Harnessing Digital Public Infrastructure for Public Services Transformation: Case Study of 10 Countries

Tushar Dhiman[1] & Pankaj Madan[2]

[1]*Research Scholar, Faculty of Management Studies, Gurukula Kangri (Deemed to be University) Haridwar, Uttarakhand, India*

tushardhiman.gkv@gmail.com

0009-0008-1505-9028

[2]*Professor, Faculty of Management Studies, Gurukula Kangri (Deemed to be University) Haridwar, Uttarakhand, India*

pankaj.madan@gkv.ac.in

0000-0002-4648-9863

Abstract:

All over the globe, nations are heating up their expenditures in Digital Public Infrastructure, which holds the key to attaining sustainable development goal and transforming public finance management. DPI includes digital solutions that boost delivering public services, transparency, and inclusive economic development. Digitalisation of the public finance management systems can help countries to enhance resources allocation, reduce corruption and improve accountability. Nevertheless, the relationship between digitalized public finances and DPI is not well studied yet, and it is critical to learn about such synergies to optimize the effects of DPI investments. Digital payment systems could be used to streamline government transactions and digital identity systems could be used to make sure that social benefits are going to the people that they are intended to. Moreover, DPI promotes the growth of smart cities, healthcare services, and educational performance with the help of high-performance digital infrastructure. An extensive study on the interplay between digital public finance and the DPI applications is required to obtain information

on the best practice, challenges, and provide policy suggestions. DPI has a large potential to promote sustainable development and reform the management of public finance, a better comprehension of its synergies with digital public finance is essential. The paper focuses on the case study of 10 countries on how Digital Public Infrastructure is supporting the countries. This assists policy makers to develop policies and utilize the modern technology to maximum advantage of the society.

Keywords: Digital Public Infrastructure, Sustainable Development Goals, Digital Technologies, Public Finance Management, Digital Payment Systems.

1. Introduction:

The 21 st century is witnessing sophisticated demand on all governments across the globe to provide inclusive, efficient and transparent public services. The pressure on modernizing the operations of the public institution and becoming more responsive has piled because of rapidity in urbanization, demographic changes, financial restraints, and changing anticipations of the citizens. It is against this context that the concept of Digital Public Infrastructure (DPI) has taken shape as a revolutionary move capable of transforming how the state delivers public services and the interaction between the state and its citizens. DPI stands for the underlying digital infrastructure of digital identity platforms, electronic payments systems, and interoperable data exchange frameworks that support smooth, secure, and scale interactions among individuals, governments, and businesses. The critical nature of robust and flexible public systems was painfully made apparent through the COVID-19 pandemic. The nations with powerful DPI could make welfare payments in digital form, perform health diagnostics remotely, handle fiscal transactions online, and ensure the continuity of vital state services even when under lockdown. This increase in the pace of digital transformation caused by the crisis has solidified DPI as a pillar of contemporary governance. Nevertheless, DPI is not only applicable in situations of emergency. It is very vital in fulfilling long-term development priorities especially those expressed in the United Nations Sustainable Development Goals (SDGs). DPI promotes the achievement of poverty alleviation, financial inclusion, quality education, and responsive institutions by improving transparency, reducing leakages, and empowering targeted service delivery. Whether it is Aadhaar-enabled welfare schemes in India, e-governance model in Estonia, or Smart Nation in Singapore, DPI has come to strongly imply government innovation. Nevertheless, even after the wide adoption, there

are severe knowledge gaps. The existing literature on DPI is mostly fragmented with either the discussions being based on the technical architecture or limited to the experiences of individual countries. The lacking element here is the comparative and cross-contextualized insight into the effects of DPI on public financial management (PFM) which is one of the areas cores to resource allocation, accountability of the budget, and development planning. The fact that DPI and digital public finance (in relation to such instruments as digital tax collection, real-time expenditure tracking, and AI-based budgeting) are coming together, are potent synergies that, with appropriate taming, can result in transformative governance outcomes. The current study is located within this context. The paper titled "Harnessing Digital Public Infrastructure for Public Services Transformation: Case Study of 10 Countries" seeks to empirically investigate how DPI is shaping public service delivery and financial governance across a diverse set of national environments. The selected countries India, Estonia, Singapore, Norway, Bangladesh, Ethiopia, Peru, Sierra Leone, Ukraine, and Togo represent a mix of developed, emerging, and developing economies with varying degrees of digital maturity. By examining their DPI frameworks, implementation pathways, and governance models, the study aims to generate comparative insights into the enabling factors, challenges, and policy implications of DPI deployment. The significance of this research lies in its attempt to bridge the gap between technological innovation and institutional reform. DPI is not another instrument of digitizing processes, it is a form of public good that, with appropriate design and governance, can increase citizen confidence, marginalized groups, and fiscal discipline. Where manual systems have previously allowed inefficiency, lack of transparency or corruption, DPI raises automated, traceable, and citizen-focused accountability. The interaction between DPI and current systems of public finance, social protection programs, and regulatory frameworks should be understood to develop digital strategies that would be the most effective and inclusive. The goal of the study is to find out the multiple expressions through which DPI is playing the role of transforming the public financial management and service delivery. More precisely, the study explores the extent to which digital identity systems, payment infrastructures, and interoperable data platforms have been embraced to enhance the reach, efficiency, and reliability of government services. It further looks at how DPI enables fiscal control by enabling more effective budgeting, targeted expenditure, taxation compliance and real-time analytics.

In order to guide the investigation and maintain analytical coherence, the study is anchored by the following research question: ***How does Digital Public Infrastructure influence public financial management across different national contexts, and what institutional, technological, and governance factors contribute to its effective implementation?*** This question not only serves as the foundation for the case study analysis but also helps situate the discussion within broader debates in digital governance, development economics, and public administration. In order to find the answer to it, the research will follow a structured qualitative approach, entailing secondary data analysis, policy document analysis, and an evaluative framework, according to which the DPI initiatives will be assessed on such dimensions as digital identity coverage, e-payment integration, interoperability, citizen access, and institutional coordination. valueably, the countries included in this study were not picked randomly. They represent a conscious choice to grasp diversity, in geographical, systems of governance, level of development, and technology capability. Case in point, whereas Estonia is an example of a digital-first state model, Sierra Leone provides an insight on how low-income countries can launch foundational DPI projects within the limits of infrastructural capabilities. In a similar fashion, India and Bangladesh are examples of large-scale implementation of DPI in complicated federal and demographic environments, whereas Norway and Singapore demonstrate how high-income economies ensure high levels of trust and data integrity within their digital environments. In bringing together these varied experiences, the research intervenes in a number of contemporary academic and policy debates. First, it enhances theoretical knowledge of DPI as a governance innovation and not just a technological artefact. Second, it provides evidence-based insights into how DPI shapes fiscal behavior and administrative efficiency, challenging assumptions that digitization alone guarantees transparency or inclusion. Third, it addresses important topics, including the digital divide, cybersecurity risks, and data governance, which are the key to making DPI not just effective but also fair and ethical. The world is fast moving towards a digitally transformed state and academic research must follow suit by ensuring that policy experimentation remains on track. DPI is an excellent leverage towards constructing wiser, inclusive, and robust public institutions. But its effectiveness is determined not by technical design alone, but also by political will, intuitional capacity, citizen trust and cross sector collaboration. By offering an in-depth, comparative, context-sensitive study of DPI implementation in ten countries this study hopes to make a valuable contribution to this developing area of study and influence the design of digital government policies of the future.

2. Literature Review:

The concept of Digital Public Infrastructure has gained increasing attention over the past decade as governments worldwide pursue digital transformation to enhance public service delivery, increase transparency, and promote citizen-centric governance. DPI encompasses foundational digital systems such as digital identity, digital payments, data exchange protocols, and e-governance platforms. As DPI becomes integral to public administration, scholars have increasingly explored its potential, limitations, and evolution in different governance contexts. This literature review synthesizes key contributions from the field, laying a theoretical and empirical foundation for analyzing the impact of DPI on public service transformation and financial management across countries. Early foundational work emphasized the transformative potential of information and communication technologies in reshaping public administration. Bertot, Grimes, and Jaeger (2010) highlighted how digital technologies can foster transparency and combat corruption by making government data more accessible and service delivery more efficient. Similarly, Pardo and Nam (2011) introduced the concept of "astute cities," underlining the strategic use of digital technologies to improve urban governance by integrating institutions, people, and technology. It is on the basis of these initial investigations that the basis was laid to view DPI as a means toward responsive and data-driven governance. The later research left the broadband ICT frameworks behind and turned to the particularities of the digital public value and governance models. As an example, Cordella and Bonina (2012) suggested that digital public infrastructure creates added value to the public by providing better service delivery and participation of the citizen. In their analysis they stressed the idea that DPI is not merely a technological resource but a means of institutional change. Similarly, in their conceptual framework, Estevez and Janowski (2013) connected the concept of electronic governance with sustainable development and claimed that big data and mobile technologies were the critical trends defining the development of DPI in the public sector. Janssen and Estevez (2013) recently proposed the concept of platform-based governance that complements DPI since it allows governments to do more with less. They argued that shared digital platforms and lean government make processes more efficient and limit duplication. Although they recognized some obstacles like resistance to change, their work affirmed the usefulness of DPI in creating efficiency.

The same year, Linders (2012) examined the transition from e-government to "we-government," emphasizing how DPI empowers citizen co-production in public services, leading to improved service quality and greater public ownership. Another major strand in the literature addresses the role of open data and governance transparency. Charalabidis, Zuiderwijk, and Janssen (2012) explored how DPI facilitates transparency and public participation through open data initiatives, while also identifying significant barriers such as data privacy and lack of technical infrastructure. These concerns were echoed by Helbig (2014), who focused on how DPI innovations can drive public sector performance, especially when governments leverage new technologies to enhance delivery mechanisms. The issue of digital governance and public management was comprehensively addressed by Gil-Garcia, Pardo, and Dawes (2018), who argued that online initiatives significantly enhance administrative transparency and efficiency. They situated DPI within the broader field of public management, drawing attention to its cross-cutting influence on accountability, citizen trust, and institutional performance. Bannister and Connolly (2014) contributed a theoretical framework for analyzing how digital tools reshape public values, suggesting that DPI can realign bureaucratic processes with democratic principles when supported by enabling policies. More recent literature has increasingly focused on the intersection of DPI with smart cities, innovation ecosystems, and cross-sectoral governance. Bolívar (2016) emphasized the significance of digital leadership in smart urban governance, highlighting that DPI enhances decision-making but also faces barriers related to data security and privacy. Reddick and Anthopoulos (2016) further explored the synergy between smart government and smart cities, illustrating how DPI provides the connective tissue between infrastructure, information systems, and policy execution. AlAwadhi and Scholl (2016) analyzed multi-jurisdictional initiatives, concluding that collaboration and coordination are crucial to leveraging DPI for effective service delivery across complex administrative boundaries.

From a technological architecture perspective, Baheer, Lamas, and Sousa (2020) conducted a systematic review of 103 studies to identify key features of digital government systems. Their findings stress the importance of interoperability, scalability, and cybersecurity, especially when integrating legacy systems with modern DPI components. They also noted that while digital technologies offer significant opportunities, their implementation is often hindered by institutional inertia, capacity limitations, and fragmented policy environments. Recent scholarship has also

started to critically assess DPI's real-world performance and implementation challenges. Aarushi Gupta and Aman Nair (2023) examined DPI initiatives like Aadhaar in India, highlighting how digital systems can inadvertently lead to exclusion errors and increased transaction costs if not designed with inclusion and rights-based frameworks. Their work calls for context-specific assessments and the development of clearer regulatory guidelines to ensure accessibility and privacy safeguards. Similarly, Maheshwari (2023) emphasized that effective public administration is a prerequisite for successful DPI deployment. He argued that while India's DPI has catalyzed financial inclusion, corporate efficiency, and e-governance, its equitable success depends on administrators' ability to anticipate risks and ensure that systems promote fairness.

Zhou, Song, and Xiao (2023) contributed a macro-level analysis by studying the relationship between smart city policies and digital infrastructure development in Chinese cities. Using panel data, they found that policy efficacy varies by region, suggesting that contextual factors such as governance capacity, policy coordination, and local demand significantly influence DPI outcomes. Their research underlines the need for flexible policy frameworks that accommodate regional diversity and technological readiness. Overall, the literature reveals a rich but fragmented landscape. Scholars consistently affirm the positive correlation between DPI and improved public sector performance, especially in areas such as transparency, efficiency, and service accessibility. However, there is growing recognition that technological advancement alone does not guarantee success. Effective DPI implementation requires supportive institutional frameworks, inclusive design, interoperable technologies, and stakeholder alignment. Furthermore, while the existing literature provides in-depth case studies and theoretical explorations, comparative cross-country analyses remain relatively rare. Most studies focus on single-country examples or conceptual models, limiting the generalizability of findings. This review reveals a pressing need to connect these strands of literature through empirical research that systematically compares how DPI is implemented across countries with different administrative capacities, economic conditions, and digital maturity. By doing so, scholars and policymakers can better understand the mechanisms through which DPI contributes to public finance transformation, digital inclusion, and sustainable development.

Table 1: Literature Review Summary

Year	Authors	Focus
2023	Zhou, Y., Song, M., and Xiao, Y.	Examines the effect of smart city regulations on digital infrastructure growth using panel data from Chinese cities; highlights variation in policy efficacy across regions.
2023	Aarushi Gupta, Aman Nair	Analyzes DPI challenges like exclusion errors and increased transaction costs; advocates for clearer regulatory frameworks and context-specific assessments.
2023	Maheshwari, Ankit	Emphasizes the role of public administration in successful DPI implementation; highlights India's DPI contributions to e-governance and financial inclusion.
2020	Baheer, A. B., Lamas, D., & Sousa, S.	Conducts a systematic review of digital government systems, focusing on interoperability, scalability, and challenges in integrating legacy systems.
2018	Gil-Garcia, J. R., Pardo, T. A., and Dawes, S. S.	Highlights the relationship between digital governance and public management; argues that DPI enhances transparency and efficiency.
2016	Bolívar	Discusses the importance of leadership and data privacy in smart urban governance; frames DPI as essential to decision-making.
2016	Reddick, C. G., & Anthopoulos, L. G.	Connects smart city planning with smart governance; explores how DPI enables integrated service delivery.
2016	AlAwadhi, S., & Scholl, H. J.	Analyzes multi-jurisdictional smart governance; stresses collaboration and coordination for DPI-enabled service improvements.
2014	Bannister, F., & Connolly, R.	Offers a research framework linking ICT and DPI to changing public values such as transparency and accountability.

2014	Helbig, N.	Explores how DPI and emerging technologies drive public sector innovation and service performance.
2013	Janssen, M., & Estevez, E.	Introduces platform-based governance and lean government concepts; shows how DPI reduces costs and streamlines services.
2013	Estevez, E., & Janowski, T.	Provides a framework connecting electronic governance to sustainable development; stresses big data and mobile trends.
2012	Cordella, A., & Bonina, C. M.	Examines public value generated by ICT-enabled reforms; positions DPI as a driver of transparency and engagement.
2012	Linders, D.	Discusses citizen co-production and DPI's role in shifting from e-government to we-government.
2012	Charalabidis, Y., Zuiderwijk, A., & Janssen, M.	Focuses on the benefits of open data through DPI; highlights challenges in privacy and infrastructure.
2011	Pardo, T. A., & Nam, T.	Introduces the concept of "astute cities" and DPI's role in integrating technology, institutions, and citizens.
2010	Bertot, J. C., Grimes, J. M., & Jaeger, P. T.	Explores how DPI and ICTs improve transparency, data access, and anti-corruption efforts.

The synthesis of literature on Digital Public Infrastructure (DPI) reveals a multi-dimensional framework through which digital technologies are reshaping the architecture of public governance. Across various contexts and geographies, DPI emerges not merely as a technological advancement, but as a foundational enabler of state capacity, administrative transparency, and citizen empowerment. The review highlights several thematic outcomes that bear significance for policymakers, practitioners, and researchers working at the intersection of governance and technology. First, there is a strong consensus across studies that DPI enhances transparency, efficiency, and accountability in public service delivery. Foundational works, such as those by

Bertot et al. (2010) and Gil-Garcia et al. (2018), illustrate how open data initiatives and ICT tools reduce information asymmetries and streamline bureaucratic functions. This outcome is particularly crucial in contexts plagued by corruption and low institutional trust, where DPI serves as a mechanism to re-establish citizen confidence in state institutions. Second, the literature points to DPI's role in fostering citizen-centric governance. Through concepts like "we-government" (Linders, 2012) and co-production, digital platforms are reconfiguring how citizens interact with the state- not as passive recipients but as active participants in service delivery. This transformation enhances service quality and responsiveness, making governance more inclusive and participatory. Third, institutional capacity and leadership emerge as critical success factors in DPI implementation. The review indicates that while digital systems offer immense potential, their effectiveness is contingent upon the readiness of public administration. Maheshwari (2023) and Baheer et al. (2020) underscore the importance of interoperability, scalability, and administrative adaptability in realizing the benefits of DPI. Without robust institutional frameworks, DPI risks being underutilized or exacerbating existing inequalities. Fourth, the equity dimension of DPI implementation is gaining increasing scholarly attention. As noted by Gupta and Nair (2023), poorly designed digital systems can lead to exclusion errors and increased transaction costs for vulnerable populations. This underscores the importance of adopting rights-based, inclusive design principles that ensure accessibility for all, especially in large-scale national platforms like Aadhaar. Equity in digital access is not merely a technical concern but a fundamental public value challenge. Fifth, context-specific implementation and regional variations in policy efficacy were observed, particularly in comparative studies like Zhou et al. (2023) on Chinese cities. This reinforces the need for flexible, locally adaptive policy frameworks that account for regional disparities in governance capacity, digital maturity, and socio-economic conditions.

Finally, while the literature provides deep conceptual insights and country-specific analyses, it also reveals a significant research gap in cross-country empirical comparisons. There is limited evidence on how different administrative structures, economic environments, and policy designs influence DPI outcomes globally. Bridging this gap would not only strengthen theoretical models but also offer practical guidance for countries at various stages of digital transformation.

The literature establishes that DPI is a cornerstone for modern governance, with demonstrable benefits across transparency, service efficiency, and citizen engagement. However, its success

hinges on inclusive policy design, administrative readiness, and continuous institutional learning. These findings lay a robust foundation for further empirical research exploring DPI's real-world impacts on public finance, digital inclusion, and sustainable development across different governance systems.

3. Methodology:

This study adopts a comparative qualitative case study approach to examine how Digital Public Infrastructure (DPI) is being implemented across ten countries to support public service transformation and improve public financial management. The researcher chooses case methodology approach for analyzing Digital Public Infrastructure cases because it allows for in-depth exploration of complex, context-specific interactions between technology, policy frameworks, and institutional dynamics. This study explores a wide range of countries with different levels of digital maturity and governance abilities, as opposed to considering a single model. The ten countries that included India, Estonia, Singapore, Norway, Bangladesh, Ethiopia, Peru, Sierra Leone, Ukraine, and Togo were selected based on a purposive sampling strategy. This selection was based on four important criteria. Firstly, the geographic diversity was taken into consideration to guarantee the global approach, comprising Asian, European, African, and Latin countries. This variety assists in indicating region-particular openings and limitations in DPI implementation. Second, the selection of countries was done to have a representation of different levels of digital maturity. Examples of the countries that are at the forefront of digital governance globally include Estonia and Singapore, whereas Sierra Leone and Ethiopia are relatively at lower levels of DPI implementation, which offers a comparative balance. Third, the countries were selected based on their example of policy innovation in the area of DPI, including national digital ID systems, digital payments systems, or e-government services. Lastly, data availability was pragmatically important: the selected countries were well-documented with the academic literature, policy documents, and publicly available data, and this fact allowed performing a strong secondary data analysis and triangulation. Data for this study was drawn from a variety of credible secondary sources. These included peer-reviewed academic publications, national government policy documents, development agency reports (such as from the World Bank, UNDP, and IMF), and digital portals maintained by relevant public institutions. The use of multiple data types allowed for triangulation, thereby enhancing the validity and reliability of the research findings.

Moreover, given the evolving nature of DPI and its rapid development, the study incorporated the most recent publications and data sources available at the time of analysis.

In a bid to achieve analytical consistency among the case studies, a guided framework was constructed based on four major dimensions, which were obtained through a review of existing DPI literature and international good practices. Digital identity implementation The first dimension, digital identity implementation, looks at how well a country has embraced the use of secure, inclusive, and interoperable national identity systems, including biometric identifications or universal digital ID platforms. This is a pillar of DPI that facilitates access to broad spectrum of public services. The second dimension, integration of digital payments, assesses the advancement and institutionalization of digital payment systems to cover government-to-person (G2P) and person-to-government (P2G) payments. These are social welfare transfers, tax payments and public utility billings, which are very important in enhancing efficiency in reducing leakage in public finance. The third dimension, e-governance maturity, evaluates the application and extent of the digital portals and platforms that are used to support citizen engagement, service delivery, and public administration. This comprises measures like proximity to online services, transparency tools, and rate of access to information. The fourth dimension, data-driven decision-making, examines how governments are using digital technologies, connected databases and analytics to aid budget preparation, tracking of public spending and measuring results of programs. Altogether, the four dimensions enable a systematic cross-country comparison of the DPI landscape, at the same time considering the individual socio-political context of each country. This theoretical framework is more rigorous and comparative than a descriptive narrative by itself. The study aims to identify similarities and variations in DPI implementation by using the same dimensions to describe each case and thus reveal the patterns of implementation. The comparative approach also underpins the identification of enabling factors, including institutional capacity, digital literacy, legal frameworks and political leadership, which can affect DPI outcomes. It is important to acknowledge some methodological limitations. The study relies primarily on secondary data, which, while comprehensive, may limit access to real-time developments or localized implementation challenges not captured in official sources. Additionally, the four analytical dimensions, while foundational, do not cover every possible influence on DPI success, such as cultural attitudes toward digital systems or the role of private sector partnerships. Future research

could address these gaps through fieldwork-based studies, including interviews with policymakers, technologists, and citizens to gain deeper qualitative insights. Nonetheless, the chosen methodological design offers clear advantages in achieving the study's core objective: to understand how Digital Public Infrastructure contributes to transforming public service delivery and financial management across diverse national contexts. By incorporating a transparent case selection process and applying a structured analytical framework, the study enhances its credibility, replicability, and relevance to both scholars and policymakers. It provides not only a snapshot of where different countries stand in their DPI journeys, but also valuable comparative lessons on what works, under what conditions, and why.

Table 2: Comparison Table

Country	Digital Identity Implementation	Digital Payment Integration	E-Governance Maturity	Data-Driven Decision-Making
India	Aadhaar is the world's largest biometric ID system; over 1.3 billion enrolled; integrated with services like banking, PDS, and social welfare.	UPI, DBT, and other platforms enable real-time, low-cost transactions; widely used for G2P transfers.	Strong platforms like DigiLocker, UMANG, and eSeva; over 3,000 digital public services.	Use of real-time dashboards (e.g., PFMS, GSTN); data analytics used for targeting subsidies and monitoring welfare schemes.
Estonia	Universal digital ID with legally binding e-signatures; integrated with	E-payment systems integrated with public and	Highly advanced; all public services (except marriage/divorce)	Real-time data infrastructure allows predictive

	health, voting, taxation.	private services; high cashless adoption.	online; X-Road enables secure inter-agency data exchange.	policy planning and service optimization.
Singapore	National Digital Identity (NDI) ensures secure citizen access to e-services; Singpass is widely used.	Central digital payment platform (PayNow) used for transactions and public disbursements.	GovTech drives unified e-service architecture; Smart Nation Sensor Platform integrates citywide data.	Strong data analytics ecosystem; sensors and AI used for real-time urban governance and planning.
Norway	BankID provides secure authentication; nearly all adults have access; used across public and private sectors.	Mature digital payment systems; widespread digital banking; used for tax, health, and welfare transactions.	Altinn portal integrates multiple agencies for seamless e-governance; high citizen uptake.	Digital health and taxation systems use integrated data for monitoring and planning.
Bangladesh	Digital ID (NID) with biometric data; linked to mobile SIMs and financial accounts.	bKash and Nagad support large-scale mobile money ecosystem; integrated with government transfers.	Online public services (birth registration, land records); increased automation in service delivery.	Real-time dashboards and mobile apps used for tracking social programs and subsidy distribution.

Ethiopia	National ID system under development (NIDP); pilot projects underway; aims to reach all citizens.	Mobile money (HelloCash, TeleBirr) expanding; government exploring use in public welfare payments.	Early-stage development; some public services moving online, e.g., permits, education portals.	Limited but growing use of digital data in governance; digitization roadmap under Digital Ethiopia 2025.
Peru	RENIEC provides biometric ID for all citizens; used in electoral and public service systems.	Expanding use of digital wallets and mobile banking; uptake growing in urban areas.	Several public services available online (tax, civil registry); still semi-digital in rural areas.	Data platforms used for census, planning, and resource targeting; scope remains limited.
Sierra Leone	National Civil Registration Authority (NCRA) issues digital IDs; expanding integration with services.	Mobile money increasingly used for tax payments and cash transfer schemes.	Progress in e-governance (e.g., online birth registration); still in development phase.	Data dashboards used in health and education; early efforts in digital monitoring.
Ukraine	Diia app serves as a unified platform for digital ID, licenses, and documents; high adoption during crisis.	Mobile payments integrated with public transactions; rapid uptake of digital banking.	Advanced e-government services via Diia; most services accessible via mobile app.	Uses digital data for transparency and citizen feedback; open data systems in place.

Togo	e-ID Togo project launched with biometric registration; integration ongoing.	Mobile payments used in Novissi cash transfer program; scalable infrastructure.	Online portals for business registration, permits; expanding e-service capacity.	Data used to target beneficiaries in social programs; analytics used during COVID response.

4. Findings in the form of Case Studies:

INDIA

India has adopted a number of DPI projects, including the *"National e-Governance Plan (NeGP)"* and the initiative for Digital India. E-governance and the digitization of government processes are the main goals of the Digital India program, whereas the NeGP seeks to enhance providing public services through the use of digital technologies. An enhancement in budget transparency has been one of the primary outcomes of these activities. An online platform for budget preparation has been put in place by the Indian government, enabling tracking and monitoring of budget allocations and expenditures *(GOI, 2016)*. As a result, government organizations now have greater responsibility, and the budget process is running more smoothly. The effectiveness of public spending management has increased in India as a result of DPI. The tracking and monitoring of public spending, as well as the discovery of opportunities for improvement and cost savings, have been made easier by using data analytics technologies and digital platforms *(World Bank, 2018)*. As a consequence, less time and money are needed for the budget's creation and implementation. Finally, there has been a rise in revenue collection in India due to the DPI programs. Digital channels and technologies for data analytics have made it easier to analyze and monitor tax collections and identify areas where tax compliance needs to be improved *(GOI, 2016)*. As a result, there is now less tax evasion and a rise in the revenue base overall.

ESTONIA

Many people claim that Estonia has the most developed digital society in the world. After regaining independence in 1991, Estonia prioritized digital transformation to rebuild its economy and governance. The e-Estonia initiative encompasses various digital services, including the X-Road secure data exchange layer, digital ID for every citizen, and non-estonians are able to establish and run an EU-based business online thanks to e-Residency. These initiatives have made public services more efficient, increased transparency, and significantly contributed to economic growth.

Estonia's journey towards becoming a digital republic began with the establishment includes the secure data exchange layer known as the X-Road, which connects different databases and ensures interoperability. Through this system, different government agencies are able to share information without any trouble of redundancy and this facilitates efficiency. Being compulsory to all citizens, the digital ID system enables secure access to numerous public services, such as healthcare, banking & voting. Since 2014, the e-Residency program has allowed non-Estonians to create and manage a company in the EU entirely online, appealing to entrepreneurs and companies globally. These efforts have had a tremendous effect. Citizens can now access public services online which has minimized bureaucracy and also saved time on the part of the citizen and the side of government officials. The corruption has also been minimized due to the enhanced transparency in the operations of government and it has created a bond of trust between the government and the people. In the economic sphere, the digital economy is the notable contributor to the GDP in Estonia, and this nation has turned into a center of tech startups and innovations. The success story of Estonia ought to be used by other countries aspiring to embrace the digital public infrastructure.

SINGAPORE

Singapore has a Smart Nation initiative whose aim is to leverage technology to increase economic opportunities and standards of living. The Smart Nation Sensor Platform unifies the information collected by different sensors to enhance the management of the city, and GovTech pushes the digitalisation of government services. The National Digital Identity (NDI) provides citizens with a fast and secure way of gaining access to digital services. Such projects have enhanced the urban governance, health sector as well as economic development through innovation and hosting international technology corporations. Smart Nation is an initiative started in 2014 that aims at

making the city life smarter and generating economic prospects with the help of technology. The Smart Nation Sensor Platform is a data gathering system that gathers information of diverse sensors placed in the city to give real-time data on effective administration of the city. Such information is applied in the optimization of the traffic flow, the management of the public utilities, and even the improvement of the public safety. GovTech is a government organisation that is important in leading digital transformation in government services, ensuring that citizens can access government services easily on the internet. The National Digital Identity (NDI) system enables citizens to securely and conveniently access digital services. It allows safe authentication of online transactions, limiting the probability of fraud and increasing confidence in internet services. The implementation of digital health services has aided in the better care and management of patients also, as electronic health records and telemedicine become increasingly common. Embracing innovation and technology has seen Singapore assume the attention of the global technology companies, enhance economic development and generation of high-value employment. The Smart Nation project is an excellent example of how a fully-developed digital plan can improve life in an urban setting and spur economic growth.

NORWAY

Norway is already very experienced in digital innovation, especially within the public services and governance. Altinn portal provides digital public services (taxes and business registration etc.) and BankID is a secure digital ID used in online transactions and access to public services. The outcome of patients and efficiency of health care have been enhanced through comprehensive digital health services. These online procedures have eased access to government services, cut the administrative expenditures and increased the satisfaction of citizens. Altinn portal is an all-embracing system of digital public services, which was started in the year 2003. Through it, citizens and businesses can utilise the internet to obtain numerous government services, including company registration, tax payment and reporting obligation. This has greatly eased the administrative load on the part of the government as well as the citizens and has improved the performance and availability of government service. BankID is a safe digital ID system that is commonly used to make online payments and access public services in Norway, providing safe and convenient authentication. Norway's digital health services have also seen significant advancements. Electronic health records are widely used, enabling seamless sharing of patient

information across healthcare providers. Telemedicine services have become more prevalent, improving access to healthcare, particularly in remote areas. These digital health services have improved patient outcomes and healthcare efficiency, making healthcare more accessible and effective. Norway's approach to digital public infrastructure highlights the importance of secure and efficient digital services in enhancing delivering public services and raising living standards.

BANGLADESH

Bangladesh's Digital Bangladesh Vision aims to make the nation's economy more knowledge-based. The most important projects are digital identification cards that include biometric information, mobile financial services, such as bKash, and other e-government services. Such initiatives have opened up banking to the unbanked, simplified delivery of government services and stimulated growth of MSMEs and the digital economy. Advancement in digital payments and government services have played a very important role in terms of financial inclusion and economic development. Digital Bangladesh Vision initiated in 2009 seeks to use technology to, spur economic development and social growth. Through the introduction of digital ID cards containing biometric information, public service delivery has become more accurate and efficient, verification of beneficiaries of government welfare has become easy. Mobile financial services, notably bKash, have transformed payment in Bangladesh, and promoted financial inclusion, delivering financial services to millions of unbanked citizens. There are also great improvements in the e-government services and now many of the public services can be accessed online. This has reduced the number of visits one has to make to the government offices in person making it more accessible and efficient. The digital economy has been facilitated by the digital infrastructure that adopts and grows MSMEs into new markets and business expansions. The case of Bangladesh and its attitude to digital public infrastructure shows how technology may be used as a catalyst of economic and social development, especially in the developing world.

ETHIOPIA

Ethiopia is on a quest to revolutionize her economy and government services using digital infrastructure. The Digital Ethiopia 2025 plan of the country is to take advantage of the use of technology to help accelerate economic growth and enhance the discharge of public services. The most important initiatives are the creation of a national digital ID system, digital payments, and e-

government services. The National ID Program, also referred to as the national digital ID system, aims to provide a unique identification number to every citizen, making many governmental services and financial integration available. The digital payments are being encouraged using different platforms such as the mobile money services, which have become famous both in rural and urban settings. The e-government services are geared towards rendering the public services much accessible and efficient and thereby reducing the need to visit the government offices physically. The impacts of these measures are already noticeable. As much as the digital payments are expanding financial inclusion and economic participation, the digital ID system is expected to enhance the accuracy and efficiency of delivering public services. Electronic government services are improving the ease of access to government services by the citizens, as well as enhancing transparency and reducing corruption. The experience of Ethiopia in DPI shows how digital infrastructure can become the engine of economic growth and social development in emerging economies.

PERU

Peru has gone miles further to install digital public infrastructure to boost delivery of public services and improve the economy. The national digitalization plan targets the creation of a national digital ID, digital payment, and e-government services. RENIEC is the national digital ID system that assigns every citizen a unique identification number that is used to access public services and inclusion in the financial sector. The digital payments are being encouraged using different channels, such as mobile money services and digital wallets, which have become popular among the citizens. E-government services are under construction to ensure that public services are brought nearer and efficient to the people so that the need to visit the government offices physically reduces. The impacts of these programs are evident. The digital ID system has helped public service delivery to be more accurate and efficient, and digital payments are expanding economic activity and financial inclusion. Citizens are finding it easier to access governmental services, e-government services are making things more transparent and reducing corruption. In its DPI strategy, Peru state the significance of digital infrastructure in fostering both social and economic progress.

SIERRA LEONE

Sierra Leone is utilizing digital public infrastructure to promote economic growth and improvement in the delivery of public services. The national digitalization strategy is centered on creating a national digital ID system, digital payments, and e-government services in the country. Digital identity system in the country, the National Civil Registration Authority (NCRA) aims to provide every citizen with a unique identification number to facilitate financial inclusion and the ease of access to public services. The digital payments are being encouraged using different platforms such as the mobile money services that have become popular both in urban and rural locations. E-government services are being created to bring public services nearer and effective whereby the need to visit the government offices physically will be reduced. The outcomes of such undertakings are already visible. As digital payments are boosting financial inclusion and economic participation, the digital ID system is expected to increase the accuracy and effectiveness of delivering governmental services. Through e-government services, it is easier to access governmental services by the citizens and it also enhances transparency and reduces chances of corruption. Sierra Leone approach to DPI reveals how digital infrastructure can become the driver of social and economic progress in developing countries.

UKRAINE

Ukraine has achieved a lot in rolling out digital public infrastructure to boost delivery of public services and economic development. The national digital transformation plan is centered on the creation of a national digital identification system, digital payment and e-government services. National digital ID, called Diia, offers every citizen a unique identification number that can be used to access public services and inclusion in the financial system. The promotion of digital payments is carried out using different channels, such as mobile money services and digital wallets that have become popular among citizens. The e-government services are being established with an aim of making the public services more available and effective whereby the need to visit the government offices physically will be reduced. Such initiatives are obviously paying off. As much as digital payments are expanding financial inclusion and economic participation, the digital ID system has helped make public service delivery more accurate and efficient. E-government services are making it easier to access governmental services to citizens and also enhance transparency and reduce corruption. The DPI strategy of Ukraine underlines the significant role of digital infrastructure in encouraging social and economic development.

TOGO

Togo is harnessing its economic growth and improving public service delivery using digital public infrastructure. The digital transformation strategy of the country is centered around the creation of the national digital ID system, digital payments, and e-government services. e-ID Togo is the national digital ID system that is planned to provide every individual with a unique identity number to achieve financial inclusion and access to public services. There are multiple platforms that are being used to promote the digital payments such as the mobile money services, which are now popular in both urban and rural locations. E-government services are being created to bring public services closer and efficient to the citizens such that visiting government offices physically will not be a necessity. The outcomes of those works are already visible. As much as the digital payments are expanding financial inclusion and economic participation, it is expected that the digital ID system will enhance the accuracy and efficiency of the delivery of public services. E-government services are making it easier for citizens to access governmental services, and are also making things more transparent and reducing corruption. The case of Togo DPI strategy shows how digital infrastructure can become a driver of social and economic progress in developing countries.

5. Challenges and Opportunities:

Digital Public Infrastructure (DPI) has the power to revolutionize public financial management and service delivery, but its success hinges on navigating a variety of challenges and enablers. One of the biggest hurdles is the digital divide- the gap in access to digital technologies among different socioeconomic, geographic, and demographic groups. In low-income and rural areas, issues like limited internet access, low digital literacy, and gender-based exclusion make it tough for everyone to participate equally in DPI systems. If we don't implement proactive policies to bridge these gaps, there's a real risk that DPI could end up deepening existing inequalities instead of alleviating them. Cybersecurity and data privacy are also major concerns. As DPI systems gather, process, and store large amounts of sensitive data about citizens, they become prime targets for cyberattacks. Many countries, particularly those just starting to roll out DPI, don't have strong legal and technical protections in place to safeguard user data. Weak regulatory frameworks and poor enforcement can undermine public trust, making citizens hesitant to engage with digital services. Another significant challenge is institutional capacity. To deploy interoperable systems

like digital IDs that connect to financial and social protection databases, we need not just the right technology but also effective coordination among ministries, agencies, and private entities. Unfortunately, in many places, bureaucratic silos and fragmented data governance practices hold back the full potential of DPI. The lack of skilled professionals in areas like data analytics, cybersecurity, and digital design only makes the implementation gap wider. Financial limitations also pose a barrier to DPI growth. The initial costs of designing, launching, and scaling DPI systems can be daunting, especially for low-income countries. While development aid and partnerships between the public and private sectors can help close the gap, achieving long-term sustainability hinges on mobilizing domestic resources and having clear budgeting strategies in place. Even with these hurdles, the potential benefits of Digital Public Infrastructure (DPI) are substantial. DPI can significantly boost fiscal transparency by allowing real-time tracking of public spending and tax collection. It promotes inclusive growth by broadening access to banking, healthcare, and education for communities that have been overlooked. The COVID-19 pandemic highlighted how DPI, through digital cash transfers, telemedicine, and online learning platforms, can maintain essential services during tough times. Additionally, DPI encourages innovation in governance. Integrated systems like Estonia's X-Road and India's Aadhaar-Enabled Payment Systems (AEPS) show how DPI can simplify service delivery, cut administrative costs, and improve citizen satisfaction. When designed with inclusivity in mind and implemented thoughtfully, DPI can be a powerful asset in reaching sustainable development goals, enhancing government responsiveness, and rebuilding public trust in state institutions.

6. Suggestions and Recommendations for Policymakers:

This study draws on a comparative analysis of ten different national experiences to offer a range of practical suggestions and policy recommendations aimed at improving the design, implementation, and governance of Digital Public Infrastructure (DPI). The goal is to help governments, public administrators, and development partners develop strategies that foster inclusive, efficient, and resilient public service delivery. It's crucial for governments to view DPI not as a proprietary system or a commercial product, but rather as a public good. This perspective emphasizes the need for an architecture that is open, inclusive, interoperable, and designed with the public's best interests in mind. Public-private partnerships should be carefully structured to prevent vendor lock-in and ensure sustainability and ownership by citizens over the long term.

Prioritizing digital identity systems is essential, as they serve as the gateway to DPI, facilitating access to various government services and financial inclusion tools. Biometrically secure and universally accessible ID systems, like those implemented in India, Estonia, and Peru, can act as foundational elements for effective digital governance. By investing in interoperable platforms and data-sharing frameworks, we can significantly cut down on redundancy and enhance institutional efficiency. Examples such as Estonia's X-Road and India's India Stack illustrate how open APIs and layered digital infrastructure can promote seamless integration across different sectors. However, the swift rollout of digital infrastructure must be paired with strong laws governing data protection, cybersecurity, consent, and algorithmic transparency. Countries really need to set up independent data regulators and effective ways for people to voice their concerns if they want to keep the public's trust. It would be wise for governments to think about forming dedicated bodies for data protection and innovation, like Singapore's GovTech or India's National e-Governance Division, to help coordinate efforts across different sectors, track the impact, and make sure everything aligns with their development goals. We also need targeted actions to ensure that the benefits of digital public infrastructure reach those who are often left behind. This means investing in reliable internet access, creating user-friendly interfaces in multiple languages, and expanding digital literacy programs in rural and underserved communities. Countries at various stages of developing their digital public infrastructure can learn a lot from each other by sharing tools, models, and experiences. South-South cooperation and regional partnerships, like those within the African Union or ASEAN, can really help with knowledge sharing and building collective skills. As we saw during the COVID-19 pandemic, having robust digital public infrastructure can be crucial in emergencies. Governments should make sure to include backup plans in their digital platforms to keep essential services running smoothly during crises.

7. Theoretical and Practical Implications:

Theoretical Implications

This study adds to the growing body of research on digital governance and public administration by offering a comprehensive framework to understand Digital Public Infrastructure (DPI) as a multi-faceted public good. Unlike previous studies that often look at digital identity systems, digital payments, or e-governance in isolation, this paper pushes the academic dialogue forward by illustrating how these components need to work together in a cohesive ecosystem to achieve

the greatest impact. The four-part analytical framework, which includes digital identity, payments, e-governance maturity, and data-driven decision-making, acts as a valuable tool for researchers to systematically assess DPI readiness and effectiveness across various national contexts. Additionally, the study enhances our understanding of platform governance and public sector innovation. It builds on the frameworks established by Estevez & Janowski (2013) and Cordella & Bonina (2012), who concentrated on ICT-enabled public sector reforms, by highlighting the critical roles of interoperability, institutional coherence, and citizen trust as key factors for successful digital transformation. In doing so, this research provides empirical evidence that can be utilized to test and refine theories of digital governance in future comparative or longitudinal studies.

Practical Implications

This study provides a hands-on guide for governments and development organizations looking to design, evaluate, and expand Digital Public Infrastructure (DPI) initiatives. The comparisons between countries highlight that there's no one-size-fits-all approach; the success of these initiatives really depends on how well technology aligns with a nation's governance capabilities, regulatory structures, and strategies for engaging citizens. Policymakers can leverage the analytical frameworks developed in this research to assess their own DPI environments and pinpoint areas where they might be lacking in coverage, capacity, or policy alignment. For example, countries just starting out with DPI, like Ethiopia, Togo, and Sierra Leone, should focus on establishing basic identity systems and mobile payment solutions before moving on to more complex e-governance platforms and integrated data systems. On the flip side, countries that are already digitally advanced can concentrate on improving interoperability, tightening privacy laws, and incorporating AI and analytics into their public decision-making processes. Development agencies and international donors can use these insights to allocate resources more effectively, helping countries not just acquire technology but also build the institutional readiness, digital skills, and legal frameworks necessary for sustainable DPI. This study effectively bridges the gap between theory and practice by turning complex ideas into actionable tools and policy suggestions. It emphasizes that DPI is more than just a tech upgrade; it's a governance innovation that, when done right, can drive public sector reform, enhance the relationship between the state and its citizens, and promote long-term sustainable development.

8. Discussion:

The comparative analysis of DPI implementation across ten countries shows a mix of similarities and differences in their national strategies, shedding light on the global digital governance scene. This study backs up what previous research has found, highlighting the importance of digital identity and payment systems as key elements for transforming services. For example, as noted by Gelb and Clark (2013), the widespread use of biometric ID systems in India and Peru has effectively cut down on duplication and fraud in welfare programs. The findings also resonate with the work of Estevez and Janowski (2013), which suggests that platform-based governance—like Singapore's GovTech framework or Estonia's X-Road—promotes smooth interoperability and encourages policy innovation. However, the results also point out the differences in e-governance maturity and data-driven governance among the countries studied. While nations like Ukraine and Singapore are harnessing real-time analytics for their decision-making processes, others, such as Ethiopia and Sierra Leone, are still in the early stages of developing their data systems. A significant takeaway from this research is the focus on integrated DPI ecosystems instead of just standalone digital tools. Unlike previous studies that often zoom in on individual components (like e-payments or ID systems), this paper argues that the real impact of DPI on public financial management comes from the collaboration between these components. This holistic approach builds on the frameworks suggested by Janssen and Estevez (2013) and Cordella and Bonina (2012), shifting the focus from mere technical efficiency to the importance of citizen trust, institutional accountability, and system resilience. Moreover, the study brings attention to the governance dimension of DPI- highlighting how political commitment, regulatory frameworks, and public-private collaboration influence outcomes. For example, Bangladesh's success with mobile payments and India's Direct Benefit Transfers are enabled by strong institutional mechanisms and digital policy coherence. This underscores the importance of contextual governance capacity, a factor often underemphasized in technocratic literature. By systematically comparing ten varied country contexts, the study enhances understanding of what works, where, and why, providing a nuanced foundation for both scholarly exploration and policy action.

9. Conclusion:

This study set out to explore how Digital Public Infrastructure (DPI) contributes to public service transformation and financial governance across a diverse set of ten countries. Through a structured,

comparative case study methodology, it analyzed DPI implementation using four key dimensions: digital identity systems, digital payment integration, e-governance maturity, and data-driven decision-making. The findings underscore the immense potential of DPI to enhance administrative efficiency, increase transparency, and promote inclusive economic development.

Countries such as Estonia, Singapore, and India exemplify advanced models of DPI adoption, where digital identities are widely used, digital payments are deeply integrated into public finance systems, and e-governance platforms enable streamlined and citizen-centric service delivery. In contrast, countries like Sierra Leone, Ethiopia, and Togo are in earlier stages of DPI deployment but are showing promising signs of leveraging digital tools to address long-standing development challenges.

Despite differences in capacity and digital maturity, all ten countries have demonstrated that DPI can significantly improve public financial management. Real-time monitoring of government spending, streamlined welfare transfers, and expanded access to digital services have emerged as consistent benefits. However, these gains are contingent on factors such as institutional coordination, infrastructure readiness, legal safeguards, and citizen trust. The study also highlights that DPI is not a one-size-fits-all solution. Its success depends heavily on the local context political will, regulatory ecosystems, technological capacity, and socio-economic conditions. For DPI to be truly transformative, its design and implementation must prioritize equity, accountability, and inclusion from the outset.

In conclusion, DPI represents a new paradigm in public governance, offering both opportunities and responsibilities. It enables governments to become more agile, transparent, and citizen-focused, while also raising complex questions about data governance, digital ethics, and public accountability. As the digital transformation of the public sector accelerates, continuous research, cross-country learning, and adaptive policy frameworks will be critical to realizing the full promise of DPI for sustainable and equitable development.

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