

**RESEARCH PAPER****Technological Leapfrogging: Estonia's E-Governance Odyssey by using Emerging Technologies and Lesson for Developing States**

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ABSTRACT

The purpose of this study to highlights the journey of Estonia's e-governance system by launching the Tiger Leap initiative and to examines Estonia's innovative initiatives comprising, e-banking, digital identity infrastructure (e-ID) and X road system. The main objective of this research is to address the privacy and security issues of Estonian e-services through emerging technologies i.e. Artificial Intelligence and Block chain technology. In the realm of the digital age, Estonia stands out as a pioneer in using Block chain technology and Artificial Intelligence to augment its e-governance framework. A small Baltic state stirred towards the transformation in the early 1990s through digitization and digitalization respectively. The explanatory approach of qualitative research is used and data sampling for this research is conducted by using secondary sources of data consisting of official reports, journal articles, official websites and documents. It provides policies that underdeveloped states can augment their e-governance by using these advance technologies.

KEYWORDS AI, Block chain Technology, e-Estonia, e-ID, e-residency, Kratt strategy, X road

Introduction

The advancement of information and communication technology pave the way for states to modernize their governance system by offering new services to their citizens Due to this, states have the competence to think outside the box by adopting digital transformation in their governance structures, also known as e-governance. The use of Information and communication technology in e-governance can augment the efficiency, effectiveness, and transparency of government and public services. It has the potential to improve communication between government-to-government G2G, as well as government-to-citizens G2C and government-to-business G2B and other institutions. Estonia, a small Baltic state has modernized its governance system to reduce the paperwork and red-tapism since the 1990s. The beginning of spark started after the development of the first draft 'Principles of Estonian Information Policy'. This policy intended to leverage the technology to advance Tallinn's social, economic, and political goals. The first desire of Tallinn was to modernize the education system to enhance internet penetration. The Tiger Leap was the first step that changed the mindset of Tallinn and began providing online services to the public. Estonia launched its first e-governance initiative in 2000 by launching e-ID, X-Road, online cabinet meetings, online voting, e-taxing and e-banking. In 2014, Tallinn also launched the e-residency program. In a digitalized state, there is a threat perception of cyberattacks as Tallinn faced a cyberattack

in 2007 due to a political dispute between Tallinn and Moscow. As a result, a group of Russian hackers used botnets and launched coordinated assaults on Estonian websites. The repercussion of this event was the economic disruption faced for Tallinn. In response to the 2007 cyber-attack, Tallinn became a pioneer in adopting block chain technology to protect its registries and data from manipulation and unauthorized access. Therefore, this research paper provides insight into how emerging technologies such as AI and block chain can boost e-governance by securing public and government data. This study investigates how emerging technologies can enhance transparency and efficiency in e-governance. Emerging new technologies can enhance e-governance and streamline public and private services. Estonia is trying to adopt these technologies to streamline processes, increase efficiency, and improve the overall quality of public services. Block chain technology can be used to secure transactions across multiple computers as well as secure information or data across multiple nodes. Likewise, Artificial Intelligence is used to analyze vast amounts of data for automation of tasks. By Automatically analyzing the data, it can improve the decision-making process. It also assists the government in making better decisions. It can detect fraud and malware infestation by automatically analyzing the data. This paper uses Tallinn as a model for other underdeveloped states to adopt similar digital governance initiatives. This research paper examines the impediments to the adoption of e-governance in underdeveloped states like Pakistan. A developing nation like Pakistan is unable to adopt e-governance due to a low literacy rate lack of education in IT, lack of public trust in government, and insecurity in using e-services. To overcome these constraints, this study provides policy recommendations to accelerate ICT infrastructure for the improvement of e-governance.

Literature Review

The e-governance is the use of information and communication technology to enhance the transparency, accountability and efficiency of government services. The intention of e-governance is to reduce the corruption, paper work and red tapism. It enables people to understand and participate in policy making process and also improves the communication between government to government, government to citizen, civil societies and others institutions. (Atique, 2024) Estonia, which is known as a digitalized state had taken the initiatives since the 1990s to enhance the governance system. Estonia returned to the map with a little legacy of technology after regaining emancipation from foreign domination in 1991. It was a challenge for policymakers to build a new technology infrastructure with limited cost. (Centre, 2009) In 1994, a collaborative effort between government officials, IT specialist and academics resulted in the creation of the "Estonian Way of the Information Society", which sets guidelines for the management of modern state information systems. (Larsson, 2019)The beginning of the spark started after the development of the first draft 'Principles of Estonian Information Policy' by Ministry of Economic Affairs and Communication. (Centre, 2009) In 1998, the government launched a network platform referred to as EEBone or "Peatee" to fortify the IT infrastructure within government departments. (Erlenheim, 2013) After gaining emancipation, Tallinn used the Cybernetic Institute, a Soviet research center in the 1960s, to modernize its education system. The Tiger Leap Foundation, established in 1997, aimed to bring mainstream schools into the digital realm by providing them with the necessary technology and promoting computer literacy among teachers and students. After that, 98 % schools were connected to internet. (Chabilan, 2020) The Tiger Leap Plus National Development Plan (2001-2005), the ProgeTiger program in 2012, and then the Lifelong Learning Strategy 2020 emphasized the importance of promoting digital competence, accelerating initiatives for virtual learning, and supporting innovative ICT solutions for teaching. (UNESCO, 2023) Estonia's next move was to launch e-banking services after the Tiger Leap program. Approximately 57% of Tallinn's population had competence to use e-banking in 2002.

(Luštšik, 2003) In 2000, e-cabinet meeting was arranged to reduce the paper-based document decision and to enhance the e-solutions into governance. Politician can attend cabinet meetings by login the e-ID on their smartphones or laptops. This saves the sitting time of Parliament from 4 hours to 30 minutes. (Kaljulaid, 2023) In 2005, Estonia offered citizens online voting by logging into the i-Voting software and signing the user's digital signature. (e-Estonia, 2020) In the 2019 parliamentary elections, about 44% of votes were cast through i-Voting. The intention of e-voting is to engage the population by augmenting their participation in the political process. (Rong, 2023) Subsequently, the Estonian Information Service Authority employed X-Road infrastructure in 2001 and e-ID around the same year. The X-Road, e-ID and KSI block chain are the main technological pillars of Tallinn's e-governance. Estonia's Electronic ID program uses a card embedded with an electronic chip, which requires two separate PIN codes. It is equipped with a microchip and dual PIN codes. By the using a smart card reader and a computer connected to the Internet, Estonian citizens can use a Digital signature and personal authentication. Through this, citizen can achieve e-services. The e-ID also paved the way for Tallinn to launch e-residency program in 2014. (Goede, 2019) The second technological pillar is X-Road. It enables data to be exchanged securely between the private and public sector. (Hirdaramani, 2024) X-Road is a secure and open-source data exchange layer solution for organizations over the Internet. To utilize the X-Road, organization first need to become a member of local X-Road federation then register the data and service it intends to share with other organization. Citizens can access over 800 services through eesti.ee platform, most of which use X-Road, enabling them to monitor their data access and modifications. (Margetts, 2016) The last pillar is KSI (Keyless Signature Infrastructure) block chain developed by Guard-time cybersecurity company after the 2007 cyberattack incident (Pamment, 2019)

Material and Methods

This study employs a qualitative research design. Specifically, it adopts an Explanatory case study method. Data sampling for this research is conducted by using secondary sources of data consisting of official reports, journal articles, official websites, documents, and professional networking platforms such as LinkedIn. This study applies the diffusion of innovation theory developed by Everett Rogers. This theory is used to explain how and why new technologies or ideas are adopted or disseminated in society. Innovation does not happen simultaneously; it happens when someone adopts it and has a tendency to adopt it. Estonia is an innovator in this, having been the first to use new ideas such as X-Road, e-ID, and the KSI block chain. In contrast, Pakistan is late majority and laggards.

Results and Discussion

Evolution of Emerging Technologies

The emerging new technologies can augment the electronic governance and streamline the public and private services. The smart cities have recognized the potential of AI and block chain. They are striving to adopt these technologies to streamline processes, increase efficiency and improve the overall quality of public services. AI and block chain are two groundbreaking technologies that can transform the e-governance. Artificial Intelligence is the development of computer systems that can emulate human intelligence. (Bron, 2023) On the contrary, the Block chain is a decentralized digital ledger. It enables to secure the transaction and data across multiple computers in a network. (Chatterjee, 2018) Natural language processing is a subfield of AI that enhances citizen engagement to access

government services and information. Similarly, Machine learning is subset of AI can be used to automate the tasks such as fraud detection, document analysis and image recognition. In Estonia, government use AI to fraud detection and to ensure the security of the system. (Vidyashram, 2023)

Longing to deploy Block-chain Technology

Block chain is known as disruptive technology because it avoids the data from a centralized authority. Satoshi Nakamoto introduced Bitcoin in 2008, describing a decentralized digital currency system. Block chain is the technology that secure the transaction record. Some argue that Estonia is a pioneer in using blockchain beyond the transactions. Estonia began testing the technology in 2008 earlier the Bitcoin white paper that first coined the term "block chain" was published. (PWC, 2019) Due to digitalization, there is concern of cyberattacks. The same case happened with Estonia. The political clash between Estonia and Russia led to the cyberattack in 2007. (Ottis, 2008) There was a massive need to implement blockchain for cybersecurity. The cyber-attack not only strengthened Tallinn's cybersecurity, but also became a blockchain pioneer (Salma, 2023).

Block-chain beyond Cryptocurrency

In Block chain, information is a decentralized and distributed ledger that records the information across multiple computers. It encrypts the information into a hash and then connects them with a chain. In simple terms, every piece of information is stored in a block and linked to a chain through a hash. Each block has the hash of the previous block. Once data is recorded then it is difficult to change it without the consensus of the network majority. (Rollout IT, 2023)

How e-services leverage Block-chain for improved services and data security?

Online voting has the potential to reduce costs and time for institutions. This eliminates the concept of paper print ballots. Voters can vote from anywhere with an internet connection. But despite these advantages there is a risk of tampering. Cybercrooks can manipulate votes. Blockchain technology gives the concept of decentralized node for online voting. It is tamper-proof for e-voting. In blockchain e-voting, a voter's vote is hashed from the original input data to form a unique character. When votes are hashed, they form blocks. Each block contains the hash of the previous block, forming a chain of blocks. Votes are thus in the form of a distributed ledger. Each node maintains a copy of the entire blockchain ledger. In a decentralized blockchain network, the consensus mechanism is critical to block validity. That way no one knows who voted for whom. (Jafar, 2021) Similarly, Blockchain also improve the e-education. Blockchain technology can keep the record of students immutable. In online learning, market for fake degrees is major concern. This technology can resolve this issue. (Raj, 2023) Blockchain also assist secure patient data through a decentralized ledger. It also facilitates secure transfer of patient medical records between medical centers or companies. (Daley, 2024) Blockchain technology can also facilitate e-residency in Estonia. The intention of employing the e-residency is to bring investment in Estonia and to boost the economy of Estonia. E-residents can manage their banks and money transfers remotely. But, in e-residency, there is a risk of money laundering and fraud. To tackle this, Blockchain decentralized the data of e-residents and then it cannot be tampered with or altered. It secures and records the transactions between the government and e-residents to minimize fraud and corruption. (Sullivan, 2017) E-Residence was launched by Estonia in 2014 but now around 109,000 people from 170 states have applied and around 29,000 companies are there (Invest, 2023).

Revolution in e-governance through AI

Artificial Intelligence has the potential to ameliorate electronic governance. Artificial intelligence is the ability of computers to imitate human intelligence in tasks such as learning, reasoning, problem-solving, language comprehension, and cognition. AI is a field that intersects with other domains such as machine learning, deep learning, data security and privacy, and natural language processing. (Mushayt, 2016) Machine learning algorithms assist in automating the task including fraud detection, image recognition, and document analysis. It consumes the time and cost of government by automating the task. Natural language processing enables computers to understand, interpret, and generate human language that is useful and meaningful. It also enables citizens to communicate and interact with government services more efficiently. (Vinay, 2023) The use of AI techniques such as machine learning and natural language processing algorithms boost e-education. Automated assessment and grading revolutionize the platform of e-learning. AI applications can grade student assignments and papers automatically by giving quick feedback regarding this. It is significant in personalized learning. (Koval, 2023) Moreover, the healthcare organization also employ the machine learning to process the huge number of clinical documents and identify the pattern to make prediction about medical outcomes. In an electronic health system, the use of AI tools can provide reminders to the patient for medical procedures, besides this, virtual health assistants assist the patient by answering questions. (Barth, 2019) Like others, digital banking is also being revolutionized by AI. Virtual assistance such as chatbots can answer customer queries and assist customers by providing bank account details. Moreover, AI is beneficial to facilitate cybersecurity by detecting phishing, ransomware and malware infestation, and denial of services. Machine learning algorithms mitigate future threats by swiftly detecting threats (sheps, 2024).

Estonia is leading forward

Due to mind-blowing innovation, Tallinn is also starting burgeoning AI in the e-governance landscape. Tallinn convened its task force to enhance AI technologies in both public and private sectors. This group was led by the Ministry of Economic Affairs and Communications (MKM) in 2018. Subsequently, this task force gave the National Artificial Intelligence Strategy for 2019 to 2022. This gives a glimpse of the future development of AI. Estonia has made significant investments to support the adoption of AI in the public and private sectors, with a total investment of more than 10 million euros since launching its national strategy of artificial intelligence in May 2019. Led more than 80 projects. (Robinson, 2022) A further expansion of at least 20 million euros in the use of AI is envisaged by 2023 with a commitment to an additional strategic phase in which plans are underway from 2024 to 2026 by contributing 85 million dollars to implement AI strategy. Tallinn has also taken start up to invest in private sectors for the development and deployment of AI. Private sectors such as Veriff also utilize AI for the optimization of business production and for time saving by automation of routine tasks. (Ministry of economic affairs and communication, 2024) KrattAI is Tallinn's next step from a digital public and private service. It envisages how public services should work in the age of AI. It has the potential to elevate economic productivity and public services to the next level. (Riisalo, 2023) The National AI Strategy relies on four pillars: promoting AI in government, AI in the economy, expertise with research and development, and the legal environment. In Estonia, technology effectively solves challenges. The Estonian Information Systems Authority uses machine learning to detect anomalies in X-Road, enabling secure information exchange between government agencies. This intelligent system extends to urban traffic management, optimizing police deployment for better efficiency. The use of AI can reduce tax fraud, provide personalized learning paths in education, automated communication with citizens, tracking illegal ads in social media. Additionally, Artificial intelligence is being used by Estonia's unemployment insurance fund to intelligently match

job seekers with available vacancies. This is because artificial intelligence connects unemployed people with job opportunities that match their qualifications, making it easier for them to get jobs. The Kratt strategy led to the development of Burokratt which is an AI-driven virtual assistant. The intent of this is to enable citizens to interact with public services and information through voice-based virtual assistants (Sadekov, 2021).

Assessing Developing Nation hurdles to Digital Transformation

According to UNDP, the term electronic governance refers to the use of ICT in government process to enhance the public services and promote efficiency, transparency and citizen participation in governance. A developing nation like Pakistan is not able to adopt e-governance due to low literacy rate and lack of education in IT, lack of public trust in government, insecurity in using e-services. (Muzaffar, et. al., 2024; Hussain, 2018) Islamabad has launched e-Government Directorate in 2000. It is intended to provide a platform for citizens to contact government officials for their complaints and suggestions. In 2005, government has launched e-police project and then The National E-Government Council (NEGC) adopted the "E-Government Strategic Five-Year Plan" in 2005. Due to all the measures, Pakistan is not able to pave the way for e-governance for the citizens. (Atique, 2024) Islamabad is continuously grappled to implement digital governance. The United Nations e-Government Survey 2022 ranks Pakistan, 150 out of 193 states in the e-Government Development Index. This emphasizes Pakistan's low digital infrastructure. This is due to the digital literacy gap, according to The Pakistan Social and Living Standard Measurement 2019-20 survey, only 40 percent of people have computer literacy. Non-implementation of the policy is also a major drawback of Islamabad. The Government of Pakistan has approved the 'Digital Pakistan' initiative in 2018 but it is slow and inconsistent. Besides this, different projects have been launched by the Pakistan Telecommunication Authority and National Database and Registration Authority such as; Cellular village connections to provide internet access in rural and urban areas, the National Rabata information portal, and e-Pakistan Vision 2020 for the development of Information and communication infrastructure in Pakistan. All these projects do not remain successful. According to the UN 2012, the reasons behind the inconsistency of projects in developing nations are deficiency of infrastructure, technical skills, low literacy rate, lack of financial resources, awareness, digital divide and effective government regulation. Sometimes, citizens do not use e-services due to sensitive data breaches, lack of awareness, and slow e-government services. (Ahmad, 2013)

The state can modernize its governance system when it tends to invest in IT sectors. Other factors like government, citizen trust, and participation play a crucial role in modernizing the e-governance system. Such as, in Estonia, the government developed and implemented effective strategies to advance its governance system by providing seamless e-services to citizens (Muzaffar, et. al., 2023; Malik, et. al., 2023). The motive of this is to maximize citizen participation by utilizing e-services in decision-making. To protect the data from unauthorized access and to build trust in citizens over government, Tallinn adopted Block chain technology and Artificial Intelligence. Both of these technologies can secure the data from unauthorized access. In developed states, the internet penetration and digital literacy are maximum such as in Tallinn, the internet penetration is 90 percent, which helps to maximize the citizen participation in the use of e-services. While in underdeveloped states, internet penetration is low such as in Pakistan, there is the digital divide. Underdeveloped states can modernize their governance systems by increasing digital literacy, financial resources for developing IT sectors, increasing citizen participation, and effective e-governance strategies. Underdeveloped states can also build the trust of the public over the government by adopting emerging technologies like AI and Block chain by securing the sensitive data of the public and government.

Conclusion

In nutshell, the odyssey of Estonia digital transformation began after gaining emancipation from Soviet Union. The expansion of ICT made the Estonians capable of digitalizing their governance system. Electronic governance became operative due to the collaborative effort of government officials, IT specialists, and academics for the formulation of effective policy 'Principles of Estonian Information Policy'. So, the government is an important player in the state that can modernize their state by enacting productive policy. Likewise, Estonia took the initiative in the education sector to eradicate the gap in digital literacy among all segments of the population and to bring awareness to citizens about electronic governance. After bringing awareness, Estonia moved forward by launching X-Road, E-ID, i-voting, and e-residency. For the utilization of e-services, citizen trust is an important factor. Tallinn used the emerging technology Blockchain technology and AI to secure the data from phishing and malware infestation as well as to build the trust of citizens over the government and to enhance the e-governance. Tallinn is just as beacon of digital innovation for other states. Developing nations have also desired to integrate ICT into their governance framework, but they are not in a position to advance their governance structure although they have all the measures or strategies. It is due to some impediments that the underdeveloped states are facing such as; low literacy rates and lack of education in IT, lack of public trust in government, insecurity in using e-services, and minimum financial resources. So, Tallinn's journey can be used as a role model to empower other underdeveloped states to take some effective initiatives to bring awareness among citizens.

Recommendations

To overcome these impediments, there are some policy recommendations to accelerate ICT infrastructure for the improvement of e-governance.

- For the e-governance initiatives, underdeveloped nations should robust the technical infrastructure. Government should invest in ICT infrastructure to enable seamless digital services.
- To implement e-governance initiatives, there must be a strong political will, similar to the political will of Estonians. Because sometimes political leaders in underdeveloped states are not reluctant to implement e-governance measures to maintain their power.
- There should be collaboration and cooperation for data interoperability between organizations or agencies to improve the delivery of e-services like the Estonian X-Road platform.
- Citizen participation should be maximized for the success of e-governance. E-governance initiatives will be successful when the government promotes digital literacy among all segments of the population.
- Sometimes, citizens do not prefer to use e-services due to sensitive data breached through unauthorized access. To address these concerns and to build trust in citizens, the government of underdeveloped states should enhance cyber security using emerging technologies like Artificial Intelligence and Blockchain, as the Estonian government did.
- In e-services applications, there should be flexibility in language as most of the applications are in English. The language flexibility is essential to increase citizen participation.
- Underdeveloped states must develop effective digital strategies for the successful implementation of e-governance.

- Governments should take initiatives like e-residency to boost commercial activities and investment in their states, as launched by Tallinn in 2014.
- The government should create awareness among the citizens by explaining the cost and benefits of e-governance to increase citizen participation.

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