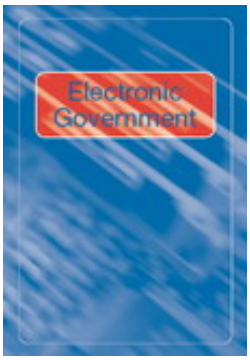

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A consolidated conceptual framework of a smart e-government ecosystem: a scoping review

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A consolidated conceptual framework of a smart e-government ecosystem: a scoping review

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Abstract: The swift societal evolution, catalysed by the COVID-19 pandemic, has given rise to the emergence of a 'super smart society 5.0'. The widespread integration of new information and communication technologies (NICTs), which has impacted various sectors, including government operations, has created opportunities for socio-economic development and the democratisation of data and services. The public sector's response to this tech revolution has varied, progressing from cautious e-government 1.0 to more mature phases (2.0, 3.0). Nonetheless, a digital divide between developed and emerging nations endures. Addressing these challenges mandates efficient data governance, proactive digital leadership, and a comprehensive strategic vision. This paper presents a consolidated smart e-government 4.0 framework, synthesising existing research and best practices to facilitate successful digital transformation within the public sector. By tracing the evolution of e-government and examining the perspectives that shape it, the paper reviews key technologies reshaping public administrations. The proposed framework aims to go beyond the current structures, offering a comprehensive approach to bolstering e-government initiatives. It seeks to create a transparent, democratic, and performance-driven public sector, addressing the nuances and challenges of contemporary governance.

Keywords: e-government; e-governance; digital transformation; ecosystem.

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1 Introduction

The transition through various societal phases, from hunting to agrarian, industrial, and information societies, has paved the way for the concept of 'super smart society 5.0' (Taj and Zaman, 2022). The advancements in new information and communication technologies (NICTs) and the evolution of the web have significantly impacted all sectors, promising socio-economic development and democratisation of data and services (Irani et al., 2006). Aligning progress indicators of 1.0 to 5.0 across domains such as logistics, marketing, education, procurement, and government operations has become a reality. However, the public sector's response to this technological revolution varied across sectors, initially focusing on internal management within administrations. The private sector embraced change early on, pursuing maximum financial benefits, while the public sector gradually adapted and progressed towards an e-government 1.0 phase in the early 1990s, sharing information with the public (Grönlund and Horan, 2005) (see Figure 1). The pursuit of good governance practices and meeting the needs of the general public drove the public sector's adoption of mature e-government, promising democracy, transparency, and emancipation from socio-economic problems (Misuraca, 2006). Nonetheless, significant disparities exist among countries in their adoption of digital technology for performance-driven public services (Dobrolyubova, 2022). Developed countries engage in discussions about 'smart government' (Huang et al., 2023), 'smart cities' (Jang et al., 2023), 'smart transport' (Tokunova and Rajczyk, 2020), and 'online voting' (Toots et al., 2016) while emerging countries are still laying the foundation for e-governance (Hatsu and Ketcha Ngassam, 2015; Prakash et al., 2023). Achieving successful digital transformation requires efficient data governance, proactive digital leadership, and a comprehensive strategic vision addressing human, organisational, regulatory, financial, technological, and data challenges.

Digital transformation in the public sector has gained significant attention in academic research. However, there is a need for conceptual clarity and more research in this area (Danielsen et al., 2022; Lima et al., 2023). Several studies have explored the success factors, processes, and case studies of digital transformation in the public sector (Escobar et al., 2023; Jonathan, 2020; Mergel et al., 2019). Public sector managers need to understand the expectations and outcomes of digital transformation projects (Jonathan, 2020; Kitsios et al., 2023). The barriers and preconditions for successful digital government transformation are complex and not solely technology-related (Liva et al.,

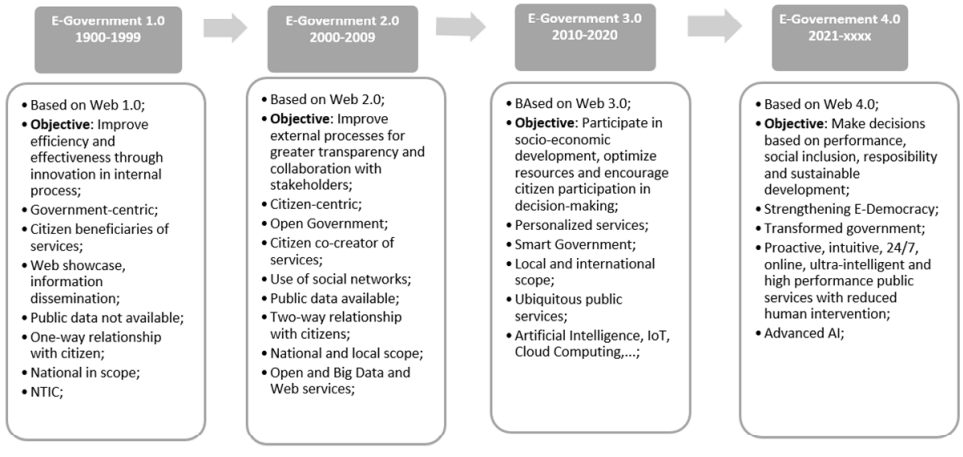
2020). Public sector organisations display a high level of variance in how they enact structural changes for digital transformation (Tinjan et al., 2023).

Overall, digital transformation in the public sector requires a deep understanding of the process, necessary resources, and benefits, as well as addressing barriers and organisational changes. To the best of our knowledge, the existing literature on e-government has focused on specific aspects, necessitating a consolidated and holistic conceptual framework (Escobar et al., 2023). Our paper aims to bridge this gap by integrating the best practices and insights into a comprehensive framework, providing a more profound understanding of e-government implementation. Building upon previous studies, we propose the Smart E-Government 4.0 framework in Section 3, which emphasises key factors for a more holistic digital transformation in the public sector.

Section 2 of our paper comprises two main subsections. The first subsection offers an overview of e-government, including its definition, *roles*, and *maturity models*, shedding light on its *evolution and perspectives on implementation*. The second subsection reviews disruptive technologies reshaping the public sector and explores their adaptability and effectiveness in aligning public administrations with stakeholders' needs for performance, integrity, and democracy.

In Section 3, our research aims to provide a unified conceptual framework, encompassing the *multifaceted* nature of e-government, to facilitate effective and efficient e-government initiatives. This paper serves as a roadmap for governments to navigate challenges and leverage opportunities presented by digital technologies. It aims to contribute to the advancement of e-government practices and sets an agenda for future research in this field.

Figure 1 Evolution of e-government



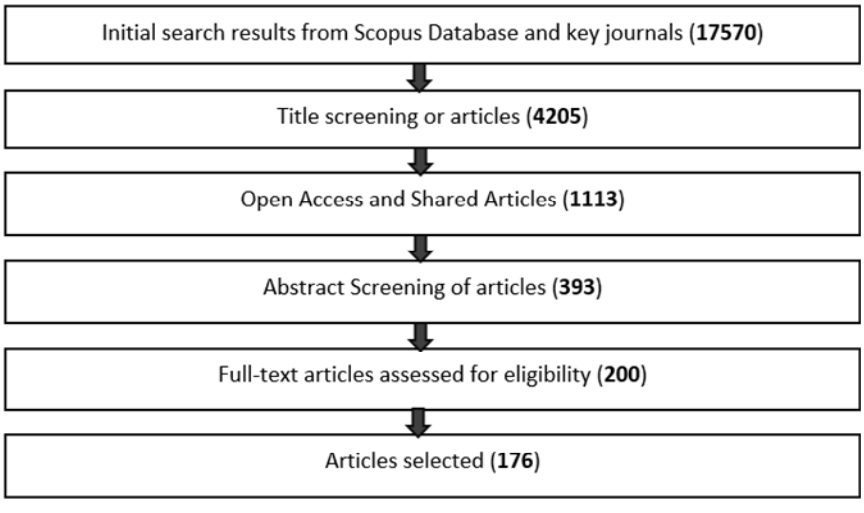
Source: Authors

2 Research method

For this scoping review, the literature search spanned from 2004 to 2023, ensuring coverage of recent and pertinent contributions to the field. The timeline was chosen with a deliberate focus on exploring the evolution of e-government. The extended timeline

allows for a comprehensive examination of the early stages of digital transformation in developing countries, offering insights into their unique challenges and trajectories. Additionally, the review extends to the present (2023) to capture the application of emerging technologies in developed countries, showcasing innovative practices in mature e-government ecosystems. The multi-decade perspective aims to provide a nuanced understanding of the diverse global landscape of e-government initiatives, from early adopters to contemporary practices. To construct our comprehensive framework for Smart E-Government 4.0 outlined in this paper, a multi-faceted research methodology was implemented. The research process was initiated with a thorough but not exhaustive literature search that included an array of sources, such as articles, reports, and case studies. Key themes related to e-government evolution, digital transformation, and the integration of NICTs in the public sector guided the search. Specific keywords employed for the literature review encompassed terms like [('digital transformation' OR 'IT Strategies' OR 'change management') AND ('government' OR 'public sector')] OR 'e-government' OR 'digital government' OR 'smart government'. The search was conducted primarily on Scopus database. In selecting articles, stringent criteria were applied, including relevance to the identified themes, recent publication dates, the presence of empirical evidence, and English language preference. The language criterion was set to English to ensure accessibility and uniformity in understanding. The chosen articles were required to provide substantial insights into e-government phases and technological disruptions. Case studies were selected from reputable international organisations such as OECD, World Bank, and United Nations reports. The criteria for choosing case studies were based on their relevance, the presence of empirical data, and their ability to provide insights into the intricacies of e-government initiatives.

Figure 2 The research methodology



Additionally, the scoping review aimed to address specific facets through broad research questions:

RQ.1 How has the concept of e-government ecosystems evolved and what factors have influenced this evolution?

RQ.2 What are the key components of an e-government ecosystem and how do they interact with each other to enhance government services?

RQ.3 What role have technological advancements played in shaping the development of e-government ecosystems?

The selection criteria were directed towards capturing a well-rounded understanding of these key aspects. The overarching purpose of this article is to present a framework that succinctly summarises the most important components of e-government projects and the pillars that underpin their success, thereby offering a valuable resource for comprehending the intricacies of effective e-government implementation (see Figure 2).

3 Literature review

3.1 E-government ecosystem definition

Governance establishes rules and practices for effective decision-making, ensuring organisational functionality and stakeholder relationships in private and public sectors at various levels (Malodia et al., 2021; The Word Bank, 2015). Originally tied to 'corporate governance', this concept's scope has expanded, involving the private sector in select public sector areas due to neo-liberal ideologies. However, this shift raises concerns about state sovereignty erosion and wealth disparities (Malodia et al., 2021). To counter this, transitioning to citizen-centred public governance is vital, emphasising transparency, accountability, and meeting population needs (Gil-García and Pardo, 2005). The government's role has evolved from sole decision-making to collaborative participation, fostering good governance conditions, political pluralism, and stakeholder inclusion (Gil-García and Pardo, 2005). NICTs have spurred a shift to citizen-centred governance models, utilising technology for enhanced governance processes and public service delivery (The Word Bank, 2015). This transformation has given rise to concepts like e-governance and e-government, designed to facilitate the digital transformation of governmental functions.

The term 'ecosystem' was coined by Arthur George Tanslye[1] in 1935 within the field of biology. It refers to a complex system comprising both living organisms (biocenosis) and non-living components that interact extensively within a natural environment (biotope). Each unique environment, defined as an ecosystem, encompasses a community of distinct living species and specific physical conditions[2]. Similar to the inter-relational logic that characterises the word 'ecosystem' in the environmental field, the digital ecosystem refers to the set of complex interdependent interactions between different actors (service provider, customer, decision-maker...) and different digital systems (online services, consultation portal, social networks, software, data...) through transmission channels (computer, smartphone, telephone, fax, drone...) governed by a certain number of governance rules and creating value (Rantanen et al., 2019).

The e-government ecosystem represents a distinctive instance within the broader concept of the digital ecosystem. This novel model of interaction primarily involves various stakeholders from society, including *citizens*, *companies*, *NGOs*, and *civil servants*, alongside *government entities*. In contemporary society, the discussion of a digital e-government ecosystem has become essential due to the proliferation of web technologies and NITCs, which have brought about significant technological and societal

changes. The genesis of the digital e-government ecosystem has led to a fundamental paradigm shift, encompassing two contradictory logics: hierarchical and networked. Information and knowledge are no longer concentrated in a central source but are accessible to everyone within a society that values collective and collaborative intelligence. This openness, combined with increased accessibility to knowledge and good governance, fosters civic responsibility.

3.2 E-government ecosystem conceptualisation

3.2.1 E-government stakeholders relationships

Users and e-government stakeholders, including citizens, businesses, government organisations, and civil servants, play a crucial role in the e-government ecosystem (Ndou, 2004). Government-to-citizen (G2C) systems provide online services, empowering citizens as active decision-makers rather than mere subordinates. Countries like Estonia have embraced electronic voting to enhance citizen engagement, though security concerns persist. Government-to-business (G2B) interactions focus on transactions like online tax payment and e-public procurement, as governments modernise administration to support businesses in the competitive Industry 4.0 landscape. Government-to-government (G2G) involves internal and external exchanges between government entities, demanding seamless interoperability and integrated government ecosystems. Government-to-employee (G2E) platforms facilitate training, communication, and information sharing among civil servants. However, challenges such as resistance to change and inadequate training impede progress within this sphere (Ndou, 2004). Consequently, addressing these stakeholder interactions is crucial for the successful implementation and advancement of public services within e-government frameworks. Research surrounding e-government and stakeholder interaction models plays a critical role in identifying and understanding the diverse perspectives and interactions among stakeholders (Greger et al., 2014). Nevertheless, governing large-scale e-government platforms presents challenges due to the multitude of stakeholders with varying interests and agendas, necessitating the adoption of extended governance models and practices (Paivarinta et al., 2019). Also, the heterogeneous nature of stakeholders and the lack of effective collaboration mechanisms hinder efficient local e-government service delivery (Weerakkody et al., 2019). Additionally, a study on smart cities revealed the importance of smart city strategies for intensifying collaboration between local government and stakeholders in the ecosystem, emphasising the need for effective collaboration mechanisms (Clement et al., 2022). Stakeholders harbour diverse perspectives, encompassing notions of efficiency, democracy, and governmental transformation, which intersect with challenges such as private sector involvement, privacy considerations, legislative frameworks, and cultural shifts within governmental organisations (Inkinen and Merisalo, 2014). The identification of stakeholders for e-government training assumes significance, with attributes like legitimacy and power playing pivotal roles in this process (Lim et al., 2016). Evaluating e-government performance from the citizen's perspective is paramount. Kamaruddin et al. (2018) focuses on constructing a conceptual model and assessment instrument tailored to gauge citizen-centricity within e-government websites. This model integrated four key components and delineated 39 distinct characteristics across seven thematic categories. Furthermore, in a related study, a refined citizen-centric checklist, comprising 40

attributes categorised into four components, was employed to assess government agency websites in Malaysia (Lim and Kamaruddin, 2023). Fostering effective stakeholder relationships is not only essential for the functionality of e-government initiatives but also pivotal for fostering trust and enhancing citizen engagement in digital governance processes.

3.2.2 E-government services

Government web portals serve as crucial platforms for delivering online services to citizens and businesses, as indicated by various academic studies (Choudrie et al., 2017; Gkikas et al., 2022). Within this sphere, a multitude of insights emerges, illuminating diverse facets of portal development and usage. Notably, Henman and Graham (2019) underscores disparities in design approaches between information repository portals and referral portals, alongside significant variations in the integration of social media platforms for online government operations. Moreover, cross-country analyses reveal disparities in portal dimensions and configurations, highlighting the complexity of portal development across different contexts (Henman and Graham, 2019; Mutambik et al., 2021; Neff et al., 2022). Evidently, Mutambik et al. (2021) emphasises the pivotal role of usability and collaboration in maximising the potential of open government data (OGD) portals. An examination of government web portals in varied countries reveals divergent design approaches and substantial differences in portal makeup, particularly in terms of hyperlink structure (Henman and Graham, 2019). Insights from Thorsby et al. (2017) shed light on the nascent stage of development of open data portals in American cities, underscoring the need for enhancements in user help and analysis features to unlock their full potential. Moreover, user perceptions of digital data portals underscore the significance of ease of access, applicability, confidence, and trust in data among end users (Murphy and Ollerenshaw, 2023).

Scholars have also emphasised the development of robust assessment frameworks tailored specifically for e-government portals, focusing on quantitative metrics to evaluate service effectiveness (Gkikas et al., 2022; Henman and Graham, 2019; Kamaruddin et al., 2018; Lim and Kamaruddin, 2023). E-government initiatives, harnessing the capabilities of information and communication technology (ICT) are recognised for their role in enhancing public services and facilitating citizen access to vital information (Bwalya and Mutula, 2014). However, this transition to e-government brings forth specific challenges and requisites for state governments, underlining the pivotal role of ICT in ensuring the smooth operation of digital services. On another hand, the emergence of one-stop government portals is increasingly prominent, signifying a trend towards the unified provision of services from various departments through a single access point (Abdulhakeem Amer, 2020; Kohlborn et al., 2015). This shift aligns with the vision outlined in a study focusing on e-government practices in Australia, which advocates for a connected digital government model. Central to this model is the integration of government business processes and the establishment of a whole-of-government platform (Fan, 2018). Similarly, initiatives such as the single digital gateway regulation (SDGR) in Europe underscore the move towards unified access points for government services, aiming to streamline processes by enabling businesses and citizens to provide data only once (Schmidt et al., 2021). In Finland, the KaPa program has introduced the Suomi platform, a national e-government service hub. Suomi serves as a one-stop portal, facilitating access to public and private sector services

for citizens and organisations alike (Yli-Huumo et al., 2018). These developments collectively reflect a broader trend towards integrated service provision within e-government frameworks. Therefore, effective portal design, comprehensive assessment methodologies, and the transformative potential of e-government initiatives are underscored as critical elements in enhancing public services and information accessibility.

3.2.3 E-Government Infrastructure

Telecommunication infrastructure and human capital are identified as crucial factors affecting the efficiency of public service provision (Doran et al., 2023; Moreno-Enguix et al., 2019). However, the efficacy of e-government technologies is hampered by insufficient funding and inadequate enabling infrastructure, leading to decreased efficiency in service delivery (Parida et al., 2023; Wadesango et al., 2023). Shaped by a variety of economic, social, political, demographic, cultural, and ICT infrastructure factors, the digital divide, stemming from disparities in access to technology and internet connectivity, further exacerbates the challenges in delivering efficient e-government services (Zhao et al., 2014). Digital inequality mirrors offline disparities linked to socioeconomic resources, underlining the importance of addressing digital divides for the long-term sustainability of digitally advanced societies (Vassilakopoulou and Hustad, 2023). E-government policies must be tailored to address the consequences of various types of digital divides, including regional disparities, urban-rural gaps, and differences in age demographics (Bannister and Leahy, n.d.). Moreover, the debate between decentralised and centralised development approaches underscores the need to strike a balance between autonomy and standardisation in e-government initiatives (Li and Zhang, 2023). Information-sharing mechanisms, supported by robust infrastructure, foster collaboration and coordination among government entities, enabling data-driven decision-making and improving service delivery (Mendes Calo et al., 2014). Additionally, diverse access channels, including web portals, mobile applications, and social media platforms, ensure accessibility and inclusivity, catering to the diverse needs and preferences of citizens (Filipe and Gouveia, 2023; Sanderson et al., 2015). As governments navigate the complexities of e-government infrastructure and emerging technologies, the focus remains on fostering interoperability, promoting information sharing, and expanding access channels to enhance citizen engagement and satisfaction.

3.2.4 E-Government Key Pillars

The success of e-government projects relies on several key pillars, each essential for their effective implementation (Oussaleh Taoufik and Azmani, 2022). Utilising digital platforms, as highlighted by Mamabolo et al. (2023), offers advantages such as enhanced service delivery and increased citizen engagement. Similarly, Liebowitz (2023) emphasises the importance of selecting and implementing suitable technological platforms tailored to the needs of various stakeholder groups. Evaluation frameworks, as outlined by Draheim (2020) and Roman (2013), play a critical role in ensuring the security, functionality, and transformation of e-government initiatives. Moreover, Draheim (2020) and Roman (2013) underscore the significance of institutional design and data governance in shaping the architecture of e-Government ecosystems and mapping data assets to accountable legal entities. Governance and coordination, as

advocated by Cordella (2013) and Prakash and Gunalan (2019), are pivotal for successful digital transformation, necessitating clear roles and responsibilities among institutions and formal cross-sectoral bodies for decision-making and inter-governmental cooperation. E-government transformation, as articulated by Islam and Ehsan (2013) and Mahmood (2014) leverages digital and communication technologies to foster continuous communication between governments and various stakeholders. Additionally, da Silva and Texeira (2020) emphasises the importance of digital governance and information infrastructure in ensuring fairness and transparency in decision-making processes. Challenges and pitfalls in implementing and evaluating e-governance, as discussed in Umbach and Tkalec (2022), highlight the sensitivity of e-governance performance to contextual factors such as policy area and institutional settings. Meanwhile, Gil-Garcia (2013) underscores the dependence of successful e-government initiatives on technical, organisational, social, and contextual factors, with measures inherent in successful e-governments on a global scale. Furthermore, the role of digital leadership, regulatory frameworks, financial resources, human capital, IT infrastructure, and data governance, as indicated by Dahiya and Mathew (2015), Kristensen and Andersen (2023) and Mamabolo et al. (2023), further contribute to the comprehensive understanding of the key pillars necessary for the success of e-government projects.

3.2.5 E-government cybersecurity

Based on the insights gleaned from the literature, addressing cybersecurity concerns within the realm of e-government is paramount. E-government services, while increasingly pivotal in modern governance, are concurrently vulnerable to substantial cybersecurity threats (Dorogovs and Romanovs, 2015; Onumo et al., 2017; Perez, 2014; Setiadi et al., 2013). Notably, studies have underscored a significant correlation between the development of e-government and cybersecurity measures, emphasising the necessity of robust security protocols in tandem with technological advancements (Onumo et al., 2017). Furthermore, research indicates that municipal e-government systems necessitate heightened security measures compared to federal systems, highlighting the diverse security challenges faced across different governmental levels (Perez, 2015, 2014). Enhancing cybersecurity in governmental organisations is driven by a multitude of factors, including technical measures, senior management roles, coercive pressures, and memetic pressures (Al-ma'aitah, 2022). Central to this discussion are the primary concerns surrounding the security and privacy of e-government services, necessitating the formulation and implementation of guidelines for continuous improvement in security and privacy protocols (Palanisamy and Mukerji, 2014). Additionally, the emergence of transformative technologies like cloud computing and big data heralds a paradigm shift in the functional architecture of new e-government systems, albeit accompanied by inherent security risks (Assaf et al., 2021; Lu, 2014; Peng, 2022). In navigating this landscape, addressing cybersecurity concerns remains integral to ensuring the integrity and reliability of e-government services. Another important measure is Digital identification which plays a pivotal role in advancing e-government services, with the National Electronic ID (NeID) serving as a cornerstone for authentication quality enhancement (Al-Nidawi et al., 2015). Through the integration of identity-based encryption and biometric technology, e-government systems bolster their security measures, ensuring robust protection of sensitive information (Aljeaid et al., 2014). Drawing from the European experience, particularly in electronic identification and authentication across

borders, valuable insights emerge, guiding the implementation of digital identification strategies in e-government frameworks (Prusa, 2015; Zafeiropoulou and Sakkopoulos, 2023). Proposals such as the unique document identifier (UDI) for key government documents and the utilisation of encrypted 2D barcode verification aim to elevate document digitalisation standards within e-governance (Raghunathan et al., 2016). Hence, the intersection of cybersecurity measures with digital identification in e-government underscores a commitment to fostering trust, transparency, and efficiency in public services while safeguarding against potential threats and ensuring the integrity of digital transactions.

Table 1 The key components of e-government conceptualisation

E-government key components	
E-government infrastructure	*E-government key pillars*
IT infrastructure capability (Doran et al., 2023; Moreno-Enguix et al., 2019; Parida et al., 2023; Wadesango et al., 2023)	Institutional design and data governance (Draheim, 2020; Roman, 2013)
Decentralised vs. Central Development (Li and Zhang, 2023)	Governance and coordination (Cordella, 2013; Prakash and Gunalan, 2019)
Information sharing (Mendes Calo et al., 2014)	Financial resources (Dahiya and Mathew, 2015; Kristensen and Andersen, 2023; Mamabolo et al., 2023)
Access channels (Filipe and Gouveia, 2023; Sanderson et al., 2015)	Human capital (Dahiya and Mathew, 2015; Kristensen and Andersen, 2023; Mamabolo et al., 2023)
	IT Infrastructure (Dahiya and Mathew, 2015; Kristensen and Andersen, 2023; Mamabolo et al., 2023)
E-government portals and online services	*E-government cybersecurity*
Portal design and effectiveness (Henman and Graham, 2019; Murphy and Ollerenshaw, 2023; Neff et al., 2022; Thorsby et al., 2017)	Cybersecurity measures (Assaf et al., 2021; Lu, 2014; Peng, 2022)
Assessment framework (Gkikas et al., 2022; Henman and Graham, 2019; Kamaruddin et al., 2018; Lim and Kamaruddin, 2023)	Digital identity (Al-Nidawi et al., 2015)
One-stop government portal (Fan, 2018; Schmidt et al., 2021; Yli-Huumo et al., 2018)	
E-government stakeholders relationships	
Citizen-centric approach (Kamaruddin et al., 2018; Kamaruddin and Johari, 2023; Lim and Kamaruddin, 2023; Rantanen et al., 2019; Sorn-in et al., 2015)	
Stakeholder interaction models (Greger et al., 2014; Paivarinta et al., 2019)	
Challenges in stakeholder relationships (Clement et al., 2022; Weerakkody et al., 2019)	
Stakeholder view and perspectives on e-government (Greger et al., 2014; Inkinen and Merisalo, 2014)	
Stakeholder identification and training (Lim et al., 2016)	

3.3 E-government ecosystem evolution

3.3.1 E-government maturity models

E-government maturity models underscore the multifaceted nature of assessing e-government maturity, recognising the impact of diverse factors such as digital readiness, gross domestic product, human and financial capital, technological infrastructure, and organisational aspects (Kachwamba and Ashatu, 2009). The evolution through four main stages, as identified by various models (Irani et al., 2006; Joshi and Islam, 2018; Kachwamba and Ashatu, 2009; Napitupulu, 2016; Ølnes and Jansen, 2018), signifies a *progressive process*. Initially, the journey begins with basic information dissemination through government websites. Subsequently, it advances towards interactive services and further develops into two-way interaction or transactional services. The integration or transformation stage strives for a consolidated one-stop-shop approach, either vertically within public administration or horizontally between administrations. However, the existing models have faced criticism for their inability to keep pace with the dynamic landscape of evolving NICTs, including social networks and artificial intelligence (AI) (Joshi and Islam, 2018; Supriyanto and Mustofa, 2016). These models also fall short in considering the rate of adoption and utilisation of proposed e-government solutions (Karkin and Janssen, 2014).

It is imperative to recognise that deploying successful e-government projects is not a one-size-fits-all endeavour (Gupta et al., 2023). The maturity of e-government is contingent upon numerous factors, such as the infrastructure in place, the level of digital transformation within a country, the readiness of the users, and political dynamics, and a notable factor – whether the focus is on local, regional, or central public administration and services. The latest distinction is pivotal in understanding the nuances of e-government deployment. Regional and local administrations may face unique challenges due to varying levels of resources, technological capabilities, and user demographics. Central administrations, on the other hand, may contend with complexities arising from the need for seamless coordination across diverse government departments. Therefore, a one-size-fits-all approach is inadequate. Deploying advanced e-government solutions demands a comprehensive understanding of the specific needs and capacities of each administrative level.

Emphasising the progressive nature of the e-government evolution, it is crucial not to rush into deploying highly developed solutions without establishing a robust foundation that supports them. A nuanced approach involves addressing existing problems with tailored solutions and leveraging NICTs for enhanced performance, efficiency, good governance, socio-economic development, and democracy. The subsequent paragraphs will delve into the current state of e-government systems globally, examining maturity models and exploring the potential for intelligent evolution, smart government initiatives, and the reality of whether the notion of intelligent government is a myth or reality (Jansen, 2012).

3.3.2 Global perspectives on digital transformation in the public sector: insights from current experiences

Digital transformation has become a significant agenda item for governments around the world as they strive to enhance public service delivery, improve efficiency, and respond to the evolving needs of citizens. Across different countries and regions, there has been a

growing focus on leveraging digital technologies to drive innovation and streamline government operations. The experiences and insights gained from various nations provide valuable lessons and benchmarks for successful digital transformation initiatives. This commitment to digital transformation has been further amplified by the onset of the COVID-19 pandemic, which has affected countries worldwide and necessitated governments to implement stringent measures to mitigate its impact (Grinin et al., 2022; Uwizeyimana, 2022). The pandemic led to economic disruptions, compelling both public and private entities to adopt containment measures and adhere to social distancing protocols following the declaration of a public health emergency by governments. As a result, digital transformation efforts have been accelerated in many countries, regardless of their level of development.

According to a 2022 survey conducted by the United Nations (2022), an increasing number of member states have made commitments to undertake the digital transformation of their public administrations as part of their efforts to implement the 2030 sustainable development agenda. In the survey, states were ranked according to their degree of digital maturity based on the e-Government Development Index (EGDI), which ranks countries by measuring their use of information and communications technologies to deliver public services. The index captures three dimensions: the scope and quality of online services (OSI), the state of telecommunications infrastructure (TII), and existing human capacity (HCI). The findings of the 2022 Survey underscore the diverse strategies adopted by countries in their pursuit of digital transformation. While a significant number of nations have primarily focused on the implementation of an e-government platform with a multi-channel presence both online and offline, others have embraced a more agile and data-centric approach. The latter group of states has directed their strategies towards forging partnerships, agile development of digital services, increased citizen participation, and the integration of data-driven methodologies.

3.3.3 Emerging technologies that have transformed government

The literature review on the application of disruptive technologies in e-government encompasses a comprehensive analysis of scholarly works and research findings about the integration and impact of emerging technologies in the realm of government services and operations. The review delves into the multifaceted landscape of disruptive technologies such as AI (Al-Mushayt, 2019; Janssen et al., 2022; Linthicum, 2017; Moore and Caudill, 2019; Sethy et al., 2023), blockchain (Batubara et al., 2018; Lykidis et al., 2021; Ølnes et al., 2017; Phadke et al., 2022), internet of things (IoT) (Chen et al., 2023; Ejaz and Anpalagan, 2019; Gubbi et al., 2013; Shao et al., 2023), big data (Janssen and van den Hoven, 2015; Samuel et al., 2023), automatic robotics (Bwalya, 2020), and geographic information systems (GIS) (Zhang, 2012) exploring their potential to transform traditional bureaucratic processes into more efficient, transparent, and citizen-centric models. Table 3 sheds light on the challenges and opportunities presented by these technologies, examining factors like policy frameworks, implementation strategies, security considerations, and the overall evolution of citizen-government interactions. Through the lens of this literature review, a deeper understanding emerges of how disruptive technologies are reshaping e-government paradigms, ultimately fostering a platform for informed decision-making and future research endeavours in this dynamic field.

Table 3 Opportunities and challenges presented by disruptive technologies in e-government

Technology	*Opportunities*	*Challenges*	*Methods*
Artificial intelligence Utilising algorithms and machine learning to mimic human intelligence for decision-making and automation	Enhancing citizen service delivery (Sethy et al., 2023), predictive analytics (Linthicum, 2017; Oussaleh Taoufik and Azmani, 2023), and chatbots for support (Moore and Caudill, 2019)	Data privacy concerns (Gupta, 2019), bias in AI decisions (Valle-Cruz et al., 2023), and complexity of implementation (van Noordt et al., 2023)	Data analysis, natural language processing, neural net
Blockchain Distributed and tamper-proof digital ledger for secure and transparent transactions	Transparent and secure transactions (Lykidis et al., 2021; Phadke et al., 2022), reducing fraud (Lykidis et al., 2021; Niknezhad et al., 2020), improving identity management (Phadke et al., 2022)	Scalability issues (Ahmad and Bharti, 2019), regulatory challenges (Abdullah et al., 2022), and integration with existing systems (Abdullah et al., 2022)	Cryptography, consensus algorithms, smart contracts
Big data Processing and analysing large volumes of data to extract insights and patterns	Informed policy-making (Samuel et al., 2023), personalised services (Samuel et al., 2023), and trend identification (Samuel et al., 2023)	Data privacy (Soni, 2017), data quality (Soni, 2017), and resource-intensive processing (Al-Sai et al., 2019)	Data mining, data analytics, machine learning algorithms
Internet of things Network of interconnected devices and sensors that share data and enable automation	Enhanced efficiency and effectiveness (Shao et al., 2023), improved citizen-government interaction (Chen et al., 2023), and increased transparency and public value (Ulrich et al., 2020)	Security vulnerabilities, interoperability, and data overload (Chen et al., 2023)	Sensor networks, data integration platforms, and communication protocols
Automatic robotics Use of automated systems and robots to perform tasks and services	Streamlined administrative tasks, and improved public service efficiency	Limited adoption and awareness (Juell-Skielse et al., 2022), lack of experience and knowledge (Lindgren, 2023), and organisational and stakeholder cooperation (Lindgren et al., 2022)	Robotic process automation, machine learning for robotics
Geographic information systems Capturing, storing, analysing, and presenting geographical data	Urban planning (Turek and Stępniak, 2023), disaster management (Eichelberger, 2018), and location-based services (Johari et al., 2022)	Data accuracy (Iskandar et al., 2014), integration with other systems (Sebie, 2015), and specialised skill requirement (Holdstock, 2016)	Spatial data analysis, cartography, remote sensing

In a realm where conventionality prevails, a select few nations stand as outliers, pioneering an exceptional approach by harnessing emerging technologies like AI and blockchain to shape the landscape of smart cities. Among these trailblazers, noteworthy instances emerge:

1 *Artificial intelligence (AI)*:
   - Singapore's 'Ask Jamie': This AI-powered chatbot adeptly addresses citizens' queries on governmental services and protocols, streamlining information dissemination (Lee Hui Shan et al., 2022).
   - The US Army is actively integrating AI into military operations to enhance performance during missions (Schaefer et al., 2021). The US Department of Defense is exploring the use of 'narrow' AI for various purposes, including swarm technology and tactics for autonomous unmanned systems (Mori, 2018).

2 *Blockchain:*
   - Ghana's Benben: This solution for land management employs blockchain to reduce confirmation times, secure land registrations, and enhance trust in the process (Ameyaw and de Vries, 2020).
   - Denmark's 'Vehicle Wallet': Utilising blockchain for vehicle registration, ensuring secure and transparent registration procedures (Banik et al., 2024).

3 *Big data and IoT:*
   - New York City's 'LinkNYC': Leveraging big data from smart kiosks to optimise urban resource allocation and enhance the quality of life for residents (Dange, 2023).
   - India's 'Smart Cities Mission': Utilising big data analytics for fine-tuning urban planning, transportation networks, and energy consumption within designated smart city domains (Dwevedi et al., 2018).
   - Singapore's autonomous vehicle (AV): The country aims to integrate AVs into its public transportation system to enhance service quality, optimise road resources, and improve efficiency, showcasing a nimble and adaptive approach to governing autonomous systems (Pande and Taeihagh, 2023).

4 *Automatic robotics:*
   - Estonia's 'Robot Judge': An automated algorithm assesses small claims court cases, expediting legal processes and ensuring impartiality (Cárdenas Krenz, 2021).
   - Tokyo's Metropolitan Government AR Navigation: Pioneering an AR navigation system for easing navigation through intricate transit networks (Xiang et al., 2023).

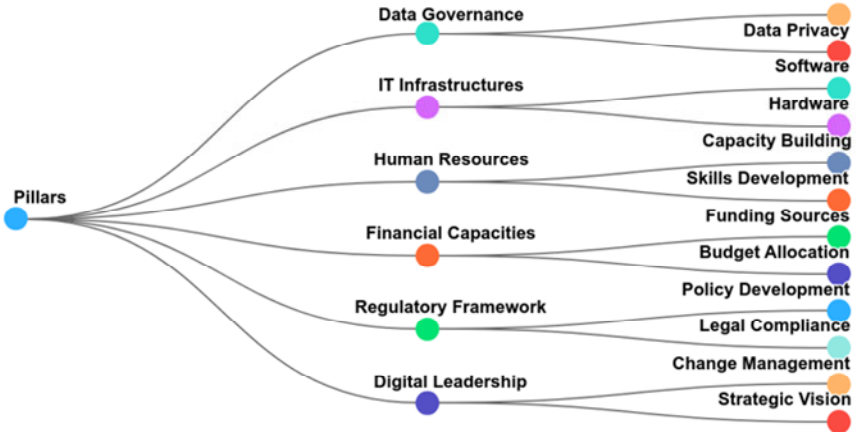
5 *Geographic information systems (GIS):*
   - UK's 'One Scotland Mapping Agreement': Consolidating diverse datasets into a unified spatial framework to enhance decision-making, plan infrastructure projects, and optimise resource allocation (Milne and Rasmussen, 2017).

4 Results: a conceptual framework

4.1 Foundations for effective e-government implementation

The successful implementation of e-government projects hinges upon establishing a robust foundation, as evidenced by the diverse strategies employed by countries that have achieved success in this domain as discussed in the previous section. This foundation is built upon several critical pillars, notably encompassing *digital leadership, regulatory frameworks, financial resources, human capital, IT infrastructure*, and *data governance*. These pillars are indispensable for the realisation of effective e-government initiatives. Effective leadership plays a pivotal role in steering the implementation of e-government projects, necessitating a clear vision, strategic direction, and stakeholder engagement (Khan et al., 2021). Moreover, a supportive regulatory framework is imperative to establish the legal and policy underpinnings essential for e-government projects, ensuring compliance, safeguarding privacy and security, and fostering interoperability (Hasan et al., 2015). Adequate financial resources are paramount for the successful execution of e-government endeavours, facilitating the development and upkeep of IT infrastructure, human resource training, and project sustainability (Tadros and Alzubi, 2015). The presence of skilled personnel is indispensable for the effective execution of e-government initiatives, requiring individuals equipped with technical proficiency, adept project management skills, and effective change management capabilities (Zarei et al., 2014). Furthermore, robust and reliable IT infrastructure forms the backbone of e-government projects, enabling seamless delivery of online services, data storage and management, and secure communication (Dahiya and Mathew, 2015). Lastly, effective data governance is indispensable for ensuring proper data management, protection, and utilisation within e-government projects, necessitating the establishment of policies, procedures, and mechanisms to uphold data quality, privacy, and security standards (Alsaad, 2023). By addressing these pillars comprehensively, governments can significantly enhance the prospects of successful e-government implementation, thereby offering citizens efficient and convenient access to services.

Figure 3 Pillars for effective e-government implementation (see online version for colours)



4.2 Navigating challenges and solutions in one-stop shop e-government

Within the framework of a smart e-government ecosystem, the notion of a one-stop shop stands out as a crucial element for optimising service provision and citizen interaction. A one-stop shop e-government project aims to streamline government service delivery by providing citizens with a single access point for multiple services. This consolidated approach integrates diverse government services and information into a centralised digital platform, thereby simplifying access for citizens and businesses. Several studies discuss the challenges and potential solutions related to one-stop shop e-government projects, offering valuable insights into enhancing their effectiveness. Scholta et al. (2019) proposes transitioning from a one-stop shop to a no-stop shop, where citizens don't need to perform any action or fill in forms to receive government services. This approach aims to eliminate the perceived burden of forms and increase proactive government service initiation. Moreover, Parida et al. (2023) and Wadesango et al. (2023) examine the efficacy of e-government technologies and identify obstacles to their efficient use, highlighting benefits such as increased citizen involvement, cost savings, and improved service delivery. However, challenges like lack of funding, inadequate infrastructure, and low ICT literacy levels remain prevalent (Parida et al., 2023; Wadesango et al., 2023). Additionally, a framework for managing e-government apps is presented, aiming to unify digitisation efforts and increase the efficiency, homogeneity, scalability, and complexity of e-government systems (Brahimi, 2022).

The concept of a one-stop shop e-government has gained traction worldwide as governments recognise the need for centralised platforms to enhance service delivery and citizen engagement. Countries such as Singapore, Australia, the UK, Estonia, and South Korea have successfully implemented one-stop shop e-government initiatives, providing citizens with convenient access to a wide range of government services and information through digital platforms. For instance, Singapore's 'Gov. sg', Australia's 'Service Australia', and the UK's 'GOV.UK' are prominent examples of centralised portals offering various government services and information in one location. These initiatives aim to streamline administrative processes, reduce bureaucratic barriers, and improve citizen satisfaction by providing a seamless and user-friendly interface for accessing government services. Overall, the global adoption of the one-stop shop e-government concept highlights its effectiveness in modernising government services and enhancing citizen-government interactions.

4.3 Ensuring security and efficiency in e-government projects through digital identification

Security is paramount in e-government projects due to the sensitive nature of the data involved. Robust security measures, such as encryption and multi-factor authentication, are necessary to protect personal and confidential information from cyberattacks. Implementing digital identification systems enhances security, efficiency, and user convenience by allowing secure access to government services online. Estonia's e-Estonia initiative exemplifies successful digital identification implementation, simplifying administrative processes and improving accessibility. However, it's crucial to ensure privacy and security through measures like strong encryption and regular audits.

Digital identification systems have emerged as indispensable tools for driving efficiency and innovation across both public and private-sector services (Mir et al.,

2020). Despite their benefits, concerns surrounding security, privacy, and inclusivity persist, necessitating comprehensive solutions (Gordon, 2023; Mir et al., 2020). To mitigate these concerns, a conceptual evaluation framework for digital identity systems (DISs) has been introduced, emphasising processes, regulations, and technologies (Mir et al., 2020). Moreover, self-sovereign digital identities (SSI) and blockchain technology are gaining traction as viable solutions for bolstering the security of digital identification (Kurfels et al., 2021). The significance of considering social dimensions alongside technical aspects cannot be overstated, ensuring that electronic identification for public services remains applicable, trusted, and compliant (Lindner et al., 2023). Challenges in managing the development of electronic identification (e-ID) encompass various organisational, management, and technical factors, underscoring the importance of a holistic approach (Melin et al., 2016). While modern technologies like blockchain hold promise for enhancing public governance, governments must prioritise personal data protection and readiness for security threats (Strielkowski et al., 2017). Additionally, the intersection of blockchain technology and government-issued electronic identity documents (eIDs) presents opportunities for establishing trusted identities within decentralised ecosystems (Kuperberg et al., 2019). Moreover, the heterogeneity of national e-government infrastructures poses challenges, prompting proposed solutions aimed at facilitating the seamless deployment and integration of third-party components into existing infrastructures (Marsalek et al., 2017). By addressing these multifaceted considerations, governments can effectively harness digital identification systems to not only enhance security and efficiency but also foster greater inclusivity in e-government projects.

4.4 Feasibility and innovation in smart e-government implementation

Implementing smart e-government is not only feasible but also offers significant potential for enhancing government services for stakeholders. While challenges exist, such as organisational, political, social, and infrastructure hurdles, they can be addressed through strategic planning and innovative approaches (Jiménez et al., 2016; Zeebaree and Aqel, 2021). The integration of emerging technologies and innovative strategies is crucial for realising the benefits of smart e-government (Gil-Garcia et al., 2014). By creatively investing in technologies like AI, blockchain, and IoT, governments can build agile and resilient governance infrastructures (Gil-Garcia et al., 2014). Smart government features enable citizens to access services easily through smart devices, social media, and mobile applications, enhancing convenience and accessibility (Algebri et al., 2017). Despite varying challenges across different countries, the growing recognition of the advantages of smart e-government suggests that with careful planning and adaptation, its implementation is indeed achievable, promising improved services for citizens and businesses alike.

4.5 Handling data diversity in e-government

The diversity of data within e-government systems reflects the intricate landscape of governance and public administration. Originating from various sources including citizen interactions, administrative processes, financial transactions, policy documents, and operational metrics, these data encompass a broad spectrum of information (Petychakis et al., 2014). Citizen-related data comprise demographic details, personal records, and

feedback collected through diverse channels such as online portals and social media platforms. Administrative data encapsulate internal government operations like budget allocations, procurement records, and personnel management. Financial data entail revenue streams, expenditure patterns, and audit reports crucial for maintaining fiscal transparency and accountability. Legal and regulatory data derived from policy documents, legislative texts, and regulatory guidelines contribute significantly to informed decision-making and compliance monitoring. Additionally, operational metrics provide insights into the efficiency and effectiveness of government programs and initiatives. The diverse array of data circulating within e-government systems underscores the complexity of modern governance and highlights the necessity for robust data management strategies to harness this diversity effectively for informed decision-making, transparency, and public service delivery (Petychakis et al., 2014).

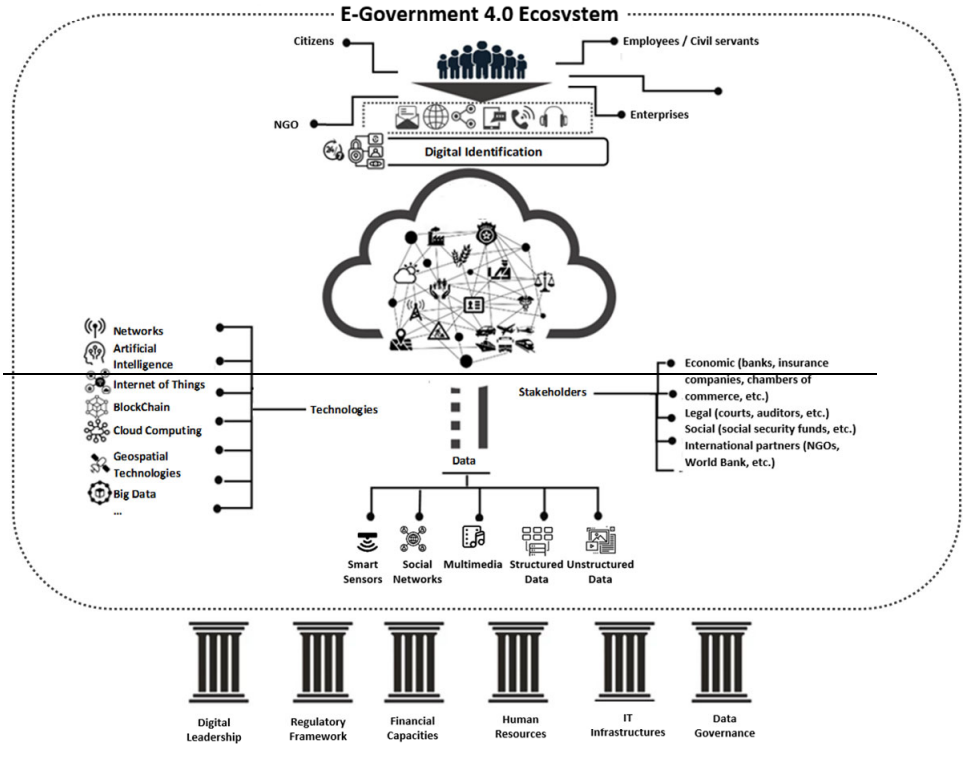
OGD initiatives across European Union countries have substantially augmented the availability of public data sources, while government big data incorporates diverse information resources generated or obtained by government departments, resulting in extensive and varied data (Zhang et al., 2022). Challenges linked with data diversity encompass issues such as data fragmentation and complexity in dealing with government data (Tambouris, 2016). Furthermore, the expanding variety of linked government statistical data on the web poses challenges in determining data quality (Abida et al., 2020). However, opportunities exist for addressing these challenges. Standardisation of open data has demonstrated enhancements in e-government services (Hyseni and Bexheti, 2023), while interoperability of e-government systems is seen to amplify transparency, efficiency, and customer service in the public sector. These insights underscore the importance of understanding and effectively managing data diversity in e-government to achieve improved service delivery and governance outcomes.

4.6 Towards a digital 4.0 e-government system

The success of a digital e-government ecosystem hinges on a comprehensive design and gradual implementation approach. The value created by this ecosystem extends beyond digitising government institutions. It aims to revolutionise the role of civil servants by automating mundane tasks and enabling them to focus on value-added activities that involve strategic thinking and decision-making. The ecosystem also promotes predictive and anti-corruption intelligent systems to safeguard government integrity, reduces data redundancy through ontologies and semantic interoperability, adopts green government principles to minimise paper usage, encourages SMEs to adopt good governance practices, fosters the development of new international business models, enhances access to information through *various channels* and intelligent assistance systems, establishes a robust digital infrastructure to promote inclusion and bridge the digital divide, ensures secure transactions with blockchain technology, and empowers citizens through community decision-making processes such as e-voting and e-democracy.

To leverage the potential of a successful digital ecosystem, it is crucial to consider the success factors outlined in *Table 4* for e-government projects. Furthermore, addressing emerging market challenges, where innovation plays a pivotal role in value creation, is vital. Whether from the private or public sector, ecosystem partners are essential for the ecosystem's success. Their contributions, such as leveraging public data, sharing existing solutions, proposing innovative approaches, and promoting scientific research, will elevate public administration to meet the expectations of the general public.

Figure 3 E-government framework 4.0



The proposed e-government framework (see Figure 3) with a digitally secured key presents a holistic approach to citizen engagement by leveraging cutting-edge technologies to create an integrated and user-centric solution. At the core of this framework is a secure digital key that serves as a unique identifier, enabling citizens to access a unified one-stop-shop e-government portal seamlessly across various IT channels. This approach capitalises on disruptive technologies such as blockchain and biometrics to ensure robust security and privacy for citizen data. This citizen-centric solution offers unparalleled convenience, enabling citizens to interact with government services and information anytime, anywhere. By adopting disruptive technologies, this framework not only streamlines administrative processes but also fosters collaboration among different stakeholders. Regulatory policies are designed to facilitate interoperability, ensuring a coherent user experience regardless of the IT channel chosen. Digital leadership drives the vision for this framework, emphasising transparent and accountable governance. Financial resources are optimised through cost-effective digital service delivery, while human resources focus on higher-value tasks as routine operations are automated. Data governance ensures that citizen data is handled responsibly, adhering to strict privacy standards. Furthermore, technology resources underpin the framework's success, embracing AI-driven chatbots, data analytics, and predictive modelling to enhance service personalisation and efficiency. The framework thrives on partnerships between government entities, private sectors, and citizens, fostering an ecosystem where innovation flourishes.

Table 4 Approaches to address challenges encountered during various stages of e-government implementation

Success factors	*Barriers*	*Implementation*			
		Stage 1: Information	*Stage 2: Interaction*	*Stage 3: Transaction*	*Stage 4: Transformation*
Digital leadership (Furuholt and Wahid, 2008; Klein, 2020; Lam, 2005; United Nations, 2020)	Lack of visionary and strategic leadership; Insufficient understanding of digital technologies; Resistance to change and risk aversion; Lack of policies and guidelines for data management	Establish a clear vision and objectives for digitalisation	Foster collaboration between departments for consistency	Develop unified service standards across all agencies	Cultivate digital leadership at executive levels
Regulatory framework (Ahmed et al., 2021; Gil-Garcia and Pardo, 2005; Lam, 2005; OECD, 2019)	Outdated or inadequate regulations; Lack of regulatory clarity and consistency; Slow pace of regulatory adaptation;	Develop guidelines for data sharing and privacy	Implement secure authentication mechanisms	Establish legal frameworks for digital signatures	Streamline regulations for online service delivery
Financial capabilities (UN Department of Economic and Social Affairs, Division for Public Administration and Development Management, 2020; Ziemba et al., 2016)	Insufficient funding and budget allocation; Inability to secure investments or partnerships; Lack of financial planning and prioritisation; High cost of IT infrastructure and emerging technologies; Need for substantial funds dedicated to maintenance;	Allocate funds for basic online information systems	Allocate budget for interactive communication tools	Invest in secure payment gateways and platforms	Optimise resource allocation for transformative tech
Human resources (UN Department of Economic and Social Affairs, Division for Public Administration and Development Management, 2020; Ziemba et al., 2016)	Skills gap and shortage of qualified professionals; Lack of digital literacy and training programs; Difficulty in recruiting and retaining talent;	Train staff for basic data input and management	Train staff for customer service and response	Train staff for online transaction management	Upskill workforce for data analytics, AI, etc.

Table 4 Approaches to address challenges encountered during various stages of e-government implementation (continued)

Success factors	*Barriers*	*Implementation*			
		Stage 1: Information	*Stage 2: Interaction*	*Stage 3: Transaction*	*Stage 4: Transformation*
IT infrastructures and technologies (UN Department of Economic and Social Affairs, Division for Public Administration and Development Management, 2020; Ziemba et al., 2016)	Exponential and rapid evolution of emerging technologies; Geographic distance not conducive to information dissemination; Digital divide; Limited access to reliable and high-speed internet connectivity; Legacy systems and lack of integration capabilities	Set up a basic website, database, and connectivity	Integrate social media, responsive design, and APIs	Implement secure payment gateways, e-commerce tools	Implement cloud solutions, AI, big data infrastructure
Data governance (Basahel and Yamin, 2017; UN Department of Economic and Social Affairs, Division for Public Administration and Development Management, 2020)	Insufficient mechanisms for data sharing and collaboration between government agencies.; Difficulty in ensuring the reliability and secure archiving of data; Inconsistent data quality and integrity across systems and databases;	Define data ownership, access, and quality standards	Ensure data privacy compliance in user interactions	Develop data storage, access, and protection protocols	Enforce advanced data governance for analytics

5 Conclusions

E-government services represent a broad array of electronic services provided by governments to citizens, businesses, and other entities. Despite their potential benefits such as improved efficiency, transparency, and citizen engagement, e-government initiatives face challenges like talent shortages and insufficient funds. To ensure effectiveness, it's crucial to regularly monitor, regulate, and optimise electronic services while integrating information systems to enhance social service functions. Implementing a shared services model can particularly benefit developing countries by allowing governments to share and leverage limited ICT resources.

The emergence of NTICs has profoundly transformed public administration and societal expectations regarding administrative procedures' performance, efficiency, interactivity, and accessibility. Access to information and innovative services has become imperative for socio-economic growth, demanding substantial digital reforms within the public sector and corresponding regulatory changes to facilitate this transition.

However, many e-government initiatives have failed due to a lack of bold and innovative digital leadership and an incomplete understanding of e-government concepts, processes, and functions. Successful digital transformation requires a holistic approach considering managerial, infrastructure, and human factors, as well as the establishment of a robust governance framework. Achieving this transformation involves strategic leadership focused on efficiency, business intelligence, tangible results, and fostering collaboration among different stakeholders.

Future studies should explore the broader societal implications of NTICs beyond public administration and consider geographical variations in e-government initiatives to gain a deeper understanding of success factors and challenges in various contexts. Addressing these limitations will contribute to a more comprehensive comprehension of the challenges and opportunities that arise in diverse global settings, fostering a refined and tailored approach to e-government conceptualisation and implementation.

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Notes

1 Sir Arthur George Tansley (August 15, 1871–November 25, 1955) was a British botanist and pioneer of plant ecology.

2 http://www.larousse.fr/encyclopedie/divers/écosystème/184800.