructure through investment in electronic payment systems and integrated financial databases is essential;
- ✔ It can be seen that reforming the legal and regulatory framework to meet digital age requirements helps protect financial transactions from cyber risks;
- ✔ Introducing a national digital identity is an example of a measure that facilitates public financial management and simplifies administrative procedures;
- ✔ Research on human capacity development indicates that investing in digital training for financial staff improves the efficiency of modern financial systems;
- ✔ It has been suggested that public-private partnerships (PPP) can accelerate the adoption of financial technology and support knowledge exchange;
- ✔ Establishing national financial cybersecurity centers is shown to be effective in monitoring risks and protecting government data;
- ✔ Evidence of innovation in FinTech highlights the importance of research and development to support banking systems and digital tax collection;
- ✔ As we have seen, promoting international cooperation by learning from advanced experiences and joining global digital finance initiatives can enhance the overall success of digital transformation.

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