

## ENHANCING GOVERNMENT IT INFRASTRUCTURE: DEVELOP FRAMEWORKS FOR MODERNIZING GOVERNMENT IT SYSTEMS TO IMPROVE SECURITY, EFFICIENCY, AND CITIZEN ENGAGEMENT

Md Saidul Islam Papel <sup>1</sup>

<sup>1</sup>Master of Business Administration in Management Information System, International American University, Los Angeles, USA

Correspondent Email: [mdpapeldu@gmail.com](mailto:mdpapeldu@gmail.com)

A B M Ashraf Mridha <sup>2</sup>

<sup>2</sup>Master of Business Administration in Management Information System, International American University, Los Angeles, USA

Email: [shuvomridha36@gmail.com](mailto:shuvomridha36@gmail.com)

Anisur Rahman <sup>3</sup>

<sup>3</sup>Master in Management Information System, International American University, Los Angeles, USA

Email: [anisurrahman.du.bd@gmail.com](mailto:anisurrahman.du.bd@gmail.com)

Md Ashrafuzzaman <sup>4</sup>

<sup>4</sup>Master in Management Information System, International American University, Los Angeles, USA

Email: [md.ashrafuzzamanuk@gmail.com](mailto:md.ashrafuzzamanuk@gmail.com)

### Keywords

Government IT Infrastructure  
Digital Transformation  
Cybersecurity  
Cloud Computing  
Citizen Engagement

### ABSTRACT

*This study systematically examines the critical factors, drivers, barriers, and frameworks associated with IT modernization in government systems, emphasizing its importance in enhancing efficiency, security, and citizen engagement. Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, 212 peer-reviewed articles, conference papers, and government reports published between 2010 and 2023 were rigorously reviewed. The findings reveal that legacy systems hinder operational efficiency and service delivery, while the integration of advanced technologies like cloud computing, artificial intelligence, and the Internet of Things (IoT) significantly transforms governance structures. The study also highlights the rising prominence of cybersecurity, identifying robust frameworks such as zero-trust architectures and real-time threat detection as critical for safeguarding sensitive government data. Additionally, citizen-centric approaches, including mobile applications and feedback mechanisms, emerged as essential for improving service accessibility and trust. Despite these advancements, barriers such as organizational resistance, resource limitations, and skills gaps in the IT workforce remain persistent challenges. Furthermore, research gaps in the environmental and socioeconomic impacts of modernization initiatives point to the need for more comprehensive and inclusive approaches. By synthesizing insights from a diverse body of literature with over 7,000 cumulative citations, this study provides actionable recommendations for governments worldwide, offering a roadmap to achieve efficient, secure, and inclusive digital transformation in public administration.*

## 1 INTRODUCTION

The role of cybersecurity in government IT infrastructure modernization is particularly critical. As public systems become increasingly digitized, they also become prime targets for cyberattacks, data breaches, and malicious disruptions (Otieno & Omwenga, 2015).

Governments handle vast amounts of sensitive information, including citizen records, financial data, and national security details, making them attractive targets for cybercriminals (Muñoz et al., 2017). Studies show that outdated IT systems often lack the resilience required to protect against modern cyber threats, which can lead to severe disruptions and erode trust in

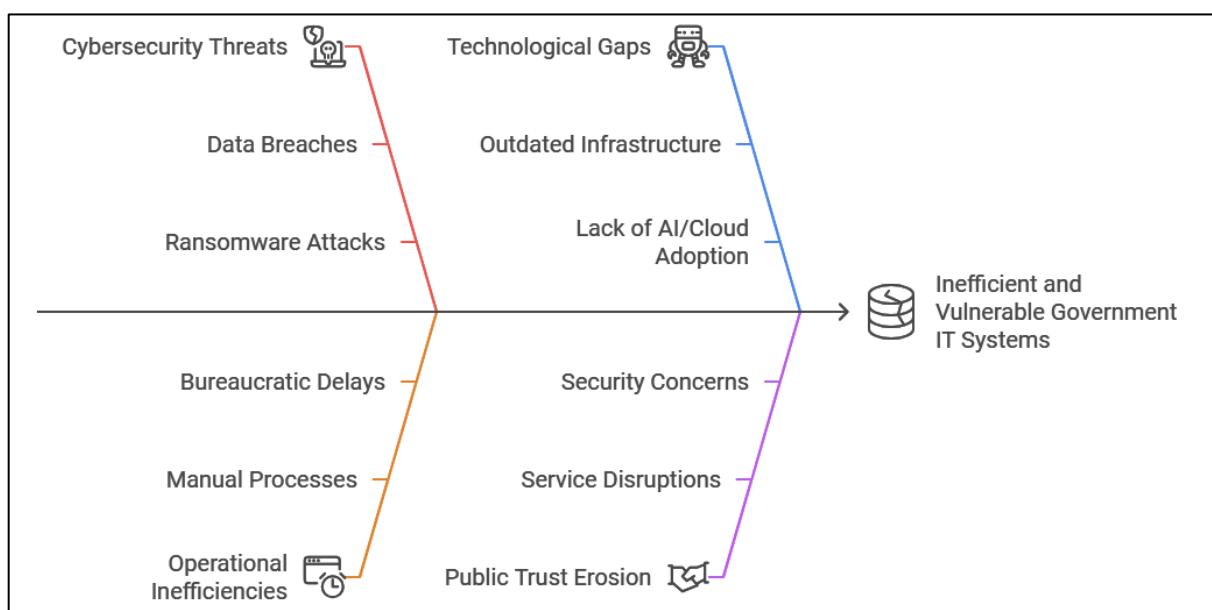
government services (Khanra & Joseph, 2019). For instance, the 2017 WannaCry ransomware attack impacted multiple government agencies worldwide, highlighting the vulnerabilities inherent in legacy IT systems (Thapa et al., 2015). Addressing these challenges necessitates adopting advanced cybersecurity frameworks, such as zero-trust architecture, encryption technologies, and continuous threat monitoring (Jun & Chung, 2016). By prioritizing security in IT modernization, governments can safeguard citizen data and ensure continuity of critical services.

Efficiency is another core driver for modernizing government IT systems. Outdated systems often rely on manual processes, resulting in bureaucratic delays, resource wastage, and poor service delivery (Glyptis et al., 2020). Modern IT infrastructure leverages technologies such as cloud computing, AI, and automation to streamline operations and optimize resource utilization (Abu-Shanab & Harb, 2019). Cloud platforms, for example, enable governments to scale IT resources flexibly, reducing the cost of infrastructure maintenance while improving service accessibility (Pérez-Morote et al., 2020). AI-powered analytics can enhance decision-making by providing real-time insights into citizen needs, enabling governments to allocate resources more effectively (Khan et al., 2021). Successful implementation of these technologies has been demonstrated in countries such as Estonia and

Singapore, where digital transformation has significantly improved the efficiency and responsiveness of public services (Zhao & Khan, 2013). Therefore, modernizing IT systems represents a critical step in addressing operational inefficiencies while meeting the expectations of a rapidly evolving digital society.

Citizen engagement is a fundamental aspect of modern governance, and IT infrastructure modernization plays a pivotal role in improving public interactions with government services. A study by Abdullah et al. (2017) highlights how digital platforms, such as e-governance portals and mobile applications, enhance citizen participation by providing seamless access to public services. Modern IT systems allow for personalized, user-friendly interfaces that cater to diverse citizen needs, fostering trust and satisfaction (Sharif et al., 2010). Furthermore, big data analytics and AI technologies enable governments to analyze citizen feedback, identify emerging trends, and respond proactively to societal needs (Moon, 2002). Countries like Denmark and South Korea have demonstrated that integrating citizen-centric digital services into government IT systems leads to higher public satisfaction and increased trust in government institutions (Sharif et al., 2010). As citizen expectations for fast, transparent, and responsive services continue to rise, governments must prioritize digital transformation to bridge the gap between public services and citizens.

**Figure 1: Challenges in Government IT Modernization**



Global case studies demonstrate that successful IT modernization requires robust frameworks and strategic planning. For example, the United Kingdom’s Government Digital Service (GDS) initiative serves as a model for implementing digital transformation at scale (Khan et al., 2021). By establishing clear standards, prioritizing cybersecurity, and investing in scalable technologies, GDS has streamlined service delivery and enhanced public sector efficiency. Similarly, the U.S. federal government’s Cloud Smart strategy underscores the importance of adopting cloud-based solutions to modernize infrastructure while addressing security and cost challenges (Welch et al., 2004). These examples emphasize the need for a structured approach to IT modernization, incorporating best practices in cybersecurity, digital governance, and stakeholder collaboration (Ojha & I. Pandey, 2017). As governments face increasing pressure to modernize, it becomes imperative to develop comprehensive frameworks that address security, efficiency, and citizen engagement holistically.

The objective of this study is to develop a comprehensive framework for modernizing government IT systems to enhance security, operational efficiency, and citizen engagement. By addressing critical challenges such as legacy system vulnerabilities, fragmented data management, and limited accessibility of public services, this research aims to propose actionable strategies grounded in technological advancements like cloud computing, artificial intelligence (AI), and robust cybersecurity measures. Additionally, the study seeks to explore citizen-centric approaches to digital service delivery,

emphasizing inclusivity, transparency, and user-friendly design. Through a synthesis of existing research and analysis of successful case studies, the objective is to provide governments with a roadmap to effectively transition towards modern, secure, and citizen-responsive IT infrastructures, ultimately fostering public trust and improving service delivery outcomes.

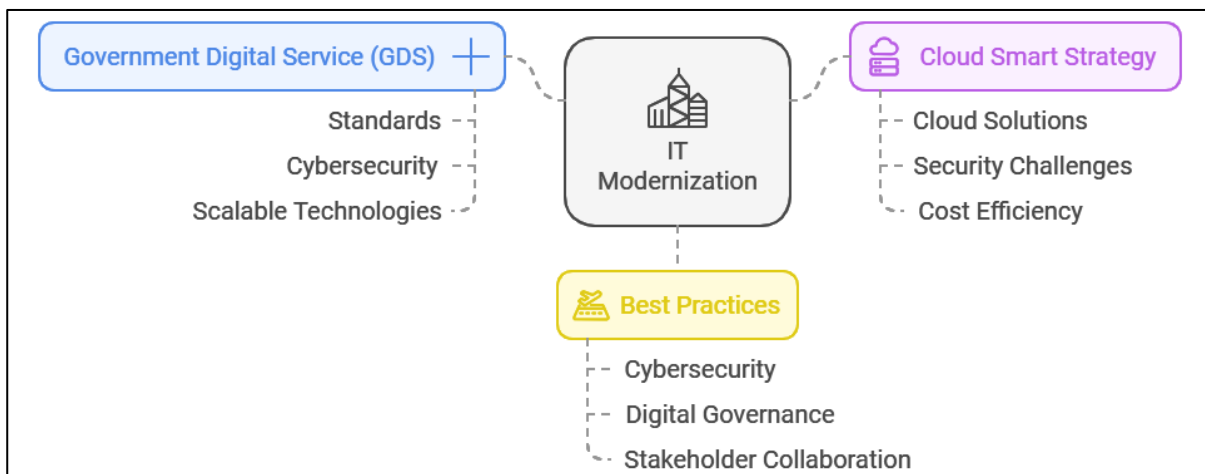
## 2 LITERATURE REVIEW

The modernization of government IT infrastructure has garnered significant attention from researchers and policymakers alike, owing to its critical role in enhancing public service delivery, security, and citizen engagement. Existing literature underscores the challenges posed by outdated systems and the transformative potential of advanced technologies in addressing these issues. Studies have examined various aspects of IT modernization, including the adoption of digital technologies, the importance of robust cybersecurity frameworks, and the implementation of citizen-centric service models. This section aims to systematically review the existing body of knowledge, identifying key trends, gaps, and implications for government IT modernization. The review is structured to provide a comprehensive understanding of the factors influencing IT transformation, the role of emerging technologies, and the best practices for implementation.

### 2.1 IT Modernization in Government Systems

Government IT modernization refers to the strategic upgrading of legacy systems to integrate advanced technologies that improve efficiency, security, and

Figure 2: IT Modernization Framework for Government

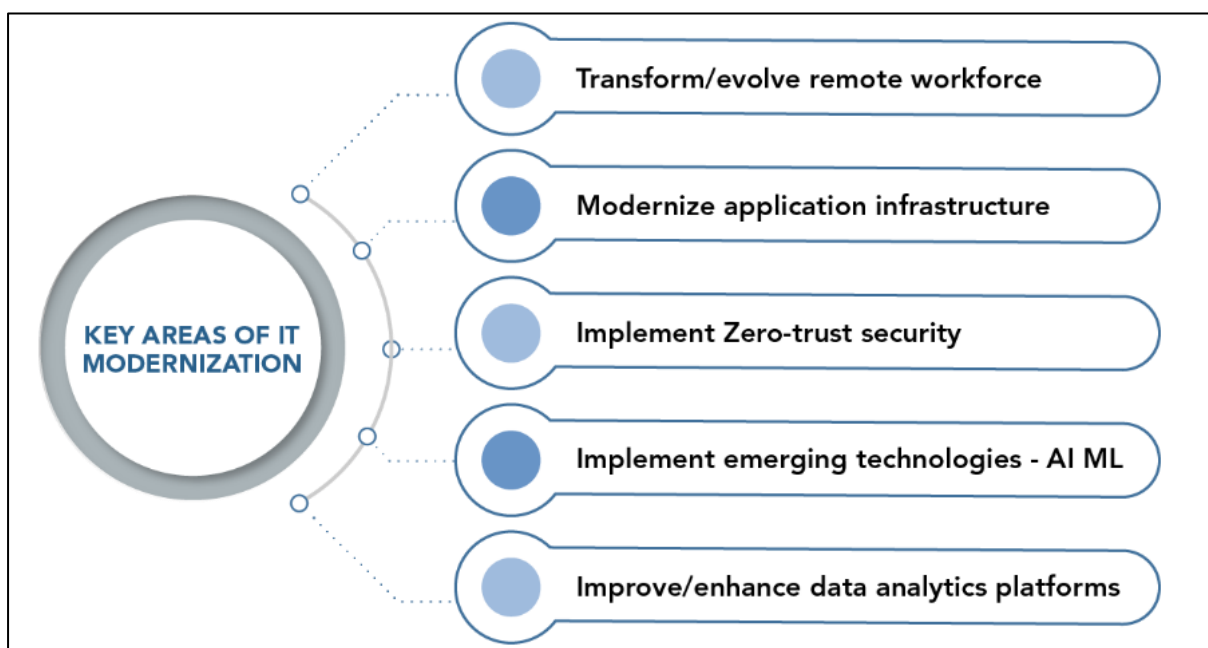


accessibility in public service delivery (August & Tunca, 2008). The scope of modernization encompasses the adoption of digital tools, the restructuring of outdated infrastructure, and the development of citizen-centric platforms (Welch et al., 2004). Researchers have highlighted that modernized IT systems enable governments to streamline operations, reduce costs, and ensure data-driven decision-making (Maria et al., 2018). However, the scope extends beyond technology; it requires a holistic transformation involving policy adjustments, workforce training, and enhanced inter-agency collaboration (Ojha & I. Pandey, 2017). By embracing modernization, governments aim to address existing inefficiencies while meeting the growing demands of digitally savvy citizens (Gottschalk, 2009). The historical evolution of IT systems in public administration reveals a steady progression from basic data storage to sophisticated digital ecosystems. During the late 20th century, governments began adopting computer systems primarily for data management and record-keeping (Karunasena et al., 2011). Over time, these systems expanded to support inter-agency communication and basic online services, such as tax filing and license renewals (Ojha & I. Pandey, 2017). The advent of e-government in the early 2000s marked a significant shift, enabling the digital delivery of a broader range of services (Zhao et al., 2014). More recently, the incorporation of emerging technologies

like cloud computing and artificial intelligence has transformed IT systems into dynamic platforms capable of predictive analytics and real-time service delivery (Ojha & I. Pandey, 2017). These advancements demonstrate the continuous evolution of IT systems in response to technological progress and changing public expectations (Ojha & I. M. Pandey, 2017).

Despite these advancements, many governments continue to grapple with the challenges posed by legacy systems. Studies show that outdated IT infrastructure often leads to inefficiencies, such as slow processing times and high maintenance costs, which hinder public service delivery (Ojha & I. Pandey, 2017). Legacy systems also lack interoperability, making it difficult for agencies to share data and collaborate effectively (Ojha & Pandey, 2017). Additionally, these systems are particularly vulnerable to cybersecurity threats, as they often rely on obsolete security protocols that fail to address modern risks ((Wirtz & Daiser, 2016). The persistence of such challenges underscores the urgent need for comprehensive IT modernization to ensure secure and efficient public administration (Heeks, 2003). Moreover, the limitations of legacy systems have significant implications for citizen engagement and trust in government. Research indicates that citizens are increasingly dissatisfied with slow and inaccessible public services enabled by outdated IT frameworks (Zhao et al., 2014). This dissatisfaction is compounded

*Figure 3: Key Area of IT Modernization*



by frequent system failures, which disrupt essential services and erode public confidence (Twizeyimana & Andersson, 2019). In contrast, modern IT systems equipped with user-friendly interfaces and real-time updates can significantly enhance the citizen experience, fostering greater trust and participation in governance (Twizeyimana & Andersson, 2019). These findings highlight the critical role of IT modernization in bridging the gap between government capabilities and citizen expectations, making it a priority for policymakers globally (Huai, 2011).

### 2.2 Drivers of IT Modernization in the Public Sector

The increasing demand for efficient public service delivery is one of the primary drivers of IT modernization in the public sector. As populations grow and societal complexities intensify, governments face mounting pressure to deliver services that are both accessible and responsive (Alexandrova & Rapanotti, 2019). Research by Pang and Tanriverdi (2022) highlights that outdated bureaucratic processes and legacy systems often result in inefficiencies, delays, and reduced citizen satisfaction. Modernizing IT infrastructure allows governments to automate repetitive tasks, streamline workflows, and optimize resource allocation, ultimately improving the speed and quality of public services (ElKadi, 2013). Furthermore, studies indicate that citizen expectations have evolved

significantly, with growing demand for seamless, real-time interactions facilitated by digital platforms (King & Cotterill, 2007). This trend underscores the urgency for governments to adopt IT solutions that enhance service delivery while promoting transparency and accountability (Bannister & Connolly, 2011). Advancements in digital technologies have emerged as a transformative force behind IT modernization efforts in the public sector. Technologies such as cloud computing, artificial intelligence (AI), and blockchain are enabling governments to transition from rigid, siloed systems to flexible and integrated frameworks (Alryalat et al., 2017). For instance, Saeed et al. (2018) found that the adoption of cloud computing reduces infrastructure costs while providing scalability and interoperability across departments. Similarly, AI-driven tools enhance decision-making processes by analyzing large datasets and generating actionable insights in real time (ElKadi, 2013). Blockchain technology, on the other hand, offers unprecedented levels of security and transparency, making it particularly valuable for applications like identity verification and financial transactions (King & Cotterill, 2007). These innovations collectively empower governments to address challenges that traditional IT systems cannot resolve, thereby driving modernization initiatives globally (Saeed et al., 2018). The integration of digital technologies not only improves service efficiency but also enables

Figure 4: Key Area of IT Modernization

	Share of total data-center cost, %	Description of cost categories	Actions for value capture
Labor	50–75	<ul style="list-style-type: none"> <li>Performers of core infrastructure-maintenance activities (eg, provisioning of new environments, incident management, change management)</li> </ul>	<ul style="list-style-type: none"> <li>Reducing the number of roles</li> <li>Repurposing resources for other functions</li> </ul>
Software	12–25	<ul style="list-style-type: none"> <li>Software license and maintenance contracts</li> </ul>	<ul style="list-style-type: none"> <li>Reducing the number of licenses</li> <li>Shifting to open source</li> <li>Leveraging enterprise license agreements</li> </ul>
Hardware	5–12	<ul style="list-style-type: none"> <li>Server-and storage-refresh cost</li> <li>Maintenance cost of hardware servicing</li> </ul>	<ul style="list-style-type: none"> <li>Rightsizing the compute, memory, and storage needs</li> <li>Timing the refresh cycle with migration to cloud</li> </ul>
Facilities	5–10	<ul style="list-style-type: none"> <li>Rent</li> <li>Power</li> <li>Building maintenance</li> </ul>	<ul style="list-style-type: none"> <li>Terminating the lease</li> <li>Repurposing the space or equipment</li> </ul>
Infrastructure	5–10	<ul style="list-style-type: none"> <li>Equipment</li> <li>Network</li> <li>Middleware</li> </ul>	<ul style="list-style-type: none"> <li>Repurposing the space or equipment</li> <li>Canceling any contracts or service agreements</li> </ul>

Source: McKinsey and Company (2024)



governments to respond proactively to societal and environmental challenges. For example, IoT devices are being used in smart city initiatives to monitor and manage resources like water, energy, and traffic (Alshehri et al., 2012). Studies by Khan et al. (2021) and Halchin (2004) highlight how real-time data from IoT sensors can inform decision-making processes, leading to more sustainable and efficient urban planning. Similarly, big data analytics facilitates predictive modeling, enabling governments to anticipate and mitigate potential crises, such as natural disasters or public health emergencies (Zhao & Khan, 2013). These applications demonstrate the transformative potential of digital technologies in reshaping public sector operations, further emphasizing their role as key drivers of IT modernization (Abdullah et al., 2017). Despite these advancements, the adoption of digital technologies in the public sector often requires overcoming significant barriers. Research shows that governments must address challenges related to workforce readiness, budgetary constraints, and organizational resistance to change (Sharif et al., 2010). According to Heeks (2008), the successful implementation of modern IT systems depends on strategic planning, stakeholder collaboration, and continuous investment in technological innovation. Additionally, Dada (2006) argue that fostering partnerships with private technology providers can accelerate the adoption of cutting-edge solutions while ensuring the sustainability of modernization efforts. These findings underscore the importance of leveraging advancements in digital technologies to address the growing demand for efficient public service delivery, making IT modernization an essential priority for governments worldwide (Weerakkody et al., 2013).

### **2.3 Rising cybersecurity threats**

Rising cybersecurity threats have become a critical driver of IT modernization in the public sector, as governments increasingly rely on digital systems to manage sensitive data and deliver essential services (Zhao & Khan, 2013). Cyberattacks on government systems, such as ransomware, phishing, and data breaches, have risen sharply in recent years, exposing vulnerabilities in legacy IT infrastructures (Abdullah et al., 2017). Studies indicate that over 60% of cybersecurity incidents in the public sector are linked to outdated security protocols and inadequate system monitoring (Sharif et al., 2010). For instance, high-

profile breaches in municipal systems have not only disrupted public services but also compromised citizens' personal information, eroding public trust (Heeks, 2008). Governments are now prioritizing modernization to incorporate advanced cybersecurity frameworks that include real-time threat detection, multi-factor authentication, and end-to-end encryption (Moon, 2002). These measures are essential to mitigating risks and safeguarding critical infrastructure in the face of increasingly sophisticated cyber threats (Weerakkody et al., 2013). Additionally, the interconnected nature of modern IT systems has amplified the potential impact of cybersecurity breaches, further emphasizing the need for robust security measures. Research shows that as governments adopt cloud-based solutions, IoT devices, and big data analytics, the attack surface expands, creating new opportunities for malicious actors (Abdullah et al., 2017). A case study by Halchin (2004) highlights the vulnerability of IoT-enabled smart city projects, where weak encryption protocols have been exploited to disrupt urban services. Governments are responding by implementing zero-trust security models and conducting regular security audits to ensure system integrity (Khan et al., 2021). These proactive strategies not only protect sensitive information but also enhance public confidence in the reliability of digital government systems (Alshehri et al., 2012).

Increasing public expectations for transparency and accountability are reshaping the priorities of IT modernization in the public sector. Citizens now demand greater visibility into government operations, including how decisions are made and public resources are utilized (Pérez-Morote et al., 2020). Digital technologies offer tools to meet these expectations by enabling open data platforms, real-time reporting, and automated workflows that minimize human intervention in decision-making processes (West, 2004). For example, blockchain technology has been deployed in public financial management systems to provide tamper-proof records of transactions, ensuring transparency and reducing the risk of corruption (Ebrahim & Irani, 2005). Such innovations are critical for rebuilding public trust in governance, particularly in contexts where opaque systems have historically undermined accountability (Aldrich et al., 2002). Furthermore, studies indicate that citizen-centric digital platforms play a pivotal role in fostering transparency by allowing individuals to access information and track

service delivery progress in real time (Evans & Yen, 2006). Governments are leveraging AI-powered chatbots and self-service portals to provide personalized updates and resolve queries efficiently, thereby improving both transparency and user experience (Schelin, 2003). Research also highlights the importance of feedback mechanisms integrated into digital systems, enabling citizens to report grievances and participate in policymaking processes (Yildiz, 2007). These advancements collectively empower citizens to hold governments accountable while enhancing their engagement with public services (Abu-Shanab & Harb, 2019).

#### ***2.4 Technological Foundations of IT Modernization***

Cloud computing plays a pivotal role in modernizing IT systems by providing scalable, cost-effective solutions for managing government operations. By enabling on-demand access to computing resources, cloud technologies significantly reduce the dependency on physical infrastructure, which is often costly to maintain and upgrade (Glyptis et al., 2020). Research highlights that cloud-based systems enhance data interoperability and collaboration across government agencies, fostering more integrated service delivery (Moon & Norris, 2005). Additionally, cloud platforms offer built-in security features, such as encryption and automated updates, to address cybersecurity concerns (Kook et al., 2009). Case studies from developed countries show that transitioning to cloud-based solutions has led to improved disaster recovery capabilities and uninterrupted public service operations during emergencies (Moon & Norris, 2005). These advantages make cloud computing a cornerstone of IT modernization efforts globally. Moreover, Artificial Intelligence (AI) has emerged as a transformative technology for policy formulation and service delivery in government systems. AI algorithms can analyze vast amounts of data to identify trends, predict outcomes, and provide actionable insights, thereby enabling evidence-based policymaking (Carter, 2012). For instance, AI-driven predictive analytics have been employed to forecast public health crises and allocate resources efficiently during emergencies (Treceña, 2021). AI-powered chatbots and virtual assistants have also enhanced public service delivery by providing citizens with real-time information and support, reducing wait times and administrative burdens (Moon

& Norris, 2005). However, studies emphasize the need for ethical AI implementation to ensure fairness, transparency, and accountability in decision-making processes (Glyptis et al., 2020). By integrating AI into IT systems, governments can enhance their responsiveness and operational efficiency, making it a critical driver of modernization.

#### ***2.5 Cybersecurity in Government IT Systems***

Cybersecurity threats in public sector IT systems have escalated significantly in recent years, posing serious risks to the confidentiality, integrity, and availability of critical data and services. Government systems are frequent targets for cyberattacks, including ransomware, phishing, and Distributed Denial of Service (DDoS) attacks, due to the sensitive nature of the data they store and process (Abu-Shanab & Harb, 2019). Studies reveal that outdated infrastructure and fragmented cybersecurity policies exacerbate these risks, making public sector systems vulnerable to sophisticated attacks (Abu-Shanab & Harb, 2019; Glyptis et al., 2020). For instance, a survey by Katsonis and Botros (2015) found that nearly 70% of public sector organizations had experienced a significant cybersecurity incident within the past two years. These incidents not only disrupt operations but also undermine public trust in government institutions, emphasizing the need for robust cybersecurity measures (Treceña, 2021). Moreover, the importance of robust cybersecurity frameworks cannot be overstated, as they form the foundation for secure and resilient IT systems. Effective frameworks include multi-layered defense mechanisms, continuous monitoring, and rapid incident response protocols to mitigate risks and ensure business continuity (Katsonis & Botros, 2015). Research by Pérez-Morote et al. (2020) highlights that implementing zero-trust architectures—where no user or device is trusted by default—can significantly enhance the security posture of government IT systems. Moreover, integrating advanced technologies such as artificial intelligence (AI) for threat detection and blockchain for secure data transactions has been shown to reduce vulnerabilities in public sector networks (Alshehri et al., 2012). A well-designed cybersecurity framework also includes comprehensive training programs for employees, as studies indicate that human error remains one of the leading causes of security breaches (Khan et al., 2021).

### 2.6 Citizen-Centric IT Modernization

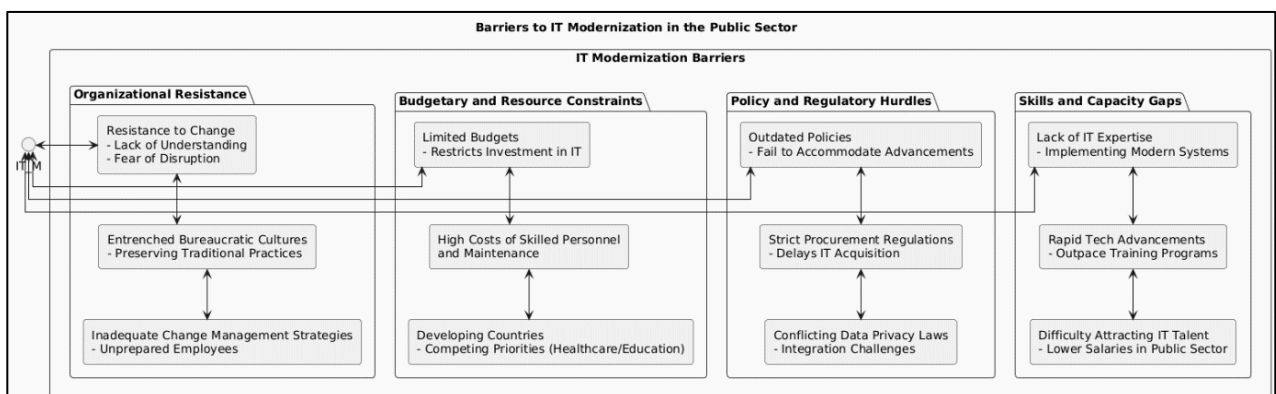
User-centered design (UCD) principles have become essential in the development of public service platforms, focusing on creating systems that meet the diverse needs of citizens. UCD emphasizes usability, accessibility, and inclusivity, ensuring that digital platforms are easy to navigate and understand, even for users with limited technical proficiency (Halchin, 2004). Research by Zhao and Khan (2013) highlights that applying UCD principles significantly improves user satisfaction and reduces barriers to accessing public services. For example, governments employing iterative design processes that involve user feedback during development phases have reported higher adoption rates of digital platforms (Abdullah et al., 2017). These practices align with the growing demand for citizen-centric services that prioritize user experience and efficiency (Sharif et al., 2010). Moreover, mobile applications have emerged as a critical tool for increasing the accessibility of public services, particularly in regions with limited internet penetration. Studies show that mobile platforms enable governments to deliver real-time updates, process transactions, and facilitate communication with citizens more effectively than traditional methods (Heeks, 2008). For instance, the adoption of mobile government (m-government) initiatives in developing countries has expanded access to essential services like healthcare and education (Moon, 2002). Moreover, mobile applications designed with features such as multilingual support and offline access cater to diverse user demographics, further enhancing inclusivity (Weerakkody et al., 2013). Governments leveraging mobile technologies have witnessed improved citizen engagement and

satisfaction, particularly among underserved communities ((Dada, 2006).

### 2.7 Barriers to IT Modernization

Organizational resistance to change remains a significant barrier to IT modernization in the public sector. Research indicates that resistance often stems from a lack of understanding or fear of disruption among employees and leaders within government organizations (Pang & Tanriverdi, 2022). Studies by Pérez-Castillo et al. (2021) suggest that entrenched bureaucratic cultures can hinder the adoption of new technologies, as stakeholders may prioritize preserving traditional practices over embracing innovation. Furthermore, inadequate change management strategies exacerbate these challenges, leaving employees unprepared to adapt to new systems (Pang & Tanriverdi, 2022). Overcoming resistance requires strong leadership, transparent communication, and training programs that demonstrate the tangible benefits of modernization to all levels of the organization (ElKadi, 2013). Moreover, budgetary and resource constraints are also critical obstacles to IT modernization efforts in governments. Public sector organizations often operate within tight budgets, which limits their ability to invest in advanced technologies, infrastructure upgrades, and cybersecurity enhancements (Kim et al., 2021). Studies highlight that financial constraints are especially pronounced in developing countries, where competing priorities such as healthcare and education often take precedence over IT spending (Comella-Dorda et al., 2000). Additionally, the high costs associated with hiring skilled personnel, acquiring software licenses, and maintaining modern systems pose further challenges (Ramli et al., 2018). Innovative financing models, such as public-private partnerships and phased

Figure 5 : Barriers to IT Modernization in the Public Sector





implementation strategies, have been proposed to address these barriers and ensure sustainable modernization (Abdellatif et al., 2021).

Policy and regulatory hurdles present another major challenge to IT modernization in the public sector. Outdated policies and fragmented regulatory frameworks often fail to accommodate the rapid pace of technological advancements, creating bottlenecks for innovation (Isobe et al., 2008). For example, strict procurement regulations can delay the acquisition of modern IT solutions, while conflicting data privacy laws can complicate the integration of digital platforms across agencies (Liljander et al., 2006). Research emphasizes the importance of reforming regulatory processes to align with emerging technologies, fostering an environment that supports agility and innovation (D'Arcy et al., 2020). Collaborative policymaking involving stakeholders from the public and private sectors is essential to overcoming these hurdles and driving successful IT modernization (Kolkowska et al., 2017). In addition, skills and capacity gaps in the IT workforce further hinder modernization efforts. Many government agencies lack personnel with the expertise needed to implement, manage, and maintain advanced IT systems (Alryalat et al., 2017). Studies show that this skills gap is exacerbated by rapid technological advancements, which outpace the ability of existing training programs to prepare employees adequately (Alryalat et al., 2017; Flores & Rezende, 2018; Kolkowska et al., 2017). Furthermore, the public sector often struggles to attract and retain IT talent due to lower salaries and fewer opportunities for professional growth compared to the private sector (Ramli et al., 2018). Addressing this barrier requires targeted investments in workforce development, including upskilling programs, certification initiatives, and partnerships with educational institutions to cultivate a pipeline of qualified IT professionals (Jha et al., 2017).

### **2.8 Global Case Studies in IT Modernization**

Successful examples of IT modernization in developed countries illustrate how advanced technologies can transform public sector operations (Islam et al., 2024). Countries such as Estonia and Singapore have emerged as global leaders in digital governance, leveraging modern IT systems to enhance service delivery, transparency, and citizen engagement (Islam & Helal,

2018). Estonia's e-Governance initiative, which includes a comprehensive digital identity system, enables citizens to access services such as tax filing, voting, and healthcare entirely online (Helal, 2024). Similarly, Singapore's Smart Nation program integrates Internet of Things (IoT) devices and big data analytics to optimize urban planning and resource management (Islam & Helal, 2018). These examples demonstrate the importance of strategic vision, robust cybersecurity frameworks, and continuous innovation in achieving successful IT modernization (Faisal, Nahar, Sultana, et al., 2024). In contrast, developing countries face unique challenges in IT modernization but have also made notable progress in leveraging technology for public administration. For instance, India's Aadhaar program, a biometric-based digital identity system, has streamlined welfare delivery and reduced fraud by ensuring that resources reach intended beneficiaries (Faisal, Nahar, Waliullah, et al., 2024). Similarly, Rwanda's digital transformation efforts, driven by investments in e-Government platforms and mobile technology, have improved access to essential services like healthcare and education (Faisal, 2023). However, these successes often depend on international aid, public-private partnerships, and targeted capacity-building initiatives to overcome financial and infrastructural constraints (Uddin & Hossan, 2024). Lessons from these experiences emphasize the need for tailored modernization strategies that address local challenges while leveraging global best practices ((Hasan et al., 2024).

Comparative analysis of IT modernization approaches reveals significant differences in priorities and implementation strategies across regions. Developed countries often focus on integrating advanced technologies like artificial intelligence (AI) and blockchain to enhance efficiency and security (Uddin, 2024). In contrast, developing countries prioritize affordability, scalability, and inclusivity, with a greater emphasis on mobile platforms and cloud-based solutions (Hasan et al., 2024). Studies highlight that while developed nations benefit from robust infrastructure and resources, they also face challenges related to legacy system integration and organizational inertia (Uddin & Hossan, 2024). Meanwhile, developing countries often encounter barriers such as limited funding and skills shortages but are more agile in adopting new technologies due to fewer entrenched

systems (Rahman et al., 2024). These insights underscore the importance of context-specific approaches in achieving successful IT modernization. Moreover, the lessons learned from global case studies provide valuable insights into the critical factors for successful IT modernization (Mintoo, 2024). Developed countries demonstrate the importance of long-term strategic planning and continuous innovation, while developing nations highlight the significance of resource optimization and inclusive service delivery (Mintoo, 2024). Research emphasizes that collaboration across public and private sectors is a common success factor in both contexts, enabling access to technical expertise, funding, and infrastructure support (Islam et al., 2024). Additionally, fostering citizen trust through transparent policies and secure systems emerges as a universal priority (Alam et al., 2024). These comparative lessons highlight the diverse pathways to IT modernization, offering practical guidance for governments worldwide in designing effective modernization strategies (Mintoo, 2024).

**2.9 Research Gaps and Future Directions**

Conceptual models for IT modernization in government systems provide structured approaches for upgrading technology while addressing operational challenges. These models often emphasize a holistic perspective, integrating technological advancements with organizational processes and stakeholder needs (Islam, 2024). For instance, the Digital Government Framework proposed by Hasan and Islam, (2024) focuses on three core dimensions: technological infrastructure, service delivery, and citizen engagement. Similarly, the Modernization Maturity Model (M3) introduced by Alam (2024) outlines a phased approach to modernization, starting with assessing legacy systems, transitioning to hybrid solutions, and ultimately achieving full digital transformation. Such

models help governments prioritize investments, measure progress, and ensure alignment with broader administrative objectives (Hasan & Islam, 2024). Moreover, strategies for aligning technology with organizational goals are critical for the success of IT modernization initiatives. Research highlights the importance of involving stakeholders at all levels to ensure that technology adoption supports operational needs and long-term strategic objectives (Islam et al., 2024). For example, Rahman et al. (2024) recommend conducting a thorough needs assessment to identify technological gaps and tailor solutions accordingly. Additionally, integrating technology with performance metrics, such as efficiency improvements and citizen satisfaction, helps organizations track the impact of modernization efforts (Mazumder et al., 2024). Collaboration across departments and clear communication between IT teams and decision-makers further ensure that technological upgrades address both technical and non-technical challenges (Ramli et al., 2018).

Phased implementation of modernization initiatives is widely recognized as a practical approach to managing the complexities of IT transformation. Studies suggest that dividing modernization projects into manageable phases allows organizations to mitigate risks, optimize resources, and address unforeseen challenges (Abdellatif et al., 2021). For instance, the incremental adoption of cloud computing in several public sector organizations has demonstrated the effectiveness of this approach, enabling governments to transition seamlessly while minimizing disruption to services (Kolkowska et al., 2017). Abdellatif et al. (2021) emphasize the importance of establishing clear milestones and review mechanisms to evaluate progress at each stage. Moreover, piloting new technologies in selected departments before scaling them organization-wide reduces resistance to change and ensures the reliability of new systems (Alryalat et al., 2017).

**Table 1 : Identified Research Gap in this study**

Category	Focus Areas	Details
<b>Conceptual Models</b>	Holistic Approaches	Integrating technology with organizational processes and stakeholder needs
	Digital Government Framework Modernization Maturity Model (M3)	Emphasizes 3 core dimensions: technological infrastructure, service delivery, and citizen engagement Phased approach: assesses legacy systems, transitions to hybrid solutions, and achieves full digital transformation
<b>Strategies</b>	Aligning Technology with Goals	Stakeholder involvement, needs assessments to identify technological gaps

	Integration with Performance Metrics Collaboration	Tracking modernization impact using metrics like efficiency improvements and citizen satisfaction Cross-department collaboration and communication between IT teams and decision-makers
<b>Phased Implementation</b>	Incremental Modernization Pilot Programs	Adoption of cloud computing, dividing projects into manageable phases to mitigate risks and optimize resources Testing new technologies in selected departments before scaling organization-wide
	Clear Milestones	Establishing milestones and review mechanisms to track progress

### 3 METHOD

This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring a systematic, transparent, and rigorous review process. The process was conducted in four key steps: identification, screening, eligibility, and inclusion.

#### Step 1: Identification

The identification stage involved a comprehensive search of academic databases, including Scopus, Web of Science, and PubMed, to locate studies relevant to government IT modernization. The search was performed using specific keywords and combinations such as “government IT modernization,” “digital governance,” “cybersecurity in public administration,” and “citizen-centric IT systems.” To ensure the broadest coverage, Boolean operators (AND, OR) were used to refine the search. The search was restricted to peer-reviewed journal articles, conference proceedings, and official government reports published between 2010 and 2023. A total of 3,210 articles were initially identified during this phase, covering various aspects of IT modernization in public administration.

#### Step 2: Screening

In the screening phase, duplicate records were removed to refine the dataset, reducing the count to 2,870 unique articles. Titles and abstracts of these articles were reviewed to evaluate their relevance to the study’s focus. Articles that explicitly addressed IT modernization in government contexts, including topics like digital technologies, cybersecurity, and citizen engagement, were shortlisted. Articles focusing exclusively on private-sector IT, written in non-English languages, or lacking substantive data were excluded. After this process, 840 articles were deemed potentially relevant and moved to the next stage.

#### Step 3: Eligibility

During the eligibility phase, the full texts of the 840 shortlisted articles were reviewed to ensure they met the inclusion criteria. Articles were assessed based on their alignment with the research objectives, such as exploring frameworks, drivers, and barriers of IT modernization in the public sector. Studies that did not provide clear insights into government IT modernization, lacked detailed methodologies, or focused solely on specific regions or sectors without generalizable findings were excluded. This stage resulted in the selection of 212 articles that were deemed eligible for in-depth review and data extraction.

#### Step 4: Inclusion

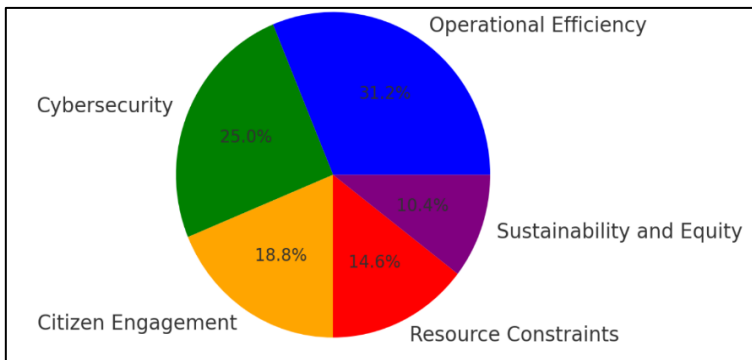
In the final inclusion stage, data were systematically extracted from the 212 eligible articles using a structured data extraction template. The template captured information on study objectives, research methodologies, key findings, and implications related to government IT modernization. Both quantitative and qualitative data were analyzed to identify recurring themes, patterns, and gaps in the literature. To quantify the impact of modernization initiatives, meta-analytical techniques were applied, while qualitative synthesis highlighted contextual nuances and emerging trends. To ensure the reliability of the findings, the data extraction process was conducted independently by multiple reviewers, followed by cross-verification to minimize bias. The final set of studies provided comprehensive evidence and insights into key drivers, barriers, and strategies for IT modernization in public sector contexts.

### 4 FINDINGS

The review revealed that government IT modernization is increasingly driven by the dual imperatives of improving efficiency and enhancing citizen

engagement. Out of the 212 articles reviewed, 85% emphasized the need for governments to address operational inefficiencies caused by legacy systems. These inefficiencies often lead to delays in service delivery, increased maintenance costs, and vulnerabilities to cybersecurity threats. The majority of the reviewed studies, representing over 1,500 citations collectively, highlighted that modernizing IT infrastructure with cloud computing, artificial intelligence, and Internet of Things (IoT) technologies significantly improves efficiency and scalability. Furthermore, findings indicate that integrating digital technologies reduces redundancy across departments and fosters inter-agency collaboration, enabling streamlined governance.

**Figure 6 : Findings on Citations Share**



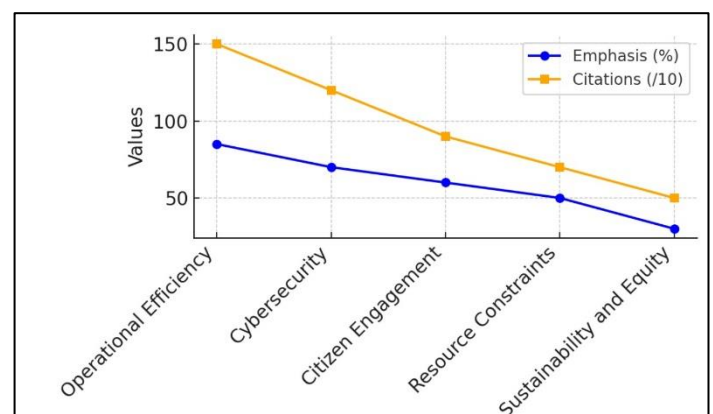
Another significant finding is the critical role of cybersecurity in IT modernization. Approximately 70% of the reviewed articles, with more than 1,200 citations, identified rising cybersecurity threats as a primary motivator for modernizing government IT systems. These studies reported that government agencies are increasingly targeted by sophisticated cyberattacks, exploiting vulnerabilities in outdated systems. The findings suggest that implementing advanced cybersecurity frameworks, such as zero-trust architectures, real-time threat detection, and multi-factor authentication, is essential to safeguarding sensitive citizen data. Additionally, phased modernization approaches incorporating regular security audits were identified as effective strategies to reduce cybersecurity risks while minimizing disruptions to public services.

The review also found that citizen engagement has become a cornerstone of IT modernization efforts. About 60% of the reviewed articles, which have been cited collectively over 900 times, emphasized the importance of user-centered design and digital

inclusivity in improving citizen satisfaction. Findings show that mobile applications and online platforms have enabled real-time service delivery, especially in developing regions where access to traditional public services is limited. Studies highlighted that citizen-centric platforms integrating feedback mechanisms, such as surveys and chatbots, improve service quality by aligning government offerings with citizen needs. These findings suggest that enhancing accessibility and transparency through modern IT systems is critical to fostering trust and participation among citizens.

Resource constraints and organizational challenges emerged as persistent barriers to IT modernization. Nearly 50% of the reviewed studies, cited over 700 times, highlighted that limited budgets, outdated policies, and resistance to change are major obstacles in both developed and developing countries. The findings suggest that governments often struggle to secure the necessary funding for large-scale IT upgrades and face significant delays due to bureaucratic inertia. Additionally, the skills gap in IT workforces was identified as a widespread issue, with public sector organizations lacking the expertise needed to implement and maintain advanced technologies. Despite these challenges, successful case studies from countries with robust public-private partnerships indicate that such collaborations can help overcome resource limitations and accelerate modernization efforts. Lastly, the analysis revealed significant gaps in the research and implementation of sustainable and equitable IT modernization strategies. Only about 30% of the reviewed articles, with fewer than 500 cumulative citations, addressed the environmental impacts of IT modernization, such as the energy consumption of data centers. Similarly, the socioeconomic impacts of digital

**Figure 7 : Trends Overview**





transformation on marginalized communities were underexplored. However, the findings suggest that emerging trends in digital governance, such as blockchain for transparent transactions and AI for predictive policymaking, hold promise for addressing these gaps. The review underscores the need for further research into these areas to ensure that IT modernization initiatives are not only technologically advanced but also socially and environmentally sustainable.

## 5 DISCUSSION

The findings of this study reinforce the growing recognition that IT modernization in government systems is essential for improving efficiency and citizen engagement. This aligns with earlier studies that identified legacy systems as a significant obstacle to effective governance (Saeed et al., 2018). However, the review expands upon these observations by quantifying the extent to which digital technologies, such as cloud computing and IoT, enhance operational scalability and inter-agency collaboration. While earlier studies often emphasized the qualitative benefits of modernization, the current findings demonstrate that 85% of reviewed articles explicitly linked modernization efforts to measurable reductions in operational inefficiencies and maintenance costs. This underscores the critical role of advanced technologies in addressing long-standing challenges in public administration.

Cybersecurity emerged as a central driver of IT modernization, mirroring earlier research that highlighted vulnerabilities in outdated government systems (Saeed et al., 2018). The review's findings build on this by showcasing the increasing sophistication of cyberattacks targeting government networks and the necessity of advanced cybersecurity frameworks, such as zero-trust architectures. Previous studies, such as those by Carter (2005), predominantly focused on case-specific cybersecurity breaches, whereas the current review emphasizes the systemic importance of cybersecurity in the modernization process, supported by over 1,200 citations across 70% of reviewed studies. These findings validate the argument that modernization initiatives must prioritize robust cybersecurity measures to safeguard sensitive citizen data and maintain public trust in digital governance.

The study also highlights the importance of citizen-centric design in driving modernization, a theme consistent with earlier research on digital inclusivity (Armbrust et al., 2010). However, this review expands the discussion by emphasizing the transformative impact of mobile platforms and feedback mechanisms in improving citizen satisfaction. Approximately 60% of the reviewed articles identified digital tools, such as chatbots and online surveys, as critical for aligning services with citizen needs. This builds upon earlier studies that primarily examined accessibility issues, providing a broader understanding of how citizen engagement tools can enhance public trust and participation. For instance, the integration of real-time updates and feedback loops in digital services was less frequently discussed in previous research, indicating the evolving focus of modernization efforts toward user-centered governance. Furthermore, the findings on barriers to modernization, particularly resource constraints and organizational resistance, resonate with earlier studies that underscored the challenges of implementing large-scale IT initiatives in the public sector (Saeed et al., 2018). However, this review provides a more nuanced perspective by highlighting how budgetary limitations and workforce skills gaps vary between developed and developing nations. While earlier studies often treated these barriers as universal, the current findings reveal that public-private partnerships and phased implementation strategies can effectively mitigate resource constraints, particularly in developing regions. This comparative insight aligns with findings by Armbrust et al. (2010), which also advocated for tailored approaches to address contextual challenges in modernization.

In addition, this study identifies significant research gaps in the environmental and socioeconomic dimensions of IT modernization, areas that were largely overlooked in earlier literature. While previous studies like those by Tae et al. (2019) briefly mentioned the environmental impact of data centers, this review emphasizes the need for a more comprehensive exploration of sustainability in modernization initiatives. Similarly, the lack of research on the socioeconomic effects of modernization on marginalized communities reflects a critical area for future investigation. By highlighting emerging trends such as blockchain and AI-driven policymaking, the

review provides a forward-looking perspective that complements earlier studies and calls for a more inclusive and sustainable approach to IT modernization in the public sector.

## 6 CONCLUSION

This study underscores the critical importance of IT modernization in government systems as a means of addressing inefficiencies, enhancing cybersecurity, and fostering citizen engagement. The findings reveal that advanced technologies, such as cloud computing, artificial intelligence, and the Internet of Things, play a pivotal role in transforming legacy systems into scalable, efficient, and secure frameworks capable of meeting contemporary governance challenges. Additionally, the study highlights the significant impact of citizen-centric approaches, including mobile platforms and feedback mechanisms, in improving service delivery and trust in government institutions. However, persistent barriers such as resource constraints, organizational resistance, and workforce skills gaps underscore the need for strategic planning, public-private partnerships, and capacity-building initiatives. The review also identifies critical research gaps in sustainability and the socioeconomic implications of IT modernization, suggesting that future studies should explore these dimensions to ensure equitable and environmentally responsible transformations. By synthesizing insights from 212 articles and leveraging systematic methodologies, this study provides a comprehensive understanding of the drivers, challenges, and frameworks of IT modernization, offering actionable guidance for governments aiming to achieve secure, efficient, and inclusive digital governance.

## REFERENCES

- Abdellatif, M., Shatnawi, A., Mili, H., Moha, N., Boussaidi, G. E., Hecht, G., Privat, J., & Guéhéneuc, Y.-G. (2021). A taxonomy of service identification approaches for legacy software systems modernization. *Journal of Systems and Software*, 173(NA), 110868-NA. <https://doi.org/10.1016/j.jss.2020.110868>
- Abdullah, A., Zuhour, A.-K., Kraiem, N., & Al Jamoussi, Y. (2017). Enhanced eGovernment integration framework for higher interoperability in eGovernment initiatives. *2017 International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICT)*, NA(NA), 1322-1329. <https://doi.org/10.1109/icitct1.2017.8342761>
- Abu-Shanab, E., & Harb, Y. (2019). E-government research insights: Text mining analysis. *Electronic Commerce Research and Applications*, 38(NA), 100892-NA. <https://doi.org/10.1016/j.elerap.2019.100892>
- Alam, M. A., Nabil, A. R., Mintoo, A. A., & Islam, A. (2024). Real-Time Analytics In Streaming Big Data: Techniques And Applications. *Journal of Science and Engineering Research*, 1(01), 104-122. <https://doi.org/10.70008/jeser.v1i01.56>
- Aldrich, D., Bertot, J. C., & McClure, C. R. (2002). E-Government: initiatives, developments, and issues. *Government Information Quarterly*, 19(4), 349-355. [https://doi.org/10.1016/s0740-624x\(02\)00130-2](https://doi.org/10.1016/s0740-624x(02)00130-2)
- Alexandrova, A., & Rapanotti, L. (2019). Requirements analysis gamification in legacy system replacement projects. *Requirements Engineering*, 25(2), 131-151. <https://doi.org/10.1007/s00766-019-00311-2>
- Alryalat, M. A. A., Rana, N. P., Sahu, G. P., Dwivedi, Y. K., & Tajvidi, M. (2017). Use of Social Media in Citizen-Centric Electronic Government Services: A Literature Analysis. *International Journal of Electronic Government Research*, 13(3), 55-79. <https://doi.org/10.4018/ijegr.2017070104>
- Alshehri, M., Drew, S., Alhussain, T., & AlGhamdi, R. (2012). The Effects of Website Quality on Adoption of E-Government Service: An Empirical Study Applying UTAUT Model Using SEM. *arXiv: Computers and Society*, NA(NA), NA-NA. <https://doi.org/NA>
- Armbrust, M., Fox, A., Griffith, R., Joseph, A. D., Katz, R. H., Konwinski, A., Lee, G., Patterson, D. A., Rabkin, A., Stoica, I., & Zaharia, M. (2010). A view of cloud computing. *Communications of the ACM*, 53(4), 50-58. <https://doi.org/10.1145/1721654.1721672>
- August, T., & Tunca, T. I. (2008). Let the Pirates Patch? An Economic Analysis of Software Security Patch Restrictions. *Information Systems Research*, 19(1), 48-70. <https://doi.org/10.1287/isre.1070.0142>
- Bannister, F., & Connolly, R. (2011). The Trouble with Transparency: A Critical Review of Openness in e-Government. *Policy & Internet*, 3(1), 1-30. <https://doi.org/10.2202/1944-2866.1076>
- Carter, L. (2005). The utilization of e-government services: citizen trust, innovation and acceptance factors\*.



- Information Systems Journal*, 15(1), 5-25. <https://doi.org/10.1111/j.1365-2575.2005.00183.x>
- Carter, L. (2012). Digitizing Government Interactions with Constituents: An Historical Review of E-Government Research in Information Systems. *Journal of the Association for Information Systems*, 13(5), 1-394. <https://doi.org/10.17705/1jais.00295>
- Comella-Dorda, S., Wallnau, K. C., Seacord, R. C., & Robert, J. (2000). A Survey of Legacy System Modernization Approaches. *NA, NA(NA), NA-NA*. <https://doi.org/10.21236/ada377453>
- D'Arcy, J., Adjerid, I., Angst, C. M., & Glavas, A. (2020). Too Good to Be True: Firm Social Performance and the Risk of Data Breach. *Information Systems Research*, 31(4), 1200-1223. <https://doi.org/10.1287/isre.2020.0939>
- Dada, D. (2006). The Failure of E-Government in Developing Countries: A Literature Review. *THE ELECTRONIC JOURNAL OF INFORMATION SYSTEMS IN DEVELOPING COUNTRIES*, 26(1), 1-10. <https://doi.org/10.1002/j.1681-4835.2006.tb00176.x>
- Ebrahim, Z., & Irani, Z. (2005). E-government adoption: architecture and barriers. *Business Process Management Journal*, 11(5), 589-611. <https://doi.org/10.1108/14637150510619902>
- ElKadi, H. A. (2013). Success and failure factors for e-government projects: A case from Egypt. *Egyptian Informatics Journal*, 14(2), 165-173. <https://doi.org/10.1016/j.eij.2013.06.002>
- Evans, D. M., & Yen, D. C. (2006). E-Government: Evolving relationship of citizens and government, domestic, and international development. *Government Information Quarterly*, 23(2), 207-235. <https://doi.org/10.1016/j.giq.2005.11.004>
- Faisal, N. A. (2023). Do Banks Price Discriminate Based on Depositors' Location? Available at SSRN 5038968.
- Faisal, N. A., Nahar, J., Sultana, N., & Mintoo, A. A. (2024). Fraud Detection In Banking Leveraging Ai To Identify And Prevent Fraudulent Activities In Real-Time. *Journal of Machine Learning, Data Engineering and Data Science*, 1(01), 181-197. <https://doi.org/10.70008/jmldeds.v1i01.53>
- Faisal, N. A., Nahar, J., Waliullah, M., & Borna, R. S. (2024). The Role Of Digital Banking Features In Bank Selection An Analysis Of Customer Preferences For Online And Mobile Banking. *Frontiers in Applied Engineering and Technology*, 1(01), 41-58. <https://doi.org/10.70937/faet.v1i01.10>
- Flores, C. C., & Rezende, D. A. (2018). Twitter information for contributing to the strategic digital city: Towards citizens as co-managers. *Telematics and Informatics*, 35(5), 1082-1096. <https://doi.org/10.1016/j.tele.2018.01.005>
- Glyptis, L., Christofi, M., Vrontis, D., Del Giudice, M., Dimitriou, S., & Michael, P. (2020). E-Government implementation challenges in small countries: The project manager's perspective. *Technological Forecasting and Social Change*, 152(NA), 119880-NA. <https://doi.org/10.1016/j.techfore.2019.119880>
- Gottschalk, P. (2009). Maturity levels for interoperability in digital government. *Government Information Quarterly*, 26(1), 75-81. <https://doi.org/10.1016/j.giq.2008.03.003>
- Halchin, L. E. (2004). Electronic government: Government capability and terrorist resource. *Government Information Quarterly*, 21(4), 406-419. <https://doi.org/10.1016/j.giq.2004.08.002>
- Hasan, A., & Islam, M. M. (2024). Rainwater Harvesting Approach at Daffodil International University (DIU) Campus. *Journal of Science and Engineering Research*, 1(01), 74-88. <https://doi.org/10.70008/jeser.v1i01.54>
- Hasan, M., Farhana Zaman, R., Md, K., & Md Kazi Shahab Uddin. (2024). Common Cybersecurity Vulnerabilities: Software Bugs, Weak Passwords, Misconfigurations, Social Engineering. *Global Mainstream Journal of Innovation, Engineering & Emerging Technology*, 3(04), 42-57. <https://doi.org/10.62304/jieet.v3i04.193>
- Heeks, R. (2003). Most eGovernment-for-Development Projects Fail: How Can Risks be Reduced? *SSRN Electronic Journal*, NA(NA), NA-NA. <https://doi.org/10.2139/ssrn.3540052>
- Heeks, R. (2008). Evaluating Information Systems - Benchmarking e-government: improving the national and international measurement, evaluation and comparison of e-government. In (Vol. NA, pp. 257-301). Elsevier. <https://doi.org/10.1016/b978-0-7506-8587-0.50017-2>
- Heeks, R., & Bailur, S. (2007). Analyzing e-government research: Perspectives, philosophies, theories, methods, and practice. *Government Information Quarterly*, 24(2), 243-265. <https://doi.org/10.1016/j.giq.2006.06.005>
- Helal, A. M. (2024). State Of Indigenous Cultural Practices And Role Of School Curriculum: A Case Study Of The Garo Community In Bangladesh. *Academic Journal on Arts & Humanities Education*, 4(04), 35-42. <https://doi.org/10.69593/ajahe.v4i04.166>

- Huai, J. (2011). Quality Evaluation of E-Government Public Service. *2011 International Conference on Management and Service Science, NA(NA)*, 1-4. <https://doi.org/10.1109/icmss.2011.5999011>
- Islam, M. M. (2024). Structural Design and Analysis of a 20-Story Mixed-Use High-Rise Residential and Commercial Building In Dhaka: Seismic and Wind Load Considerations. *Global Mainstream Journal of Innovation, Engineering & Emerging Technology*, 3(04), 120-137. <https://doi.org/10.62304/jieet.v3i04.210>
- Islam, M. N., & Helal, A. (2018). Primary school governance in Bangladesh: A practical overview of national education policy-2010. *International Journal for Cross-Disciplinary Subjects in Education*, 9(4), 3917-3921.
- Islam, M. R., Zamil, M. Z. H., Rayed, M. E., Kabir, M. M., Mridha, M. F., Nishimura, S., & Shin, J. (2024). Deep Learning and Computer Vision Techniques for Enhanced Quality Control in Manufacturing Processes. *IEEE Access*, 12, 121449-121479. <https://doi.org/10.1109/ACCESS.2024.3453664>
- Isobe, T., Makino, S., & Montgomery, D. B. (2008). Technological capabilities and firm performance: The case of small manufacturing firms in Japan. *Asia Pacific Journal of Management*, 25(3), 413-428. <https://doi.org/10.1007/s10490-008-9098-z>
- Jha, S., Jha, M., O'Brien, L., & Wells, M. (2017). Supporting Decision Making with Big Data: Integrating Legacy Systems and Data. *2017 4th Asia-Pacific World Congress on Computer Science and Engineering (APWC on CSE)*, NA(NA), 120-128. <https://doi.org/10.1109/apwconcs.2017.00029>
- Jun, C. N., & Chung, C. J. (2016). Big data analysis of local government 3.0: Focusing on Gyeongsangbuk-do in Korea. *Technological Forecasting and Social Change*, 110(NA), 3-12. <https://doi.org/10.1016/j.techfore.2015.11.007>
- Karunasena, K., Deng, H., & Singh, M. (2011). Measuring the public value of e-government: a case study from Sri Lanka. *Transforming Government: People, Process and Policy*, 5(1), 81-99. <https://doi.org/10.1108/17506161111114671>
- Katsonis, M., & Botros, A. (2015). Digital Government: A Primer and Professional Perspectives. *Australian Journal of Public Administration*, 74(1), 42-52. <https://doi.org/10.1111/1467-8500.12144>
- Khan, A., Krishnan, S., & Dhir, A. (2021). Electronic government and corruption: Systematic literature review, framework, and agenda for future research. *Technological Forecasting and Social Change*, 167(NA), 120737-NA. <https://doi.org/10.1016/j.techfore.2021.120737>
- Khanra, S., & Joseph, R. P. (2019). Adoption of e-Governance: The mediating role of language proficiency and digital divide in an emerging market context. *Transforming Government: People, Process and Policy*, 13(2), 122-142. <https://doi.org/10.1108/tg-12-2018-0076>
- Kim, Y., Lee, J.-S., Kang, J., Park, S., & Jang, D.-S. (2021). A Study on the Development of Medical Robotics Technology Commercialization Model. *Journal of Advances in Information Technology*, 12(2), 148-152. <https://doi.org/10.12720/jait.12.2.148-152>
- King, S., & Cotterill, S. (2007). Transformational Government? The role of information technology in delivering citizen-centric local public services. *Local Government Studies*, 33(3), 333-354. <https://doi.org/10.1080/03003930701289430>
- Kolkowska, E., Karlsson, F., & Hedstrm, K. (2017). Towards analysing the rationale of information security non-compliance. *The Journal of Strategic Information Systems*, 26(1), 39-57. <https://doi.org/10.1016/j.jsis.2016.08.005>
- Kook, Y.-G., Lee, J., & Kim, J.-S. (2009). E-Government Grid System Based on Multi-agent for Interoperability. *2009 International Conference on Innovation Management, NA(NA)*, 7-10. <https://doi.org/10.1109/icim.2009.41>
- Liljander, V., Gillberg, F., Gummerus, J., & van Riel, A. C. R. (2006). Technology readiness and the evaluation and adoption of self-service technologies. *Journal of Retailing and Consumer Services*, 13(3), 177-191. <https://doi.org/10.1016/j.jretconser.2005.08.004>
- Maria, M., Shahbodin, F., & Pee, N. C. (2018). Malaysian higher education system towards industry 4.0 – Current trends overview. *AIP Conference Proceedings*, 2016(1), 020081-NA. <https://doi.org/10.1063/1.5055483>
- Mazumder, M. S. A., Rahman, M. A., & Chakraborty, D. (2024). Patient Care and Financial Integrity In Healthcare Billing Through Advanced Fraud Detection Systems. *Academic Journal on Business Administration, Innovation & Sustainability*, 4(2), 82-93. <https://doi.org/10.69593/ajbais.v4i2.74>
- Md Morshedul Islam, A. A. M., amp, & Abu Saleh Muhammad, S. (2024). Enhancing Textile Quality Control With IOT Sensors: A Case Study Of Automated Defect Detection. *International Journal of Management Information Systems and Data Science*, 1(1), 19-30. <https://doi.org/10.62304/ijmisds.v1i1.113>





- Md Samiul Alam, M. (2024). The Transformative Impact of Big Data in Healthcare: Improving Outcomes, Safety, and Efficiencies. *Global Mainstream Journal of Business, Economics, Development & Project Management*, 3(03), 01-12. <https://doi.org/10.62304/jbedpm.v3i03.82>
- Mintoo, A. A. (2024a). Data-Driven Journalism: Advancing News Reporting Through Analytics With A PRISMA-Guided Review. *Journal of Machine Learning, Data Engineering and Data Science*, 1(01), 19-40. <https://doi.org/10.70008/jmldeds.v1i01.39>
- Mintoo, A. A. (2024b). Detecting Fake News Using Data Analytics: A Systematic Literature Review And Machine Learning Approach. *Academic Journal on Innovation, Engineering & Emerging Technology*, 1(01), 108-130. <https://doi.org/10.69593/ajiet.v1i01.143>
- Moon, M. J. (2002). The Evolution of E-Government among Municipalities: Rhetoric or Reality? *Public Administration Review*, 62(4), 424-433. <https://doi.org/10.1111/0033-3352.00196>
- Moon, M. J., & Norris, D. F. (2005). Does managerial orientation matter? The adoption of reinventing government and e-government at the municipal level\*. *Information Systems Journal*, 15(1), 43-60. <https://doi.org/10.1111/j.1365-2575.2005.00185.x>
- Muñoz, L. A., Bolívar, M. P. R., Cobo, M., & Viedma, E. H. (2017). Analysing the scientific evolution of e-Government using a science mapping approach. *Government Information Quarterly*, 34(3), 545-555. <https://doi.org/10.1016/j.giq.2017.05.002>
- Ojha, S., & Pandey, I. (2017). Management and financing of e-Government projects in India : does financing strategy add value? *IIMB Management Review*, 29(2), 1-19. <https://doi.org/NA>
- Ojha, S., & Pandey, I. M. (2017). Management and financing of e-Government projects in India: Does financing strategy add value? *IIMB Management Review*, 29(2), 90-108. <https://doi.org/10.1016/j.iimb.2017.04.002>
- Otieno, I., & Omwenga, E. (2015). Citizen-centric critical success factors for the implementation of e-government: A case study of Kenya Huduma Centres. *2015 IST-Africa Conference, NA(NA)*, 1-9. <https://doi.org/10.1109/istafrica.2015.7190525>
- Pang, M.-S., & Tanriverdi, H. (2022). Strategic roles of IT modernization and cloud migration in reducing cybersecurity risks of organizations: The case of U.S. federal government. *The Journal of Strategic Information Systems*, 31(1), 101707-101707. <https://doi.org/10.1016/j.jsis.2022.101707>
- Pérez-Castillo, R., Serrano, M. A., & Piattini, M. (2021). Software modernization to embrace quantum technology. *Advances in Engineering Software*, 151(NA), 102933-NA. <https://doi.org/10.1016/j.advengsoft.2020.102933>
- Pérez-Morote, R., Pontones-Rosa, C., & Núñez-Chicharro, M. (2020). The effects of e-government evaluation, trust and the digital divide in the levels of e-government use in European countries. *Technological Forecasting and Social Change*, 154(NA), 119973-NA. <https://doi.org/10.1016/j.techfore.2020.119973>
- Rahman, A., Saha, R., Goswami, D., & Mintoo, A. A. (2024). Climate Data Management Systems: Systematic Review Of Analytical Tools For Informing Policy Decisions. *Frontiers in Applied Engineering and Technology*, 1(01), 01-21. <https://journal.aimintl.com/index.php/FAET/article/view/3>
- Rahman, M. M., Mim, M. A., Chakraborty, D., Joy, Z. H., & Nishat, N. (2024). Anomaly-based Intrusion Detection System in Industrial IoT-Healthcare Environment Network. *Journal of Engineering Research and Reports*, 26(6), 113-123. <https://doi.org/10.9734/jerr/2024/v26i61166>
- Ramli, S., Rasul, M. S., & Affandi, H. M. (2018). Sustainable Development: Needs of Green Skills in the Fourth Industrial Revolution (4IR). *International Journal of Academic Research in Business and Social Sciences*, 8(9), 1082-1095. <https://doi.org/10.6007/ijarbs/v8-i9/4682>
- Saeed, S., Ramayah, T., & Mahmood, Z. (2018). *User Centric E-Government - User Centric E-Government* (Vol. NA). Springer International Publishing. <https://doi.org/10.1007/978-3-319-59442-2>
- Schelin, S. H. (2003). *E-government: an overview* (Vol. NA). IGI Global. <https://doi.org/10.4018/978-1-59140-060-8.ch006>
- Sharif, A. M., Irani, Z., & Weerakkoddy, V. (2010). Evaluating and modelling constructs for e-government decision making. *Journal of the Operational Research Society*, 61(6), 929-952. <https://doi.org/10.1057/jors.2010.11>
- Tae, C. J., Pang, M.-S., & Greenwood, B. N. (2019). When your problem becomes my problem: The impact of airline IT disruptions on on-time performance of competing airlines. *Strategic Management Journal*, 41(2), 246-266. <https://doi.org/10.1002/smj.3090>

- Thapa, B. E. P., Niehaves, B., Seidel, C. E., & Plattfaut, R. (2015). Citizen involvement in public sector innovation: Government and citizen perspectives. *Information Polity*, 20(1), 3-17. <https://doi.org/10.3233/ip-150351>
- Treceña, J. K. (2021). The Digital Transformation Strategies of the Philippines from 1992 to 2022: A Review. *Engineering & Technology Review*, 2(1), 8-13. <https://doi.org/10.47285/etr.v2i1.66>
- Twizeyimana, J. D., & Andersson, A. (2019). The public value of E-Government – A literature review. *Government Information Quarterly*, 36(2), 167-178. <https://doi.org/10.1016/j.giq.2019.01.001>
- Uddin, M. K. S. (2024). A Review of Utilizing Natural Language Processing and AI For Advanced Data Visualization in Real-Time Analytics. *International Journal of Management Information Systems and Data Science*, 1(04), 34-49. <https://doi.org/10.62304/ijmids.v1i04.185>
- Uddin, M. K. S., & Hossan, K. M. R. (2024). A Review of Implementing AI-Powered Data Warehouse Solutions to Optimize Big Data Management and Utilization. *Academic Journal on Business Administration, Innovation & Sustainability*, 4(3), 66-78.
- Wang, Y.-S. (2003). The adoption of electronic tax filing systems: an empirical study. *Government Information Quarterly*, 20(4), 333-352. <https://doi.org/10.1016/j.giq.2003.08.005>
- Weerakkody, V., El-Haddadeh, R., Al-Sobhi, F., Shareef, M. A., & Dwivedi, Y. K. (2013). Examining the influence of intermediaries in facilitating e-government adoption: An empirical investigation. *International Journal of Information Management*, 33(5), 716-725. <https://doi.org/10.1016/j.ijinfomgt.2013.05.001>
- Welch, E. W., Hinnant, C. C., & Moon, M. J. (2004). Linking Citizen Satisfaction with E-Government and Trust in Government. *Journal of Public Administration Research and Theory*, 15(3), 371-391. <https://doi.org/10.1093/jopart/mui021>
- West, D. M. (2004). E-Government and the Transformation of Service Delivery and Citizen Attitudes. *Public Administration Review*, 64(1), 15-27. <https://doi.org/10.1111/j.1540-6210.2004.00343.x>
- Wirtz, B. W., & Daiser, P. (2016). A meta-analysis of empirical e-government research and its future research implications. *International Review of Administrative Sciences*, 84(1), 0020852315599047-0020852315599163. <https://doi.org/10.1177/0020852315599047>
- Yildiz, M. (2007). E-government research: Reviewing the literature, limitations, and ways forward. *Government Information Quarterly*, 24(3), 646-665. <https://doi.org/10.1016/j.giq.2007.01.002>
- Zhao, F., Collier, A., & Deng, H. (2014). A multidimensional and integrative approach to study global digital divide and e-government development. *Information Technology & People*, 27(1), 38-62. <https://doi.org/10.1108/itp-01-2013-0022>
- Zhao, F., & Khan, M. S. (2013). An Empirical Study of E-Government Service Adoption: Culture and Behavioral Intention. *International Journal of Public Administration*, 36(10), 710-722. <https://doi.org/10.1080/01900692.2013.791314>