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Digital, Smart and Super Smart Nation: Evolutionary Model and Prospective Analysis

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Abstract

Globally, countries are increasingly facing challenges to their national future post the COVID-19 pandemic. These challenges include decreasing and aging populations; dwindling workforces; trade wars owing to restricted movement of goods, people, and services; and overcoming economic and societal problems by 2035. Considering this, nations, governments, and lawmakers should now work toward building people-friendly and egalitarian super-smart societies. However, digitalization does not occur automatically in developed, emerging, or developing economies. It depends on several factors such as the education system, awareness, people and society, technologies, adoption of technology, research and innovation ecosystem, digital infrastructure, political leadership, laws, regulatory frameworks and policies, and proactive measures through regional, domestic, and international cooperation. All countries today are beset by myriad challenges divided into 10 broad categories: people and society, robots, technology, research and innovation, digital infrastructure, data, politics, governance, economics and business, and sustainability.

In this dissertation, a framework for a *super-smart nation is build*. Such a nation, it is hoped, will improve living standards, ease of doing business, public services, and international cooperation among nations, especially given the future challenges. The framework will help enhance socio-economic development and overcome social problems pertaining to population density, workforce, and the free movement of goods, people, and services across various nations through international cooperation and collaboration.

This dissertation statement covers three contributions of an

evolutionary model for building a super smart nation. First, a *digital nation framework* is presented. Nations worldwide are increasingly seeing a need for digitalization, that is, for offering better services, increasing efficiency, collaboration, transparency, communication, and reducing bribery and corruption, making digitalization critical. This transformation has been the best solution for improving living standards, ease of doing business, and better public service access in the past in developed nations and now in developing countries. A prosperous digital nation entails cooperation among digital governments, digital businesses, and digital societies underpinned by a strong foundation of people, technology, institutions, policy, economics, and sustainability.

Second, a *smart nation framework* is presented. Smart nations can resolve endemic urban problems such as aging, energy crises, pollution, safety, and crime using advanced technologies. The increasing numbers of pandemics since the last century, the use of the Internet, and the growth in the use of advanced technologies (e.g., blockchain, Internet of Things, artificial intelligence, big data, and cloud computing) are ushering in a paradigmatic shift in how societies can exist and grow through the development of smart societies. It comprises three stakeholders—government, economy (companies), and society—and is characterized by smart people, governance, mobility, environment, and living; and seeks to overcome challenges relating to people and society, technology and innovation, digital infrastructure, politics, governance, economics and business, and sustainability.

Third, a *super-smart nation framework* is presented. The Delphi method was used to identify the stakeholders, characteristics, challenges, and solutions pertaining to building a framework for a super-smart nation.

The projected trends for 2035 are kept in mind, such as population aging, mass retirement, and climate change, to create a framework that will help governments take appropriate steps toward long-term planning. The scenario planning technique helped to identify people and society, robots, technology, research and development, digital infrastructure, data, politics, governance, economics and business, and sustainability as the 10 challenges for 2035 and people and society, educational institutions, robots, technology, research and innovation, digital infrastructure, data, politics, governance, economics and business, and sustainability as the 11 pillars of a future super-smart nation.

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1 Introduction

This doctoral thesis intends to build a framework for a *super-smart nation*. Such a nation, it is hoped, will improve living standards, ease of doing business, public services, and international cooperation among nations, especially given the future challenges that will arise by 2035. The framework will help enhance socio-economic development and overcome social problems pertaining to population density, workforce, and the free movement of goods, people, and services across various nations through international cooperation and collaboration.

The first two chapters of this thesis present a systematic literature review. I then use the Delphi method for an empirical analysis of interviews by technology experts, industry professionals, and subject matter experts with experience in digital transformation, super-smart societies, digital nations, smart nations, and smart cities. Figure 1.1 illustrates the evolution of a super smart nation.

This thesis is structured into three parts in order to build a super-smart nation framework as well as identify the key stakeholders, characteristics, challenges, and pillars.

First, I comprehensively discuss the concept of a super-smart nation. Second, I discuss the rationale for and objectives of the study and present the research questions. Third, I outline the methodological approaches. Finally, I present the structure of the thesis and the findings of the study.

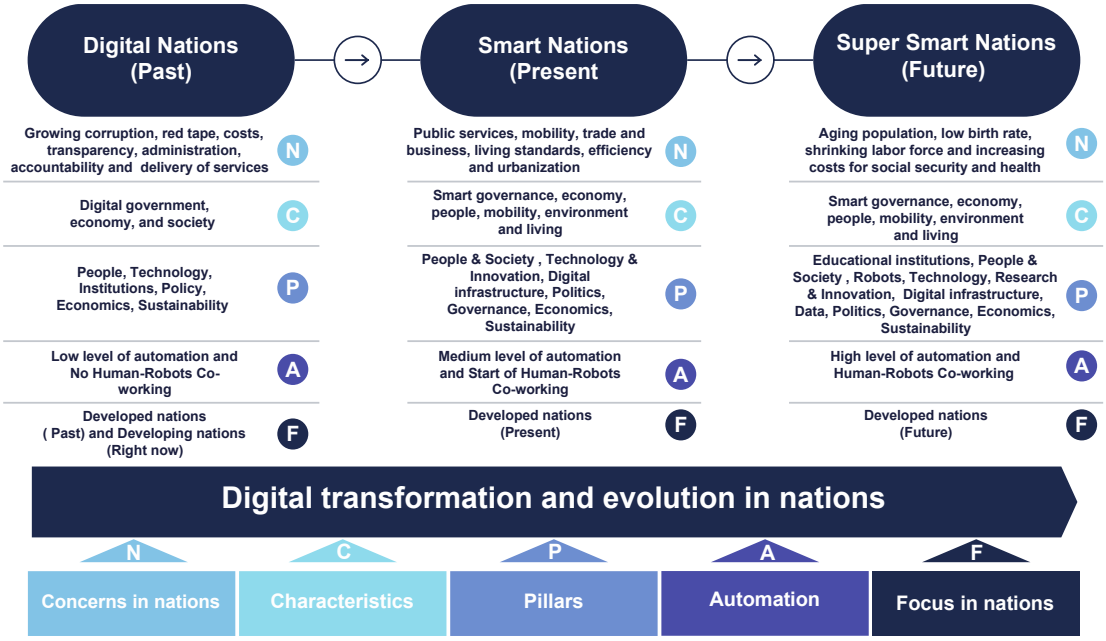

Figure 1.1. Digital transformation and evolution in nations

1.1 The origins and evolution of super smart nation

Nations worldwide are now increasingly seeing a need for digitalization; that is, the need for offering better services, increasing efficiency, collaboration, transparency, and communication has made digitalization critical. The 2019 novel coronavirus pandemic and urban problems have also reinforced the importance of digitalization and pushed countries to become smart nations (Kar et al., 2019). As nations increasingly see a need for digitalization, they are moving from digital transformation toward the realization of digital nations (Penmetsa & Bruque, 2021) and smart nations (Kar et al., 2019) to provide citizens with better public services, innovative solutions to social challenges, and technological support (Kar et al., 2019). We are currently amid a historical epoch, and governments and businesses are finding themselves dependent on the Internet and technology to minimize disruptions caused by anti-pandemic measures, such as

lockdowns (Soto-Acosta, 2020). Developing countries (Ray, 2018) are currently racing to quickly digitalize the entire infrastructure in education, governance, administration, industrial innovation, societal development, labor deployment, smart city enablement, and power/energy distribution.

The process of digital transformation (Kamolov & Stepnov, 2020) has been greatly affected by the pandemic but, most importantly, this global crisis has compelled new and different national stakeholders to understand the benefits of digitalization. Moreover, nations globally are facing megatrends such as demographic changes, shifts in global economic power, urbanization, natural resource scarcity, climate change, and technological disruption. Keeping megatrends and future socio-economic problems in mind, nations, governments, and lawmakers should now work toward building people-friendly and egalitarian super-smart societies by exploiting the ideas of the digital nations and smart nations.

According to the European Commission, by 2050, two-thirds of the world population will live in cities and consume 70% of energy, thus becoming the largest emitters of greenhouse gases. As city populations increase, the demand for resources will increase. This migration to cities will increase the pressure for procurement of energy, water, waste, mobility, and any other services essential for a city's sustainable development. According to the Population Reference Bureau, 75% of the European population already stays in cities, compared with 51% Asia and 43% in Africa. Urbanization will also increase exponentially by 2035, and then 2050, in developed, emerging, and developing countries. This mass migration will create a new set of challenges in areas of infrastructure, air and water pollution, traffic congestion, energy demand and use, and crime.

Presently, the world population is 7,773 million and is forecasted to

increase to 8,937 in 2035 and 9,876 million in 2050. Europe's population is approximately 747 million and expected to decrease to 744 million in 2035 and 729 million in 2050. Similarly, in Asia, the current population of 4,626 million is estimated to increase to 5,112 million in 2035 and 5,331 million in 2050. These numbers for Africa, at 1,338 million now, are 1,897 million in 2035 and 2,560 million in 2050.

It should be also noted that 19% of Europe's population is aged above 65 years compared with 3% in Africa and 9% in Asia. The same segment of population is also expected to increase in Europe by 2035 and 2050, raising more concerns about decline in the size of the workforce, increase in social security costs, socio-economic development, and other social problems. Besides this, the age group of the population under 15 years in Europe is 16% compared with the global average of 26% (41% in Africa and 24% in Asia), raising concerns about insufficient workforce in future.

A digital nation is a concept where urban and rural citizens, governments, and businesses live in a digital society, interact digitally, gain faster access to information, offer better services, increase efficiency, collaboration, transparency, communication, and reduce bribery and corruption. A digital nation has three key characteristics'—a digital government, digital business, and digital society. However, such a concept of a digital nation requires a strong foundation built on the people, technology, institutions, policy, economics, and sustainability (Penmetsa & Bruque, 2021).

A smart nation is a new concept wherein all urban and rural citizens, the government, and businesses live in a smart society to access better public services, mobility, trade, and business, and living standards with high efficiency. Smart nations are intended to resolve endemic urban problems

such as aging, energy crises, pollution, safety, and crime (Jo et al., 2019) through the use of advanced technologies (Rivera et al., 2017) such as artificial intelligence, big data, 5G, and other networks (Bifulco et al., 2016) that connect humans and machines. They will help overcome challenges at the urban, municipal, city, or provincial level (Hoe, 2016) similar to a smart city at national level. Such nations have the same three stakeholders as any formulation of a city, namely, government, businesses, and people, and six main characteristics: a smart economy, smart people, smart governance, smart mobility, smart environment, and smart living (De Azambuja et al., 2020; Joshi et al., 2016; Orecchini et al., 2019; Sharifi, 2019; Vasudavan & Balakrishnan, 2019). Such a society is dependent on people and society, technology and innovation, digital infrastructure, politics, governance, economics and business, and sustainability as its foundation as well. Irrespective of the type of economy, however, digitalization is not *automatic*. It depends on several factors such as the existing education system, public awareness, the people and society, technologies, adoption of technology, research and innovation ecosystem, digital infrastructure, political leadership, laws, regulatory frameworks and policies, proactive measures from the government, and international cooperation.

A super-smart nation is a concept developed based on theories of a super-smart society (Mavrodieva & Shaw, 2020) and a smart nation (Kar et al., 2019). Each of these is an intermediate step toward building an integrative super-smart nation. Shiroishi et al. (2018) describe Society 5.0 or super-smart society as a Japanese initiative to develop a sustainable society for human security and well-being. Holroyd (2020) states that super-smart societies aim to overcome social and economic problems by gathering data from several sources and interconnecting the virtual (cyber), the physical, and all humans. Its objective is to create a road map for the rest of the world.

However, such a framework or roadmap to build a super-smart society is not yet publicly available. Similarly, Aldabbas et al. (2020) state that a super-smart, human-centered society aims to improve quality of life by increasing the use of automation to overcome challenges in human resources.

Mavrodieva and Shaw (2020) describe a super-smart society as one where humans transform from "Society 1.0"—hunter-gatherers—to "Society 2.0," when humanity transformed into an agricultural society and settlements of people with similar language and culture arose. Then comes "Society 3.0," marked by industrialization, and finally "Society 4.0," our current age of the Internet.

"Society 5.0," a super-smart society, will be one that overcomes future economic and social problems through the use of advanced technologies, such as artificial intelligence, augmented reality, big data, blockchain, cloud, drones, edge computing, Internet of Things, 3D printing, mobile, machine learning, public key infrastructure, 5G, sensors and robots, and virtual reality (Shiroishi et al., 2018). However, the speed of automation (Demir et al., 2019), which is inherent to such societies, will depend on how well technology and robotics are accepted by the people. Robotics technology itself presents challenges, and understanding these as well as the pros and cons is thus crucial (Demir et al., 2019). It is expected that human–robot co-working will become a reality in the quest for better sustainable economic development and eradication of social ills.

1.1.1 Aim of a super-smart nation

The challenges nations are witnessing in the twenty-first century are part of seemingly insurmountable megatrends, such as pandemics,

population decline, dwindling workforce, aging populations, and multinational trade wars. The pandemic has especially revealed the weaknesses inherent to nations, as national and regional governments have been forced to close borders, mobilize a limited healthcare infrastructure, and urgently integrate and streamline digital infrastructure.

Developed nations such as Japan, Singapore, Estonia, and countries within the European Union are already radically transforming toward super-smart governance, business, and lifestyles. A full transformation will require long-term planning.

The first step is to assess new challenges to growth and how these challenges can be addressed to create an egalitarian and smart society by 2035. Given what we already know of the megatrends, including climate change, disease, and aging, the race to create a new society is urgent.

Nevertheless, nations have thus far failed to act or plan. The most important element is for the leadership to develop a long-term strategic plan with a vision and mission, which is only possible in societies with common goals, political stability, and stakeholder cooperation.

The concept of a digital nation in its current form is a more centralized model characterized by less automation. It addresses challenges by taking a whole-nation approach for ease of living, doing business, and availing public services presently in developing nations and developed nations in the past.

A smart nation is a concept wherein all urban and rural citizens, the government, and businesses live in a smart society with *semi*-automation to improve public services, mobility, trade, and business, and living standards with high efficiency. Smart nations, when built, are intended to resolve

endemic urban problems such as aging, energy crises, pollution, safety, and crime using advanced technologies. However, this is seen as a solution presently for developed nations and less populated nations such as Singapore.

In Japan, Holroyd (2020) argues that a super-smart society is still in its nascency; it is an innovative government initiative that has been developed in response to the 2011 Tōhoku earthquake and tsunami, an aging population, low birth rate, decreasing labor force, and increasing costs for social security and healthcare. It is not an eventuality but a path new nation must take through technology use and massive collaboration and cooperation with stakeholders.

Shiroishi et al. (2018) state that the objectives of a super-smart society are human security and social well-being. In Japan, the intent is to create a sustainable community with low poverty, increased security, and greater prosperity through all stakeholders' involvement, heightened collaboration, and a shared vision.

However, research on building super-smart nation concepts is also still at a nascent stage. The agenda of the United Nations Sustainable Development Goals, for example, is to transform the financial, economic, and political systems that govern our societies and create a plan for peace, prosperity, and work opportunities. Advanced technologies can help in the digital transformation of super-smart societies and industries in this goal. As mentioned in the *Introduction*, in this regard, human–robot co-working is a possibility and may be the first step toward a truly egalitarian and healthy society. Educational institutions, robotics, research and development, digital infrastructure, and data can be considered challenges that, once overcome, can usher in a new era of freedom, prosperity, and international cooperation.

This thesis addresses an important gap in the research on super-smart nations and frameworks thereof. A systematic review of the relevant literature and then use the Delphi method to develop a useable framework for developing a super-smart nation is presented. This approach can help in identifying potential stakeholders, characteristics, pillars, and challenges that could reveal the factors that help and impede in building a super-smart nation. This approach is both systematic and holistic.

1.2 Study Methodology

In this section, the methodologies that have been used for building a super-smart nation is presented.

1.2.1 Systematic literature review

An in-depth systematic literature review was conducted to fulfil the first and second objectives of the dissertation thesis (see *section 1.1.1* and *1.4*), that is, a systematic literature review of the research on the digital nation and smart nation. I follow the methodology laid down in extant research (Agarwal et al., 2017; Chauhan et al., 2016; Grover et al., 2020; Singh et al., 2020), which includes four stages: 1) development of the review protocol, 2) inclusion decision based on the title and keywords, 3) inclusion decision based on the abstracts, and 4) final selection and synthesis.

1.2.1.1 Protocol development

First, the protocol for gathering research papers was developed. The literature review was conducted using the Emerald and Scopus databases to gather interdisciplinary and relevant results. The reputation of the databases

was factored into the selection. Key search terms were defined based on the research questions. The search included journal articles, conference papers, books, and government documents published entirely in English with a list of the key search terms and corresponding alternatives.

1.2.1.2 Inclusion decision based on search terms, title, and sort by relevance

Second, the articles extracted from the databases were screened based on the title, search terms, and sorted by relevance; relevant papers were extracted, and all others removed. The authors excluded articles irrelevant to the study. This stage narrowed the sample of articles.

1.2.1.3 Inclusion decision based on the abstract and conclusion

Third, the abstract and conclusion of the papers are reviewed. Each paper containing the required keywords and alternative keywords was discussed, who based their exclusion criteria on the relevance of the paper to the current study.

1.2.1.4 Final selection

The authors read the full text of research papers and further screened them according to the defined criteria. Based on the defined criteria, the potential papers were selected from peer-reviewed academic and research papers databases. Then, the reference list was reviewed for each extracted article, but no other suitable articles that were relevant to this study were discovered. Also, the distribution of research papers shortlisted for this study was done by year and publication type.

1.2.2 Delphi method

To achieve the third objectives of the dissertation thesis (see *section 1.1.1* and *1.4*), the Delphi method was applied. This method is based on an established process (Melander et al., 2019), and has six stages: (1) developing projections, (2) questionnaire development, (3) inviting experts, (4) first round of questionnaire, (5) second round of study and feedback, and (6) third round of questionnaire and feedback.

1.2.2.1 Developing projections

The year 2035 was chosen as the target year for scenario planning as it is far enough into the future to forecast challenges to nations arising from mass aging, decreasing birth rate and workforce, urbanization, technology disruption, trade wars, and socio-economic and societal problems. Additionally, long-term planning helps nations take steps to achieve certain objectives.

As part of the research methodology process, a questionnaire was developed to identify the challenges of building a super-smart nation. Accordingly, one of the first steps was identifying the variables for the stakeholders, characteristics, and challenges that influence the development of a super-smart nation and grouping them into different categories. To identify the study variables, a search was conducted using the Emerald and Scopus databases, which helped in gathering published interdisciplinary and relevant results.

1.2.2.2 Questionnaire development

Based on the findings of the literature review, the most important variables and questionnaire were discussed with four experts with experience

in digital transformation, super-smart societies, digital nations, smart nations, and smart cities. In addition, a web-based study, along with Zoom discussions with experts, was identified as an efficient methodology. After developing the questionnaire, a pilot study was conducted by sending the questionnaire to three subject matter experts. As part of the web-based study, the participants were given an introductory page with instructions and a page to share background information on their industry and years of experience. The remaining questions were placed on one page for each question. For each projection, the experts answered on a seven-point Likert scale (1 = strongly disagree and 7 = strongly agree).

1.2.2.3 Inviting experts

Experts from nine nationalities, including Canada, Denmark, India, Netherlands, Singapore, South Korea, Switzerland, Turkey, and the United States, were selected to gain a broader view of this study. In total, 12 experts agreed to participate in the Delphi study.

1.2.2.4 First round of the questionnaire

Twelve experts who expressed interest in participating in the study were sent an automated personalized message and URL link to answer the study. Further, the anonymity of each participant was maintained, and each participant's details were linked to the study URL through the expert's email address. Accordingly, the experts were reassured of the privacy and security of the personal details that they shared. The experts were given a period of one week to complete the first round of the study. After five days, a gentle reminder email was sent to those who had not yet participated in the study. After one week, the study was closed, and the findings were shared with all the experts the following day.

1.2.2.5 Second round of the questionnaire

Based on the results of the first round of the study, the mean values (average) of variables with a score of 5, or an average value of less than 5, were dropped to facilitate the consensus approach. Then, 11 experts were interviewed through Zoom for approximately 90 minutes each, and the discussions were recorded. The second round of the study mainly focused on the solutions for overcoming the challenges identified and shortlisted via the consensus approach in the first round.

1.2.2.6 Third round of the questionnaire

In the final round, 10 experts answered the online study sent. This round focused on challenges wherein some of the experts gave suggestions for additional challenges in round one. The experts had one week to complete this round. After five days, a gentle reminder email was sent to experts who had not yet participated in the study. After one week, the study was closed, and the findings were collected and shared with all the experts.

1.3 Structure of the thesis

This doctoral thesis consists of five chapters, and each chapter addresses one of the three objectives outlined in *sections 1.1.1* and *1.4*. The second chapter provides a systematic literature review of the literature on building a digital nation framework. It examines the characteristics of the digital nation, namely, digital government, digital economy, and digital society. In this chapter, I identify and integrate the elements (also called stakeholders), challenges, and pillars of a super-smart nation; reveal gaps in the literature; and offer novel insights into the research of this field.

The third chapter provides a systematic literature review of the literature on building a smart nation framework. It draws from research on the use of this technology in smart governance (e.g., e-identity, e-residency, e-voting, and e-justice), smart businesses (e.g., digital currencies, payments), and smart living (e.g., housing, health, education, and personal safety). To create such a society, the literature review identifies three stakeholders (government, companies, and people), six characteristics (smart economy, smart people, smart governance, smart mobility, smart environment, and smart living), and seven challenges (people and society, technology and innovation, digital infrastructure, politics, governance, economics and business, and sustainability).

The final chapter develops the framework for developing a super-smart nation. This concept is developed with the building blocks of smart nations and super smart society. The ultimate objective is for such a society to fully overcome future challenges by 2035 (see *Introduction*).

The research questions in this chapter are answered mainly using a literature review and Delphi methodology to identify the stakeholders, characteristics, challenges, and solutions pertaining to building a framework for a super-smart nation. The projected trends for 2035, such as population aging, mass retirement, and climate change, are kept in mind. The aim is for this framework to help governments take appropriate steps toward long-term planning. I further delve into these six characteristics and identify more challenges (robots, research and innovation, and data) and pillars (educational institutions, robots, research and innovation, and data) for building a super-smart nation.

In conclusion, each of the three chapters outlines the motivation for the research, identifies gaps in the literature, and provides insights into how

to address these gaps. Detailed theoretical background is presented for each "smart" concept, followed by an empirical analysis that addresses the three research questions. Finally, the findings are presented and discussed, followed by the contributions of the thesis and future lines on enquiry. The bibliography is presented at the end of the thesis. The figures and tables are numbered separately for each chapter.

1.4 Research Objective

In the following points below, I delineate the study objectives and the rationale for choosing these objectives:

1) To provide a systematic review of the available scientific literature in the field of a digital nation and its characteristics to achieve the following main objectives:
   - ❖ To identify the characteristics of a digital nation
   - ❖ To identify the challenges in building a digital nation
   - ❖ To identify solutions for overcoming the challenges of building a digital nation
   - ❖ To build a framework for developing a digital nation
2) To provide a systematic review of the available scientific literature in the field of smart nation and its characteristics to achieve the following main objectives:
   - ❖ To identify the characteristics of a smart nation
   - ❖ To determine the challenges to building a smart nation
   - ❖ To identify solutions for overcoming the challenges of building a smart nation
   - ❖ To build a framework for developing a smart nation
3) To provide an empirical analysis by using the Delphi method in order to gather more information through literature reviews and

scenario planning techniques and thus achieve the following objectives:

- To identify the characteristics of a super-smart nation
- To determine the challenges to building a super-smart nation
- To identify solutions for overcoming challenges of building a super-smart nation
- To build a framework for developing a super-smart nation

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2 Digital Nation

2.1 Introduction

Nations worldwide are increasingly seeing a need for digitalization, i.e., offering better services, increasing efficiency, collaboration, transparency, and communication by making digitalization critical. As nations increasingly see a need for digitalization, they are moving from digital transformation towards the realization of a digital nations to provide citizens with better public services, innovative solutions to social challenges, and technological support (Kar et al., 2019). Countries globally are witnessing one of the most significant transformations in history as governments and businesses have come to rely heavily on the internet and technology to minimize the disruption caused by lockdowns (Soto-Acosta, 2020). As a digital nation (Penmetsa & Bruque, 2021), Singapore has laid the groundwork for national digitization by involving three key stakeholders—government, businesses, and people— a digital government, digital business, and digital society at the national level (Smart Nation and Digital Government Office, 2018).

Digitalization is a driving force in the 21st century. Several developing countries (Ray, 2018) are currently in a race to quickly and completely digitalize their processes, using the power of the internet to empower citizens in areas like education, governance, administration, industrial innovation, societal development, labor deployment, smart city enablement, and power/energy distribution. Singapore (Chia, 2016) aims to be the world's first digital nation, using technology to improve the quality of life, strengthen businesses, and help government agencies serve citizens better. Furthermore, presently developing nations and developed nations in the past used technology to improve the quality of life, strengthen businesses, and help

government agencies serve citizens better. This transformation will also help urban and rural citizens, governments, and companies live in a digital society, interact digitally, gain faster access to information, offer better services, increase efficiency, collaboration, transparency, communication and reduce bribery and corruption. According to Weerakkody et al. (2011), a digital government, can increase efficiency, transparency, and offer better public services to citizens and businesses. It will also help improve (Weerakkody et al., 2011) public trust concerning the perception of corruption, increase faster access to government information, decrease administrative costs, and increase accountability (Tonggiroh, 2017).

Nations globally are encountering challenges to integrating and streamlining digital infrastructure. Digitization is not automatic in developing economies; instead, they depend on people, human talent, and institutions as well as supportive government policies, regulations, and standards to develop adequate technologies and infrastructure for digitization. According to Asogwa (2013), nations are challenged by several factors, including the digital divide, internet and communications technology infrastructure, human resources, the lack of ICT policies and legislation, political commitment, government's financial commitment, awareness, and low stakeholder involvement (Samsor, 2021). The challenges identified from the literature can be divided into six broad categories (see Appendix 2.1).: (1) people, (2) technology, (3) institutions, (4) policy, (5) economics, and (6) sustainability.

According to Penmetsa and Bruque (2021), digital nation initiatives can be planned by adapting the lessons learned from digital government, digital business, and digital society implementation. However, the research on the development of digital nations is still at a very early stage (Kar et al., 2019). Based on this gap in the existing literature, the following research questions

have been identified:

- What are the characteristics of a digital nation?
- What are the challenges and solutions for nations to build a digital nation?

In reply, this chapter identifies the three main characteristics of a digital nation: digital government, digital economy, and digital society, and presents a framework for addressing the challenges of building such a nation for ease of living, doing business, and availing public services.

The motivation of this research is to build a digital nation framework. Research in the digital nation domain, as identified by authors like Kar et al. (2019), remains nascent, and few published frameworks are available. To fill this gap, this study presents a robust framework to better understand the patterns and rationales that give rise to successful, or unsuccessful, digital nations globally and to help achieve the United Nations' sustainable development goals (SDGs) towards digitalization. This chapter is organized as follows: Section 2 describes the concept of a digital nation and its elements; Section 3 explains the systematic literature review methodology; Section 4 discusses the findings regarding the challenges of digitization as well as potential solutions; Section 5 presents a new framework for building a digital nation based on the six challenges identified, and Section 6 concludes the paper.

2.2 Concept of a Digital Nation

A digital nation is where urban and rural citizens, government, and businesses live in a digital society, interact digitally, gain faster access to information, offer better services, increase efficiency, collaboration,

transparency, improving communication and reduce bribery and corruption. Growing corruption, red tape, governments costs, adequate transparency, poor administration, accountability, delivery of services population are some factors that motivate national governments to develop digital nations. Smart Nation and Digital Government Office (2018) stated that building a digital nation's theoretical building blocks could stem from theories on digital government, digital business, and digital society. Moreover, e-government and digital government theories can facilitate the transformation of digital nations by broadly outlining plans for the relationship between governments and citizens (G2C), between the government and businesses and industrial departments (G2B), and among different government units (G2G) (Singh et al., 2020; Tonggiroh, 2017; Weerakkody et al., 2011). The triangle relationship (Fang, 2002) shown in Figure 2.1 illustrates how government, businesses, and citizens can be categorized into the characteristics (also called as elements) of a digital nation—digital government, digital economy, and digital society.

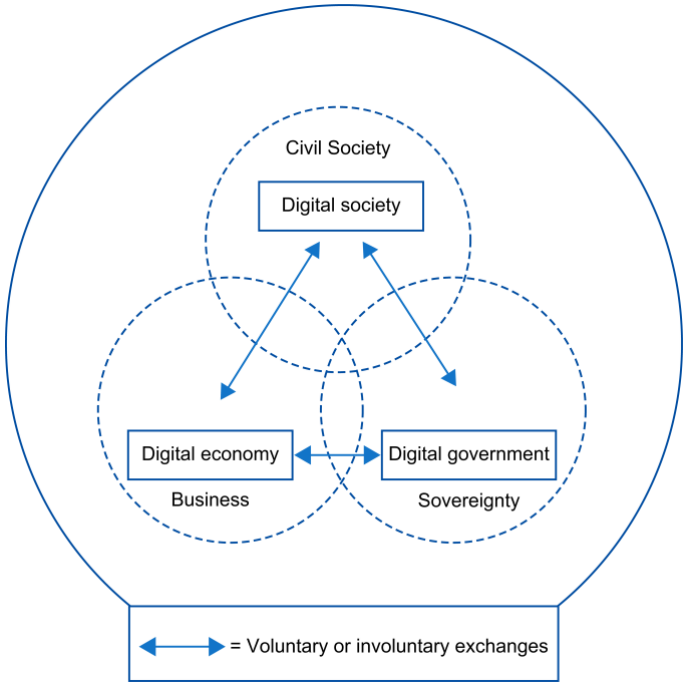

Figure 2.1. Triangle relationship of digital government, economy, and citizens.

Presently developing countries and developed countries in the past can be considered as digital nations, and it has approached digitization by involving all three stakeholders—government, businesses, and citizens—at the national level. It has laid plans to build a digital government, digital economy, and digital society by keeping these three key characteristics of digital nation in mind (Table 2.1). This initiative requires every citizen, business, and government institution to accelerate the nation's digitalization efforts to build a digital society with digitally ready citizens and businesses. In turn, the government plays a significant role as a facilitator by bringing these three stakeholders together. On the other hand, nations must also co-create digital societies by involving relevant stakeholders and using technologies. As the use of technologies such as robotics and automation are quite low in digital nations.

Table 2.1. Digital nation characteristics.

Digital Nation Characteristics	**Description**	**References**
Digital Government (Government)	A digital government, is defined as a government in which the various sectors provide information and services to citizens by electronic means quickly and accurately, at minimum cost and effort, through a single website. It helps to achieve greater efficiency and effectiveness in government performance by improving services for beneficiaries such as citizens, businesses, institutions, and societies.	Odat (2012, p. 1)
Digital Economy (Businesses)	A digital economy is an economy that accelerates the digital transformation of existing economic sectors, fosters new ecosystems enabled by digital technologies, and develops a next-generation digital industry in sectors with cybersecurity as an engine of growth.	Smart Nation and Digital Government Office (2018)
Digital Society (Citizens)	A digital society is defined as a society formed by rapid, recent change, through the adoption of new technologies that increasingly affect citizens' daily lives. A digital society is one characterized	Metcalf (2019)

	by an increasing ability to perform various transactions without direct human contact, via electronic means made possible by the internet and digital tools.	

The digital nation concept is also a objective that will help citizens, businesses, and governments by improving living standards, making it easier to do business, and offering better services. However, this concept requires an ecosystem conducive to this digital transformation. To execute such plans, strong foundations in terms of people, technology, institutions, policy, economics, and sustainability can act as pillars to support the development of a digital government, digital economy, and digital society. These pillars can provide possible solutions to deal with the challenges to becoming a digital nation.

2.3 Methodology

The research methodology for this literature review is based on the systematic literature review process followed by other researchers (Agarwal et al., 2017; Chauhan et al., 2016; Grover et al., 2020; Singh et al., 2020) and includes four stages: [1] development of review protocol, [2] inclusion decision based on title and keywords, [3] inclusion decision based on abstract, and [4] final selection and synthesis.

2.3.1 Protocol development

First, we developed the protocol for gathering research papers. The literature review was conducted using the Emerald and Scopus databases to

gather interdisciplinary and relevant results. The reputation of the databases was factored into the selection. We extracted most papers from Emerald and Scopus. Key search terms were defined based on the research questions. Apart from the above databases, the research paper by Fang (2002) about the triangle relationship among Government, Economy and Citizens shown in Figure 1 has been not available in any of above databases. So, it has been gathered using google scholar. Additionally, the Singapore digital government office publications repository was used to gather information focused on transforming into a digital nation.

The search included journal articles, conference papers, and government documents published entirely in English on or after 2010 except the research paper shown by Fang (2002). Table 2.2 provides a list of the key search terms and corresponding alternatives. The Boolean "AND" operator was used to combine the search terms and "OR" was used for alternative key search terms. All possible combinations of the search terms were used. However, no relevant published literature was found with all search terms together, so we used the following terms together: 1) "Digitalization," "Digital nation," "Challenges," and "Nation"; 2) "Digital government or e-government," "Challenges," and "Nation"; 3) "Digital economy," "Challenges," and "Nation"; 4) "Digital society," "Challenges," and "Nation". The extracted data combinations addressed three characteristics of digital nations: digital government, digital economy, digital society search terms. The entire database search process resulted in 12,624 hits, including one research paper gathered from the Singapore digital government office and one research paper from google scholar. Though these papers contained the required search terms, most did not focus on the digital nation or the three elements and alternative search terms.

Table 2.2. Search terms used in this study.

Search terms	**Alternative search terms**
Digitalization	
Digital nation	
Digital government	e-government
Digital economy	
Digital society	
Challenges	
Nation	

2.3.2 Inclusion decision based on search terms, title, and sort by relevance

Second, the articles extracted from the databases were screened based on the title, search terms, and sorted by the relevance of the first ten pages with fifty search results in each page; relevant papers were extracted, and all others removed. This stage narrowed the sample to 2,700 articles, including two research papers from google scholar and Singapore digital government office.

2.3.3 Inclusion decision based on abstract and conclusion

Third, the authors reviewed the abstract and conclusion of the papers. Each paper containing the required keywords but not focusing on digital

nation or smart nation or the three digital nation elements and alternative keywords was discussed by the authors, who based their exclusion decision on the paper's relevancy. A total of 83 research papers remained after this review.

2.3.4 Final selection

The authors read the full text of the 83 papers and further screened them according to the following criteria:

a) Does the research paper address a specific nation/country, developing economy, or developing countries concerning a digital nation, digital government or e-government, digital economy, digital society?

b) Does the research paper address the challenges of a digital nation, digital government or e-government, digital economy, digital society, for a specific nation, developing economy, or developing countries?

Based on these criteria, 39 potential papers were selected from peer-reviewed academic and research papers from Emerald and Scopus databases, including the Singapore digital government office publications and google scholar. The authors then reviewed the reference list for each extracted article but discovered no other suitable articles that were relevant to this study. Also, five research papers on systematic literature review suggested by journal reviewers were included. Thus, a total of 44 research papers were shortlisted for this study. The selection process is summarized in Figure 2.2. Figure 2.3 illustrates the distribution of research papers shortlisted for this study by year and publication type. In total, 44 research papers were selected from the peer-reviewed academic and research papers identified.

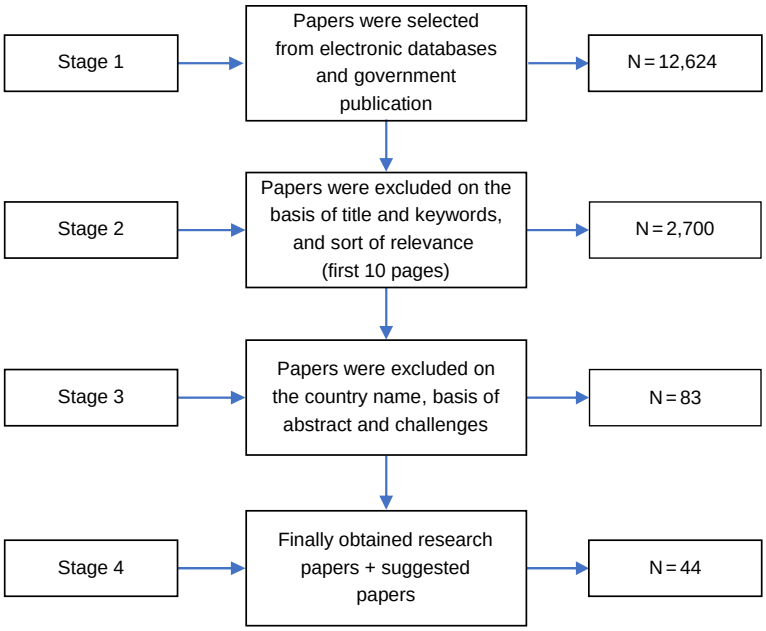

Figure 2.2. Stages of the study selection process.

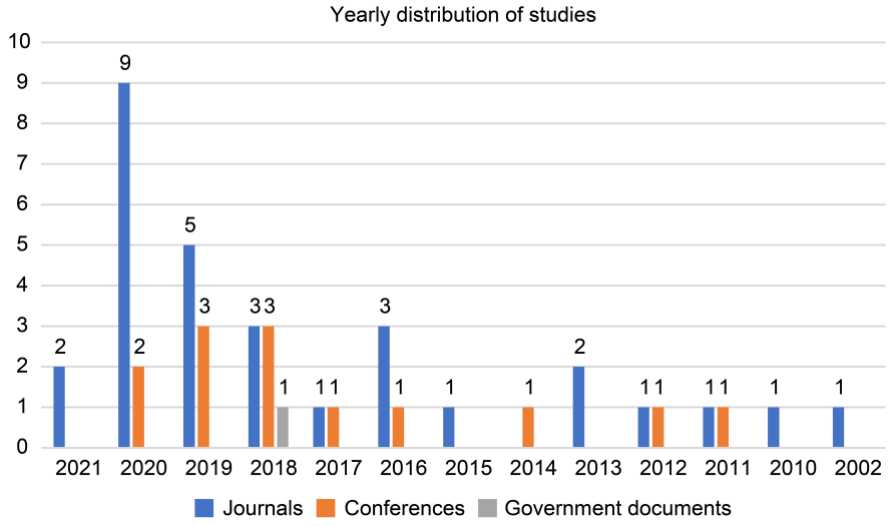

Figure 2.3. Distribution of studies by year and publication type.

2.4 Results

In this section, the selected research papers are reviewed and the challenges for the three elements of digital nations are classified into six broad categories (see Appendix 2.1) (Agarwal et al., 2017; Chauhan et al., 2016; Singh et al., 2020). The broad categories are based on smart city

development theories and related concepts (Aghimien et al., 2020; Ali et al., 2018; Glyptis et al., 2020; Joshi et al., 2016; Rana et al., 2019; Silva et al., 2018), as well as the categories identified by other researchers (Singh et al., 2020). The challenging categories, provide the basis for building a framework for developing digital nations, and they can also be categorized as pillars if they are strengthened. The remainder of this section discusses each challenge and its solution.

2.4.1 People

People are one of the main challenging factors for transforming digital nations as they are the key stakeholders who will be managing and using technology. We grouped all individual challenges related to poverty, awareness, adoption, citizen training and education, citizen-centric focus, culture, the digital divide, digital illiteracy, social and economic disparities, and trust under the challenging factor of people as shown in Figure 2.4 and Appendix 2.1. The findings from the literature review (see Figure 2.4) show that the digital divide, awareness, and culture are the three major challenges associated with people.

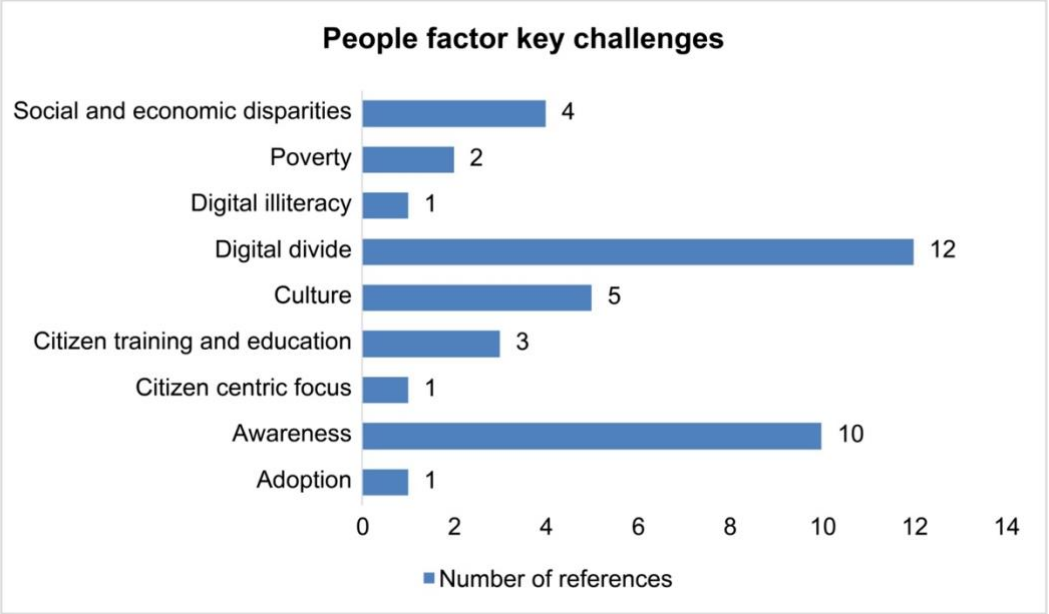

Figure 2.4. Key challenges associated with people of transforming digital nations.

Suggestions for overcoming these challenges include creating demand for digitalization through government investment, through the provision of training programmes, incentives for education, and building infrastructure (Paul et al. (2020). According to Weerakkody et al. (2011), it is vital to raise awareness about the benefits of digitization by providing the necessary infrastructure and training as well as educating citizens on how to overcome the challenges of the digital divide. According to (Samsor, 2021), ICT literacy can be increased throughout both the government and private sectors by organizing training programs for all internal and external stakeholders, as done by the Government of South Korea, and through awareness campaigns using television, radio, and other mass media. Singapore's government has also started skill-development training programs for its citizens (Hoe, 2016).

2.4.2 Technology

Another important challenging factor is technology. We have grouped all individual challenges related to computers and technology, access to the latest technologies, network and telecommunication infrastructure, internet penetration, ICT infrastructure, information technology standards, security and privacy, data privacy, system integration, incomplete e-government platform, interactive public services, innovation ecosystem, information security management professionals, lack of technological skills, lack of qualifications, communication systems, lack of digitized information, interoperability, records mobility, lack of hardware and software, trust, legacy systems, and centrally accessible information and personal details of citizens under the technology factor as shown in Figure 2.5 and Appendix 2.1. The findings from the literature review (see Figure 2.5) show that security and privacy, network and telecommunication infrastructure, ICT infrastructure, and access to computers and technology are the major challenges associated with technology.

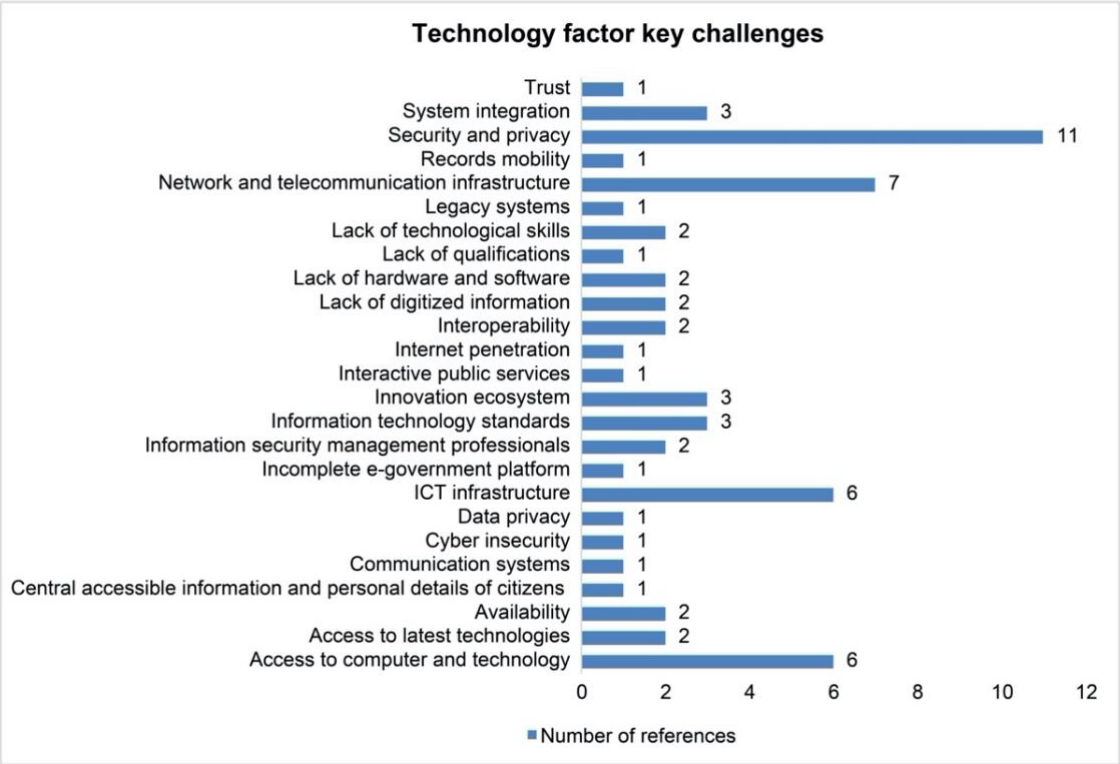

Figure 2.5. Key challenges associated with technology of transforming digital nations.

However, governments and institutions can overcome these challenges (Paul et al., 2020) by taking measures to build the required digital infrastructure, making technology affordable to everyone, and providing a safe environment (Weerakkody et al., 2011) that is reliable and trusted for e-government services. According to the Smart Nation and Digital Government Office (2018), robust and secure foundations in cybersecurity and digital infrastructure are essential for driving the transformation approach.

2.4.3 Institutions

The commitment of political leadership and the top management of institutions is another challenging factor that can act as a pillar for a nations' digital transformations. We have grouped all individual challenges related to

political authority, political willingness, government support, leadership, motivation, common goals, vision and mission, independent ministries, funds, and legal and regulatory issues under the heading of the institutions factor. We have also grouped factors such as organizational structure and culture; coordination, collaboration, and consultation; distribution of decision making power and hierarchy; transparency; inefficient public organizations; bureaucracy; bribery and corruption; resistance to change; prioritization of deliverables; information system strategy; resource allotment; financial and fiscal limitations; information technology management; ICT implementation; service delivery; few trained workers in jobs that use ICT; inadequate resources; human resource shortages; workforce turnover; information inconsistencies; information sharing; government and community involvement; stakeholders involvement; trust among organizations; and feedback systems under the heading of the institutions factor as shown in Figure 2.6 and Appendix 2.1. The findings from the literature review (see Figure 2.6) also show that a small number of trained workers in jobs that use ICT, coordination, collaboration and consultation, transparency, shortage of human resources, and leadership are the major challenges for institutions.

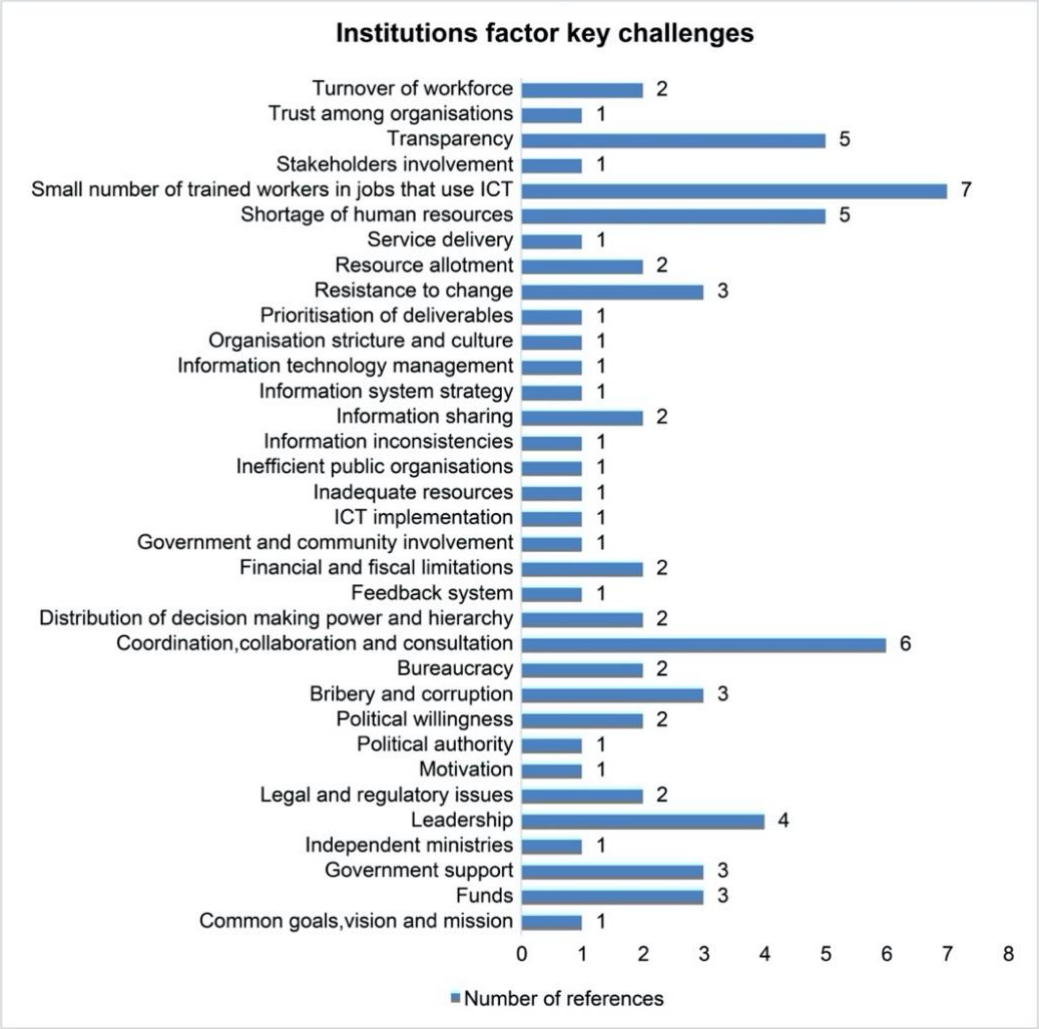

Figure 2.6. Key challenges associated with institutions of transforming digital nations.

To overcome these challenges, Singapore (Chia, 2016) has taken a national approach to enhance the quality of living for its citizens by developing an entire digital ecosystem under the leadership of its Prime Minister with a common goal, vision, and mission. India's government (Paul et al., 2020) has also developed a national digital communication policy to transform the nation into a digitally connected society. According to Weerakkody et al. (2011), political commitment, strong leadership, financial support, and regulatory guidelines are essential for building successful e-government services. Moreover, according to (Samsor, 2021), governments should include all relevant stakeholders from the beginning

of any project through formal or informal meetings and discussions via emails, chat rooms, video conferencing, and social media along with effective coordination and information sharing using printed media, written reports, magazines, newspapers, and radio. According to Zhao et al. (2012), the Dubai Government has started an e-transformation program by integrating and standardizing government information and agencies so that all governmental departments can share resources, infrastructure, operating systems, expertise, and human resources to improve efficiency in operations and all technical processes. Singapore (Apriliyanti et al., 2020) has successfully applied reward and punishment policies as well as training and development programs to motivate governmental employees. Indonesia (Apriliyanti et al., 2020) has taken a different approach by motivating employees through rewards. Metcalf (2019) also explains how to build e-governance in a digital society using Estonia as a case study.

2.4.4 Policy

The digital nation evolution cannot be successful without appropriate policy, regulations, and standards. We have grouped all individual challenges related to policies, regulations, and standards; accountability; bribery and corruption; intellectual property theft; information and cybersecurity risks; ICT systems; certificate center requirements; electronic document recognition and transactions; laws and legislation; and policies support under the policy factor as shown in Figure 2.7 and Appendix 2.1. The findings from the literature review (see Figure 2.7) also show that bribery, corruption and lack of policies, and laws and regulations are the three major challenges associated with policy.

To overcome these challenges, Asogwa (2013) shows that it is

advisable to assess e-government readiness using the United Nations' global e-government benchmark and plan for the necessary legislative and regulatory frameworks and technology. According to (Samsor, 2021), successfully implementing e-government requires a clear policy and legal framework for people regarding data insecurity and privacy when disclosing personal information. According to Deng et al. (2018), clearly displaying public policies, laws, and regulations; disclosure of government organizations' budgets and expenses along with other details and outcomes; and allowing complaints to be made online can improve government openness.

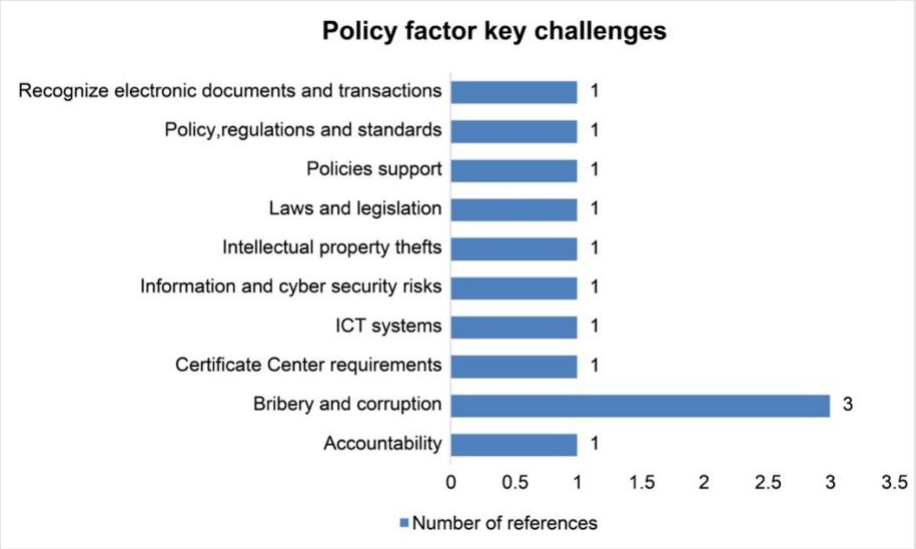

Figure 2.7. Key challenges associated with policy of transforming digital nations.

2.4.5 Economics

Economic challenges, such as the costs associated with ICT acquisition, maintenance, and training and education, as well as economic value, cost savings, benefits, and return on investment to society are major challenges that can help or hinder a nation's ability to evaluate the success

of the digital transformation. We have grouped all individual challenges related to high access cost, expensiveness, funding, lack of hardware and software maintenance, availability of resources, and corruption and misuse of public money under the economics factor as shown in Figure 2.8 and Appendix 2.1. The findings from the literature review (see Figure 2.8) also show that corruption and misuse of public money, high access cost, and funding are the three major challenges.

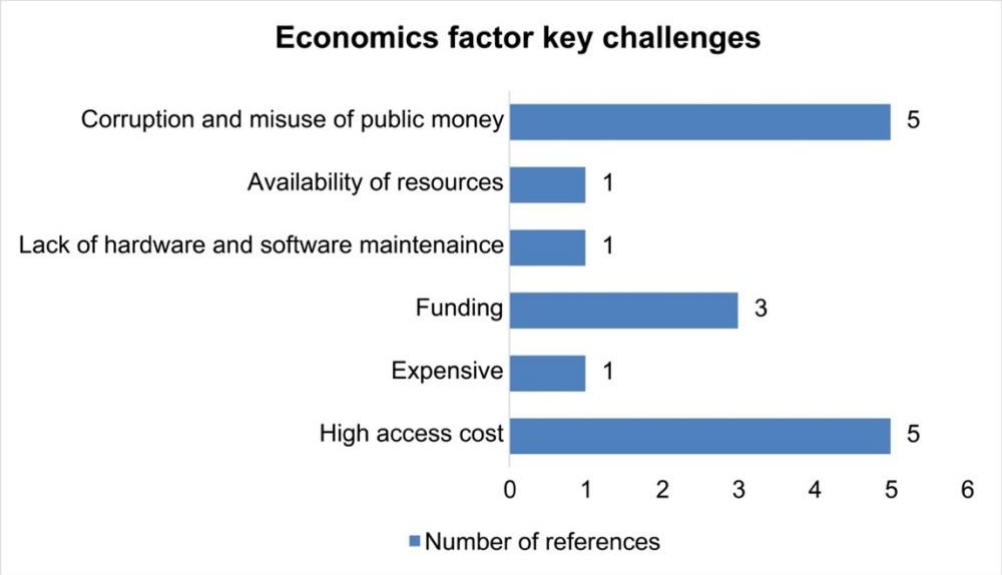

Figure 2.8. Key challenges associated with economics of transforming digital nations.

To overcome these challenges, Paul et al. (2020) suggest that governments and institutions build the required infrastructure, including digital infrastructure services, and ensure that these networks are widely available and affordable to everyone. According to Weerakkody et al. (2011), the government should fund the development of infrastructure, including the building, technology, and human resources needed to provide digital government services to all citizens. It is vital to raise awareness about the benefits of technology by training and educating citizens to overcome the challenges of the digital divide Weerakkody et al. (2011).

2.4.6 Sustainability

Sustainability can be defined as promoting economic and social development without disrupting the environment (Joshi et al., 2016). We have grouped all individual challenges related to the power supply, education, digital literacy, and lack of employment under the sustainability factor as shown in Figure 2.9 and Appendix 2.1. The findings (see Figure 2.9) show that digital literacy, power supply, and education are the three major challenges associated with sustainability. Other technological and institutional challenges, like network and telecommunication infrastructure; access to computers, internet, and technology; political willingness; and government support can also be categorized under the sustainability factor.

To overcome these challenges, Apriliyanti et al. (2020) suggest that e-government implementation and sustainability depend on national institutional settings, political stability, government policies and regulations, and good infrastructure development. According to (Deng et al., 2018), environmental sustainability can be achieved in developing countries by reducing the use of power and paper, switching off computer systems, and disposing of energy-inefficient computer systems.

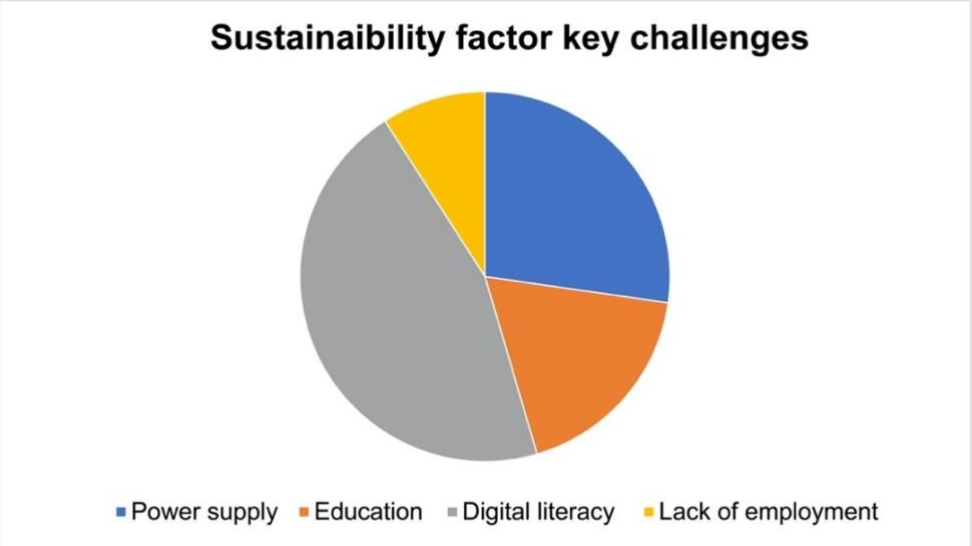

Figure 2.9. Key challenges associated with sustainability of transforming digital nations.

2.5 Discussion

Figure 2.10 illustrates the framework for building a digital nation. The current study analyzed the existing literature on the challenges faced by nations in the digital transformation process, focusing on the three characteristics of a digital nation: digital government, digital economy, and digital society. The triangle relationship (Fang, 2002) illustrates how these three characteristics represent the relationship between governments, businesses, and citizens. Digital government theories (Singh et al., 2020; Tonggiroh, 2017; Weerakkody et al., 2011) can also facilitate the transformation of digital nations based on the broadly outlined plans for G2C, G2B, and G2G interactions. The objective of this review was to help develop a framework for building a digital nation considering these three key stakeholders and characteristics.

This section explains the entire framework in detail. The new framework, as illustrated in Figure 2.10, is built with the objectives of promoting living standards, making it easier to do business, and offering public services. It has three main elements: digital government, digital business, and digital society—and six pillars—people, technology, institutions, policy, economics, and sustainability. These pillars are based on the challenges identified in the literature review and the solutions countries have developed to overcome them.

One pillar for transforming digital nations is people, as they manage the technology. However, many people lack the necessary ICT skills and know-how to use technology (Ambira et al., 2019; Lazović & Duričković, 2014;

Samsor, 2021), lack training and education (Shin et al., 2020; Weerakkody et al., 2011), or do not understand the benefits of technology (Lazović & Duričković, 2014; Paul et al., 2020; Samsor, 2021; Weerakkody et al., 2011). However, this challenge can be overcome by providing training programmes and educational incentives (Paul et al., 2020). According to Joshi et al. (2016), social media plays a vital role in altering attitudes as communication is a critical factor in engaging people. Singapore's government has taken key initiatives (Smart Nation and Digital Government Office, 2018) to build a digitally ready workforce, including SkillsFuture Singapore, TechSkills Accelerator, smart nation scholarships and fellowships, and the center of excellence for lifelong learning.

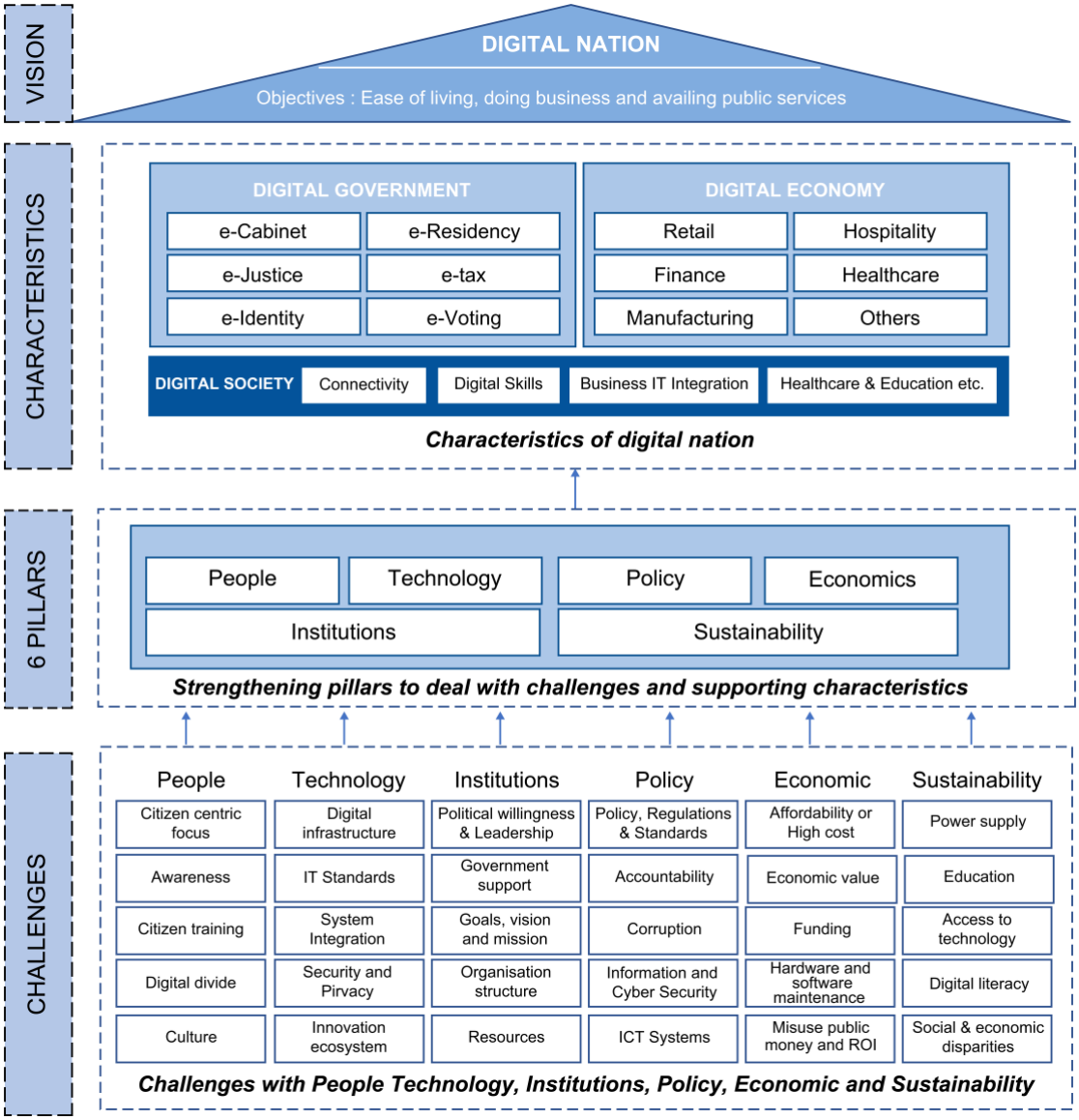

Figure 2.10. A Digital nation framework.

Technology is another crucial challenging factor that can act as a pillar to transform a nation. Nations often face challenges due to a lack of reliable telecommunication infrastructure (Gladkova & Ragnedda, 2020; Masinde & Mkhonto, 2019; Paul et al., 2020; Shin et al., 2020; Tonggiroh, 2017; Zhao et al., 2012), access to computers and technology (Chia, 2016; Masinde & Mkhonto, 2019; Paul et al., 2020; Ray, 2018; Weerakkody et al., 2011), and an innovation ecosystem (Ray, 2018; Shin et al., 2020). However, these challenges can be overcome if governments and institutions (Paul et al., 2020) take measures to build the required digital infrastructure and make it affordable to everyone. According to Kar et al. (2019), focusing on technology-driven innovations and developing ICTs can improve the stability, flexibility, robustness, reliability, and sustainability of smart cities and nations. Chauhan et al. (2016) show that new technologies like big data analytics provide opportunities to gather and effectively use data to enhance information awareness, facilitate decision-making, and offer social interaction opportunities.

Commitment by institutions and top management is another essential pillar. However, some nations face challenges due to a lack of technological skills, government support (Weerakkody et al., 2011), and strong leadership (Samsor, 2021; Tonggiroh, 2017) as well as legal and regulatory issues (Samsor, 2021; Weerakkody et al., 2011). This challenge can be overcome, however, by taking a whole-nation approach (Chia, 2016), similar to the approach used in Singapore, which has outlined plans to digitally transform the nation and developed an entire ecosystem with a common goal, vision, and mission(Smart Nation and Digital Government Office, 2018). Agarwal et al. (2017) note that governments can gather data

on human behavior using sensors and mobile crowdsensing to help with the decision-making process. According to Joshi et al. (2016), ICT can enhance processes and increase opportunities for individuals and communities to interact with the government using smart governance that facilitates service integration, collaboration, communication, and data exchange. According to Grover et al. (2020), artificial intelligence can help to explore utilization in operations management, and Metcalf (2019) explains how Estonia implemented e-governance.

Policy is another important factor in a digital nation's evolution. However, nations face challenges due to a lack of appropriate policies, regulations, and standards (Chia, 2016). These challenges can be overcome by developing benchmarks, standards, and guidelines to assess e-government readiness and plan for legislative and regulatory frameworks (Asogwa, 2013). According to the research findings from Kar et al. (2019), policy actions focused at the city level can be widened to the national level. These policies can be adapted to meet the larger-scale needs of digital nations transformations.

Economics is another factor that helps nations evaluate the success of their transformation in terms of economic value, cost savings, and investment return. However, nations face challenges due to a lack of funding (Weerakkody et al., 2011) and high access costs (Gladkova & Ragnedda, 2020; Paul et al., 2020). However, this can be overcome through government investment in the necessary infrastructure (Weerakkody et al., 2011) to make it affordable to everyone (Paul et al., 2020). According to Joshi et al. (2016), building an environment for business creation, job creation, workforce development, and productivity improvement is essential for smart city development.

Sustainability can be defined as creating economic and social development without disrupting a nation's environment (Joshi et al., 2016). However, nations face challenges due to a lack of power supply (Asogwa, 2013; Oni et al., 2019), limited network and telecommunication infrastructure (Gladkova & Ragnedda, 2020; Masinde & Mkhonto, 2019; Paul et al., 2020; Shin et al., 2020; Tonggiroh, 2017; Zhao et al., 2012), and social and economic disparities (Lazović & Duričković, 2014; Ray, 2018). However, these can be overcome by a nation's institutional settings, including political stability, government policies and regulations, development of required infrastructure, creating awareness, and educating citizens (Weerakkody et al., 2011). According to Kar et al. (2019), developing nations can initiate pilot projects that can become the basis for digital nation development using ICT and investing in advanced infrastructure and skill development programs for new generations by collaborating with stakeholders.

A whole-nation approach involving the three key stakeholders — governments, businesses, and citizens, can improve citizens' quality of life, strengthen businesses, and help government agencies offer better public services (Hoe, 2016). A digital government can address the challenging factors, or provide the pillars, that enable it to shape the digital economy and digital society (Smart Nation and Digital Government Office, 2018). The digital economy will then work closely with the digital government to support public services, and, in turn, the government will function as a facilitator by bringing these three stakeholders together to work on the futuristic objective of developing a digital nation (Smart Nation and Digital Government Office, 2018).

2.6 Conclusion

Nations worldwide are now increasingly seeing a need for digitalization, i.e., offering better services, increasing efficiency, collaboration, transparency, and communication has made digitalization critical. As nations increasingly see a need for digitalization, they are moving from digital transformation towards the realization of a digital nation to provide citizens with better public services, innovative solutions to social challenges, and technological support. Growing corruption, red tape, governments costs, adequate transparency, poor administration, accountability, delivery of services population are some factors that motivate national governments to develop digital nations. A digital nation is where urban and rural citizens, government, and businesses live in a digital society, interact digitally, gain faster access to information, offer better services, increase efficiency, collaboration, transparency, communication and reduce bribery and corruption.

The digital nation will help citizens, businesses, and governments by improving living standards, making it easier to do business, and offering better public services. It has three main characteristics: digital government, digital business, digital society—and six pillars—people, technology, institutions, policy, economics, and sustainability. This research aimed to build a digital nation framework to promote ease of living, conduct business, and offer citizens public services. A rigorous, systematic literature review was conducted to identify the challenges of becoming a digital nation and the solutions to address them to accomplish this objective. The selected papers were reviewed, analyzed, and interpreted to create a framework for building a digital nation based on its characteristics and pillars.

This study is relevant for public decision-makers and practitioners as it gathers preliminary information regarding the concept of digital nations so

that clearer classification and comparison techniques can be put into place. This study also develops a set of characteristics and factors that may prove useful for measuring the degree of implementation of the concept of a digital nation and identifying the factors for success or failure. This digital nation framework may interest public administrations and corporate executives as digitalization actions are being carried out rapidly in developing countries, and as government and scholarly interest has risen exponentially since the COVID-19 crisis. This study has some limitations, all of which are derived from the cross-sectional analysis conducted. In addition, the results on the structure of digital nations for sustainability could have been reviewed by a panel of experts instead of using the available data and secondary sources.

Furthermore, future studies can examine research on smart cities and use of advanced technologies for developing smart nations wherein all urban and rural citizens, the government, and businesses live in a smart society, to improve public services, mobility, trade, and business, and living standards. Further resolve endemic urban problems such as aging, energy crises, pollution, safety, and crime using advanced technologies such as artificial intelligence, big data, 5G, and other networks that connect humans and machines. Furthermore, it is recommended that future studies delve deeper into smart societies as a new frontier of doing business, living, and offering better public services.

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Appendix 2.1. Six categories of key challenges associated with transforming digital nations.

Categories	**Key Challenges**	**References**
People (PE)	Adoption (PE1)	Paul et al. (2020)
	Awareness (PE2)	Ambira et al. (2019), Meiyanti et al. (2018), Mutula and Mostert (2010), Odat (2012), Ovais Ahmad et al. (2013), Paul et al. (2020), (Samsor, 2021), Weerakkody et al. (2011), Lazović and Duričković (2014)
	Citizen-centric focus (PE3)	Weerakkody et al. (2011)
	Citizen training and education (PE4)	Shin et al. (2020), Weerakkody et al. (2011), Samsor (2021)
	Culture (PE5)	Ray (2018), Waller and Genius (2015), Zhao et al. (2012), Lazović and Duričković (2014), Samsor (2021)
	Digital divide (PE6)	Ambira et al. (2019), Asogwa (2013), Deng et al. (2018), Gladkova and Ragnedda (2020), Masinde and Mkhonto (2019), Meiyanti et al. (2018), Odat (2012), (Samsor, 2021), Shin and Ibahrine (2020), Waller and Genius (2015), Weerakkody et al. (2011), Zhao et al. (2012)
	Digital illiteracy (PE7)	Mutula and Mostert (2010)
	Poverty (PE8)	D. Aghimien et al. (2019), Mutula and Mostert (2010)
	Social and economic disparities (PE9)	Masinde and Mkhonto (2019), Mutula and Mostert

		(2010), Ray (2018), Yanqing (2011)
	Trust (PE10)	Meiyanti et al. (2018)
Technology (TE)	Access to computer and technology (TE1)	D. Aghimien et al. (2019), Chia (2016), Masinde and Mkhonto (2019), Paul et al. (2020), Ray (2018), Weerakkody et al. (2011)
	Access to latest technologies (TE2)	Oni et al. (2019)
	Availability (TE3)	Ambira et al. (2019), Shin and Ibahrine (2020)
	Central accessible information and personal details of citizens (TE4)	Mutula and Mostert (2010)
	Communication systems (TE5)	Meiyanti et al. (2018)
	Cyber insecurity (TE6)	D. Aghimien et al. (2019)
	Data privacy (TE7)	Ovais Ahmad et al. (2013)
	ICT infrastructure (TE7)	Ambira et al. (2019), Apriliyanti et al. (2020), Deng et al. (2018), Mutula and Mostert (2010), Waller and Genius (2015), Samsor (2021)
	Incomplete e-government platform (TE8)	Shin and Ibahrine (2020)
	Information security management professionals (TE9)	Odat (2012), Tonggiroh (2017)
	Information technology standards (TE10)	Ambira et al. (2019), Weerakkody et al. (2011), Nasution et al. (2020)
	Innovation ecosystem (TE11)	Osifo (2018), Ray (2018), Shin and Ibahrine (2020)
	Interactive public services (TE12)	Weerakkody et al. (2011)

	Internet penetration (TE13)	Asogwa (2013)
	Interoperability (TE14)	Meiyanti et al. (2018), Odat (2012)
	Lack of digitized information (TE15)	Meiyanti et al. (2018), Odat (2012)
	Lack of hardware and software (TE16)	Meiyanti et al. (2018), Odat (2012)
	Lack of qualifications (TE17)	Meiyanti et al. (2018)
	Lack of technological skills (TE18)	Meiyanti et al. (2018), Odat (2012)
	Legacy systems (TE19)	Mutula and Mostert (2010)
	Network and telecommunication infrastructure (TE20)	Ambira et al. (2019), Gladkova and Ragnedda (2020), Masinde and Mkhonto (2019), Paul et al. (2020), Shin and Ibahrine (2020), Tonggiroh (2017), Zhao et al. (2012)
	Records mobility (TE21)	Meiyanti et al. (2018)
	Security and privacy (TE22)	Asogwa (2013), Chia (2016), Oni et al. (2019), Osifo (2018), Aghimien et al. (2020), Shin and Ibahrine (2020), Sulistya et al. (2019), Waller and Genius (2015), Yanqing (2011), Zhao et al. (2012), Samsor (2021)
	System integration (TE24)	Asogwa (2013), Meiyanti et al. (2018), Weerakkody et al. (2011)
	Trust (TE25)	Osifo (2018)
Institutions (IN)	Common goals, vision, and mission (IN1)	Apriliyanti et al. (2020)
	Funds (IN2)	Ambira et al. (2019), Masinde and Mkhonto (2019),

		Weerakkody et al. (2011)
	Government support (IN3)	Ovais Ahmad et al. (2013), Waller and Genius (2015), Weerakkody et al. (2011)
	Independent ministries (IN4)	Shin and Ibahrine (2020)
	Leadership (IN5)	Meiyanti et al. (2018), Odat (2012), Samsor (2021), Tonggiroh (2017)
	Legal and regulatory issues (IN6)	Weerakkody et al. (2011), Samsor (2021)
	Motivation (IN7)	Apriliyanti et al. (2020)
	Political authority (IN8)	Lazović and Duričković (2014)
	Political willingness (IN9)	Ambira et al. (2019), Apriliyanti et al. (2020)
	Bribery and corruption (IN10)	Ambira et al. (2019), Asogwa (2013), Sulistya et al. (2019)
	Bureaucracy (IN11)	Shin and Ibahrine (2020), Sulistya et al. (2019)
	Coordination, collaboration, and consultation (IN12)	Asogwa (2013), Meiyanti et al. (2018), Odat (2012), Osifo (2018), Samsor (2021), Waller and Genius (2015)
	Distribution of decision-making power and hierarchy (IN13)	Apriliyanti et al. (2020), Weerakkody et al. (2011)
	Feedback system (IN14)	Apriliyanti et al. (2020)
	Financial and fiscal limitations (IN15)	Odat (2012), Osifo (2018)
	Government and community involvement (IN16)	Tonggiroh (2017)
	ICT implementation (IN17)	Ambira et al. (2019), Apriliyanti et al. (2020)
	Inadequate resources (IN18)	Mutula and Mostert (2010)
	Inefficient public organizations (IN19)	Deng et al. (2018)

	Information inconsistencies (IN20)	Shin and Ibahrine (2020)
	Information sharing (IN21)	Shin and Ibahrine (2020), Samsor (2021)
	Information system strategy (IN22)	Weerakkody et al. (2011)
	Information technology management (IN23)	Yanqing (2011)
	Organization stricture and culture (IN24)	Weerakkody et al. (2011)
	Prioritization of deliverables (IN25)	Weerakkody et al. (2011)
	Resistance to change (IN26)	Ambira et al. (2019), Odat (2012), Waller and Genius (2015)
	Resource allotment (IN27)	Shin and Ibahrine (2020), Samsor (2021)
	Service delivery (IN28)	Mutula and Mostert (2010)
	Shortage of human resources (IN29)	Asogwa (2013), Deng et al. (2018), Tonggiroh (2017), Zhao et al. (2012)
	Small number of trained workers in jobs that use ICT (IN30)	Ambira et al. (2019), Apriliyanti et al. (2020), Asogwa (2013), Mutula and Mostert (2010), Osifo (2018), Waller and Genius (2015)
	Stakeholders' involvement (IN31)	Samsor (2021)
	Transparency (IN32)	Apriliyanti et al. (2020), Meiyanti et al. (2018), Odat (2012), Shin and Ibahrine (2020), Sulistya et al. (2019)
	Trust among organisations, (IN33)	Apriliyanti et al. (2020)
	Turnover of workforce (IN34)	Meiyanti et al. (2018), Odat (2012)
Policy (PO)	Accountability (PO1)	Apriliyanti et al. (2020)
	Bribery and corruption	Ambira et al. (2019), Asogwa

	(PO2)	(2013), Sulistya et al. (2019)
	Certificate Centre requirements (PO3)	Shin and Ibahrine (2020)
	ICT systems (PO4)	Ambira et al. (2019)
	Information and cyber security risks (PO5)	Aghimien et al. (2020)
	Intellectual property thefts (PO6)	Paul et al. (2020)
	Laws and legislation (PO7)	Odat (2012)
	Policies support (PO8)	Meiyanti et al. (2018)
	Policy, regulations, and standards (PO9)	Chia (2016)
	Recognize electronic documents and transactions (PO1s0)	Meiyanti et al. (2018)
Economics (EC)	Availability of resources (EC1)	Meiyanti et al. (2018)
	Corruption and misuse of public money (EC2)	Ambira et al. (2019), Asogwa (2013), Meiyanti et al. (2018), Mutula and Mostert (2010), Sulistya et al. (2019)
	Expensive (EC3)	Tonggiroh (2017)
	Funding (EC4)	Meiyanti et al. (2018), Yanqing (2011), Weerakkody et al. (2011)
	High access cost (EC5)	D. Aghimien et al. (2019), Gladkova and Ragnedda (2020), Mutula and Mostert (2010), Paul et al. (2020), Waller and Genius (2015)
	Lack of hardware and software maintenance (EC6)	Meiyanti et al. (2018)
Sustainability (SU)	Education (SU2)	D. Aghimien et al. (2019), Mutula and Mostert (2010)
	Digital literacy (SU3)	Ambira et al. (2019), Masinde and Mkhonto (2019), Shin

		and Ibahrine (2020)
	Lack of employment (SU4)	D. Aghimien et al. (2019)
	Power supply (SU1)	D. Aghimien et al. (2019), Asogwa (2013), Mutula and Mostert (2010)

Note:

PE = People

TE = Technology

IN = Institutions

PO = Policy

EC = Economics

SU = Sustainability

Source: Authors' work-based literature review

3 Smart Nation

3.1 Introduction

The coronavirus disease (COVID-19) pandemic and urban problems in cities have triggered unprecedented challenges globally. At the same time, these challenges have reaffirmed the need for digitalization for ease of living, ease of doing business, and to offer better services to the public by introducing concepts such as smart cities, digital nations, and innovative solutions to social challenges through advanced technologies.

The concept of "smart nation" involves three key stakeholders—government, companies, and people—when considering the urban, municipal, city, or provincial administration of a smart city project (Hoe, 2016). The smart, intelligent, digital, and wired city (Capdevila *et al.*, 2015, Lenk, 2020, Sahib-Kaudeer *et al.*, 2016, Sharifi, 2019) can integrate technology with strategic urban planning to improve citizens' well-being, economic and business development, and sustainability. Mohasses (2019) also lists these elements as the benefits of a smart city. Countries are now prioritizing creative solutions to the challenges (Sahib-Kaudeer *et al.*, 2016) of large-scale urban population migration, sustainable development, and improving services (Bifulco *et al.*, 2016). This digital transformation (Bifulco *et al.*, 2016) seeks to improve living standards by connecting all things and people through advanced technologies such as the Internet of Things (IoT), artificial intelligence, machine learning, big data, cloud computing, and blockchain (Glyptis *et al.*, 2020).

The above-mentioned urban problems are set to cross national boundaries and become global problems, pressurizing nations and cities to innovatively optimize living standards by developing and integrating digital

infrastructure. However, in developing economies, digitization is not as easily achieved as in advanced economies; it depends on their people and society, developing technology, governance, supportive government policies, regulations, standards, and economic and sustainable development. Extant studies have already established that countries face diverse of challenges (Table S1); these can be classified into seven major broad categories: (1) people and society, (2) technology and innovation, (3) digital infrastructure, (4) politics, (5) governance, (6) economics and business, and (7) sustainability.

A smart nation can build upon best practices from smart cities. In spite of this, researchers are only beginning to study smart nations (Kar *et al.*, 2019). Shin and Ibahrine (2020) state that theories from socio-technical system studies can inform builders of a smart society. Such a society has an interconnected ecosystem with the integration of social and technical applications.

The department of economic and social affairs at the United Nations (UN) advocates sustainable development and believes that advanced technologies can contribute to food safety, clean energy, and digital transformation as part of the global transformation.Additionally, sustainability has become the blueprint for universal peace in the 2030 Agenda of the UN—"a plan for people, planet, and prosperity." For sustainable development, the UN wants countries to ensure that all people have access to quality education, digital infrastructure, online and mobile technology, earning opportunities, and technological advancement. Yet, a question often arises as to how to reconcile technological requirements for digital transformation with ecological sustainability. The sustainable development goals agenda is to transform the financial, economic, and political systems that govern our societies, and thus create a plan for peace

and prosperity and to provide opportunities for all. To ensure robust and sustainable industrial development, policies that facilitate affordable, reliable, and modern energy services are essential. Moreover, the sustainability transition has placed cities and communities at the forefront of addressing urban challenges (Haarstad and Wathne, 2019). Smart nations can help in digital transformation of societies and industries. Thus, addressing the lacunae in the literature, we identify the following research questions:

- What are the characteristics of a smart nation?
- What are the challenges and solutions associated with building a smart nation ?.

The study objectives primarily leaned toward building a smart nation framework, as research on smart nations is scant, and no frameworks have been published. Considering these limitations, this study presents a framework for better understanding the patterns that define successful or unsuccessful smart nations worldwide, contributing to the achievement of sustainable development goals.

Within our framework, we identify and address the challenges of building a smart nation within a smart society at the sub-regional and national levels, in addition to identifying the three main stakeholder groups within a smart nation—government, companies, and people.

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3.2 Smart Nation Concept

A nation that seeks to become a smart nation must involve its citizens

in intelligence gathering, producing, and consuming by implementing a "national information strategy" in order to create a "virtual intelligence community" (Steele-Vivas, 1996). Furthermore, new educational systems and corporate training programs should be designed for a smart nation, and openness should be a catalyst for unleashing collective intelligence among citizens. A smart nation uses data and technology to address strategic issues through a holistic national approach (Hoe, 2016). Hoe (2016) highlights the case of Singapore, which achieves this by addressing problems at a comprehensive level rather than only at the local level. Meanwhile, Kar *et al.* (2019) defined a smart nation as a society where rural and urban residents, governments, and companies interact and coordinate online to drive value creation for everyone. Growing urbanization and population growth are driving governments to adopt digital nation building policies. Considering the aforementioned conceptualizations, we can define a smart nation as one that makes use of information and communication technology (ICT) to enhance operational efficiency, share timely information with citizens, and improve public services. Through the use of advanced technologies and data analysis, a smart nation primarily aims to solve urban and rural problems, optimize its functions, and promote economic growth by facilitating ease of life and doing business and by offering better public services. A smart nation also takes full advantage of all the interconnected information available to control its resources, and better understand its citizens.

Sustainability enables a smart nation to enhance its functioning and promote economic growth by facilitating ease of life and doing business as well as offering better public services. Nevertheless, the UN points out that an inclusive society cannot be developed without addressing the concerns regarding digital divides, digital infrastructures, and access to technologies. Moreover, a lack of public awareness of the smart city concept and what it

means for quality of life (Aghimien *et al.*, 2020, Rana *et al.*, 2019) in addition to inadequacies in technical skills necessary to use the Internet, devices, and technology are also seen as challenges (Mukherjee *et al.*, 2021). The lack of citizen involvement and the central government's failure to properly engage local governments are further seen as barriers to sustainable smart city development (Tan and Taeihagh, 2020). Insufficient legislation, policies, funding, infrastructure, and technology could also restrict the creation of smart cities for sustainable development (Khan *et al.*, 2020). Meanwhile, a robust Internet connection that can withstand extreme weather and open-air conditions (Mukherjee *et al.*, 2021) is of utmost importance, as smart cities rely heavily on IoT, big data, and cloud technologies. However, IoT and cloud computing technologies are also considered technologies that consume large amounts of energy, making sustainable smart nation development difficult. Furthermore, integration, interoperability, security and privacy, as well as cyberattacks and the exponential growth of data are all seen as challenges in developing smart cities (Georgiou *et al.*, 2020).

As a part of smart nation development, developing advanced technologies for addressing endemic urban problems is a prerogative of developed countries and less populous countries, such as Singapore. For instance, the e-residency initiative, as seen in Estonia (Metcalf, 2019), opens digital borders to anyone or anywhere (Georgiou *et al.*, 2020, Li, 2018, Mukherjee *et al.*, 2021, Orecchini *et al.*, 2019, Rivera *et al.*, 2017, Wong *et al.*, 2020) through decentralized techno-governance. It allows citizens to rapidly take advantage of e-health, e-education services, technology, and equal business opportunities with ease, enabling sustainable development without geographical barriers. Its objective is to transform the financial, economic, and political systems that govern societies and create a framework for peace, prosperity, and work opportunities.

The results of initiatives adopted in smart cities (De Azambuja *et al.*, 2020, Joshi *et al.*, 2016, Orecchini *et al.*, 2019, Sharifi, 2019, Vasudavan and Balakrishnan, 2019) and digital nations (Kar *et al.*, 2019) mark an intermediate step toward a smart nation, helping to transition the governance system from a centralized to more decentralized model**.**

The six main characteristics of a smart city include smart economy, smart people, smart governance, smart mobility, smart environment, and smart living (De Azambuja *et al.*, 2020, Joshi *et al.*, 2016, Orecchini *et al.*, 2019, Sharifi, 2019, Vasudavan and Balakrishnan, 2019) (Table I). A smart nation is built upon the foundation of three stakeholders—government, economy, and society—and the six features of smart cities; all citizens, businesses, and government institutions are required to accelerate digitalization and the development of smart societies. An ecosystem is crucial for this novel concept to work. The implementation of such plans requires a strong foundation encompassing people and society, technology and innovation, digital infrastructure, politics, governance, economics, and sustainability.

Table 3.1. Smart nation characteristics.

Characteristics	**Description**	**References**
Smart economy	A smart economy is defined as an economic dimension characterized by innovation, research and development, entrepreneurship, labour, investments, and partnerships. Sustainable smart cities should provide economic stability, bring innovation, attract business and capital, increase regional attractiveness and competitiveness, improve productivity, and develop, attract, and retain the workforce. In conclusion, it aims to ensure economic growth, creating opportunities for diverse and economic sustainability.	De Azambuja et al. (2020, p. 5)
Smart people	Smart people are defined as a people dimension of offering innovative services to understand people's requirements while preparing or developing smart city smart systems. Some of the essential factors in smart people are people's privacy and security concerns. Also, the legislation and policies applied in the information processing environment should be educated to the public. Social networking sites can also help inform the public about smart cities initiatives and take opinions.	Vasudavan and Balakrishnan (2019, p. 2)

Smart governance	Smart governance comprises leadership directions, resource allocation and budget, interactions with external actors, and internal cooperation's with different departments, agencies, and stakeholders. It also includes regulations, policies, and processes in a standardized manner. Other governance factors include collaboration, leadership, participation and partnership, communication, data-exchange, service and application integration, accountability, and transparency.	De Azambuja et al. (2020, p. 6)
Smart mobility	Smart mobility is defined as mobility that arises due to increased road congestion and related side effects, including noise, fatality, and delay. Smart mobility is a new concept under mobility or going from one place to another in simpler, healthier, and more efficient ways. Besides reducing the environmental impact, increase public transport mode efficiency, optimize parking spaces, and prioritizing citizen's needs.	Vasudavan and Balakrishnan (2019, p. 2)
Smart environment	The smart environment is defined as the environmental dimension usually related to natural environment protection and restoration, green building	De Azambuja et al. (2020, p. 2)

	practices, and energy-saving, often included in the city's strategic objectives and city initiatives of creating environment-friendly for creation of better spaces to live. It is about establishing an environmentally sustainable approach that meets today's needs without sacrificing future generations' needs, reinforcing prevention and resilience from natural and human-made disasters, and addressing climate change impacts.	
Smart living	Smart living is defined as a living that includes cities' public security, health services, learning ability, tourism and intelligent buildings, and all factors that enhance citizens' living standards and well-being. Smart cities also focus on the health management of the elderly and disabled citizens and develop an approach to monitor them in real-time with special care and a smart living approach of providing emergency assistance when necessary.	Vasudavan and Balakrishnan (2019, p. 2)

3.3 Methodology

Our systematic literature review (Chauhan *et al.*, 2016, Penmetsa and Bruque, 2021) involved four stages: (1) developing the study protocol, (2) selecting articles based on keywords in titles, (3) selecting articles based on abstracts and conclusions, and (4) final selection for analysis.

3.3.1 Developing the study protocol

The Emerald and Scopus databases were selected for retrieving pertinent research papers because of their reputation as well as the presence of relevant interdisciplinary results. A set of keywords for search were defined in relation to the research questions.

The inclusion criteria were journal articles, book chapters, and conference papers published entirely in English since 2015 in the Emerald and Scopus indexes. To combine the search terms, the Boolean "AND" operator was applied, while "OR" served as an alternative key search term. Every combination of the search terms was considered. Because all search terms together failed to provide relevant published literature, we used the following sets: 1) "Digital nation" and ("Digital government" or "e-government “) and "Digital economy" and "Digital society"; 2) "Smart nation"; and 3) "Smart city" or "Smart cities." Thus, we extracted data about digital governments, digital economies, and digital societies, as well as terms associated with those subjects—smart nations and smart cities. In total, 5,958 articles were identified. Despite the fact that the research papers included the required and alternative keywords, they did not discuss the digital nation or its three characteristics, nor did they mention smart nations or smart cities.

Table 3.2. Search terms used in this study.

Search terms	**Alternative search terms**
Digital nation	
Digital government	e-government
Digital economy	
Digital society	
Smart nation	
Smart city	Smart cities

3.3.2 Selecting articles based on keywords in titles and sorting by relevance

The title and search terms were used to screen the retrieved articles, which were then sorted according to relevance based on the first ten pages, displaying 50 results per page. Thereafter, the relevant articles were selected by considering the main factors related to the digital nation—digital government, digital economy, and digital society—or by considering smart nations and smart cities. Based on this process, we narrowed down the articles to 1,747 relevant articles.

3.3.3 Selecting articles based on abstracts and conclusions

Thereafter, we reviewed the abstracts of the research papers and their conclusions. Despite the papers including all the keywords, most of them where not focusing nor did they mention on smart nation, smart city, or

digital nation characteristics. Thus, alternate keywords were considered. Consequently, 125 research papers were identified.

3.3.4 Final selection

While screening all 125 papers, we considered the following factors:

- Does the paper deal with nations/countries, developing economies, or developing countries covering areas such as digital governments or e-government, digital economies or digital societies, or smart nations or smart cities?

- Does the paper address the challenges facing nations/countries, developing economies, or developing countries regarding that nation's digital government or e-government, digital economy or digital society, or a particular smart nation or smart city?

A total of 62 research papers were chosen from the Scopus index of peer-reviewed publications based on these questions. After examining each article's references, we found no other articles relevant to this study in their reference lists. Moreover, we included six research papers that were recommended by journal peer reviewers; among these, one paper on smart nations is from the year 1996 and presents the initial concept and definition of smart nation. Another paper from 2022 that focuses on smart energy management to improve sustainability has been added based on reviewer comments. Thus, a total of 69 peer-reviewed academic and research papers were shortlisted. Figure 3.1 depicts the selection process, while Figure 3.2 presents the distribution of the shortlisted papers according to year and publication type.

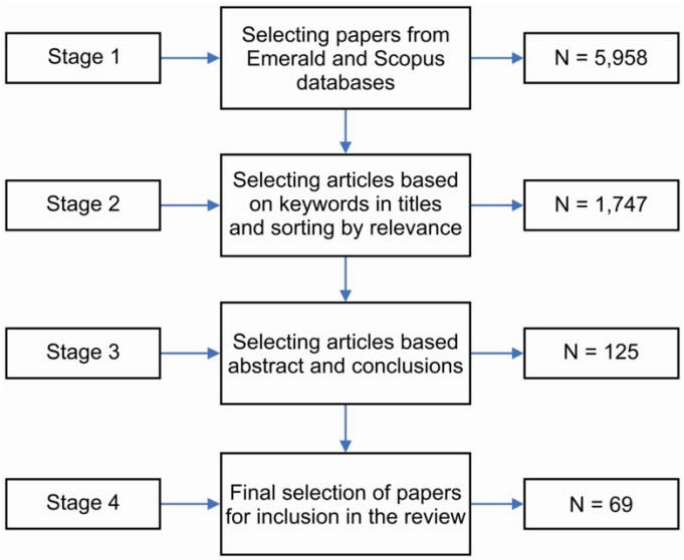

Figure 3.1. Stages of the study selection process.

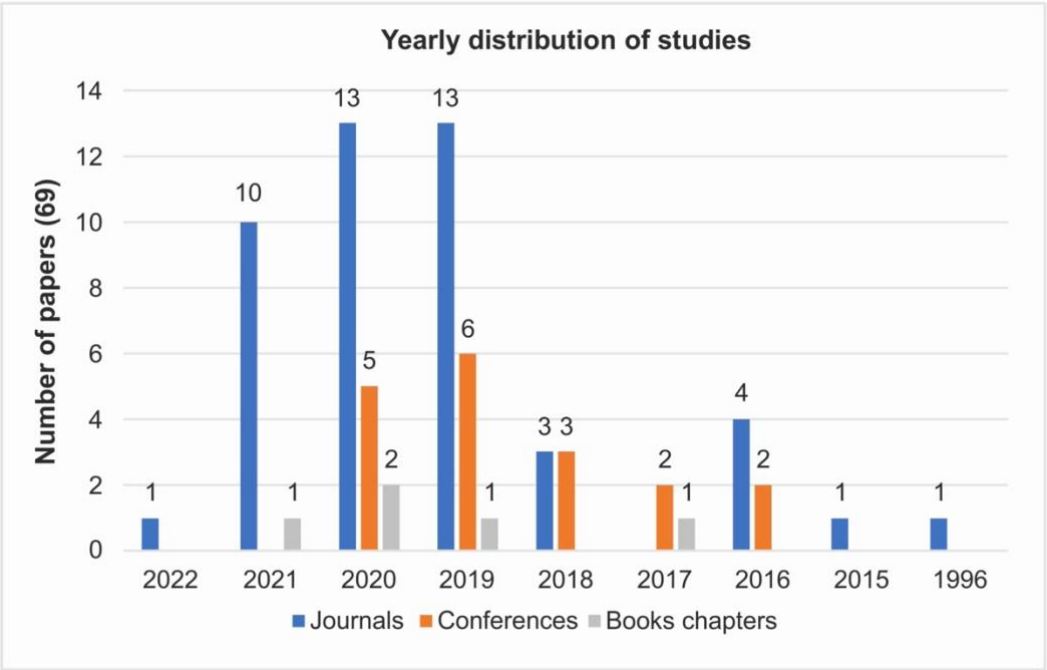

Figure 3.2. Distribution of research papers by year and publication type.

3.4 Results

Based on the review of the 69 selected research papers, a broad list was drawn of seven major categories of challenges facing digital nations and smart cities: (1) people and society, (2) technology and innovation, (3) digital

infrastructure, (4) politics, (5) governance, (6) economics and business, and (7) sustainability (Table S1). This broad list of categories is classified based on digital nation elements, development theories of smart cities, and related concepts identified in the literature (Aghimien *et al.*, 2019, Rana *et al.*, 2019). As relevant research on smart nations is scant, these challenge categories of smart cities also provide the principles for building a smart nations framework. These categories could develop and become pillars of a smart nation if they are strengthened.

3.4.1 People and Society

People are the key stakeholders who are expected to manage and use technologies. Figure 3.3 and Table 3.1 present the associated challenges. The literature review findings in Figure 3.3 show that digital illiteracy and divide, awareness, culture, social and economic disparities, and citizen participation are the most significant challenges associated with people and society.

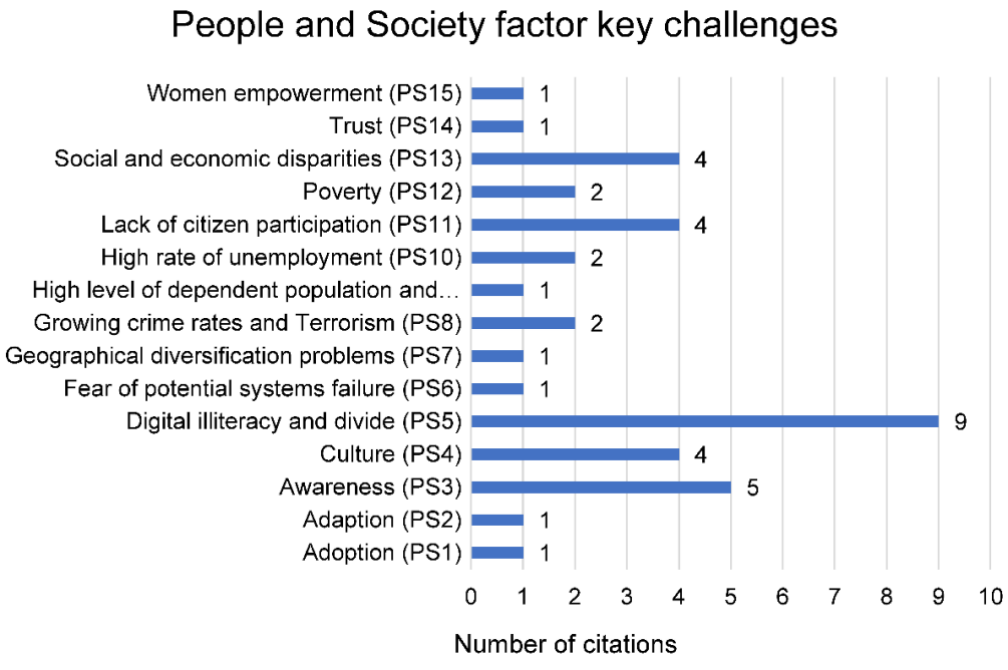

Figure 3.3. Key challenges associated with people and society of transforming smart nations.

The analysis shows that, for digital illiteracy and divide, the subgroup mainly concerns insufficient access to devices, Internet speed, bandwidth, skills, and high access costs (Paul *et al.*, 2020, Tan and Taeihagh, 2020). Moreover, lack of capabilities for developing core technologies that drive the creation of the smart city is a key concern (Tan and Taeihagh, 2020). Lack of public awareness of the smart city concept, its implications on quality of life (Aghimien *et al.*, 2020, Rana *et al.*, 2019), and lack of technical skills to use the Internet, devices, and technology (Mukherjee *et al.*, 2021) are concerns under the awareness subgroup. Lack of creativity, culture of sharing knowledge (Rana *et al.*, 2021), and cultural diversity of expatriates in some multicultural cities such as Dubai (Zakzak, 2019) fall under the culture subgroup. The high degree of inequality in citizens education, income levels, and skills (Aghimien *et al.*, 2020, Rana *et al.*, 2019) fall under social and economic disparities. Under the citizen participation subgroup, lack of required skills and understanding on how exactly smart cities can transform society and what they would look like (Rana *et al.*, 2019), knowledge to participate in digital society (El-Kholei and Yassein, 2019, Paul *et al.*, 2020), lack of process of involving citizens, and the local governments not being duly engaged by the central government are also seen as concerns for smart city development (Tan and Taeihagh, 2020). However, these challenges can be overcome by improving the education system (Aghimien *et al.*, 2019), which allows people to acquire skills and better jobs, improve their livelihoods through poverty alleviation programs, and, thus, ultimately reducing the crime rate.

3.4.2 Technology and Innovation

Technology is another critical and challenging factor in this context. Figure 3.4 and Table 3.1 present the associated challenges. Figure 3.4 shows that security and privacy issues, access to the latest technologies, and innovation ecosystem are the three most significant challenges associated with technology and innovation.

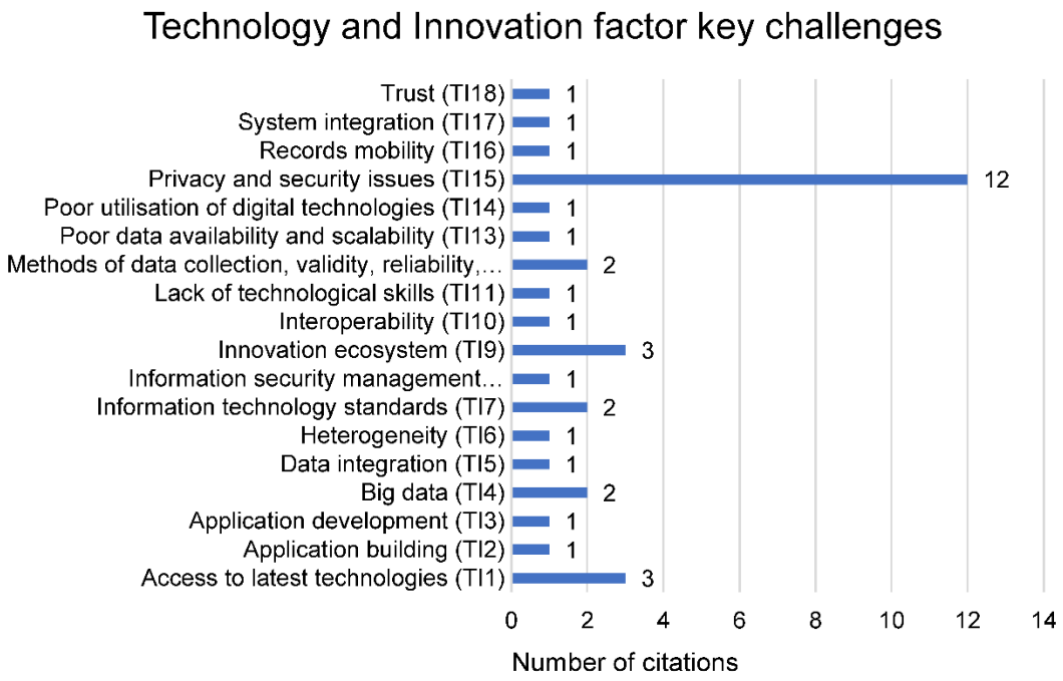

Figure 3.4. Key challenges associated with technology and innovation of transforming smart nations.

The analysis shows that the security and privacy categories are key concerns owing to issues related to security threats posed by hackers and viruses. Privacy (Aghimien *et al.*, 2020, Rana *et al.*, 2019) and misuse of sensitive citizen data during collection, processing, storage, and transmission after gathering detailed information about citizens for electronic governance services are seen as major concerns as well (Mukherjee *et al.*, 2021, Shin *et al.*, 2020, Sulistya *et al.*, 2019). Under the access to technologies subgroup, lack of access to modern digital technology for the

majority of citizens is seen as a major challenge toward smart city development (Rana *et al.*, 2019). Moreover, prolonged development period, not paying attention to innovative platforms and technologies, the lack of public–private partnerships for technology development (Shin *et al.*, 2020), the lack of capabilities to develop core technologies needed to drive smart city development (Tan and Taeihagh, 2020), and the lack of required technical skills (Meiyanti *et al.*, 2018) are seen as some of the concerns under innovation ecosystem subgroup.

To overcome these concerns, robust and secure foundations in cybersecurity are essential (Joshi *et al.*, 2016). More specifically, blockchain can provide increased security, privacy, and trust levels (Li, 2018). Blockchain also increases data integrity, as data within a blockchain are anonymous and do not require third-party technology or services (Rivera *et al.*, 2017). According to Kar *et al.* (2019), focusing on technology-driven innovations and developing ICT, such as IoT, can improve smart cities' or nations' stability, flexibility, robustness, reliability, and sustainability. According to Georgiou *et al.* (2020), blockchain provides an opportunity to cooperate and collaborate in a transparent, secure process in smart cities, ensuring sustainability and accountability. Chauhan *et al.* (2016) state that new technologies such as big data analytics provide opportunities to effectively use data to enhance information awareness, increase fact-based decision-making, and identify opportunities for improvements.

3.4.3 Digital infrastructure

When analyzing the significance of digital infrastructure, we compiled the associated challenges, as shown in Figure 3.5 and Table 3.1. Figure 3.5 illustrates that access to computers and technology, network and

telecommunication infrastructure, ICT infrastructure support, and poor Internet connectivity are the most significant digital infrastructure challenges.

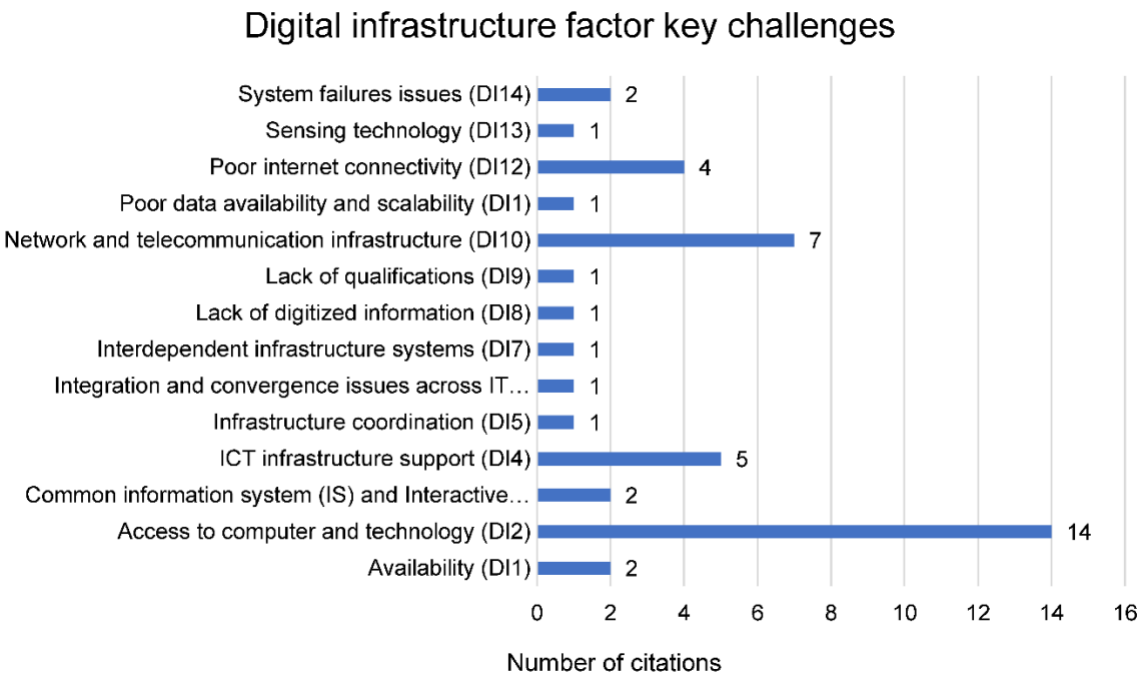

Figure 3.5. Key challenges associated with digital infrastructure of transforming smart nations.

According to our analysis, access to computers and technology categories are mainly an issue in developing nations due to inadequate access to devices, bandwidth, Internet speed, needed skills, and high access costs (Paul *et al.*, 2020, Tan and Taeihagh, 2020). Further, cybersecurity is a concern due to a lack of cybercrime awareness and inadequate use of technology to prevent these crimes (Chatterjee *et al.*, 2019). Under the network and telecommunication infrastructure subgroup, passive adoption of digital technology in areas of national development, incomplete e-government platforms, poor broadband network, and lack of a centralized government platform to integrate information technology resources are seen as major concerns (Shin *et al.*, 2020). Furthermore, Chatterjee *et al.* (2021) mentions that the protection of data generated by IoT devices is another

major issue. Within the subgroup on ICT infrastructure, the leaders, employees, and civilians lack the necessary technology skills, as well hardware, software, communication systems, integration systems, and interoperability, which hinders the efficient delivery of public services and information to citizens electronically (Meiyanti *et al.*, 2018). With regard to the Internet connectivity subgroup, concerns have also been raised regarding the need for an Internet connection that can stand up to extreme weather and open air conditions (Mukherjee *et al.*, 2021).

Motivated by these concerns, the island nation of Singapore is reforming the building code to ensure that every house includes Internet connectivity, just like electricity and water (Sahib-Kaudeer *et al.*, 2016); this indicates that the Internet is becoming an increasingly significant infrastructure in our lives as we evolve toward digital transformation. The government of Dubai has developed user-friendly, interconnected web portals and mobile applications, including Dubai Now, that provide more than 50 services. The government has also begun using AI and robots to improve public service provision (Mohasses (2019). It is imperative to motivate citizens to use information technology to safeguard cyberspace and raise awareness through social media, word of mouth, and organizations such as banks, post offices, and different financial institutions (Chatterjee *et al.*, 2019). Enforcing an information technology act similar to the one implemented by the Government of India in 2000 (with further amendments) also provides a beneficial regulatory ecosystem surrounding cybercrime. Chatterjee *et al.* (2021) highlight the importance of technology when it comes to protecting data generated by IoT devices via modern enterprise information systems. Enterprises can also contribute to securing the big data generated by IoT-enabled devices in smart cities by following appropriate codes of conduct, protecting privacy, maintaining cyber ethics,

and enforcing relevant laws and mechanisms. Additionally, initiatives such as making necessary investments toward building smart nation infrastructure, along with revenue models for digital infrastructure and asset recycling plans, contribute to the value and quality of life, thus motivating stakeholders to participate in smart nation development.

3.4.4 Politics

Commitment of the political leadership is another challenging factor influencing digital transformations. Figure 3.6 and Table 3.1 present the associated challenges. Figure 3.6 depicts that lack of cooperation and coordination, poor governance, and lack of trust in government, leadership, transparency, and resource allotment are the most significant political challenges.

The analysis shows that the lack of cooperation and coordination subgroup concerns the lack of cooperation and collaboration between city networks and government institutions (Aghimien *et al.*, 2020, Osifo, 2018, Rana *et al.*, 2019). There is also a lack of trust between governments and people, which subsequently delays smart city development (Aghimien *et al.*, 2020, Rana *et al.*, 2019). Under the leadership category, the lack of vision in IT management, political stability, lack of effective leadership (Aghimien *et al.*, 2020, Rana *et al.*, 2019), and the leadership's neglect of e-government implementation are challenges (Tonggiroh, 2017). The resource allocation category includes budgetary constraints, financing issues, corruption and misuse of public money (Meiyanti *et al.*, 2018, Tan and Taeihagh, 2020), as well as lack of skilled human capital, especially people who can handle technology-enabled functional roles (Tan and Taeihagh, 2020). The transparency category includes unclear lines of political accountability in

delivering services (Rana *et al.*, 2019).

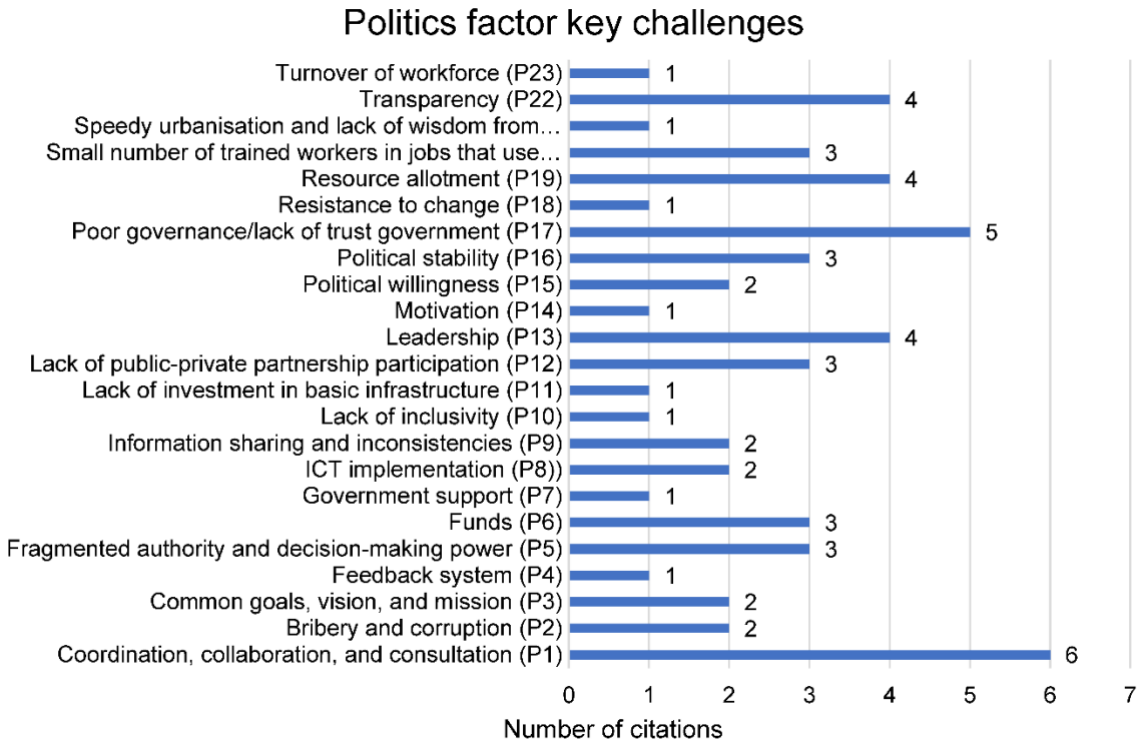

Figure 3.6. Key challenges associated with politics of transforming smart nations.

Politics is key to digital transformation, as all change is dependent on political leaders' commitment. Singapore has taken a national approach to enhance its citizens' quality of life (Chia, 2016); it is developing an entire digital ecosystem under its prime minister's leadership. According to Saxena and Al-Tamimi (2018), a national vision, along with an emphasis on investment and development of world-class infrastructure, are essential for ensuring better living standards for the people, higher quality of public services, and decreased expenses; countries following this path include Bahrain, Kuwait, Oman, Qatar, and Saudi Arabia. Public–private partnerships are also important. For example, Estonia has been using blockchain technology for e-voting to increase transparency levels in politics.

3.4.5 Governance

We consider governance issues as a key challenge in creating a smart nation, and Figure 3.7 and Table 3.1 present the associated challenges. Figure 3.7 depicts that lack of regulatory norms, policies, directions, and standardization are the most significant challenges in governance.

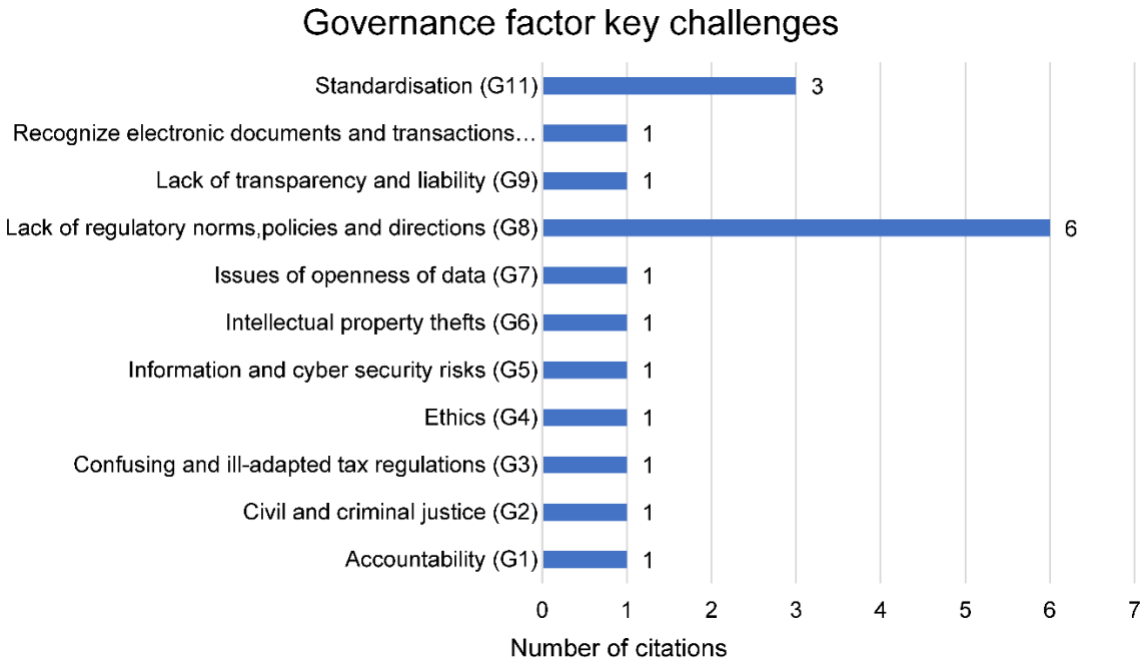

Figure 3.7. Key challenges associated with governance of transforming smart nations.

The analysis shows that lack of regulatory frameworks and policies subgroup is a key concern, given the lack of appropriate laws, regulations, or directives for smart city development (Aghimien *et al.*, 2020, Rana *et al.*, 2019, Tan and Taeihagh, 2020). Under the standardization subgroup, lack of standardization across smart technologies, security, privacy, environmental sustainability, physical infrastructure, and mobile networks are also seen as major concerns (Aghimien *et al.*, 2020, Rana *et al.*,

2019).

Regarding governance solutions, Kar et al. (2019) find that policy actions focused at the city level can be widened to the national level to overcome governance issues. Moreover, a proper national policy and smart city plan at the national level makes it easier to build smart cities quickly by incorporating feedback from citizens (Kwak & Lee, 2020). According to Tan and Taeihagh (2020), constructing regulatory frameworks for smart city governance is essential; a clear roadmap for smart city development will help decrease the risks of unintended consequences.

3.4.6 Economics and business

Economic challenges, such as costs associated with ICT acquisition, maintenance, and training and education, as well as economic value, cost savings, benefits, and return on investment to society, are significant challenges that can help or hinder a nation's ability to evaluate the success of digital transformation. Figure 3.8 and Table 3.1 present the associated challenges. Figure 3.8 shows that high cost of IT training and skills development programs, budget for operation and maintenance costs, lack of funding, slow economic growth, and lack of competitiveness are the most significant challenges in economics and business.

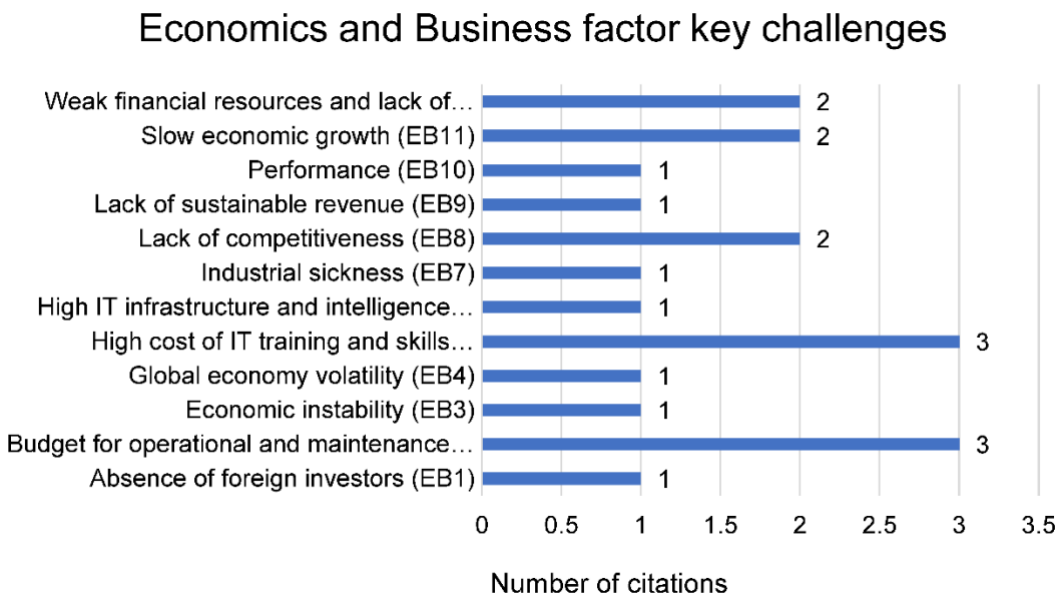

Figure 3.8. Key challenges associated with economics and business of transforming smart nations.

Furthermore, the high costs of IT training and skills development for IT professionals are seen as a challenge to smart city development (Aghimien *et al.*, 2020, Rana *et al.*, 2019). The high cost of IT in general, hiring and retaining IT professionals, equipment installations, operational requirements, maintenance, and training programs are seen as concerns as well (Meiyanti *et al.*, 2018, Mukherjee *et al.*, 2021, Rana *et al.*, 2019). The state and central government's over-dependency on development funds is also an obstacle. Adding to this are the increasing uncertainties in the global economy (Rana *et al.*, 2019), specifically, slow economic growth, along with the lack of competitiveness among local firms to deal with challenges (Aghimien *et al.*, 2020, Rana *et al.*, 2019).

Regarding economics and business solutions, Saxena and Al-Tamimi (2018) affirm that a national vision plan and a serious focus on investment and development of world-class infrastructure are essential. According to (Joshi et al., 2016), an environment for business and job creation, workforce development, and efficiency in smart city development processes is

necessary. Human, social capital, and traditional and modern communication infrastructures are also necessary for sustainable economic growth (Bifulco et al., 2016). Tan and Taeihagh (2020) further state that governments must prioritize innovative solutions by increasing funds of smart city development.

3.4.7 Sustainability

Integrating sustainability considerations into smart nations' frameworks seeks to improve efficiencies and ease of living in urban and rural areas. Figure 3.9 and Table 3.1 present the associated challenges.

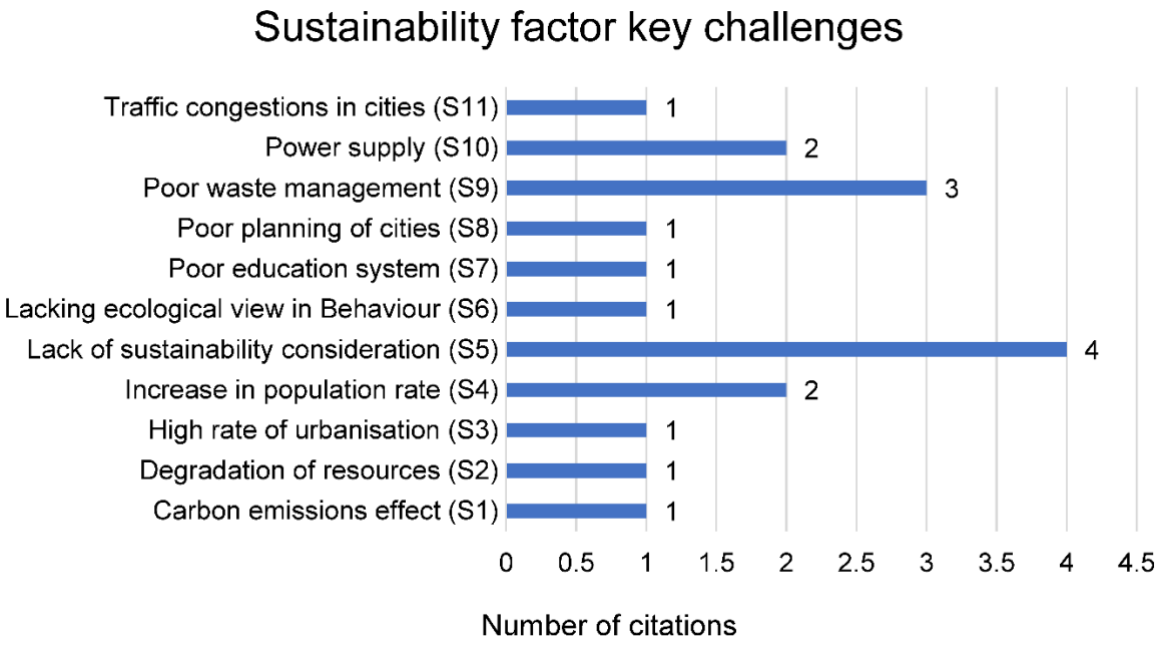

Figure 3.9. Key challenges associated with sustainability of transforming smart nations.

Figure 3.9 shows that lack of sustainability considerations, poor waste management, increase in population rate, and power supply are seen as some of the most significant challenges related to sustainability. The lack of sustainability considerations (e.g., traffic congestions, notifying residents

about parking availability, and reducing gas emissions), energy issues, and a lack of better standards of living (Aghimien *et al.*, 2020, Rana *et al.*, 2019) are seen as challenges in urban areas. In addition, lack of city planning, rapidly increasing populations, poor waste management, and dearth of information systems and technologies are also seen as major concerns for smart city development. Smart nation development also faces challenges in the rural context. For instance, tribal area development in India involves several challenges due to their lifestyle, remoteness of habitations, and dispersed population. Data driven planning involving data analytics has also not been taken into consideration for tribal development by planners and policy makers for identifying infrastructural gaps in smart and sustainable tribal village development (Kapoor *et al.*, 2021). In addition to an increase in population, Aghimien *et al.* (2020) state that the volume of data is also increasing. If not handled properly, this can be a deterrent to the sustainability of smart nations. Additionally, poor living conditions may be experienced by citizens due to a lack of sustainability considerations (such as improper waste management) in city planning or administration. Under the poor waste management subgroup, lack of physical infrastructure (including vehicles to transport waste), lack of digital infrastructure (including mobile networks, robust Internet connection, bandwidth), and access to advanced technologies (such as IoT, big data, cloud computing, sensors) to gather information have led to inefficient waste management services; meanwhile, unplanned cities generate congestion and pollution (Aghimien *et al.*, 2020, Tan and Taeihagh, 2020).

With regard to sustainability solutions, Fahmi et al. (2019) state that the creation of smart villages, smart cities, smart regencies, smart provinces, and ultimately, the smart nation requires an ecosystem of sustainable development involving diverse stakeholders to tackle challenges smartly.

Haarstad and Wathne (2019) argue that by integrating technology in city management and operations, cities and urban regions can overcome challenges related to sustainability, equity, and economic growth by achieving sustainability goals like reducing emissions, increasing energy efficiency, and improving quality of life. Hoang *et al.* (2021) argue that integrating renewable energy in smart city energy systems is a solution to achieve cleaner processes and sustainable development. Citing Singapore as an example, Huseien and Shah (2022) state that 5G technology will facilitate high-quality services, provide efficient functionality, and help achieve sustainable development goals. Francisco *et al.* (2020) argue that top-down benchmarking of buildings can incorporate previously undetectable temporal fluctuations through smart metering data analytics and smart metering infrastructure. Lewandowska *et al.* (2020) suggest that urban transformation using renewable energy sources is a good example of the smart city concept and examine how Poland is incorporating clean energy in its development. According to Akin-Ponnle and Carvalho (2021), ambient energy can be found almost everywhere there are vibrations, sunlight, heat, wind, radio frequencies, and water. Through energy harvesting, IoT devices can be used as long-lasting energy sources to develop smart cities. Further, Chatterjee and Kar (2017) state that every village has a great number of resources; if efficiently used, villages can be self-sustainable without concerns regarding energy management. An ecosystem should be developed for smart villages based on location as well as investment opportunities. Moreover, Kushwaha *et al.* (2021) state that applications of big data can provide actionable insights with respect to volume, variety, and veracity of data and can enable individuals and organizations to take informed decisions; this, in turn, could help reduce gas emissions, increase energy efficiency, ensure treatment and conservation of water resources, promote

waste management, and alleviate traffic congestion. According to Bisello (2020), the European Union is focusing on making the urban energy transition more sustainable. Technological innovation and societal change can enhance citizens' quality of life by providing new investment opportunities for real estate upgrades. The European Union smart city project SINFONIA has developed and tested a comprehensive framework for defining, identifying, and evaluating the main benefits of such a project.

Vasudavan and Balakrishnan (2019) state that integration of technologies into waste management systems can help manage waste more effectively. Mokale (2019) states that public awareness of waste-related health factors has also been positively impacted by schemes like Swachh Bharat Mission. To make their city clean, healthy, and smart, both the local government and residents must participate in implementing such policies. According to Gade and Aithal (2021), an Internet-connected solid waste monitoring system that uses cloud computing and IoT technology can be used by local authorities and citizens to manage the menace more effectively by providing reliable information about the state of the solid waste throughout the city. Gade and Aithal (2021) presented the architecture, building blocks, and software tools of their proposed smart waste management system, iSmartWMS, as well as the sensors and technologies included therein, to address daily waste generation for smart cities. Meanwhile, Kapoor *et al.* (2021) state that a data science approach can help identify the infrastructural gaps that can be addressed to build a smart and sustainable tribal village. The UN’s sustainable development goals highlight the need to achieve sustainable and inclusive economic growth. Developing policies that promote universal access to affordable, reliable, and modern energy services as well as high-quality infrastructure is key to achieving sustainable development.

3.5 Discussion

Figure 2 illustrates the framework for building a smart nation by identifying the stakeholders, characteristics, challenges, and solutions. The objectives of smart nations include ease of living, ease of doing business, and better public services using advanced technologies and development of virtual societies.

A smart nation is built on digital concepts such as the digital nation and smart cities. As illustrated in Figure 2, the new framework is built to generate value for all stakeholders and is based on a smart society, which opens digital borders by using advanced technologies such as artificial intelligence, big data, 5G, and other networks that connect humans and machines through semi-automation and wireless networks.

Notably, blockchain technology can be seen as having the potential for developing a blockchain-based application for the six characteristics of smart nations. Blockchain technology is a disruptive technology that has the potential to transform and improve pan-industry efficiency with its features of decentralization, transparent transactions, and higher security. It is often portrayed as a game-changing technology that can reshape financial transactions and influence how people interact within a digital society. It has important legal applications, such as in tamper-proof smart contracts. Nations can develop blockchain-based applications such as digital

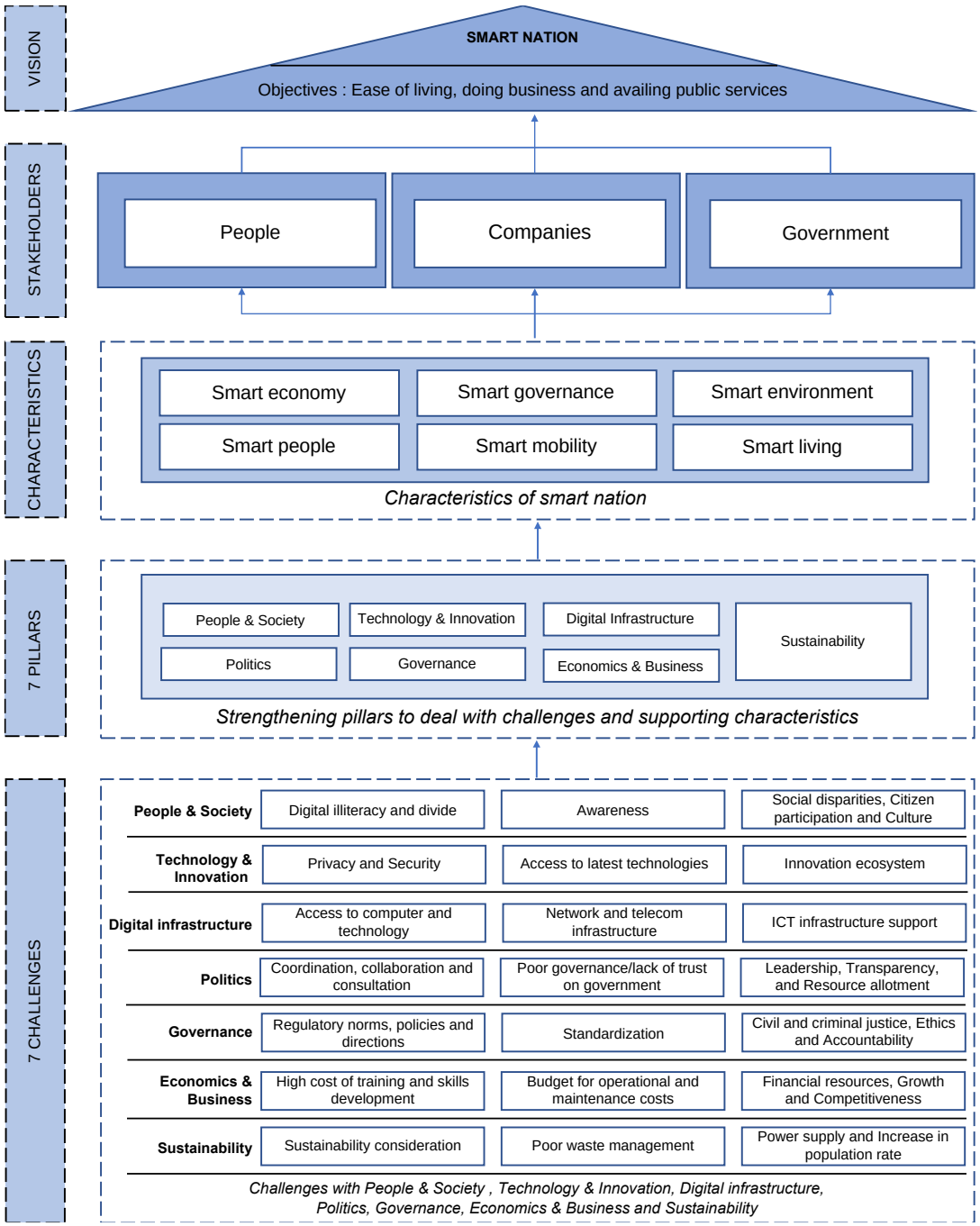

Figure 3.10. A Smart nation framework.

currencies, digital identities, e-voting, and a common platform for interoperability, which, together, can help governments enforce policies and automate regulations. Overall, these developments could greatly enhance security and privacy through such decentralized techno-governance.

Digital nations are created by combining the concepts of digital government, digital business, and online societies, according to Penmetsa and Bruque (2021). Moreover, the theories on digital government provide a comprehensive framework that defines a nation's relationship to its citizens, companies, and industrial units, as well as relationships among government departments.

Earlier research on smart cities focused on the cities, municipalities, and provinces (Hoe, 2016) of a smart city project. There are also challenges to building a smart city (Chauhan *et al.*, 2016, Singh *et al.*, 2020) that center around people, technology, politics, governance, economics, and sustainability.

A holistic national approach should involve the government, companies, and citizens of a smart nation. Furthermore, it must incorporate the six characteristics of a smart city for better quality of life, stronger economic growth, and improved public services. The overall objective should be to transform the financial, economic, and political systems that govern societies, thereby creating a framework for peace, prosperity, and equal work opportunities for enhancing the ease of living, doing business, offering better public services using technologies, and development of virtual societies. The people should be empowered by better health, education, safety, and standards of living, and nations must work toward overcoming the challenges of large-scale rural migration to cities.

We expect the government to shape business and society. In addition, companies can work closely with public services to promote sustainable development. To achieve the UN Sustainable Development Goals, the government can act as a facilitator for the three stakeholder groups to come together.

3.5.1 Future research agenda

Our findings indicate several directions for future research. Using advanced technologies, smart nations seek primarily to address endemic urban problems such as aging, energy crises, pollution, safety, and crime. However, a country's transformation into a smart nation does not take place automatically. The smart nation concept is dependent on several factors, including people and society, education system, technology and innovation, political leadership, digital infrastructure, and regulatory frameworks. Based on these factors, future research should examine the benefits of smart nations to the society at large and the underlying mechanisms. First, education standards must be devised to meet industry skill requirements and overcome challenges such as poverty and the digital divide. Second, innovations applications in the use of advanced technologies such as blockchains, IoTs, and big data analytics must be developed for building smart nations. Third, future research should guide the political leadership in formulating a national vision plan with a focus on the digital ecosystem. Fourth, regulatory frameworks for smart nation governance should be developed. Fifth, studies should help devise policies that promote universal access to high-quality, affordable, and reliable energy services for sustainable development. Thus, substantial research is required to guide governments and policymakers in implementing these solutions/strategies to overcomes challenges in smart nation building.

Cooperating and collaboration on the above-mentioned strategies is essential for a smart region to be constructed at the national and continental levels (e.g., European Union and Association of Southeast Asian Nations). Countries will face future challenges due to declining birth rates, low labor force participation rates, multinational trade wars, poor socioeconomic development, and weak international cooperation apart from existing challenges for smart nations. Accordingly, future research, based on varied methods such as literature reviews and interviews, should delve deeper into these challenges.

3.6 Conclusion

Global megatrends are compelling nations to digitize their governance, businesses, and overall society much faster than before. The increasing number of pandemics in the last hundred years, the spread of the Internet, and the advent of advanced technologies such as blockchain, IoT, artificial intelligence, big data, cloud computing, and robots are ushering in a paradigmatic shift in how societies can exist and grow.

In this study, we conducted a systematic literature review to identify and address the challenges to becoming a smart nation. The selected research papers were reviewed, analyzed, and interpreted to create a framework for building a smart nation based on its stakeholders, characteristics, and pillars. The seven key challenges that affect the construction of smart nations are delineated and can be the starting point for national and international institutions and decision-makers to establish the path toward not only improving the technological endowment of the country but also creating new technological and political structures that facilitate the birth of genuine, decentralized, high-tech smart nations or

smart societies.

Through this study, we also aimed to understand factors that affect the success of adopting, or the failure to adopt, advanced technologies at the country level, which can inform future decision making. This smart nation framework may interest public administrations and researchers involved in digitalization to study the key challenges within seven categories for smart nation development for emerging and developing economies.

Despite its strengths, the study has some limitations. First, our work is mainly derived from a literature review. Future studies should conduct exploratory research using national case studies and should interview experts from governments, businesses, and citizenry. Our research will continue to improve these findings with interventions from experts and goal-directed research to enable the development of the super smart nation of the future. We hope that such nations and societies are better equipped to overcome challenges such as aging population, low birth rate, shrinking labor force, and the increasing costs for social security and healthcare arising from issues of socio-economic development; free movement of goods, people, and services; ease of living and doing business; access to public services; and international cooperation among developing nations.

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Appendix 3.1. Seven categories of key challenges associated with transforming smart nations.

Categories	Key Challenges	References
People & Society (PS)	Adoption (PS1)	Paul et al. (2020)
	Adaption (PS2)	Zakzak (2019)
	Awareness (PS3)	Ambira et al. (2019), Paul et al. (2020), Samsor (2021), Aghimien et al. (2020), Rana et al. (2019)
	Culture (PS4)	(Ray, 2018), (Nasution et al., 2020), Aghimien et al. (2020), Zakzak (2019)
	Digital illiteracy and divide (PS5)	Ambira et al. (2019), Deng et al. (2018), Gladkova and Ragnedda (2020), Masinde and Mkhonto (2019), Meiyanti et al. (2018), Samsor (2021), Shin and Ibahrine (2020), Tan and Taeihagh (2020), El-Kholei and Yassein (2019)
	Fear of potential systems failure (PS6)	Aghimien et al. (2020)
	Geographical diversification problems (PS7)	Rana et al. (2019)
	Growing crime rates and terrorism (PS8)	Aghimien et al. (2020), Saini and Sandhiyaa (2020)
	High level of dependent population and overpopulation (PS9)	D. Aghimien et al. (2019)
	High rate of unemployment (PS10)	Aghimien et al. (2020), D. Aghimien et al. (2019)
	Lack of citizen participation (PS11)	Aghimien et al. (2020), Rana et al. (2019), Tan and Taeihagh (2020), El-Kholei and Yassein (2019)
	Poverty (PS12)	Aghimien et al. (2020), D.

		Aghimien et al. (2019)
	Social and economic disparities (PS13)	Masinde and Mkhonto (2019), Ray (2018), Meiyanti et al. (2018), Zakzak (2019)
	Trust (PS14)	Meiyanti et al. (2018)
	Women empowerment (PS15)	Saini and Sandhiyaa (2020)
Technology and Innovation (TI)	Access to latest technologies (TI1)	Oni et al. (2019), Rana et al. (2019), D. Aghimien et al. (2019)
	Application building (TI2)	Jo et al. (2019)
	Application development (TI3)	Nasution et al. (2020)
	Big data (TI4)	Silva et al. (2018), Farid et al. (2021)
	Data integration (TI5)	Jo et al. (2019)
	Heterogeneity (TI6)	Silva et al. (2018)
	Information technology standards (TI7)	Ambira et al. (2019), Shin and Ibahrine (2020)
	Information security management professionals (TI8)	Tonggiroh (2017)
	Innovation ecosystem (TI9)	Osifo (2018), Ray (2018), Shin and Ibahrine (2020)
	Interoperability (TI10)	Meiyanti et al. (2018)
	Lack of technological skills (TI11)	Meiyanti et al. (2018)
	Methods of data collection, validity, reliability, and analysis (TI12)	Tan and Taeihagh (2020), El-Kholei and Yassein (2019)
	Poor data availability and scalability (TI13)	Rana et al. (2019)
	Poor utilization of digital technologies (TI14)	Aghimien et al. (2020)
	Security and privacy issues (TI15)	Rana et al. (2019), Jo et al. (2019), Chia (2016), Oni et al. (2019), Osifo (2018), Paul et

		al. (2020), Samsor (2021), Shin and Ibahrine (2020), Sulistya et al. (2019), Aghimien et al. (2020), D. Aghimien et al. (2019), Nasution et al. (2020)
	Records mobility (TI16)	Meiyanti et al. (2018)
	System integration (TI17)	Meiyanti et al. (2018)
	Trust (TI18)	Osifo (2018)
Digital infrastructure (DI)	Availability (DI1)	Ambira et al. (2019), Nasution et al. (2020)
	Access to computer and technology (DI2)	Chia (2016), Masinde and Mkhonto (2019), Paul et al. (2020), Ray (2018), Rana et al. (2019), D. Aghimien et al. (2019), Tan and Taeihagh (2020), El-Kholei and Yassein (2019), Nasution et al. (2020), Ambira et al. (2019), Apriliyanti et al. (2020), Deng et al. (2018), Samsor (2021), Meiyanti et al. (2018)
	Common information system (IS) and Interactive public services (DI3)	Aghimien et al. (2020), Shin and Ibahrine (2020)
	ICT infrastructure support (DI4)	Ambira et al. (2019), Apriliyanti et al. (2020), Deng et al. (2018), Samsor (2021)
	Infrastructure coordination (DI5)	Farid et al. (2021)
	Integration and convergence issues across IT networks (DI6)	Rana et al. (2019)
	Interdependent infrastructure systems (DI7)	Farid et al. (2021)

	Lack of digitized information (DI8)	Meiyanti et al. (2018)
	Lack of qualifications (DI9)	Meiyanti et al. (2018)
	Network and telecommunication infrastructure (DI10)	Ambira et al. (2019), Gladkova and Ragnedda (2020), Masinde and Mkhonto (2019), Paul et al. (2020), Shin et al. (2020), Tonggiroh (2017), Meiyanti et al. (2018)
	Poor data availability and scalability (DI1)	Rana et al. (2019)
	Poor internet connectivity (DI12)	Aghimien et al. (2020), Silva et al. (2018), Farid et al. (2021), D. Aghimien et al. (2019)
	Sensing technology (DI13)	Farid et al. (2021)
	System failures issues (DI14)	Rana et al. (2019), Silva et al. (2018)
Politics (P)	Coordination, collaboration, and consultation (P1)	Aghimien et al. (2020), Rana et al. (2019), Khan et al. (2020), Meiyanti et al. (2018), Osifo (2018), Samsor (2021),
	Bribery and corruption (P2)	Ambira et al. (2019), Sulistya et al. (2019)
	Common goals, vision, and mission (P3)	Rana et al. (2019), Apriliyanti et al. (2020)
	Feedback system (P4)	Apriliyanti et al. (2020)
	Fragmented authority and decision-making power (P5)	Tan and Taeihagh (2020), Shin et al. (2020), Apriliyanti et al. (2020)
	Funds (P6)	Ambira et al. (2019), Masinde and Mkhonto (2019), Osifo (2018)
	Government support (7)	Tonggiroh (2017)
	ICT implementation (P8))	Ambira et al. (2019), Apriliyanti et al. (2020)
	Information sharing and	Samsor (2021), Shin et al.

	inconsistencies (P9)	(2020)
	Lack of inclusivity (P10)	Tan and Taeihagh (2020)
	Lack of investment in basic infrastructure (P11)	Tan and Taeihagh (2020)
	Lack of public-private partnership participation (P12)	Aghimien et al. (2020), Rana et al. (2019), Khan et al. (2020)
	Leadership (P13)	Aghimien et al. (2020), Meiyanti et al. (2018), Samsor (2021), Tonggiroh (2017),
	Motivation (P14)	Apriliyanti et al. (2020)
	Political willingness (P15)	Ambira et al. (2019), Apriliyanti et al. (2020)
	Political stability (P16)	Aghimien et al. (2020), Rana et al. (2019), El-Kholei and Yassein (2019)
	Poor governance/lack of trust government (P17)	Aghimien et al. (2020), Rana et al. (2019), Saini and Sandhiyaa (2020), El-Kholei and Yassein (2019), Deng et al. (2018)
	Resistance to change (P18)	Ambira et al. (2019)
	Resource allotment (P19)	Samsor (2021), Shin et al. (2020), Deng et al. (2018), Tonggiroh (2017)
	Small number of trained workers in jobs that use ICT (P20)	Ambira et al. (2019), Apriliyanti et al. (2020), Osifo (2018)
	Speedy urbanization and lack of wisdom from government (P21)	Khan et al. (2020)
	Transparency (P22)	Apriliyanti et al. (2020), Meiyanti et al. (2018), Shin et al. (2020), Sulistya et al. (2019)
	Turnover of workforce (P23)	Meiyanti et al. (2018)

Governance (G)	Accountability (G1)	Apriliyanti et al. (2020)
	Civil and criminal justice (G2)	Farid et al. (2021)
	Confusing and ill-adapted tax regulations (G3)	Saini and Sandhiyaa (2020)
	Ethics (G4)	Farid et al. (2021)
	Information and cyber security risks (G5)	Paul et al. (2020)
	Intellectual property thefts (G6)	Paul et al. (2020)
	Issues of openness of data (G7)	Rana et al. (2019)
	Lack of regulatory norms, policies, and directions (G8)	Rana et al. (2019), Aghimien et al. (2020), Tan and Taeihagh (2020), Saini and Sandhiyaa (2020), Meiyanti et al. (2018), Chia (2016)
	Lack of transparency and liability (G9)	Rana et al. (2019)
	Recognize electronic documents and transactions (G10)	Meiyanti et al. (2018)
	Standardization (G11)	Aghimien et al. (2020), Rana et al. (2019), Shin et al. (2020)
Economics and Business (EB)	Absence of foreign investors (EB1)	Aghimien et al. (2020)
	Budget for operational and maintenance costs (EB2)	Kwak and Lee (2020), Silva et al. (2018), Rana et al. (2019)
	Economic instability (EB3)	Aghimien et al. (2020)
	Global economy volatility (EB4)	Rana et al. (2019)
	High cost of IT training and skills development (EB5)	Aghimien et al. (2020), Rana et al. (2019), D. Aghimien et al. (2019)
	High IT infrastructure and intelligence deficit (EB6)	Rana et al. (2019)

	Industrial sickness (EB7)	Saini and Sandhiyaa (2020)
	Lack of competitiveness (EB8)	Rana et al. (2019), Aghimien et al. (2020)
	Lack of sustainable revenue (EB9)	Kwak and Lee (2020)
	Performance (EB10)	Silva et al. (2018)
	Slow economic growth (EB11)	El-Kholei and Yassein (2019), D. Aghimien et al. (2019)
	Weak financial resources and lack of funding (EB12)	Kwak and Lee (2020), Nasution et al. (2020)
Sustainability (S)	Carbon emissions effect (S1)	Rana et al. (2019)
	Degradation of resources (S2)	Rana et al. (2019)
	High rate of urbanization (S3)	Aghimien et al. (2020)
	Increase in population rate (S4)	Aghimien et al. (2020), Rana et al. (2019)
	Lack of sustainability consideration (S5)	Aghimien et al. (2020), Rana et al. (2019), Tan and Taeihagh (2020), Silva et al. (2018)
	Lacking ecological view in Behavior (S6)	Rana et al. (2019)
	Poor education system (S7)	D. Aghimien et al. (2019)
	Poor planning of cities (S8)	Aghimien et al. (2020)
	Poor waste management (S9)	Aghimien et al. (2020), Silva et al. (2018), Saini and Sandhiyaa (2020)
	Power supply (S10)	D. Aghimien et al. (2019), Saini and Sandhiyaa (2020)
	Traffic congestions in cities (S11)	Aghimien et al. (2020)

Note:

PS = People and Society

TI = Technology and Innovation

DI = Digital Infrastructure

G = Governance

P = Politics

E = Economics and Business

S = Sustainability

Source: Authors' work-based literature review

4 Super Smart Nation

4.1 Introduction

Countries across the globe are currently facing new and unprecedented challenges to their national future post the COVID-19 pandemic. The pandemic crisis is revealing the present strengths and weaknesses of countries' local governments based on their decisions regarding closing national borders for domestic and international travel, mobilizing the healthcare infrastructure immediately, and integrating and streamlining digital infrastructure. Moreover, nations globally are facing megatrends such as demographic changes, shifts in global economic power, urbanization, natural resource scarcity, climate change, and technological disruption.

Market research organizations and governmental research bodies try to predict the next election's outcome, economic growth rates, or futuristic trends for the following years. Furthermore, developed nations, such as Japan, Singapore, Estonia, and countries in the European Union, have started taking radical national transformational steps toward building people-centric super smart societies to overcome future economic development challenges and societal problems and enable free movement of goods, people, and services to facilitate living, doing business, offering public services, and enhancing international cooperation at the national, continental, and global levels. Long-term planning will help nations to forecast future challenges and take radical transformation steps toward facing them, as in the case of the COVID-19 pandemic crisis and the trade wars. Therefore, it is crucial to assess the future growth challenges and the requirements for transforming nations in a sustainable manner that pre-empts future socio-economic developmental

and societal problems. To do so, nations must contemplate these issues right now, and use the projected figures on the population in 2035, the present population, and the proportion of the population that will retire, among others, to forecast and prepare for the future. Although this information is readily available for national governments, nations fail to take appropriate steps toward long-term planning. Furthermore, achieving this desirable future depends on the futuristic thinking of national leadership, vision, common goals, mission, political stability, stakeholder involvement, and the actions the national governments.

The current world population (Population Reference Bureau, 2022) is 7,837 million and is predicted to increase to 8,847 million in 2035 and 9,688 million in 2050. Furthermore, 19% of Europe's population is above 65 years, whereas 3% and 9% of African and Asian populations, respectively, are above 65 years. The same segment of the population is also expected to increase in Europe by 2035 and 2050, raising more concerns about the decline in the size of the workforce, increase in social security costs, socio-economic development, and other social problems. Moreover, the percentage of the population aged less than 15 years in Europe is 16%, whereas the global average is 26% (41% in Africa and 24% in Asia), raising concerns about insufficient workforce in future.

Sustainable development and global transformation are the main targets of the United Nations' 2030 Agenda to strengthen universal peace, a plan for people, planet, and prosperity. To eliminate global poverty and address the challenges of sustainable development, all countries and stakeholders need to implement this plan through international cooperation. Furthermore, its vision is to ensure global access to the highest

quality of education at all levels. Countries around the globe are facing tremendous challenges in areas such as the digital divide, access to digital infrastructure, access to online and mobile technologies, income levels, climate change, and technology when it comes to sustainable development, leading to a rise in inequality within and between countries. However, the advent of information and communication technologies, global interconnectivity, and scientific and technological innovation in a wide range of fields, such as medicine and energy, present tremendous opportunities. It is now easier for people to gain access to education than before. We can accelerate human progress, bridge the digital divide, and develop knowledge societies. All national targets should be formulated in line with global ambition while taking local circumstances into consideration. Sustainable development must be considered in conjunction with other relevant ongoing processes in the economic, social, and environmental spheres.

Furthermore, the revised agenda of the United Nations calls for national policies for sustainable, inclusive, and inclusive economic growth. Moreover, regional and subregional integration, as well as interconnectedness among regional economic zones, are crucial for sustainable development. In the process of achieving sustainable development, each country is confronted with specific challenges. A special emphasis should be given to the most vulnerable countries, including African countries, the least developed countries, landlocked developing countries, and small island developing states. Further, to ensure that no one is left behind, quality education, health, and well-being should be prioritized. To achieve sustainable and inclusive economic growth, which are essential for prosperity, income inequality and wealth sharing should be addressed. Societies must be dynamic, resilient, innovative, and people-centered. Countries need to adopt policies that

promote sustainable industrial development, universal access to reliable, affordable, and modern energy services, and high-quality and resilient infrastructure. The implementation plan of each country will determine the country's economic and social development.

The process of digital transformation (Kamolov & Stepnov, 2020) has changed drastically since the start of the COVID-19 pandemic, and different national stakeholders have started to understand the benefits of digitalization. Hence, nations, governments, and lawmakers should shape nations toward building people-centric super-smart societies based on the concepts of smart nation, and super-smart society to improve people's living standards and boost the economic development of nations to ensure that nobody is left behind, that is, with regard to sustainable economic growth and addressing future social problems in developed, emerging, and developing nations. However, digitalization is not automatic in developed, emerging, or developing economies; it depends on several factors such as the education system, awareness, people and society, technologies, adoption of technology, research and innovation ecosystem, digital infrastructure, political leadership, laws, regulatory frameworks and policies, and proactive measures from government and international cooperation with nations, among others. Furthermore, countries are beset by a myriad of challenges that can be divided into 10 broad categories: people and society, robots, technology, research and innovation, digital infrastructure, data, politics, governance, economics and business, and sustainability.

Furthermore, Holroyd (2020), taking Japan as a case study, states that a super-smart society is still in the initial phases of development, and it is an innovative governmental initiative developed in response to the 3/11

earthquake and tsunami, futuristic challenges regarding the aging population, low birth rate, shrinking labor force, and the increasing costs for social security and healthcare. Super-smart societies cannot develop naturally; rather, nations must co-create them by involving relevant stakeholders and the use of advanced technologies. However, research on building super-smart nation concepts is in its nascent stage. Thus, we identify the following research questions to address the gaps in the literature.

- What are the characteristics of a super-smart nation?
- What are the challenges and solutions for nations in building a super-smart nation?

Additionally, we integrate the three key stakeholders of a smart nation, namely, government, companies, and people, which could be helpful for developing a super-smart nation and building a relevant framework by identifying the stakeholders, characteristics, pillars, and challenges for building a more people-centric society. The primary motivation of this study is to construct a framework for building a super-smart nation to overcome future challenges such as a pandemic crisis; decreasing population and workforce; increasing social security and healthcare costs; and restricted movement of goods, people, and services to boost economic development and solve societal problems. Unfortunately, research on building super-smart nations remains scarce, and a just a few of published frameworks are available. Accordingly, this study presents a robust framework to better understand the megatrends, stakeholders, characteristics, pillars, challenges, and rationales that are pivotal to the success of super-smart nations globally.

The remainder of this paper is structured as follows. The Background

section presents the theoretical background information on the concept of super smart nations and the relevant stakeholders, characteristics, pillars, and challenges; The Methodology section describes the Delphi methodology used in this study; it is followed by the Results section. The next section presents the discussion, and finally, we have the Conclusion section.

4.2 Background

A super-smart nation is a concept that can be built by analyzing the super-smart society (Mavrodieva & Shaw, 2020) and smart nations (Chia, 2016; Hoe, 2016). These concepts can be considered intermediate steps toward building a super-smart nation based on centralized and decentralized governance structures. Additionally, super-smart nations must adopt the theories developed to create a society that is people-centric and super-smart (also called society 5.0).

In addition, Sá et al. (2021) state that a super-smart society offers technological development to solve social challenges and build a sustainable society. According to Potočan et al. (2021), the super-smart society vision includes incorporating advanced technologies such as artificial intelligence (AI), big data, blockchain, Internet of Things, robots, and virtual reality in all industries and social activities to achieve economic development and solve social problems to accomplish the United Nations' Sustainable development goals (SDG's). On the one hand, according to Nair et al. (2021), a super-smart society is a concept whereby nations start to visualize AI and robots taking over human jobs to improve the quality of life of stakeholders (Aldabbas et al., 2020), and solve challenges that arise from the declining birth rate and workforce as well as the increasing social security costs for healthcare. On the other hand, according to Holroyd (2020), nations must co-create super-smart

societies by involving relevant stakeholders and using advanced technologies, as they do not develop naturally.

A smart nation is a concept in which all urban and rural citizens, governments, and businesses live in a smart society with semi automation, to improve public services, mobility, trade, and business, and living standards with high efficiency. It addresses challenges by taking a whole-nation approach for ease of living, doing business, and availing public services. Furthermore, smart nations are intended to resolve endemic urban problems such as aging, energy crises, pollution, safety, and crime using advanced technologies. However, this is presently a solution for developed nations and less populated nations such as Singapore. One way to achieve this is through e-residency, which opens digital borders to anyone, anywhere Georgiou et al., 2020; Li, 2018; Mukherjee et al., 2021; Orecchini et al., 2019; Rivera et al., 2017; Wong et al., 2020) through decentralized techno-governance for doing business and smart governance for offering better public services. It enables sustainable development and free movement of work without spatial and geographical barriers. It enables sustainable development and free movement of work without spatial and geographical barriers. It ensures sustainable development and free movement of workers without spatial or geographical limitations. Further, its mission is to foster innovation in the fields of online governance, cybercrime, and the development of the information society. A smart nation involves the transformation of governance from centralized to decentralized, and smart cities or digital nations can be seen as intermediate steps.

However, this is presently only a feasible solution for developed and less populated nations, such as Singapore, Estonia and Luxembourg. The Singapore Smart Nation and Digital Government Office views digital

government, digital business, and digital society as the building blocks of a smart nation. Furthermore, Estonia can also be considered a smart nation. Before the COVID-19 pandemic, Estonia built one of the world's most advanced smart and information societies, providing services like electronic voting, online education in schools, and electronic government. A defining characteristic of Estonia is its digital identity, accessible services, and secure data exchange via the X-Road, where Estonians retain full ownership of their data. Further, Deloitte reports that Luxembourg is also working towards becoming a smart nation because of its small size, lack of natural resources, and geographical location, in addition to other unique sets of challenges. To maintain its competitive position and address global trends and shifts, it is continuously developing its capabilities and competencies. A key component of Luxembourg's pursuit of becoming a smart nation is its emphasis on six pillars, namely technology and infrastructure, data, skills, and competencies, innovation culture, and public-private ecosystems.

Smart cities (De Azambuja et al., 2020; Joshi et al., 2016; Orecchini et al., 2019; Sharifi, 2019; Vasudavan & Balakrishnan, 2019) and Digital nations (Kar et al., 2019) can be seen as intermediate steps toward a smart nation, transforming governance from being centralized towards being more decentralized. Smart cities in smart nations are characterized by six main features: smart economy, smart people, smart governance, smart mobility, smart environment, and smart living. Every citizen, business, and government institution must accelerate digitalization and create smart societies. Moreover, smart cities have faced numerous challenges related to people, technology, politics, governance, economics, and sustainability. Further, IMD-SUTD (MD World Competitiveness Center, 2021) has developed a Smart city index that measures residents' perceptions of the available resources in their city, such as structures and technology. Overall, the

rankings range from 1 to 118, and they are evaluated in five key areas: health and safety, mobility, activities, opportunities, and governance. Singapore is ranked 1st, Zurich is 2nd, and Oslo is 3rd on the index. Switzerland had three cities in the top 10, with Lausanne, Geneva, and Zurich ranked 5th, 8th, and 10th, respectively.

The super smart nation comprises the government, companies, and people as its three key stakeholders. In addition, all such innovative solutions require full support, participation, and cooperation from citizens and the international community's support through dialogue. Therefore, this concept is cogent on participation by all members of society (Nagy & Hajrizi, 2019). However, this new concept requires an ecosystem for digital transformation. To execute such plans, it is essential to understand the stakeholders, characteristics, pillars, and challenges relevant to building a nation. A literature review on digital and smart nation helped to identify smart nation's stakeholders (i.e., government, companies, and people) and characteristics such as smart economy, smart people, smart governance, smart mobility, smart environment, and smart living. The literature review on digital nations and smart nations and the results from this study help categorize the challenges of building a super smart nation into ten categories (see Appendix A1): 1) people and society, 2) robots, 3) technology, 4) research and innovation, 5) digital infrastructure, 6) data, 7) politics, 8) governance, 9) economics and business, and 10) sustainability.

The three key stakeholders and the above-mentioned characteristics can be considered foundational building blocks for developing a super smart nation, and every citizen, business, government, and public institution (such as universities) plays a vital role in accelerating digitalization and building this new concept. Here, the government should act as a facilitator by creating an

environment that engenders more research and innovation along with more investments wherever necessary, bring all three stakeholders together to create a road map for the rest of the world, and create a modern nation through the development of super smart nation concepts.

4.3 Materials and Methods

This study attempts to gather more information on the characteristics of a super-smart nation through a literature review. In addition, scenario planning techniques based on the Delphi methodology (Arief & Sensuse, 2018; De Haes & Van Grembergen, 2009; Hsu & Sandford, 2007; Kluge et al., 2020; Melander et al., 2019; Schmalz et al., 2021; Thangaratinam & Redman, 2005) are used to identify the possible challenges and solutions in building a super-smart nation.

The literature review helped in developing the questionnaire for two to three rounds of interviews (Arief & Sensuse, 2018). We limit the Delphi rounds to a maximum of three rounds through consensus (Arief & Sensuse, 2018) approach to choose the study variables for identifying the challenges, which are conducted from June 21 2021 until July 25 2021. The experts are asked to select the challenges for super-smart nations by agreeing or disagreeing on a seven-point Likert scale (1 = strongly disagree and 7 = strongly agree). All mean values from the expert study with a value of five or less are deleted to measure the consensus approach. The Delphi research methodology is based on an established process (Melander et al., 2019) and comprises six stages: (1) developing projections, (2) questionnaire development, (3) inviting experts, (4) first round of questionnaire, (5) second round of study and feedback, and (6) third round of questionnaire and feedback. Figure 4.1 illustrates the Delphi research methodology used in this study.

Figure 4.1. Delphi research methodology process

4.3.1 Developing projections

The year 2035 is chosen as the target year for the scenario planning as it is far enough into the future to forecast the future challenges and solutions nations may have due to the increasing older population, decreasing birth rate and workforce, urbanization, technology disruption, trade wars, and socio-economic and societal problems. Additionally, long-term planning helps nations take steps to achieve their objectives. As part of the research methodology process, a questionnaire is required to identify the pillars and challenges concerning building a super-smart nation. Accordingly, one of the first steps is identifying the variables for the challenges that influence the development of a super-smart nation and grouping them into different categories of solutions (pillars).

We conduct a search using the Emerald, and Scopus databases to identify the study variables. This helps us gather interdisciplinary and relevant results published since 2016. Finally, we identify 74 relevant research papers, and two researchers engage in the review to identify the variables. Keywords such as smart cities, smart nations, digital nations, and super-smart societies are used to gather relevant research papers to identify and group the stakeholders, characteristics, and challenges into broad categories such as people and society, robots, technology, research and innovation, digital infrastructure, data, politics, governance, economics and business, and sustainability (see Appendix 4.1) to develop a questionnaire for the study.

4.3.2 Questionnaire development

Based on the findings of the literature review, the most important variables and questionnaire are discussed with four experts with experience in digital transformation, super-smart societies, digital nations, smart nations, and smart cities. In addition, a web-based study along with Zoom discussions with experts is identified as an efficient methodology for this study. After developing the questionnaire, a pilot study is conducted by sending the questionnaire to three subject matter experts. As part of the web-based study, the participants are given an introduction page with instructions, a page to share background information regarding their industry and years of experience, followed by one question per page. In addition, for each projection, the experts have the option to answer on a 7-point Likert scale (1 = strongly disagree and 7 = strongly agree).

4.3.3 Inviting experts

We select experts (see Appendix 4.12) from nine nationalities to obtain a broader study perspective and list research papers' corresponding authors as referees and experts in this area. We contact several experts through email and phone calls to ask if they are interested in participating in the study. We contact several experts to provide background information on the study through email with a PowerPoint presentation copy about stakeholders, characteristics, pillars, challenges and clear instructions, timelines, and mutually beneficial cooperation proposals to work together in the long term. In addition, the experts are informed about the kind of support that is required from them, how much time is needed for study participation, and how the information shared will be used. In total, 12 experts agree to participate in the

Delphi study. To obtain the best output for the analysis in a timely manner, several best practices are followed to improve the participation of experts, namely, clearly explaining the process and timelines, limiting the study to short online questionnaires followed by interactive Zoom sessions, sharing short updates on study progress and next steps, staying in touch with experts, and providing feedback regarding participation in the study.

4.3.4 First round of the questionnaire

The 12 experts who expressed interest in participating in the study are sent an automated personalized message and URL link to answer the study. We maintain the anonymity of each participant, and each participant's details are linked to the study link connected to the expert's email address. Accordingly, the experts are reassured of the privacy and security of the personal details that they share. The experts are given a period of one week to complete the first round of the study. After five days, a gentle reminder email is sent to participants who have not yet participated in the study. After one week, the study is closed, and the findings are shared with all the experts the following day. Then, based on the results, the reviewers of this study change the choices in the questionnaire for additional variables and make the necessary adaptations with experts' inputs for further rounds of the study.

4.3.5 Second round of the questionnaire

Based on the results of the first round, the mean values of variables with a score of five or less than five are dropped to facilitate the consensus approach. Then, 11 experts are interviewed through Zoom for approximately 90 minutes each, and the discussions are recorded. One of the 12 experts

dropped out due to health reasons. The second round of the study mainly focuses on the solutions for overcoming the challenges identified and shortlisted via the consensus approach in the first round. Moreover, we ensure that the time gap between the two Delphi rounds does not exceed one week. Thus, experts' knowledge and availability of time is not affected, and we have a higher response rate.

4.3.6 Third round of the questionnaire

In the final round, only 10 experts answer the online study sent via the SurveyMonkey tool. This round focuses on challenges wherein some of the experts gave suggestions for additional challenges in round one. The experts have one week to complete this round. After five days, a gentle reminder email is sent to experts who have not yet participated in the study. After one week, the study is closed, and the findings are collected and shared with all the experts.

4.4 Results

In this section, we describe the results of the challenges and pillars from online studies and expert interviews and outline a framework for building a super-smart nation. The challenges for super-smart nations are classified into 10 broad categories: people and society, robots, technology, digital infrastructure, data, research and innovation, politics, governance, economics and business, and sustainability (see Appendix 4.1). The extant research categories of smart cities (D. O. Aghimien et al., 2019; Rana et al., 2019), digital nations, and smart nations are further subcategorized without focusing on robots, data, and educational institutions. Since relevant research is scare, the challenge categories provide the basis for building a framework for

developing super-smart nations. The remainder of this section discusses each challenge, its pillars, and the framework.

4.4.1 Stakeholders

To identify the stakeholders of building super-smart nations, we use the stakeholders identified in the literature review for digital nations and smart nations for questionnaire preparation and use the Delphi research methodology process with experts through online studies and expert interviews to corroborate the findings. Additionally, the experts are asked to add to the list of challenges if they feel anything is missing. In this way, we identify three stakeholders as people, companies, and government from the three Delphi rounds. As Table 4.1 shows, the mean scores, and standard deviations of the stakeholders with respect to building a super-smart nation by 2035 are identified as well. Stakeholders with a score of five or a mean value of less than five are dropped.

Table 4.1. Key stakeholders associated with building super-smart nations

Categories	**Stakeholders to building super-smart nations**	**Mean**	**Standard deviation**
Stakeholders	People (Citizens)	6.75	0.60
	Businesses (Companies)	6.42	0.64
	Government	6.50	0.65

4.4.2 Characteristics

To identify the characteristics of building super-smart nations, we use the characteristics identified in the literature review for smart cities (Aghimien et al., 2020; Ali et al., 2018; Bifulco et al., 2016; Glyptis et al., 2020; Joshi et

al., 2016; Rana et al., 2019; Silva et al., 2018) for questionnaire preparation and use the Delphi research methodology process with experts through online studies and expert interviews to corroborate the findings. Additionally, the experts are asked to add to the list of challenges if they feel anything is missing. In this way, we identify six stakeholders from the three Delphi rounds. As Table 4.2 shows, the mean scores, and standard deviations of the characteristics with respect to building a super-smart nation by 2035 are identified as well. Characteristics with a score of five or a mean value of less than five are dropped.

Table 4.2. Key characteristics associated with building super-smart nations

Categories	**Characteristics to building super-smart nations**	**Mean**	**Standard deviation**
Characteristics	Smart economy	6.42	0.64
	Smart environment	5.67	0.94
	Smart governance	6.17	0.69
	Smart living	6.17	0.55
	Smart mobility	6.17	0.80
	Smart people	6.25	1.01

4.4.3 Challenges

To identify the challenges of building super-smart nations, we incorporate the challenges identified in the literature review for smart cities (Aghimien et al., 2020; Ali et al., 2018; Glyptis et al., 2020; Joshi et al., 2016; Rana et al., 2019; Silva et al., 2018), digital nation characteristics (Penmetsa & Bruque, 2021) and smart nations (Chia, 2016) for questionnaire preparation. Following this, we use the Delphi method and conduct online studies and interviews with a panel of experts. Additionally, the experts are asked to add to the list of challenges if they feel anything is missing. In this

manner, we identify 68 challenges from the three Delphi rounds. We also identify the mean scores and standard deviations of the challenges faced in building a super-smart nation (Table 4.3). Challenges with a score of five or a mean value of less than five are dropped.

The identified challenges are grouped into 10 categories to develop appropriate categories or new categories of challenges. The experts' inputs helped us to identify 68 challenges in 10 broad categories (Table 4.3).

Table 4.3. Key challenges associated with building super-smart nations.

Categories	**Challenges for building super-smart nations**	**Mean**	**Standard deviation**
People and Society	Digital literacy and divide (PS1)	6	0.95
	Changing nature of work (PS2)	6	0.58
	Poverty (PS3)	5.83	1.14
	Social and economic disparities (PS4)	5.75	0.83
	Aging population (PS5)	5.58	0.64
	Generation divide (Difference of opinions between younger people, their parents, and grandparents) (PS6)	5.4	0.80
	Lack of citizen participation (PS7)	5.25	1.09
	Decreasing work force (PS8)	5.08	1.19
Robots	Education and training to work with robots (R1)	5.82	1.11
	Safety (R2)	5.8	0.75
	Evolution of organizational workflows (R3)	5.42	1.04
	Privacy and trust in a human-robot co-working environment (R4)	5.42	1.50
	Acceptance of robots in workplace (R5)	5.25	1.36
Technology	Interoperability (T1)	5.92	0.95
	Lack of user-friendly applications (T2)	5.92	1.11
	Lack of technical support (T3)	5.67	1.03
	System integration (T4)	5.58	1.32
	Access to latest technologies (T5)	5.5	1.26
	Lack of data availability (T6)	5.33	1.18
	Information technology standards (T7)	5.25	1.09

Research and Innovation	Lack of funding (RI1)	6	0.82
	Education system (RI2)	5.92	1.19
	Focus on research and development on new technologies (RI3)	5.75	1.09
	Research into smart applications (RI4)	5.7	0.78
	Innovation ecosystem (RI5)	5.67	1.11
	Investment in disruptive technologies (RI6)	5.58	1.11
	Increased cost of research and development (RI7)	5.42	1.38
Digital infrastructure	Security and privacy (DI1)	6.25	0.83
	Power reliability (DI2)	6	1.10
	Internet reliability (DI3)	5.9	1.14
	Lack of interactive public services (DI4)	5.67	0.94
	Poor data availability and scalability (DI5)	5.67	1.11
	Lack of internet connectivity (DI6)	5.42	1.38
	System failures (DI7)	5.33	1.03
	Lack of network and telecommunication infrastructure (DI8)	5.25	1.30
	Lack of access to computer and technologies (DI9)	5.17	1.14
Data	Security (D1)	6.9	0.30
	Veracity (Managing the data quality, uncertainty, and trustworthiness of data) (D2)	6.5	0.50
	Privacy (D3)	6.4	0.80
	Value (Data is worthless until it is converted into value) (D4)	6.1	0.54
	Velocity (Speed at which data must be analyzed) (D5)	5.9	1.70

	Human dynamics (Humans' role in data collection, data analysis and decision making) (D6)	5.5	1.36
	Volume (Huge amount of data) (D7)	5.5	1.14
Politics	Political cooperation between countries (P1)	6.5	0.50
	Political leadership (P2)	6.5	0.67
	Political stability (P3)	6.17	0.69
	Common goals, vision, and mission (P4)	6.08	1.04
	Lack of government support (P5)	5.92	0.95
	Lack of governance and trust (P6)	5.92	1.50
	Coordination, collaboration, and consultation (P7)	5.67	1.25
	Corruption (P8)	5.5	1.19
	Lack of investment (P9)	5.33	1.18
	Lack of public-private partnership (P10)	5.17	1.46
Governance	Lack of regulatory frameworks and policies (G1)	6.25	0.92
	Lack of transparency (G2)	6.17	0.90
	Lack of accountability (G3)	6	1.29
	Lack of standardization (G4)	5.83	0.80
	Lack of stringent civil and criminal law (G5)	5.58	1.44
	Ethical practices (G6)	5.5	1.43
	Culture (G7)	5.08	1.04
Economics and Business	Know how in use of smart applications for business (EB1)	5.7	1.27
	Lack of financial resources (EB2)	5.33	1.31

	Lack of sustainable revenue (EB3)	5.33	0.75
	Lack of budget for operational and maintenance costs (EB4)	5.17	0.99
	Lack of laws and regulatory frameworks (EB5)	6.8	0.40
Sustainability	Lack of innovation integrated education system (S1)	6.4	0.92
	Lack of sufficient natural resources (S2)	5.6	1.36
	Lack of energy efficient devices (S3)	5.5	0.92
	Lack of energy supply (S4)	5.08	1.38

4.4.4 Pillars

In this subsection, we group the solutions identified from the analysis of the challenges into 11 categories including people and society, educational institutions, robots, technology, research and innovation, digital infrastructure, data, politics, governance, economics and business, and sustainability. If these categories are strengthened, they may be further categorized as pillars. Additionally, in the figures, the citations with numbers in parentheses denote the frequency with which the different experts propose the solutions to overcome the challenges. The remainder of this subsection discusses each pillar of the identified challenges.

4.4.4.1 People and Society

One pillar for building a super-smart nation is the people and society as they manage the technology. As notable in Figure 4.2, discussions with the experts reveal that creating more awareness and confidence is a solution for building a super-smart nation. After analyzing the data (see Appendix 4.4 to

4.11), we group the relevant solutions suggested by experts under the people and society pillars.

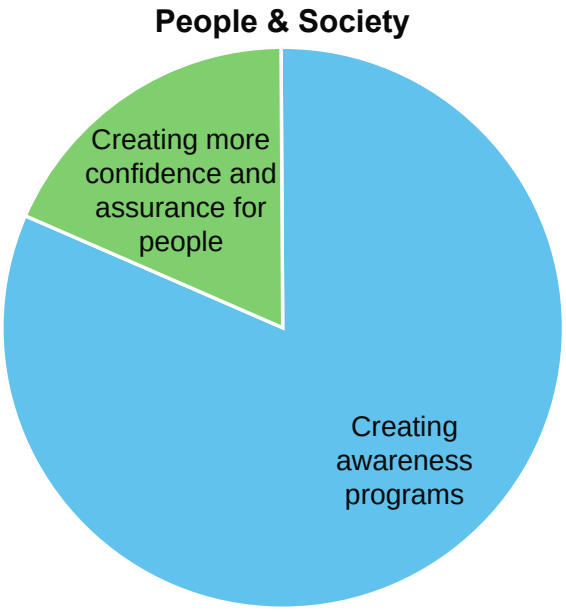

Figure 4.2. Key solutions associated with people & society for building a super-smart nation.

4.4.4.1.1 Creating awareness programs

According to respondent R3, creating more awareness programs using promotional channels, such as media using celebrities and society influencers, can help to motivate people to learn how to use technology and make everyone aware of digitalization. Furthermore, R2 expresses that creating more awareness programs on cybersecurity threats to young students at the gymnasium level, like what has been done in Denmark, can be viewed as a solution. R5 also expresses that identifying the segments of people who are digitally illiterate, visiting their homes, and helping them understand the benefits of using technology by educating them can be viewed as practical steps. Similarly, R1 states that countries must develop a specific policy to go out and find homeless people, create devices that are easier for the elderly to see and use, and give free digital devices to the poor.

Likewise, R8 states that creation of awareness programs about the benefits of robotics and automation and making older people understand the positive benefits of robots is necessary. R8 and R11 express that people and employees can take advantage of working for fewer hours than before by utilizing robots for less productive activities; having more social and personal life with a family can help to change the perception of people towards the use of robots. Additionally, R6, R12, R7, and R2 mention creating awareness of what robots can and cannot do, safety benefits for working for a longer duration of time, increasing efficiency by doing some activities in a shorter time than humans, and creating more confidence for humans in integrating humans and robots to work together, respectively, Further, R4 and R7 state that there is a need to create awareness among employees in organizations that they will not lose their jobs, will be rewarded with more value-adding activities, and further explain to them that change management is a lifelong learning process in organizations, make them accept the benefits of using technology and highlight the need for organizations to move forward with lifelong learning by upskilling to perform activities better and accepting robots in the workplace.

4.4.4.1.2 Creating more confidence and assurance for people

R8 mentions creating more confidence among people that they will be educated and trained how to use robots at work, so that people start to accept robots at work. Moreover, R7 states that educating citizens about successful use cases in Japan and similar countries would be very helpful. Similarly, R3 and R7 express that creation of more confidence and assurance among humans that robots are not going to replace humans, the work activities of robots will be integrated with those of humans, and an environment to enhance human skills will be provided, along with proactive measures by the

government developing policies to increase confidence and remove insecurity perception toward robots will be very helpful.

4.4.4.2 Educational institutions

Another pillar for building a super-smart nation are educational institutions. The analysis of this data (see Appendix 4.4 to 4.11) from the experts shows that the need for education and training is considered a solution to build super-smart nations. After analyzing the data, we group all the relevant solutions suggested by experts under the educational institution pillar.

4.4.4.2.1 Education and training

Discussions with R11 and R12 reveal a need to transform the education system as in Finland and South Korea, and develop long-term strategies and policies as in Estonia, by teaching coding in schools at the age of five years. Furthermore, R3 and R7 express that developing global uniform education standards to meet industry skill requirements is necessary, as most of nations' education systems are similar, excluding one or two country-specific courses. Moreover, R2 and R3 express that educating student about cybersecurity threats at the primary education level, such as gymnasiums, addressing the steps toward bridging the skills requirement gaps by involving the three stakeholders, that is, students, universities, and companies, and transforming the education system by meeting the expectations of demand and supply through proper education policies and stakeholder alignment can be beneficial initiatives. R4 expresses that encouraging citizen to study by offering free education can be helpful and motivating. In addition, R11 expresses that encouraging online education from top-ranking universities

and service providers at reasonable costs would be a beneficial initiative.

4.4.4.3 Robots

Robots are another pillar for building a super-smart nation. As observable in Figure 4.3, the analysis of data (see Appendix 4.4 to 4.11) from the experts shows that learning from the use cases of successfully adopted technology in countries and the use of advanced technologies, such as robotics and automation, are viewed as solutions for building a super-smart nation. After analyzing the data, we group all relevant solutions suggested by experts under the robot pillar.

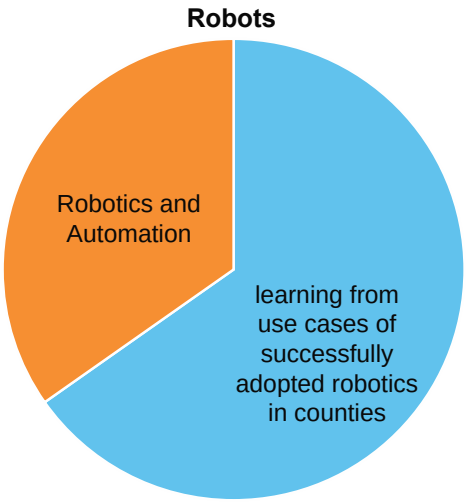

Figure 4.3. Key solutions associated with robots for building a super-smart nation.

4.4.4.3.1 Learning from use cases of countries that have successfully adopted robotics

The experts state that learning from use cases of successfully adopted robotics in countries is one of the solutions to overcome this challenge. R5 expresses that it is ideal to start using robots at home and later integrate

them into companies to make people understand the benefits of using robots. In addition, R1 states that Japan has been the best example to gain more knowledge on robots and cultural friendliness toward the use of technology and robots for many years. Additionally, R3 states that some schools in Japan have started using robots as teachers, some restaurants have replaced waiters with robots, and homes have started using robots for cleaning purposes as well. Furthermore, R1 mentions that making robots talk like humans and giving them googly eyes would make humans more comfortable and facilitates the acceptance of robots in society. Further, R12 expresses that robot can be used in locations where people get injured and automate processes in manufacturing sites.

4.4.4.3.2 Automation and robotics

Furthermore, R10 and R12 express that automation and the use of robots can help overcome these challenges. One of the best examples to explain automation and the use of robots is the Amazon Go store in America that has no human employees except the people who are managing it. Moreover, the entire checkout is performed automatically with cameras, including refilling the order of new stocks. In conjunction, R2 expresses the need for more research on human-friendly robots and adoption practices, including the challenges that we may encounter when we introduce robots in the human environment and mitigating dangers about safety and security while using robots.

4.4.4.4 Technology

Another pillar for building a super-smart nation is technology. The analysis of this data (see Appendix 4.4 to 4.11) from the experts shows that

the adoption of technology, involvement of the right stakeholders, and development of infrastructure are considered solutions for building a super-smart nation. After analyzing the data, we group all relevant solutions suggested by experts under the technology pillar as shown in Figure 4.4.

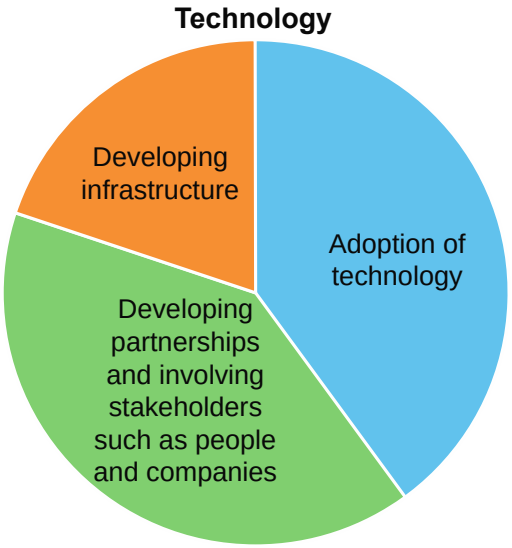

Figure 4.4. Key solutions associated with technology for building a super-smart nation.

4.4.4.4.1 Adoption of technology

R3, R5, and R8 express that developing user-friendly applications and smart assistance can help people adopt technologies. Accordingly, citizens can ask questions in whatever language they want and use video tutorials to use the technology. Furthermore, R11 states that involving the right stakeholders and building partnerships can be very helpful. Further, R11 goes on to say that public-private partnerships can help develop technologies and digital infrastructure if the government cannot fund the development of technologies, as is the case in Africa. The respondents mention that some top companies," such as Google, Facebook, and Amazon, revenues are much higher than that of some of the developing nations and building public-private partnerships for mutual benefit will be helpful. Similarly, R4

expresses that open-source collaboration is an excellent source for software development for people from various countries and regions to collaboratively work together toward common objectives and mutual benefit.

4.4.4.4.2 Developing partnerships and development of infrastructure

The experts mention that the development of infrastructure is significant for the development of a super-smart nation. Giving the example of self-driving cars, R8 states that developing interoperable infrastructure is very important because digital infrastructure must be interoperable with several other technologies such as blockchain, artificial intelligence, and 5G technology, among others. R7 expresses a need for the integration of a single and straightforward platform as interoperability does not currently exist, and we have many passwords for several purposes such as profile, medical, bank, and children's education. This kind of single and simple platform will change the perception and adoption of technology.

4.4.4.5 Research and Innovation

Another pillar for building a super-smart nation is research and innovation. The analysis of this data (see Appendix 4.4 to 4.11) from the experts shows that creating an innovation-based education system, developing an innovation ecosystem, funding for technology development, and public and private partnerships are solutions for building a super-smart nation. After analyzing the data, we group all the relevant solutions suggested by experts under the research and innovation pillar as shown in Figure 4.5.

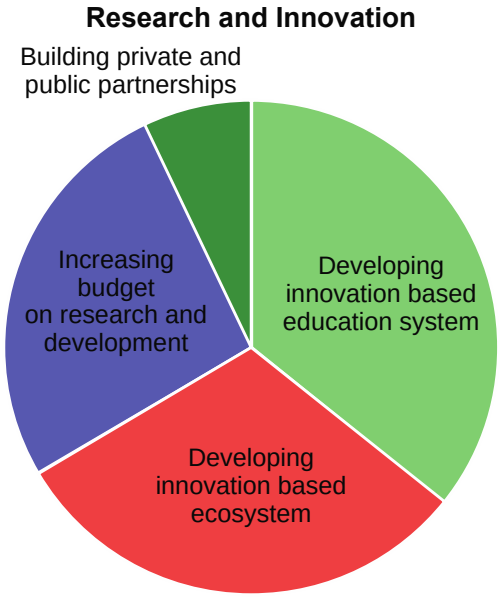

Figure 4.5. Key solutions associated with research and innovation for building a super-smart nation.

4.4.4.5.1 Innovation based education system

R3 mentions that there is a need to develop a global standard for education systems like global standards for mobile phones, the Internet, and cars. It is essential to educate students on case studies suitable for primary schooling with respect to future demands and innovation. People will talk about these technologies and understand their benefits. Moreover, R2 expresses that governments should redesign the education system with project-based education to promote creative skills. The expert mentions that the education system in India is far behind in this respect, and there is a need to address the gap between education at universities and industry requirements with mutual collaboration and cooperation. Furthermore, R8 expresses that the education system should evolve, as most education offered globally is similar except for two courses, namely, geography and history. Moreover, R12 expresses that integrating research-based curriculum into the education system can be helpful. In addition, R3 expresses that designing

study programs and curricula according to industry requirements is essential to finding jobs and avoid wasting time and money.

4.4.4.5.2 Developing innovation system

Experts R1, R2, R4, and R5 express that it is crucial to involve governments, companies, researchers, and citizens to build ecosystems that facilitate research, experiments, and building new technologies. Furthermore, R5 states that building an innovation ecosystem can be done such that students and companies are in the same building and work closely together to solve social problems and resolve smart nations' future challenges. Additionally, R2 mentions that the government needs to increase the budget for research and development, and R3 expresses that companies should collaborate with universities in pursuit of research and development. Finally, R7 states that working on customer-driven innovation is more critical as compared to design-driven innovation to ensure that people buy valuable and helpful things.

4.4.4.5.3 Increasing budget for research and development

R2 expresses the need to increase funding for the adoption of technology, as the budget spent by some countries is minimal. Moreover, universities and companies must cooperate to overcome national challenges. For example, in Denmark, universities and companies work closely together, which is not the case in India. Therefore, the government must fill this gap by bringing both stakeholders together with appropriate policies. Furthermore, R8 expresses that there is a need for research and development on Internet bandwidth regarding future technologies, such as 6G, as we are all heavily dependent on the Internet. Moreover, R8 goes on to say that research on

technological advancement on the blockchain is essential to storing our information, and if it is compromised, the whole nation will be in distress. Furthermore, quantum computing, a fast-processing computer, is in development. Therefore, we need to consider how to make secure data. In addition, R2 expresses that by increasing the budget on technology adoption, research on sustainable energy and sustainable development initiatives can help overcome these challenges.

4.4.4.5.4 Private and public partnerships

R10 expresses that private and public partnerships are important solutions. Furthermore, R11 states that the top five companies globally can provide services to governments that cannot solve all the problems. Moreover, the respondents express that there is a need for governments to develop regulations and laws to ensure that data are secure and not in the control of big companies in exchange for support extended by top companies. In addition, R6 states that collaboration with relevant stakeholders can help in utilizing the resources actively and catalyzing research on new technologies.

4.4.4.6 Digital infrastructure

Another pillar for building a super-smart nation is digital infrastructure. The analysis of this data from the experts shows that the use of blockchain technology for security and privacy, accessibility to digital infrastructure, and stakeholders' involvement are solutions for building a super-smart nation. After analyzing the data (see Appendix 4.4 to 4.11), we group all relevant solutions suggested by experts under the digital infrastructure pillar as shown in Figure 4.6.

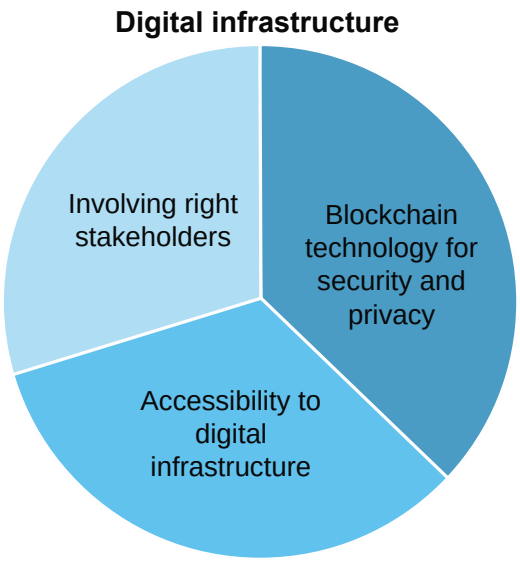

Figure 4.6. Key solutions associated with digital infrastructure for building a super-smart nation.

4.4.4.6.1 Blockchain technology for security and privacy

Experts R3 and R11 express that blockchain technology can be considered a solution for overcoming security and privacy challenges, and R2 states that the underlying mechanism of blockchain is based on cryptography. Furthermore, R12 expresses that blockchain can be used for identity and access management and critical digital infrastructure for accessing healthcare records information. Moreover, giving South Korea as an example, R8 mentions that future Internet technologies based on domain names are helpful in taking measures on security and privacy about digital infrastructure. In addition, R5 expresses that digital infrastructure that uses secure protocols is critical for overcoming the challenges of Internet reliability; even if the Internet goes down, the other parts of the system still function safely and securely.

4.4.4.6.2 Accessibility to digital infrastructure

The experts state that access to digital infrastructure is crucial. R1 states that national governments' top priority should include building a digital infrastructure, taking inspiration from, or following the lead of Central Africa. The steps taken by the governments of these nations have helped citizens access banking, retail operations, and political movements using the Internet. Furthermore, R3 states that the Internet, like education, should become a fundamental human right for everyone and be available across all living conditions.

Moreover, R7 expresses that Internet satellite infrastructure (star link) would be a perfect solution to overcome future challenges concerning Internet reliability. In addition, R6 mentions that it is essential to think holistically by considering other interactive devices and systems when developing digital infrastructure. Further, R8 goes on to say that network and telecommunication infrastructure is essential for smart home devices as it is based on the Internet of Things and is connected to other devices (e.g., self-driving cars for transportation). On the one hand, to ensure that everything is ordered, R5 states that a regulatory framework on the reliability of infrastructure is essential (e.g., Chinese telecom equipment used to build 5G infrastructure). On the other hand, R7 expresses that edge computing capabilities are required to analyze data at the edge before the use of cloud or data centers.

4.4.4.6.3 Involving right stakeholders

The experts mention that stakeholders' involvement is equally significant. R4 states that the government's topmost priority should be to develop new technologies through the development of public-private partnerships. Furthermore, giving the African partnership model as an

example, R11 mentions that public-private partnerships can help overcome the challenges of developing cheaper devices. This model can help overcome the challenge of affordability, and concurrently, companies can offer their services. Moreover, R6 expresses that it is essential to think holistically, and diversity involvement helps obtain feedback from different stakeholders. In addition, R4 states that to overcome the challenges of red tape, such as taking ten signatures to make decisions to push a file through various departments, it is crucial to bring all ten stakeholders into one room and then sit for one hour to have ten decision-makers' signatures or opinions. Furthermore, R4 goes on to say that a single-window permission system for foreign direct investors could be a good solution, as this is a working model in some nations.

4.4.4.7 Data

Another pillar for building a super-smart nation are data. As observable in Figure 4.7, the analysis of the experts' responses shows that the use of blockchain technology and advanced technologies can be considered solutions for building a super-smart nation. After analyzing the data (see Appendix 4.4 to 4.11), we group all relevant solutions suggested by experts under the data pillar.

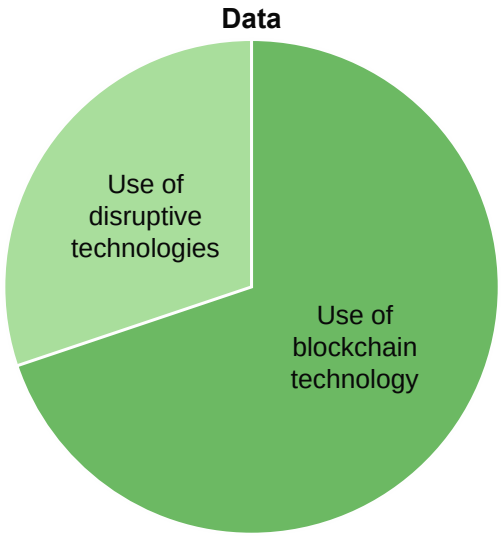

Figure 4.7. Key solutions associated with data for building a super-smart nation.

4.4.4.7.1 Use of blockchain technology

Experts R3 and R8 state that blockchain technology is a solution to manage data security protect data. R5 mentions that compliance by design with the mechanisms of self-sovereign identity can help overcome the above challenges.

4.4.4.7.2 Use of disruptive technologies

R2 expresses that big data architecture and new algorithms, such as deep learning and, more importantly, new computing paradigms, such as quantum computing, will help solve data challenges. Moreover, R7 states that faster data processing solutions can be used to secure high volume data, which can also be helpful in identifying value from data and process data at the edge for faster outcomes. In addition, R5 mentions that these semantic technologies can help to provide proactive services. R6 states that standardization could help in the management of data. R11 states that

standardization of data types and data processing is necessary.

4.4.4.8 Politics

Another pillar for building a super-smart nation is politics. As notable in Figure 4.8, the analysis of this data from the experts shows that top leadership motivation and commitment, technology, and digital knowledge and skills are solutions for building a super-smart nation. After analyzing the data (see Appendix 4.4 to 4.11), we group all the relevant solutions suggested by experts under the politics pillar.

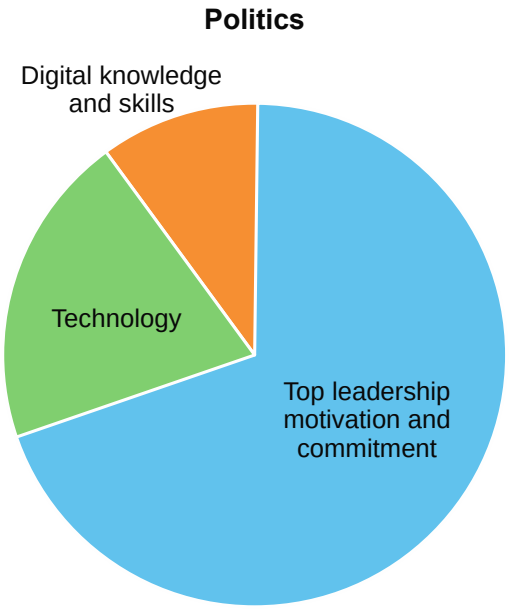

Figure 4.8. Key solutions associated with politics for building a super-smart nation.

4.4.4.8.1 Top leadership motivation and commitment

Experts R1, R2, R5, R6, and R12 express that having exemplary political leadership, understanding, motivation, and commitment is crucial. Without firm political leadership, commitment, and motivation, long-term objectives cannot be achieved. Furthermore, R12 gives Estonia's former

president as an example, as he was a former tech guru and saw the opportunity for a small country to expand its horizons using digital footprint. Moreover, R3, R5, and R12 state that shared goals, vision, and mission, and involving the right stakeholders by motivating them to support building a super-smart nation with agility is fundamental in understanding the changing global circumstances. On the one hand, R1 and R5 express that long-term planning with goals is beneficial (e.g., Japan has planned for the next 100 years, and China has a long-term strategy). On the other hand, R7 states that in addition to long-term plans, execution is essential. Most nations usually have long-term plans, but execution is always a problem. Lastly, R7 mentions a need for political evolution instead of having multiparty politics of 20 or 30 parties. It is good to have between two to five parties.

4.4.4.8.2 Technology

Expert R2 states that, with the right motivation from leadership, technology can play a role in increasing transparency. Furthermore, R3 expresses that big data could play an essential role in identifying exemplary leadership for governance as opposed to a group of political parties selecting their leadership. Moreover, R2 and R12 express that blockchain technology can play a significant role in increasing accountability and transparency, overcoming corruption, and keeping records safe and secure.

4.4.4.8.3 Digital knowledge and skills

Experts R5, R8, and R10 mention that education and awareness are fundamental; if leaders are not knowledgeable, planning for long-term goals and achieving them is difficult. Therefore, leaders must be tech-savvy and execute the plans in a knowledgeable manner. Lastly, R2, R6, and R7 state

that maintaining political cooperation between countries is crucial for a nation's growth.

4.4.4.9 Governance

Another pillar for building a super-smart nation is governance. As notable in Figure 4.9, the analysis of this data from the experts shows that developing policies, regulations, and laws, proactive measures from the government, top-down or forced-to-do approach, leadership, and use of advanced technologies are considered solutions for building a super-smart nation. After analyzing the data (see Appendix 4.4 to 4.11), we group all relevant solutions suggested by experts under the governance pillar.

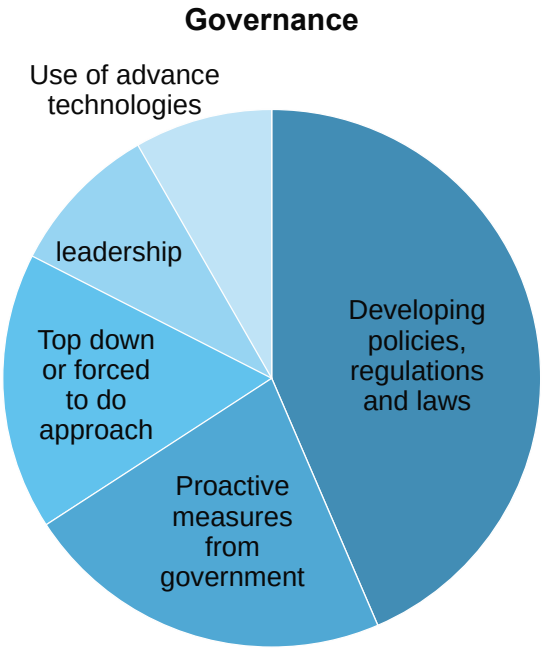

Figure 4.9. Key solutions associated with governance for building a super-smart nation.

4.4.4.9.1 Developing policies, regulations, and laws

R5 states that developing policies, regulations, and laws is essential to

building a super-smart nation. R5 goes on to say that, in the future, we need to automate the execution of policies, regulations, and laws for super-smart nations. Further, compliance by infrastructure like privacy by design, transparency by design, accountability by design, and everything by design are critical aspects of a super-smart nation. Furthermore, R2 mentions that governments must develop a legal framework that does not kill innovation (e.g., cryptocurrency is banned in India). In addition, R7 expresses that the government must develop regulatory policies and frameworks by involving key stakeholders and provide necessary guidance and required expertise for sustainable development.

Similarly, R3 mentions a need to develop policies, regulations, and laws on data security, privacy, and the use of public data. R11 expresses that there is a need for standardization of all data types and data processing. Therefore, these regulations can help in the management of data. Moreover, R5 states that compliance with infrastructure is required to manage the quality and security of data. Further, R3 mentions the need for new regulations regarding how corporations can use public data through data protection and privacy laws. R5 further states the need to develop a regulatory framework on telecom equipment reliability. Additionally, R3 expresses the need for a regulatory framework or document that states our rights regarding digital infrastructure.

On a different note, R11 expresses the need to develop policies, regulations, and laws about organizational workflows, accountability of robots, places to keep robots, certification of robots, and rules and regulations that every robot, machine, and person should follow in addition to a need to develop separate divisions for robots. Furthermore, R7 mentions that the government should develop a policy on robot use such that it helps employees and companies simultaneously. Moreover, R3 expresses the need to develop

new labor laws by considering the regulations of robots. In addition, there is a need for a system that could balance technology and resources equally and establish a board of control, as currently, there are no regulations regarding malpractice or mistakes in the use of robots because there is no accountability for robots. R3 goes on to say that robots should belong to people, as in the case of computers, the persons using the computers take responsibility if something goes wrong. Similarly, advanced devices, such as robots, must be the responsibility of real humans. In contrast, R10 states the fact that Volvo, the car manufacturer, takes responsibility for mistakes in their faulty autonomous driving system as another solution.

Additionally, R7 mentions that the government must take more innovative moves toward building a super-smart nation that will help develop low energy consumption devices and account for complementary industries and technologies. Some countries, such as India and China, are still dependent on coal, and others are pushing toward electric vehicles. Furthermore, R10 expresses that standardization is essential (e.g., COVID-19 vaccine certification) and there is a need to have global standards for the use of global technologies. However, it is essential to set the standard and interoperability from this point of view as well. Similarly, giving Bluetooth and USB 2.0 and 3.0 as examples, R4 states that international standards are essential, as they facilitate trade standardization. In addition, R7 expresses that there is a need for a central regulatory body irrespective of the councils of the different states. Further, cross-border trade must be a more streamlined process as in space exploration. For space exploration, most countries work together without restrictions. However, trade functions differently. For example, Countries may conduct selective trading with respect to other countries' products. Therefore, it is crucial that governments establish a kind of trade body to work together.

4.4.4.9.2 Proactive measures from the government

Expert R2 expresses that governments' proactive measures can be considered as significant factors for the development of super-smart nations through digitalization as in Denmark and European countries. Furthermore, R1 mentions that following the steps of developed nations by identifying the gaps for the development of gigabyte speed, and then moving quickly toward achievement can be viewed as a proactive measure. Additionally, R1 goes on to say that some nations are following the lead of Canada, the United States, Australia, New Zealand, and Scandinavia. Moreover, R4 and R7 express that the government must play an active role in establishing infrastructure, supporting the use of technology, incentivizing people to use technology, encouraging people to participate and contribute to their national development for benefits and good career opportunities, and encouraging people to use specific mobile applications and schemes to purchase devices.

In addition, R5 states that reducing uncertainty from the governments' side is crucial. Accordingly, R5 says that the government should play a significant role in building the vision of a super-smart nation; otherwise, companies will not make investments due to uncertainty. Furthermore, R7 states that the government should create a vision by scaling up technology through scenario planning. R1 expresses that the government should act as a supporting pillar by creating an environment for good incomes, decent jobs, and creative work. Similarly, R3 mentions that smart data would help us to understand the demand system accurately, and create solutions accordingly, such that funds are used wisely and for correct requirements.

4.4.4.9.3 Top down or force to do approach

The experts mention that a top-down or force-to-do approach is another

solution. R1 mentions authoritarian countries, such as China and Russia, imposing the need for and use of technology on people. Likewise, R3 references the Indian government's actions regarding the use of digital technology in 2016 during the demonetization of the currency. Similarly, R10 expresses that pandemic, such as COVID-19, are forcing people to adopt the use of technology. In addition, R8 expresses that the government should force application developers toward developing user-friendly applications. R8 and R4 go on to say that national development policies concerning having more children as in China and developed nations changing immigration policies by encouraging a skilled workforce are solutions to overcome the challenges of an aging population and shrinking workforce. Additionally, R2 advocates the national policies of imposing appropriate taxes based on income without loopholes. Moreover, R7 proposes that offering staggered solutions for educated people, rich people, and rural people can help to reduce social and economic disparities.

Further, R12 references Australia building a digital identity scheme through a public consultation program and creating a digital identity dashboard to highlight the importance of stakeholder involvement. Thus, the public can give their views and consent on what is acceptable. Other experts express that the government should involve people in critical decisions through awareness programs to make them feel involved and satisfied. Additionally, R7 states that people learn from other examples or use cases of other countries and talk about the best practices. Therefore, it is vital to get them involved by explaining the use cases of other countries.

4.4.4.9.4 Leadership

The experts further mention that leadership could be viewed as one of

the solutions to overcome these challenges. R3 expresses that, for example, Microsoft and Google do not follow the traditional culture of handing over the company to their children or local people. Instead, they identify and choose exemplary leadership based on merit. Such a model can help in choosing exemplary leadership for governance as well. Additionally, R7 states that there should be strict requirements for the criteria and skills needed to become a minister, including education, technology, knowledge, and experience outside of politics.

Furthermore, R5 expresses that this problem can be overcome by creating a sense of urgency and stability with a long-term strategy for leadership. R1 mentions that it depends on the country and people's trust in the government. As in some countries, leadership and trust in the government have been challenged. Some experts express that proper motivation from the leadership and increasing the budget for sustainability are essential. R2 expresses that the biggest challenge for governments is to understand innovation and devise a legal framework that does not hamper innovation. Since innovation is backed by people, the government must devise mutually agreeable regulatory frameworks. However, R1 cites the Singapore government as an example, and references the fact that the government has a high level of trust in civil servants, provides them with good pay, and fires them if they fail to perform.

4.4.4.9.5 Use of advanced technologies

Expert R5 mentions that the use of semantic technologies with accountability by design, transparency by design, regulatory frameworks, and policies by design, and automating these frameworks is essential. Furthermore, R3 expresses that blockchain can help minimize public money

by improving its efficiency and increasing transparency. In addition, R2 and R8 express that blockchain technology can play a significant role in automating some activities and increasing security and privacy. Moreover, R3 states that AI and the Internet of Things can help us understand human behavior in choosing appropriate people and specialists with respect to national requirements and public opinion.

4.4.4.10 Economics and business

Another pillar for building a super-smart nation is economics and business. As observable in Figure 4.10, the analysis of this data from experts shows that encouraging entrepreneurship, self-sustainability measures, and public and private partnerships are solutions for building a super-smart nation. After analyzing the data (see Appendix 4.4 to 4.11), we group all the relevant solutions suggested by experts under the economics and business pillar.

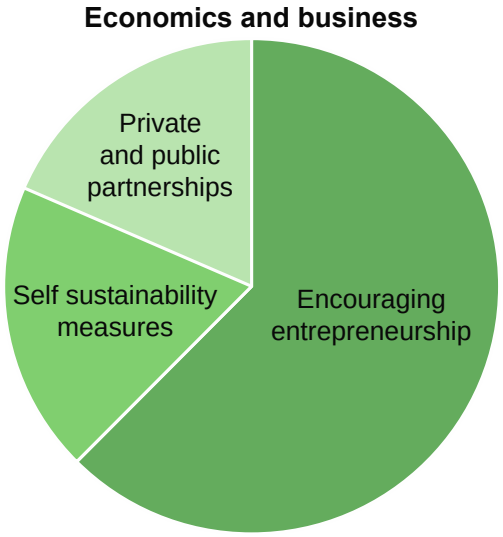

Figure 4.10. Key solutions associated with economics and business for building a super-smart nation.

4.4.4.10.1 Encouraging entrepreneurship

Expert R7 proposes that the government could devise a formal way to engage with startups, which will contribute to the growth of societies by incentivizing startups on the road to building a super-smart nation. In other words, it is crucial to facilitate the growth of startups as opposed to selling the firms to cash in on a popular idea. Furthermore, R4 expresses that the government must develop economic policies to increase funding for micro, small, and medium enterprises, develop special economic zones to set up startup shops in the region, and fine-tune the banking system by encouraging entrepreneurship and taking risky steps that may be helpful for promoting entrepreneurship. Moreover, R12 cites Estonia as an excellent example in the promotion of entrepreneurship. In addition, there are initiatives in the US by many venture capitalists and government programs to minimize the barriers to entry with respect to the startup community, including providing capital to those startups that require it for building infrastructure.

Likewise, R3 has expresses that identifying talent irrespective of previous education, grades, age, gender, or color is equally important to promote entrepreneurship and innovation. This can be done by taking advantage of hackathons, which present challenges for random people and create opportunities for them with investment opportunities, such that, regardless of age and education, talent and resources from the world over can be identified to solve global problems. Similarly, R2 states that promoting entrepreneurship among students can be viewed as a possible solution. R7 mentions that his companies extend free consulting services to startups as part of corporate social responsibility to encourage entrepreneurship and innovation.

4.4.4.10.2 Self-sustainability measures

R3 mentions the significance of self-sustainability measures by local institutions for the development of super-smart nations. In other words, local institutions do not have to depend on any other entities to build their power resources and developing intelligent transport systems for a super-smart nation or smart city is not only about technology, but also about enhancing lives to be more simplified and healthier. Additionally, R3 goes on to cite Switzerland, which developed technology for themselves and equally for the global requirement, as an example. Thus, the concept of a super-smart nation includes helping increase the quality of life of other people as well. Furthermore, R6 expresses that the government can provide guidelines on areas that may receive governmental help initially but must later be supported by companies.

4.4.4.10.3 Private public partnerships

R5 states that public-private partnerships are a solution to overcome this challenge. In addition, R5 goes on to say that the government must create a collaborative ecosystem for companies, businesses, and governments regarding incentives and subsidies by encouraging and inviting companies to participate in super-smart nation development. Furthermore, R11 expresses that companies would play a significant role, as governments in some nations do not have the required resources. Here, companies must fund the resources, push for research, encourage startups by reaching out to people, and build a digital society.

4.4.4.11 Sustainability

Sustainability is another pillar for building a super-smart nation. As observable in Figure 4.11, the analysis of this data from the experts shows

that the development of sustainable energy sources, international cooperation, and trade agreements are relevant solutions. After analyzing the data (see Appendix 4.4 to 4.11), we group all relevant solutions suggested by experts under the sustainability pillar.

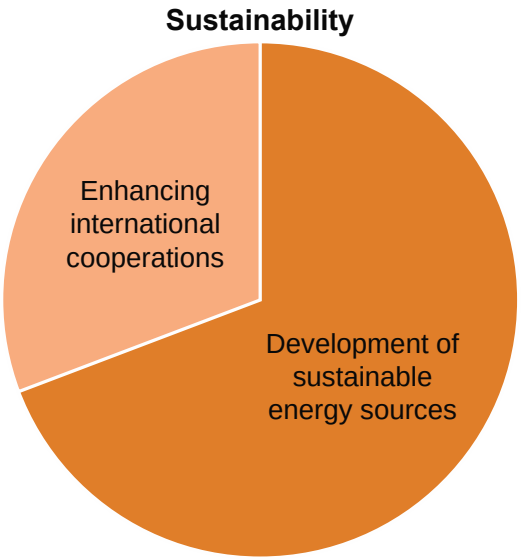

Figure 4.11. Key solutions associated with sustainability for building a super-smart nation.

4.4.4.11.1 Development of sustainable energy sources

Experts R5 and R11 mention that sustainable energy sources can be considered a solution, as we have plenty of natural sources, and bioeconomy, such as solar energy, is a promising and sustainable solution. Similarly, recycling is a good solution as opposed to throwing away old devices. Likewise, the present oil prices are relatively cheaper, but they are damaging our planet. R2 expresses that Denmark receives 50% - 60 % of its total energy from wind power. Developing countries like India are moving toward such energy sources as well. R12 references the Australian government pushing for solar panels on the roofs of all houses in Australia by providing subsidies. However, R8 expresses that the lack of natural resources is not a

problem, and this can be overcome with international cooperation and collaborations (e.g., Singapore supporting other nations with technology).

4.4.4.11.2 International cooperation's and trade agreements

R7 states that international cooperation and trade agreements are essential to overcome some of China's challenges. China controls most of the rarer minerals used to produce mobile phones. If China stops producing or stops allowing other companies or countries to access these minerals, it will pose a severe challenge. China can potentially monopolize some resources. In addition, R12 mentions that internet and cybersecurity treaties are crucial for national security within countries.

4.5 Discussion and Conclusions

Figure 12 illustrates the framework for building a super smart nation based on a literature review of stakeholders, characteristics, challenges, and solutions (see Background Information and Results sections), using a scenario planning technique. The overall objective of building a super smart nation is to facilitate living, conducting business, offering public services, enhancing international cooperation for socio-economic development, and overcoming future social problems. The theories that have been developed to create a people-centric and super-smart society and smart nations can be incorporated into building a super-smart nation.

Using the results from the Delphi methodology, as shown in Figure 12, a new framework is built to generate value for all key stakeholders, namely, the government, companies, and people. The framework has six

characteristics—smart economy, smart people, smart governance, smart mobility, smart environment, and smart living—and eleven categories of pillars—people and society, educational institutions, robots, technology, innovation and entrepreneurship, digital infrastructure, data, politics, governance, economics and business, and sustainability. These stakeholders, characteristics, and pillars help in creating a super smart nation and overcoming the corresponding challenges. These pillars are developed based on challenges (see Results sections) and were identified and analyzed through experts' discussions and interviews. This study helps identify 10 categories of challenges and 11 pillars of solutions, as opposed to extant research, which provides only six categories of challenges in smart cities and digital nations. The characteristics of a super smart nation continuously interact with each other using cyber-physical systems and future technologies, such as ambience intelligence. Continuous interactions between humans and machines provide opportunities for the development of super smart nations.

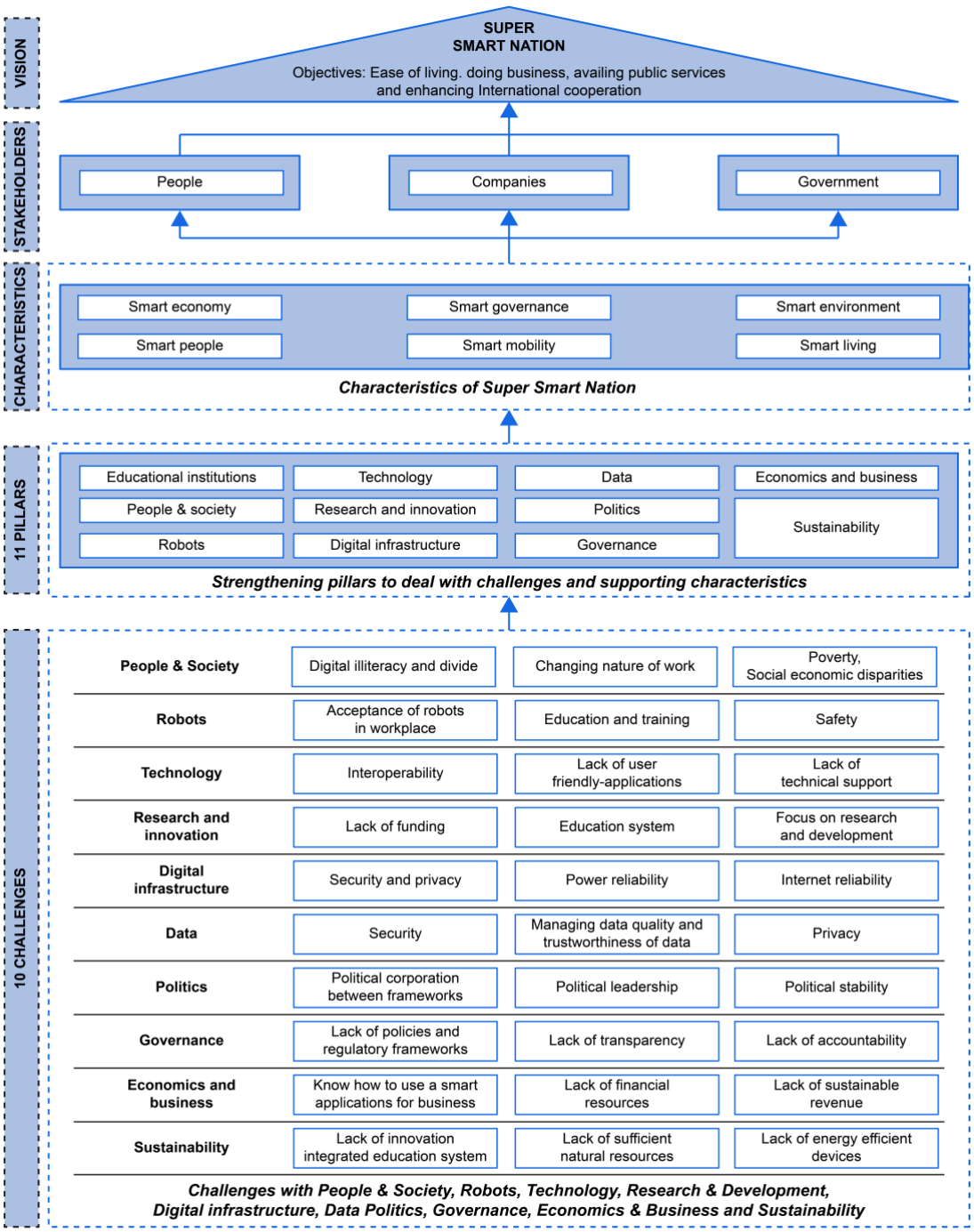

Figure 4.12. A super-smart nation framework.

According to earlier research by Penmetsa and Bruque (2021), on digital nations, this concept is developed by adopting the theories that could stem from digital government, digital business, and digital societies. Moreover, digital government theories can facilitate the transformation of digital nations by broadly outlining plans for the relationship between governments and citizens (G2C), between the government and businesses and industrial departments (G2B), and among different government units (G2G) (Singh et al., 2020; Tonggiroh, 2017; Weerakkody et al., 2011). Furthermore, research on digital nations has three main elements: digital government, digital business, digital society—and six categories of challenges and pillars—people, technology, institutions, policy, economics, and sustainability. This study was focused on building a digital nation framework to promote ease of living, conduct business, offer citizens public services, and identify the stakeholders and mainly challenges at a national level.

Similarly, early research on smart nations focuses on how urban and rural citizens, government, and businesses live in a smart society, to improve public services, mobility, trade, business, and high efficiency living standards. The overall objective of building a smart nation is for ease of living and doing business and to offer better public services and resolving endemic urban problems such as aging, energy crises, pollution, safety, and crime through the use of advanced technologies such as artificial intelligence, big data, 5G, and other networks that connect humans and machines. The building blocks of a smart nation is based on digital concepts such as digital nations, and smart cities. This concept is developed to allow citizens to access better health services, education, and technology, as well as equal work opportunities with ease, and enable sustainable development at sub-regional and national levels. It involves three stakeholders: the government, economy, and society and has six characteristics: smart economy, smart people, smart governance, smart

mobility, smart environment, and smart living of smart cities. Moreover, there are seven pillars: people and society, technology and innovation, digital infrastructure, politics, governance, economics and business, and sustainability to accelerate digitalization and to develop smart societies.

The study of building a super smart nation also illustrates some important solutions to overcome potential challenges that have not been addressed by prior research on digital nation, smart nations, and smart cities.

The creation of super smart nations is initiated by the people. To create a smarter society, awareness programs (using celebrities and other society influencers) need to be developed. Furthermore, it would be helpful to educate citizens about successful use cases in Japan and other comparable countries; to identify the segments of people who are digitally illiterate, to visit their homes and motivate them to use technology; to design devices that are easy for the elderly to see and operate, and to provide free devices to needy people. Moreover, it is also very important to instill more confidence among workers that they will be trained and educated about operating robots at work. Additionally, it creates the perception among humans that robots will not replace them.

Robotics is crucial for nations dealing with an aging population and a declining workforce. The use of use cases of successful technology adoption in countries to overcome these challenges is a helpful starting point (ideal to start using robots at home before integrating them into businesses; Japan is a great example for learning more about robots and cultural compatibility when using technology). Likewise, the use of advanced technologies, such as robotics and automation (such as the Amazon Go store in the United States, which is run solely by robots, just the people who manage it) is seen as a way to create a super-smart nation.

Likewise, technologies are considered crucial to super-smart nations. Technology (the development of technologies through public-private partnerships; open-source collaboration) can be a useful tool for collaboration and attaining common goals. It is also crucial to develop an interoperable infrastructure that is compatible with multiple advanced technologies, such as blockchain, artificial intelligence, and 5G. Moreover, creating a single platform for interoperability across numerous use cases is beneficial.

A super smart nation also relies on research and innovation. According to the results, a global standard for education systems can be developed based on an innovation-based education system like global standards for mobile phones, the Internet, and cars. Further, development of an innovation ecosystem (involving governments, companies, researchers, and citizens) and increase the budget for research and development (increase funding for the adoption of technology; the need for research and development on Internet bandwidth regarding future technologies, such as 6G; research on sustainable energy and sustainable development initiatives). Additionally, forming public and private partnerships (such as creating a collaborative ecosystem by encouraging and inviting companies, encouraging startups) and developing infrastructure (developing interoperable infrastructure) could also be beneficial.

Digital infrastructure is also a prerequisite for a super-smart nation. Among the solutions to overcome challenges such as ensuring cybersecurity and privacy using blockchain technology; ensuring accessibility to digital infrastructure (making access to the Internet a fundamental right; developing Internet satellite infrastructure such as star links); and implementing infrastructure regulatory frameworks and initiating policies similar to Africa Partnership Model, which allows foreign direct investment

approval on a single-window basis.

Super-smart nations rely on data as well. To overcome the challenges experts have advised that blockchain technology (which can protect sensitive data and is compliant by design with mechanisms for self-sovereign identities) and semantic technologies (which can deliver proactive solutions) can contribute to the development of a smart nation.

Super smart nations begin with an unwavering commitment from the nation's top leadership and political pillar. Some of these include top leadership commitment (e.g., Estonia's former president was a technologist); developing long-term goals (e.g., Japan has planned for the next 100 years); developing a vision and mission (by involving right stakeholders such as people, companies, and government).

In addition, a super-smart nation must have effective governance. The findings of the study indicate that these challenges can be overcome through proactive steps from the government (such as identifying the gaps for the development of gigabyte speed, then moving quickly toward achievement; government playing an active role in establishing infrastructure, and encouraging people to participate in and contribute to national development) and creating awareness programs (on the benefits of robotics and automation). Additional issues include the development of policies, legal frameworks, and laws (automating the execution of policies, regulations, and laws through compliance; developing infrastructure for privacy, transparency, and accountability by design; a legal framework that does not dampen innovation; developing policies, regulations, and laws on accountability of robots) can help strengthen the governance pillar. Further, educational institutions could also be an instrumental support for governance. This can be done by transforming the education system (transforming the education

system as in Finland and South Korea, and developing long-term strategies and policies as in Estonia, by teaching coding in schools from the age of five years; developing global uniform education standards).

Another pillar is economics and business. Among the solutions for overcoming these challenges is encouraging entrepreneurship (incentivizing startups on the road to building a super smart nation, and identifying talent irrespective of previous education, grade, age, gender, or color). Further, implementing self-sustainability measures for economics and business (build own power resource and guidelines for initial governmental assistance); focusing on sustainable energy sources (bioeconomy, solar energy, and wind power); and enhancing international cooperation and collaboration.

Sustainable development of super smart nations relies on sustainability as well. Among the solutions to these challenges can be found the development of sustainable energy sources (bioeconomy, including solar energy, is promising, recycling old devices as an alternative to throwing them away), international cooperation, and free trade agreements.

The characteristics of a super smart nation continuously interact with each other using cyber-physical systems and future technologies, such as ambience intelligence. Continuous interactions between humans and machines provide opportunities for the development of super smart nations.

Furthermore, the study on super-smart nation follows a “whole-nation” approach by involving the three key stakeholders—governments, companies, and citizens—along with six characteristics of a super-smart nation for ease of living, doing business, offering public services, and enhancing international cooperation between developing, emerging, and developing nations to overcome socioeconomic development and social problems. The primary

objective of a super-smart nation is to overcome the challenges stemming from the increase aging populations, decreasing birth rates, shrinking workforces, increasing costs for social security services and healthcare, pandemics, natural disasters, and trade wars by increasing the use of robots and automation in order to overcome challenges in human resources. Thus, the framework developed in this study serves as a roadmap for countries globally regarding fostering the use of super-smart concepts and advanced technologies such as 6G telecommunication networks, advanced 3D printing, ambient intelligence, AI, battery technologies, big data, blockchain, cloud computing, cyber-physical systems, cyborg enhancement technologies, drones, the Internet of Things, machine learning, smart mobile phones, robots, and sensors to achieve the United Nations' SDGs at national, regional, and global levels.

A super smart nation could be built through international cooperation among developed and developing countries. By integrating cyberspace, physical space, and humanity, this study can have significant implications at the sub-regional, national, continental, and global levels for building nations with the ability to overcome and solve social problems. We discuss a variety of stakeholders, characteristics, pillars, and challenges as well as factors that may determine whether a super smart nation is successful. As digitalization activities are being rapidly carried out, especially in developed markets where aging populations, shrinking workforces, and societal problems are causing concern, this framework may be of interest to government officials and corporate executives. Further, it is useful for governments, along with scholars, since interest in smart societies has grown exponentially since the COVID-19 crisis.

We expect that super-smart nation governments will help to reshape

business and societies at sub-regional, national, continental, and global levels. In turn, companies can work closely with the government to support public services, while the government can act as a facilitator that ties the three stakeholders together to achieve the UN SDGs.

We established a set of stakeholders, characteristics, pillars, and challenges that could help facilitate digital transformation. This super smart nation framework may interest public administrations and researchers involved in digitalization who study the critical challenges within the 10 categories listed above, along with identified solutions, and thus pursue the building of a super smart nation for developed, emerging, and developing economies.

Nevertheless, this study has some limitations. First, our work is mainly derived from interviews with a small group of 12 subject matter experts. The structure of a super smart nation could have been further reviewed through additional interviews with experts from governments, companies, and citizens, instead of experts with research experience on this topic and through the Delphi methodology. Future studies can examine exploratory research using national case studies at the individual level for scenario planning. Furthermore, future studies can select research studies with common characteristics at the national, continental, and global levels. Our research will continue to improve our findings through expert interviews and national scenario planning by involving the three stakeholders to enable the development of a super smart nation.

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Appendix 4.1. Ten categories of key challenges associated with building a super-smart nation.

Categories	**Key Challenges**	**References**
People & Society (PS)	Adoption (PS1)	Paul et al. (2020)
	Adaption (PS2)	Zakzak (2019), Nahavandi (2019)
	Aging population (PS3)	Holroyd (2020), Mavrodieva and Shaw (2020), Zengin et al. (2021)
	Awareness (PS4)	Ambira et al. (2019), Paul et al. (2020), Samsor (2021), Aghimien et al. (2020), Rana et al. (2019)
	Changing nature of work (PS5)	Holroyd (2020), Nair et al. (2021)
	Cyber addiction (PS6)	Aldabbas et al. (2020)
	Culture (PS7)	Ray (2018), Nasution et al. (2020), Aghimien et al. (2020), Zakzak (2019), Meiyanti et al. (2018), Ambira et al. (2019)
	Decreasing labor force or population (PS8)	Mavrodieva and Shaw (2020), Zengin et al. (2021), Nair et al. (2021), Shiroishi et al. (2018)
	Digital illiteracy and divide (PS9)	Ambira et al. (2019), Deng et al. (2018), Gladkova and Ragnedda (2020), Masinde and Mkhonto (2019), Meiyanti et al. (2018), Samsor (2021), Shin et al. (2020), Tan and Taeihagh (2020), El-Kholei and Yassein (2019), Sá et al. (2021), Aldabbas et al.

		(2020), Nahavandi (2019), Mavrodieva and Shaw (2020), Sarfraz et al. (2021), Apriliyanti et al. (2020), Osifo (2018)
	Geographical diversification problems (PS10)	Rana et al. (2019)
	Growing crime rates and Terrorism (PS11)	Aghimien et al. (2020), Saini and Sandhiyaa (2020), Shiroishi et al. (2018)
	Healthcare (PS12)	Mavrodieva and Shaw (2020)
	High level of dependent population and overpopulation (PS13)	D. Aghimien et al. (2019)
	High rate of unemployment (PS14)	Aghimien et al. (2020), D. Aghimien et al. (2019), Zengin et al. (2021) , Aldabbas et al. (2020)
	Inclusion of communities and participation (PS15)	Mavrodieva and Shaw (2020), Potočan et al. (2021)
	Internet gaming disorder (PS16)	Aldabbas et al. (2020)
	Issues of ethics and different values (PS17)	Mavrodieva and Shaw (2020)
	Increase in population rate (PS18)	Aghimien et al. (2020), Rana et al. (2019)
	Lack of citizen participation (PS19)	Aghimien et al. (2020), Rana et al. (2019), Tan and Taeihagh (2020), El-Kholei and Yassein (2019)
	Motivation for compliance (PS20)	Aldabbas et al. (2020)
	Poverty (PS21)	Aghimien et al. (2020), D. Aghimien et al. (2019), Zengin et al. (2021)

	Skilled technological support (PS22)	Sarfraz et al. (2021)
	Social and economic disparities (PS23)	Mavrodieva and Shaw (2020), Ray (2018), Meiyanti et al. (2018), Zakzak (2019), Aldabbas et al. (2020)
	Social acceptance (PS24)	Shiroishi et al. (2018), Aldabbas et al. (2020), Tan and Taeihagh (2020)
	Women empowerment and gender bias (PS25)	Saini and Sandhiyaa (2020), Aldabbas et al. (2020)
Robots (R)	Humans competing with robots (R1)	Demir et al. (2019)
	Learning to work with robots (R2)	Demir et al. (2019)
	Personal preference toward working with robots (R3)	Demir et al. (2019)
	Social and psychological issues resulting from human-robot co-working (R4)	Demir et al. (2019)
	Technology vs Humans: Who is in the driver seat (R5)	Aldabbas et al. (2020)
Technology (T)	Access to latest technologies (T1)	Oni et al. (2019), Rana et al. (2019), D. Aghimien et al. (2019), Shiroishi et al. (2018), Holroyd (2020), Nair et al. (2021)
	Application development (T2)	Jo et al. (2019), Nasution et al. (2020)

	Big data (T3)	Silva et al. (2018), Farid et al. (2021)
	Data availability and heterogeneousness (T4)	Zengin et al. (2021), Aldabbas et al. (2020), Rana et al. (2019), Tan and Taeihagh (2020), El-Kholei and Yassein (2019)
	Hardware environment compatibility and heterogeneity (T5)	Silva et al. (2018), Aldabbas et al. (2020), Meiyanti et al. (2018)
	Information technology standards (T6)	Ambira et al. (2019), Shin et al. (2020)
	Information security management professionals (T7)	Tonggiroh (2017)
	Lack of technological skills (T8)	Meiyanti et al. (2018)
	Lack of technical support equipment (T9)	Zengin et al. (2021)
	Poor utilization of digital technologies (T10)	Aghimien et al. (2020)
	Records mobility (T11)	Meiyanti et al. (2018)
	Data and System integration (T12)	Meiyanti et al. (2018) , Jo et al. (2019)
Research and innovation (RI)	Focus on research and development on technologies (RI1)	Mavrodieva and Shaw (2020)
	Increased cost of development (RI2)	Mavrodieva and Shaw (2020)
	Innovation ecosystem (RI3)	Osifo (2018), Ray (2018), Shin et al. (2020)
	Successful investment in a disruptive technology (RI4)	Holroyd (2020)
	Lack of funding (RI5)	Sarfraz et al. (2021)
Digital infrastructure (DI)	Availability (DI1)	Ambira et al. (2019), Shin et al. (2020)
	Access to computer and technology (DI2)	Chia (2016), Masinde and Mkhonto (2019), Paul et al.

		(2020), Ray (2018), Rana et al. (2019), D. Aghimien et al. (2019), Tan and Taeihagh (2020), El-Kholei and Yassein (2019), Nasution et al. (2020), Ambira et al. (2019), Apriliyanti et al. (2020), Deng et al. (2018), Samsor (2021), Meiyanti et al. (2018)
	Common information system (IS) and Interactive public services (DI3)	Aghimien et al. (2020), Shin et al. (2020)
	Different infrastructure systems (DI4)	Farid et al. (2021), Zengin et al. (2021)
	Digital social movements (DI5)	Aldabbas et al. (2020)
	ICT infrastructure support and coordination (DI6)	Ambira et al. (2019), Apriliyanti et al. (2020), Deng et al. (2018), Samsor (2021), Farid et al. (2021)
	Lack of qualifications (DI8)	Meiyanti et al. (2018)
	Network, telecommunication infrastructure and internet connectivity (DI9)	Ambira et al. (2019), Gladkova and Ragnedda (2020), Masinde and Mkhonto (2019), Paul et al. (2020), Shin et al. (2020), Tonggiroh (2017), Meiyanti et al. (2018), Zengin et al. (2021), Aghimien et al. (2020) ,Silva et al. (2018), Farid et al. (2021), D. Aghimien et al. (2019), Sarfraz et al. (2021), Potočan et al. (2021)
	Risks to digital rights (DI10)	Aldabbas et al. (2020)

	Sensing technology (DI11)	Farid et al. (2021)
	System failures issues (DI12)	Rana et al. (2019), Silva et al. (2018), Aghimien et al. (2020)
	Trust in e-voting (DI3)	Aldabbas et al. (2020)
Data (D)	Data availability and heterogeneousness (D1)	Zengin et al. (2021), Aldabbas et al. (2020), Rana et al. (2019), Tan and Taeihagh (2020), El-Kholei and Yassein (2019)
	Information and Cyber security, Privacy, Trust (D2)	Rana et al. (2019), Ambira et al. (2019), Chia (2016), Oni et al. (2019), Osifo (2018), Paul et al. (2020), Samsor (2021), Shin et al. (2020), Sulistya et al. (2019), Aghimien et al. (2020), D. Aghimien et al. (2019), (Nasution et al., 2020), Mavrodieva and Shaw (2020), Aldabbas et al. (2020), Nair et al. (2021), Osifo (2018), Paul et al. (2020)
	Veracity (Managing the data quality, uncertainty, and trustworthiness of data) (D3)	Chauhan et al. (2016)
	Value (Data is worthless until it is converted into value) (D4)	Chauhan et al. (2016)
	Velocity (Speed at which data must be analyzed) (D5)	Chauhan et al. (2016)
	Human dynamics (Humans' role in data collection, data analysis	Chauhan et al. (2016)

	and decision making) (D6)	
	Volume (Huge amount of data) (D7)	Chauhan et al. (2016)
Politics (P)	Coordination, collaboration, and consultation (P1)	Aghimien et al. (2020), Rana et al. (2019), Khan et al. (2020), Meiyanti et al. (2018), Osifo (2018), Samsor (2021), Shin et al. (2020)
	Bribery and corruption (P2)	Ambira et al. (2019), Sulistya et al. (2019)
	Common goals, vision, and mission(P3)	Rana et al. (2019), Apriliyanti et al. (2020)
	Feedback system (P4)	Apriliyanti et al. (2020)
	Fragmented authority and decision-making power(P5)	Tan and Taeihagh (2020), Shin et al. (2020), Apriliyanti et al. (2020),
	Government support (P6)	Tonggiroh (2017), Zengin et al. (2021)
	ICT implementation (P7)	Ambira et al. (2019), Apriliyanti et al. (2020)
	Lack of funding, investment, and resource availability (P8)	Tan and Taeihagh (2020), Ambira et al. (2019), Masinde and Mkhonto (2019), Osifo (2018), Samsor (2021), Shin et al. (2020), Deng et al. (2018), Tonggiroh (2017)
	Lack of public-private partnership participation (P9)	Aghimien et al. (2020), Rana et al. (2019), Khan et al. (2020)
	Motivation (P10)	Apriliyanti et al. (2020)
	Political stability, willingness, and leadership (P11)	Aghimien et al. (2020), Rana et al. (2019), El-Kholei and Yassein (2019), Ambira et al. (2019), Apriliyanti et al. (2020), Aghimien et al. (2020), Meiyanti et al. (2018), Samsor (2021),

		Tonggiroh (2017),
	Poor governance/lack of trust government (P12)	Aghimien et al. (2020), Rana et al. (2019), Saini and Sandhiyaa (2020), El-Kholei and Yassein (2019), Deng et al. (2018)
	Transparency (P13)	Apriliyanti et al. (2020), Meiyanti et al. (2018), Shin et al. (2020), Sulistya et al. (2019), Nahavandi (2019)
	Turnover of workforce (P14)	Meiyanti et al. (2018)
Governance (G)	Accountability (G1)	Apriliyanti et al. (2020), Sarfraz et al. (2021), Mavrodieva and Shaw (2020)
	Civil and criminal justice (G2)	Farid et al. (2021)
	Confusing and ill-adapted tax regulations (G3)	Saini and Sandhiyaa (2020)
	Changing role of human resources departments(G4)	Demir et al. (2019)
	Ethical issues and practices (G5)	Farid et al. (2021), Nahavandi (2019), Aldabbas et al. (2020), Demir et al. (2019)
	Governmental surveillance(G6)	Aldabbas et al. (2020)
	Issues of openness of data (G7)	Rana et al. (2019)
	Lack of regulatory frameworks, policies, and directions (G8)	Rana et al. (2019), Aghimien et al. (2020), Tan and Taeihagh (2020), Saini and Sandhiyaa (2020), Meiyanti et al. (2018), Chia (2016), Nair et al. (2021), Demir et al. (2019), Mavrodieva and Shaw (2020), Shiroishi et al. (2018), Aldabbas et al.

		(2020), Nahavandi (2019)
	Lack of transparency (G9)	Rana et al. (2019), Apriliyanti et al. (2020), Meiyanti et al. (2018), Shin et al. (2020), Sulistya et al. (2019), Nahavandi (2019), Aldabbas et al. (2020)
	Ministries and agencies (G10)	Shiroishi et al. (2018)
	Standardization (G11)	Aghimien et al. (2020), Rana et al. (2019), Shin et al. (2020), Nahavandi (2019)
Economics and Business (EB)	Absence of foreign investors (EB1)	Aghimien et al. (2020)
	Budget for operational and maintenance costs (EB2)	Kwak and Lee (2020), Silva et al. (2018), Rana et al. (2019)
	Growing economic disparity and volatility (EB3)	Shiroishi et al. (2018), Rana et al. (2019), Aghimien et al. (2020), El-Kholei and Yassein (2019), D. Aghimien et al. (2019), Saini and Sandhiyaa (2020)
	High cost of IT training and skills development (EB4)	Aghimien et al. (2020), Rana et al. (2019), D. Aghimien et al. (2019)
	High IT infrastructure and intelligence deficit (EB5)	Rana et al. (2019)
	Increasing cost for social security (EB6)	Mavrodieva and Shaw (2020)
	Lack of competitiveness (EB7)	Rana et al. (2019), Aghimien et al. (2020)
	Loss of jobs due to robots (EB8)	Aldabbas et al. (2020)
	Lack of sustainable revenue (EB9)	Kwak and Lee (2020)
	Performance (EB10)	Silva et al. (2018)

	Weak financial resources and lack of funding (EB11)	Kwak and Lee (2020), Nasution et al. (2020), Sarfraz et al. (2021)
Sustainability (S)	Air pollution, carbon emissions and environmental degradation(S1)	Rana et al. (2019), Zengin et al. (2021), Holroyd (2020)
	Degradation of resources (S2)	Rana et al. (2019), Shiroishi et al. (2018)
	Diminishing food security due to climate change (S3)	Mavrodieva and Shaw (2020)
	Global warming and climate change(S4)	Shiroishi et al. (2018), Mavrodieva and Shaw (2020)
	High rate of urbanization (S5)	Aghimien et al. (2020)
	Increasing demand for energy(S6)	Mavrodieva and Shaw (2020)
	Lack of sustainability consideration (S7)	Aghimien et al. (2020), Rana et al. (2019), Tan and Taeihagh (2020), Silva et al. (2018)
	Natural disasters (e.g., earthquakes, tsunamis, storms) (S8)	Holroyd (2020) , Mavrodieva and Shaw (2020), Zengin et al. (2021)
	Poor education system (S9)	D. Aghimien et al. (2019)
	Poor planning of cities (S10)	Aghimien et al. (2020)
	Poor waste management (S11)	Aghimien et al. (2020), Silva et al. (2018), Saini and Sandhiyaa (2020)
	Power supply and energy shortages (S12)	D. Aghimien et al. (2019), Saini and Sandhiyaa (2020), Holroyd (2020)
	Traffic congestions in cities (S13)	Aghimien et al. (2020)

Note:

PS = People and Society; R = Robots; TI = Technology and Innovation; DI =

Digital Infrastructure; G = Governance; P = Politics; E = Economics and Business; S = Sustainability

Source: Authors' work-based literature review

Appendix 4.2. Key solutions associated with transforming super Smart nations based on challenges identified under people and society category.

Challenges under people and society category	**Experts**	**Experts' suggestions on overcoming the challenges (Solutions)**
Digital literacy and divide (PS1) Poverty(PS3) Generation divide (Difference of opinions between younger people, their parents and grandparents (PS6)	R1, R2, R3, R4, R5, R6, R7, R10, R11, R12	R1: The expert stated that "The digital literacy and digital divide are significant factors that are closely related to income and poverty. One classic example is Central Africa, which has the fastest-growing wireless telephone internet system in the world. They managed to get very inexpensive digital devices and digital services into the hands of the average person. It had a massive impact on Africa and will continue to bring changes over the next decade. Another example is Sweden. The country has a specific policy to go out and find homeless people. They create devices that are easier for the elderly to see and use. They give a free digital device to the poor." R2: The expert stated that "The government needs to be more proactive to motivate the citizens to be better with the use of technology and displace the governance structures. If one looks at nations like Denmark, all the processes are already digitalised. Therefore, it is not the citizens who lack digital literacy but the inability of the government to provide digital infrastructure and tools." R3: The expert stated that "The new technology added to our lives is constantly getting simplified. A classic case study of India, after demonetisation, was when the country witnessed a complete change in infrastructure and the introduction of digital apps and services. Most people from rural backgrounds could adapt to the new technologies in less

		than a month. The process required the use of existing media to educate people on how to use new technology through celebrities and social influencers." R4: The expert stated that "Any technology needs to be user-friendly. It should not require extra effort to educate the person." R5: The expert stated that "The new digital spaces need to be inclusive. Educating and training people to adapt to new technology is the next step. The goal is to help people find answers to their queries on their own using the digital platform." R6: The expert stated that "The elderly need to be taught the basic operations like- how to use this technology, how to use internet banking, how to make online transactions." R7: The expert stated that "With digital literacy, one can have access to education easily. However, to teach digitally, we require servers with fast internet and a stable connection." R10: The expert stated that "At a certain people feel forced to switch over to avoid being left behind." R11: The expert stated that "The problem is not about just digital literacy. It is about the educational differences. For example, Finland and South Korea have the best education system." R12: The expert stated that "Estonia used a long-term strategy by teaching coding and other things in schools that help build a foundation for digital literacy from the age of five. It can be used as a model to focus on

		building a foundation for digital literacy.”
Changing nature of work(PS2) Decreasing workforce(PS8)	R1, R2, R4, R12	R1: The expert stated that “There is a need to think about ways in which backlashes may occur and how to counterattack them while considering the concept of a super-smart society. People need to be assured that a smart society will be benefitting them in having a better life in all aspects.” R2: The expert stated that “Robotics and digitalisation could be the solutions to explore to understand and adjust to the changing nature of work.” R3: The expert stated, "There is a need to create a holistic stress-free work environment as health and psychological issues have become very common. The incorporation of robots into the workflow can help people have quality time with their families. One must put effort into making people understand that these machines are not replacing them.” R4: The expert stated, "The education system and population need to understand that change is permanent, and one needs to get along with time. So, people need to be prepared to accept change through various institutions and learning spaces.” R12: The expert stated that “Automation of the workforce plays a big part too. It helps reduce the burden on the person and enables them to

		work longer by supervising the robots in doing the manual work.”
Social and economic disparities(PS4)	R2, R3, R4, R7	R2: The expert stated that “Denmark has taken steps to minimise this gap by imposing many taxes. Maybe that is one of the ways the other democracies can follow. However, in countries like America, even people with high income pay significantly fewer taxes ". R3: The expert stated that “There is always a communication gap between demand and supply. People keep searching for jobs, and companies keep looking for candidates. However, with initiatives like proper communication and proper training, one can find a way to bridge the demand and supply.” R4: The expert stated that “While the government continues to focus on governance, policies that make education mandatory by default provide basic job security to people.” R7: The expert stated that “Social and economic disparities various from developed and developing countries. For example, developed countries offer staggered solutions differently to educated people, rich people compared to people in the rural areas “.
Aging population(PS5)	R3, R4, R5, R10, R11, R12	R3: The expert stated that “There must be ways to utilise the experience and expertise of people using big data and data science. Even after 60 years of 65 years, people should not have restrictions from work. People need to be treated based on skillset and abilities, instead of their age.” R4: The expert stated that “The whole country of the USA is grown on people that have

		immigrated. It is a perfect example where different backgrounds and different ethnic people can come together and build a nation." R5: The expert stated that "The issue could be solved automatically with the use of robots. Additionally, homes built for the elderly can bring them together under one roof." R10: The expert stated that "Theoretically, robots and technology can prove helpful to the elders with medical issues that come with age. They can help via tracking devices for people who get lost or alert people during an emergency." R11: The expert stated that "Having a robot at their home can monitor their health help with some household work." R12: The expert stated that "The retirement age is being pushed further in many countries. There is no more compulsory retirement in countries like Australia and the United States, and people can work until they die."
Lack of citizen participation(PS7)	R3, R7, R8	R3: The expert stated that "It is a common observation that the efforts of many honest people are ignored and do not get many incentives. Instead of merely promoting the limited group of people who take advantage of society and benefits, honest people need to be supported." R7: The expert stated that "Incentivising using proper program design can be helpful. To make citizens more participative, the government needs to incentivise behaviour and not an action. " R8: The expert stated that "Government organisations need to find what is skills people

		have and accordingly assign them to work based on their interests.”

Appendix 4.3. Key solutions associated with transforming super smart nations based on challenges identified under robot's category.

Challenges under the robot's category	**Experts**	**Experts' suggestions on overcoming the challenges (Solutions)**
Education and training to work with robots(R1)	R1, R3, R6, R7, R8, R11	R1: The expert stated that "The issue with robots is making people understand their functioning and high level of reliability. People need to trust that robots are as safe as other things of daily use." R3: The expert stated that "We have to create confidence in students and the market on how robots enhance our lives without replacing us." R6: The expert stated that "There needs to be awareness or education to know what the robot can or cannot do." R7: The expert stated that "Nations and people need to exist alongside robots based on use cases. Also, the government need to lay down policies and regulations with the development of policy and guidelines. So, it can protect employees at the same time, and it can help the companies ". R8: The expert stated, "Reassuring people that the robot is not taking their job but helping them get work done efficiently". R11: The expert stated that "The use of robots improves the quality of life for people to spend more time with family and friends by reducing the number of working hours."

Safety(R2)	R1, R2, R5, R6, R10, R11	R1: The expert stated that “There is a need for basic regulations. It takes time to adjust to the new technologies, but we have been doing that for years.” R2: The expert stated that “The robots function the way they are programmed. Therefore, we are not at a stage where we need to feel threatened by robots and technology. Of course, there are safety concerns like their battery life.” R5: The expert stated that “Robots that meet certain criteria need to be certified and bought from authorized places.” R6: The expert stated that “a legal framework that addresses people's concerns of the safety and reliability of robots and insurances in case of damages.” R10: The expert stated that "Volvo has mentioned that they want to introduce self-driving cars, which are fully automated, and they claim responsibility for any accidents or issues one may encounter using these machines. Such instances make people more comfortable while buying the products.” R11: The expert stated that “Laws need to be developed addressing the safety concerns and who would be accountable if a robot harms a human.”
Evolution of organisational workflows(R3)	R3, R4, R5, R8, R11, R12	R3: The expert stated that “There must be some rules and regulations in the industry and link a robot to a human where a human will take responsibility for any errors in giving wrong instruction or controlling errors.” R4: The expert stated that “Organisations need to reorganise themselves to adapt to the new

		changes and accept them as permanent changes." R5: The expert stated that "The accountability of robots needs legal frameworks. The UN is working on protocols to address such issues in the future." R8: The expert stated that "If the industry intends to use robots at work, they need to focus on teaching and training people on how to use them." R11: The expert stated that "The legal framework accounts for a big part in the building of the super-smart nation. The legislation must make sure that there are adequate legal laws for it. The governments should work on creating this legislation as fast as they can." R12: The expert stated that "law can cope with artificial intelligence, and we do not need humans to be accountable to the law. Our established common law in most countries have legal frameworks that work well with this. We just have not utilized them yet. Accountability always must go back somewhere to a human who is our business owner or the software developer, and we can have control mechanisms for that".
Privacy and trust in a human-robot co-working environment(R4)	R2	R2: The expert stated that "Educating the people on working in the same environment is required. Mainly for those who are going to work with robots. Moreover, how humans can integrate both robots and humans. We need more multidisciplinary research in that direction, especially from social scientists and robotics.
Acceptance of robots in the workplace(R5)	R1, R2, R3, R4, R5, R7, R11,	R1: The expert stated that "The major solutions are cultural. Japan can be a good example; the Japanese have long loved robots and are very

	R12	comfortable with robots. People must learn to be comfortable with technology and robots. People need to realize that a robot is to the workplace as an automobile is to transportation." R2: The expert stated that “Robots so far have been developed as technical infrastructure, which has to work in isolation. That means they are usually in chemical factories with dangerous materials. There is a need for more research on introducing robots in the workplace and bringing humans to interact with them in a user-friendly manner.” R3: The expert stated that “We have to build a nation where humans and machines are both integrated. New laws should be brought in that balance humans' work instead of making them feel like they have no job. New labour laws like involving people to create them and incentivize them ". R4: The expert stated that “Educating people is the solution to help them let go of all misconceptions regarding the functions of robots. People need reassurance that their jobs are safe and that robots support people to function better.” R5: The expert stated that “One could start by introducing robots at home and then introduce them to companies. It helps people get comfortable trusting and working with them.” R7: The expert stated that “The management needs to innovate and educate on the advantages of using robots. They make work more efficient, save time, and increases production accuracy. Moreover, there is also no need for Robots to be paid. So, when robots help improve the efficiency of the output of people, they automatically receive

		more pay.” R11: The expert stated that “People will need some time to get accustomed to working with robots or learning from a robot teacher.” R12: The expert stated that “Robotizing the workforce without laying off people helps ease the manual work and avoid injuries. For example, Amazon has used Robotics extensively ".

Appendix 4.4. Key solutions associated with transforming super smart nations based on challenges identified under technology category.

Challenges under the technology category	**Experts**	**Experts' suggestions on overcoming the challenges (Solutions)**
Interoperability(T1)	R3, R7, R8	R3: The expert stated that "With the benefit of interacting systems, the new technology has replaced the use of manuals to understand their functions. For example, cars have started interacting with us." R7: The expert stated that "A simple example like a single user having multiple accounts and passwords on different platforms denies the existence of interoperability in the present time. The focus needs to be more on integration that allows easy access to all the profiles on professional and personal terms. Developing a system that gives access to everything using a single platform with a single key." R8: The expert stated that "The infrastructure interoperability can be understood with self-driving cars as an example. The internet system gets integrated and made compatible with the mechanically constructed car. Similarly, there is a need to integrate a combination of technologies to address the issue of infrastructure interoperability."
Lack of user-friendly applications(T2)	R1	R1: The expert stated that "The solution to that could be System integration."
Lack of technical support(T3)	R1, R3	R1: The expert stated that "One must understand this aspect as an educational thing." R3: The expert stated, "There is a need to

		create proper infrastructure, proper training processes, and use the latest advanced technologies like smart assistance. It helps with clarification of doubts using simple methods without language barriers, even while introducing new technology."
System integration(T4) Lack of data availability(T6)	R1	R1: The expert stated that "Bringing people under one roof to understand and discussing ways to manage issues leads to effective decision-making. Similarly, bringing together databases and technologies can aid in finding quick solutions and preventing unnecessary time and expenditure. One such place that used interoperability and system integration is the city Sault Ste. Marie**,** Ontario, Canada."
Access to latest technologies(T5)	R2, R5, R7,	R2: The expert stated, "The solution could be to invest more in funding research to handle the challenges. We need the research from both the universities and the companies going together." R5: The expert stated, "Although we have the foundation, there is still a reluctance to use semantic technologies. However, the shift is crucial to provide proactive services." R7: The expert stated, "The regulation and the government need to have a framework to support complementary industries or technologies that will help move faster towards the smart nation concept. Another way could be switching to low power consumption devices instead of heavy power consumption devices."
Information technology standards(T7)	R3, R7, R8, R10	R3: The expert stated that "The advent of new technology has led to many standardisations in processes. Cars, for example, have started interacting with us, reducing the need for extra manuals or tutorials to understand the

		new operating systems. The same concept has been applied to other technologies as well." R7: The expert stated that "It is time to start thinking about integrating technologies to have a one-stop solution for all our needs. It can be achieved in the next 10-15 years but, there is essential to have a single platform to govern everything." R8: The expert stated that "There is a need for one to combine technologies. For example, integration of blockchain technology, artificial intelligence, 5G, telecommunication, and networking." R10: The expert stated that "Standardization is a simple thing. Nevertheless, to decide who gets to make decisions and set standards is still a big question. Consider the COVID certificate as a good example here. We need a global solution for this certificate, and yet there is difficulty in managing it. Even in one continent, it is difficult to come up with a common solution, and then it needs to be applied worldwide."

Appendix 4.5. Key solutions associated with transforming super smart nations based on challenges identified under research and innovation category.

Challenges under the research and development category	**Experts**	**Experts' suggestions on overcoming the challenges (Solutions)**
Lack of funding (RI1)	R2, R4, R12	R2: The expert stated that "There is a need for the government to increase the budget." R4: The expert stated, "We need to bring policies to encourage angel investors and startups and build required ecosystems. Policies need to be made to fine-tune our banking systems and innovative ways to take some risks. Governments should also work to make some of these things possible by developing necessary policies for funding and establishing SEZs (special economic zones). R12: The expert stated that "The biggest challenge for research anywhere in the world is getting research funding. So, the government and the private sector need to pay more attention to the importance of research and think of ways to fund it."
Education system (RI2)	R2, R3, R7, R8, R12	R2: The expert stated that "Entrepreneurship could be one of the solutions to promoting entrepreneurship events. It would help add new perspectives in students on technology, implementing solutions, research, and practical development." R2: The expert stated that "The governments have to rethink and redesign the education system. The gap between education and

		industrial experience needs to be bridged and then link it with the research. The inclusion of project-based education helps students boost their creativity and skills." R3: The expert stated that "Global standards for education are needed. Countries like Finland and Scandinavia, Switzerland, and Germany are continuously progressing and innovating towards student-oriented learning. Whereas, in most Asian countries, education is becoming a burden for students. There is a need to centralise the education body to make students competent professionally and adapt to cultural differences in any part of the globe." R7: The expert stated that "The education system needs to evolve. The curriculum needs to change because the information available in the textbook is also available on the internet. Then where is the additional value-added learning in education?" R8: The expert stated that "With everything becoming digitalised, there is a need for even education systems to go online by integrating the necessary technologies and innovation systems." R12: The expert stated that "Research needs to be integrated into the curriculum."
Focus on research and development on new technologies (RI3)	R1, R7	R1: The expert stated that "The government started investing using disruptive technologies. When the government takes leadership in adopting and testing new technologies, even school systems and universities start becoming technologically sophisticated places." R7: The expert stated that "The startup culture

		is more around the technology itself. So, the startups need to be aligned to the government's smart nation roadmap concept.”
Research into smart applications (RI4) Innovation ecosystem (RI5)	R1, R3, R5, R6, R7, R10, R11	R1: The expert stated that “People need to gather in a place and discuss government policies, to develop a strategy for a new economy.” R3: The expert stated that “One cannot standardize a person's intellectual ability based on the certificate in university and marks. There need to be several ways that test the intellectual capacity of an individual and identify them. The corporate world is taking advantage of events like hackathons to challenge random people by giving people opportunities to showcase their skills to solve global problems.” R5: The expert stated that “It is essential to develop an innovation ecosystem that allows governments, companies, citizens, and researchers to work together. Education also becomes a part of it by making internships compulsory. Consider the example of a professional education institute and the company co-existing in a building. Such kinds of ecosystems work together to innovate and advocate for a purpose. These kinds of developments need to be combined in smart nations.” R6: The expert stated that “Collaboration helps in the effective and efficient use of resources. Additionally, it also helps in speeding up a lot of other new technologies as well.” R7: The expert stated that “The government can encourage a formal way to engage startups. It is a good idea to focus on contributing to the

		growth of these startups when they, in turn, contribute more to society. The government can also incentivize startups towards the creation of smart nations." R10: The expert stated that "The government should initiate and support public-private partnerships." R11: The expert stated that "Startup companies are contributing to more innovation than big and well-established tech companies. So, investing in startup companies can give a head start to future innovations."
Investment in disruptive technologies (RI6)	R7	R7: The expert stated that "Design-driven innovations tend to be rejected by people because they are not necessities. Therefore, the innovations need to be consumer-driven with high practical values."
The increased cost of research and development (RI7)	R3	R3: The expert stated that "The cost of funding innovation and research is naturally higher in new countries. Identifying people with experience can help in solving problems."

Appendix 4.6. Key solutions associated with transforming super smart nations based on challenges identified under digital infrastructure category.

Challenges under digital infrastructure category	**Experts**	**Experts' suggestions on overcoming the challenges (Solutions)**
Security and privacy (DI1)	R1, R2, R3, R8, R11	R1: The expert stated that "The government plays a significant role in providing basic IT infrastructure. Some governments are already good at providing basic infrastructure. The government functions by providing power reliability and internet reliability either through direct ownership or regulation. In the same way, it can also provide security and privacy. Successful societies would have all these factors functioning efficiently. The only problems would be the access to devices and the affordability of devices. Nevertheless, what people thought impossible 20 years ago; changed the scenario with the impact of cell phones. Millions of people in Central Africa now have access to services ranging from banking to retail operations to political movements. Therefore, the setting up of appropriate infrastructure should be the top priority of the government." Note: This is a standard answer for security and privacy, power, and internet reliability challenges. R2: The expert stated that "Out of all the challenges, security and privacy may be one of the main issues. With new devices, new data, new applications, and the advancement of technology, the threats are also increasing. Therefore, handling these issues needs more

		research, and "security and privacy" becomes the focus areas." R3: The expert stated that "There can be new laws and restrictions on how we use public data. One could opt for smart solutions to fix security and privacy issues. All the data can be secured using blockchain technology. Using the same technology, data access to corporates can be limited. However, one must ensure that the data is not under single control." R8: The expert stated that "One can trust blockchain as a solution for security and can be seen as a solution for use worldwide. It supports learning and access to anybody interested in it. However, one needs stable internet and a continuous power supply. Moreover, it is a good solution for the development of digital infrastructure." R11: The expert stated that "Blockchain will provide a good solution to security and privacy issues."
Power reliability (DI2)	R1, R2	R1: The expert stated that "The government plays a significant role in providing basic IT infrastructure. Some governments are already good at providing basic infrastructure. The government functions by providing power reliability and internet reliability either through direct ownership or regulation. In the same way, it can also provide security and privacy. Successful societies would have all these factors functioning efficiently. The only problems would be the access to devices and the affordability of devices. However, what people thought impossible 20 years ago; changed the scenario with the impact of cell

		phones. Millions of people in Central Africa now have access to services ranging from banking to retail operations to political movements. Therefore, the setting up of appropriate infrastructure should be the top priority of the government." Note: This is a standard answer for security and privacy, power, and internet reliability challenges. R2: The expert stated that "Many countries are moving toward the direction of renewable energy. For example, in Denmark, almost 50 to 60 per cent of total energy is harnessed from wind energy.".
Internet reliability (DI3)	R1, R5, R8	R1: The expert stated that "The government plays a significant role in providing basic IT infrastructure. Some governments are already good at providing basic infrastructure. The government functions by providing power reliability and internet reliability either through direct ownership or regulation. In the same way, it can also provide security and privacy. Successful societies would have all these factors functioning efficiently. The only problems would be the access to devices and the affordability of devices. Nevertheless, what people thought impossible 20 years ago; changed the scenario with the impact of cell phones. Millions of people in Central Africa now have access to services ranging from banking to retail operations to political movements. Therefore, the setting up of appropriate infrastructure should be the top priority of the government." Note: This is a standard answer for security and privacy, power, and internet reliability

		challenges. R5: The expert stated that "Progress in infrastructure development is necessary to ensure that the processes keep running in auto mode even when issues occur in one part of the internet. It requires more secure protocols to have a reliable infrastructure." R8: The expert stated that " Internet reliability can be improved using dominant protocols such as IPv4 and IPv6 ".
Lack of interactive public services (DI4)	R4, R12	R4: The expert stated that "The government will have to take more initiatives in building public-private partnerships to keep upgrading and adapting to new technologies. These should be able to benefit the government, companies and the citizens." R12: The expert stated that "blockchain technology can be used as identity and access management to verify the identity of a person for a bank or health records that are held on blockchain infrastructure. Furthermore, everybody got on the blockchain wagon when they started to see that it was more than just cryptocurrency, and now it is scaling back, and people realise what they can do with it. ."
Lack of internet connectivity (DI6)	R3	R3: The expert stated that "Access to basic internet facility that allows people to communicate with the government and their communities is crucial."
Poor data availability and scalability (DI5) and	R4, R6, R7	R4: The expert stated, "outsource it to a company, and these guys are professionals ". R6: The expert stated that "A holistic view

System failures (DI7)		and approach are required to come up with solutions that solve a bunch of interrelated problems concerning system issues with relative ease." R7: The expert stated that "The scalability of solutions has to be inbuilt today. The availability of a broadband connection and high-speed internet is still a recurring issue. The development of 5g networks and future projects like Satellite-based internet by Elon Musk support super-smart nations that could be achieved in about ten years."
Lack of network and telecommunication infrastructure (DI8)	R5	R5: The expert stated that " One also needs to talk about reliability in the regulatory framework. For example, the entire discussion of whether one should use the Chinese telecom equipment in the 5g infrastructure also needs to be considered. One needs to give a clear picture of what is allowed or not allowed, what kinds of protocols can be used. The policy-making process must focus more on information and technology. Questions like: What are the properties of the technology? What can be expected of the technology? could be included."
Lack of access to computers and technologies (DI9)	R2, R3, R7, R8	R2: The expert stated, "During our studying years, the shift from costly foreign textbooks to special editions for Asian countries being sold at a low price to increase affordability was a big step. Similarly, there is a need for companies to rethink offering advanced technologies to African-Asian countries at lower costs." R3: The expert stated that "Owning a mobile phone, having access to a power station or internet under all living conditions should be made mandatory like other basic human

		rights. Governments should include electricity and the internet under necessities and use sustainable ways to provide them for free or at low costs.” R4: The expert stated that "Opening up markets, opening up the economy and ecosystem, will make it easier to upgrade necessary infrastructure for access to technologies. For example, this could be done by implementing single window systems of getting required permissions for a foreign company to invest in other countries, which has already been solved ". R7: The expert stated that "The edge computing technique is the ability to capture the process and analyses the data at the source. It goes to the data center or the cloud and comes back after being processed. So, it is time-taking. Scaling the process is the smart way to overcome challenges on the digital infrastructure. Therefore, the government should look into ways of developing micro-mini data centers that straight away analyses data and give out results quickly.” R8: The expert stated that the "Internet must be free for everyone. However, making it accessible for everyone is challenging.”

Appendix 4.7. Key solutions associated with transforming super smart nations based on challenges identified under data category.

Challenges under data category	**Experts**	**Experts' suggestions on overcoming the challenges (Solutions)**
Security(D1) Privacy(D3)	R3, R5, R8, R12	R3: The expert stated that "Public needs to be assured that their data is secure and not misused by the private. Public data should be a national asset, and no corporate should have the right to take advantage of it." R5: The expert stated that "A compliance-by-design infrastructure is needed, based on self-sovereign identities and other mechanisms ". R8: The expert stated that "blockchain is one of the solutions to manage data security ". R12: The expert stated that "Technology will eventually address many current challenges. Law/regulation and standards will also play a significant role ".
Value (Data is worthless until it is converted into value) (D4) Velocity (Speed at which data needs to be analysed) (D5) Human dynamics (Human's role in data collection, data analysis and decision making) (D6)	R2, R6, R7, R11	R7: The expert stated that "Analytics are required to identify value from data." R2: The expert stated that " The advancement of Big Data Architectures, new algorithms such as Deep learning and, more importantly, new computing paradigms like Quantum Computing will help solve the data challenges ". R7: The expert stated, "Ability to process data at the edge for faster outcomes must be developed". R7: The expert stated that "Focus needs to be on Faster data processing solutions that are secure as well as capable of high volume ". R6: The expert stated that "Standards on the

Volume (Huge amount of data) (D7) Variety (Unlimited heterogeneous data) (D8) Veracity (Managing the data quality, uncertainty, and trustworthiness of data) (D2)		management of data will help “. R11: The expert stated that "Standardization of all types of data, data types and data processing is required.”.

Appendix 4.8. Key solutions associated with transforming super smart nations based on challenges identified under politics category.

Challenges under politics category	**Experts**	**Experts' suggestions on overcoming the challenges (Solutions)**
Political cooperation between countries(P1)	R2	R2: The expert stated that "Cooperation and Collaboration between the countries to exchange technologies will help develop the smart nation. One example can be the creation of the European Union."
Political leadership(P2) Lack of government support(P5) Coordination, Collaboration, and consultation(P7) Lack of investment(P9)	R1, R2, R3, R4, R5, R6, R7, R10, R12	R1: The expert stated that "There is a need for political leadership that understands what it means to be a super-smart country, region, or nation. The Japanese model states there are two ways of innovating. One is to fund and let the scientists and the business community decide where innovation is going. The other way is to leave it to people where they want to invest their money. " R2: The expert stated that "There is a need for political leadership without which other goals are impossible to achieve." R3: The expert stated that "Big data using artificial intelligence plays a key role in identifying people who can govern us. Companies like Microsoft and Google identified the next leaders based on their merit to carry forward the company. The same model used to choose School representatives could be used in running companies by breaking the tradition. However, again, the criteria for judging merit plays an important role." R4: The expert stated that "A committed leadership also involves a human aspect. With changing ways of educating people, the need for formal education to understand and know a

		good way of living has reduced." R5: The expert stated that "People need to be educated and digital savvy and ensure that they know what they are talking about." R6: The expert stated that "People need to be convinced that this is the way to go." R7: The expert stated that "There should be stricter criteria like education, knowledge of technology, and experience outside politics to be eligible to serve as a minister." R10: The expert stated that "The government needs educated people to execute plans properly." R12: An ex-president, a former tech company guru, saw an opportunity for a small country to increase its digital footprint using the E-residency program.
Political stability (P3)	R7	R7: The expert stated that "The government or the political system needs to evolve to the sense that they cannot have multi-party politics. It invites much confusion with different ideologies, different goals, different visions and fails to conclude. The solution would be to put down some curbs on how many political parties can exist. National development can be accomplished through the legal system within each country."
Common goals, vision and mission(P4)	R1, R3, R5	R1: The expert stated that "It is the super-smart communities that are the goal. However, to understand it well, people need common goals, visions, and missions. Japan works on a hundred-year plan which works well."

		R3: The expert stated that “There is a need to change the existing political system, the rules, and the regulations. Switching of governments might hamper these goals. Hence, having long-term goals with the smart nation as a common agenda takes us towards the right solutions.” R5: The expert stated that “In China, they have a long-term strategy which could be the key to their success. Therefore, a long-term perspective is important to address the issues at hand along with the automation of regulations.”
Lack of governance and trust(P6)	R2, R8	R2: The expert stated that “The blockchain has good potential as a public ledger. For example, technologies like blockchain help solve challenges to a certain extent. Even though the technology is strong and built on goals to solve these technology challenges like transparency, one of the major challenges is a lack of motivation and a genuine wish to change.” R8: The expert stated that “Some countries like Estonia have already switched to blockchain-based e-voting systems, and now blockchain is used in every field. Thus, keeping transparency in those things.”
Corruption(P8)	R2, R5, R12	R2: The expert stated that “The government's focus on increased transparency in technology could help.” R5: The expert stated that "Compliance by infrastructure, for example, privacy by design, transparency by design, accountability by design, and everything by design is a solution." R12: The expert stated, "The technology using blockchain plays a great role in preventing corruption because it records everything and provides security .”

Lack of public-private partnership(P10)	R7	R7: The expert stated that "The government or the political systems need to find ways to bring public-private partnership, but with the interference of outside parties. They need to bring in subject matter experts, advisors or consultants who can advise or provide information on the topics."

Appendix 4.9. Key solutions associated with transforming super smart nations based on challenges identified under governance category.

Challenges under governance category	**Experts**	**Experts' suggestions on overcoming the challenges (Solutions)**
Lack of regulatory frameworks and policies(G1) Lack of stringent civil and criminal law(G5) Ethical practices(G6) Culture(G7)	R1, R2, R3, R4, R5, R11	R1: The expert stated that "The solution here is to find out what works by taking more examples, understanding how other countries function, and adopting the methods that help create best standardisation policies and best regulatory frameworks." R2: The expert stated that "One of the biggest challenges for the governments is understanding this innovation and developing a legal framework, which does not kill this innovation. Since people back the innovation, the government needs to develop some mutually agreeable regulatory frameworks." R2: The expert stated that "Having a regulatory framework for the under-linked technologies, like blockchain and others, automatically brings out the required output." R3: The expert stated that "There is a need for laws and rules that validate the behaviour of people and grant them incentives or pensions accordingly." R3: The expert stated, "There need to be some new rules or laws in choosing leadership and validating using AI data science and the internet. Further steps will follow once all the data is collected." R4: The expert stated that "Good leadership is the solution, and results depend on the leader's ability to make things happen."

		R5: The expert stated that “everything by design, accountability by design, transparency by design policies, regulatory frameworks, and automation can help." R11: The expert stated, "Some governments have the legislation in hand, and other governments try to copy them. Instead, they need to focus on research and creating more regulatory policies.”
Lack of transparency(G2)	R2, R7, R8, R12	R2: The expert stated that "Technologies like blockchain and the upcoming technologies bring accountability, transparency, and standardizations into many processes. Therefore, technology has a major role to play in bringing the solutions to these challenges. The right motivation by leaders enhances the problem-solving process.” R7: The expert stated that "Since the issue is with the political system itself, there is a need for stricter criteria for eligibility to be a minister. The qualifications could include good education, knowledge of technology, and bringing in outside perspectives instead of bringing their whole family into politics.” R8: The expert stated that “The government needs to be more transparent and answerable to the public while making decisions on their behalf.” R12: The expert stated that "Australia used a digital public consultation technique while proposing a digital identity scheme. They put up all the benefits of the scheme that include a digital identity dashboard. Whenever a digital identity is used, the person gets notified and can give or deny consent. Such transparency allows people to have more

		trust, and they get a chance to share their views on policies.”
Lack of accountability(G3)	R2, R8	R2: The expert stated that “The use of technologies like blockchain can bring accountability and transparency into many processes and hence, technology plays a major role in finding solutions to these challenges.” R8: The expert stated that "Blockchain eliminates the need for a third-party involvement. Since it works based on consensus, it adds to the accountability of decisions.
Lack of standardization(G4)	R2, R5	R2: The expert stated that “ Technology along with the right motivation can bring Standardization to processes using blockchain and other related technologies.” R5: The expert stated that "Standardization becomes less an issue once we have semantic technologies because they understand each other.”

Appendix 4.10. Key solutions associated with transforming super smart nations based on challenges identified under economics and business category.

Challenges under economics and business category	**Experts**	**Experts' suggestions on overcoming the challenges (Solutions)**
Know-how in use of smart applications for business (EB1)	R1	R1: The expert stated that "People learn best from examples. Hence, promoting discourses on methods used by other countries and how the models could be applicable in their own country could prove helpful. There is a need to model the best regulatory frameworks and standardization policies that work best for the particular country."
Lack of financial resources (EB2)	R1, R3, R5, R11,	R1: The expert stated that "There is a need to create a vibrant ecosystem that helps people learn and sort mutual support during difficult times from each other." R3: The expert stated that "Most organizations tend to opt for yearly budgeting. However, by the time budgets get released, the whole requirement scenario changes, leading to misuse of funds. Integrating data using blockchain technology helps yield a better understanding of the demand system and create solutions accordingly. Smart systems would enhance the decision-making process based on analytics and graphs and utilize funds more effectively." R5: The expert stated that "When the commitments are long-term, people would be more willing to invest. It is essential to tackle the uncertainty. The government has a significant role in combating uncertainty while also having an efficient, smart, patient vision. "

		R11: The expert stated that "Companies and businesses play a major role, followed by the government. Because the government lacks the resources or capability to lead this, but companies will become the driving force to super-smart nation-building. They will provide the resources. They will push, they will fund the resources, they will push the research. They will find startups that will generate it. They will try to reach out to all the people and make it a digital society."
Lack of sustainable revenue (EB3)	R1, R2, R3, R5, R6, R7, R8	R1: The expert stated that "Singapore has a unique system where they make decisions instantly. In other countries like Canada, Britain, the processes for making decisions are opposite to innovation. Getting the government involved kills innovation. People hired for jobs are well paid and can be trusted to make good decisions, failing which they get fired." R2: The expert stated that "The companies are naturally motivated by the profits and tend to be more efficient in enhancing processes, optimizing products. So, the governments need to take steps towards motivating companies to invest in the smart cities." R3: The expert stated that "The idea of the smart-cities duopoly is self-sustained. The goal is to be self-reliant and take charge while generating power and all kinds of resources for themselves. Creating smart cities is about enhancing lives by making them simpler and holistically healthier. Initially, this may not generate breakeven on investments, but robotics and other advancements need to be channelized to create that confidence and proper network. Switzerland at present is creating technology for a global

		requirement. In the same way, Smart cities can become models for countries and institutions across the globe. The focus is on quality living over quantity." R5: The expert stated that "It is the task of the governments to reduce the uncertainty and sustainability. No government in the world assures incentives and money subsidies for doing it in a way." R5: The expert stated that " I think they have to take care in one way or another to ensure that it is sustainable, and they can also save from it. They need to create a sense of urgency while also ensuring stability." R6: The expert stated that "The government can provide guidelines. However, once things become stable, the company must make sure that they are competing to be able to sustain that business." R7: The expert stated that "It is not feasible to set up new cities or setups and scale up from scratch in every place. The gradual progression must happen. It is important to make sure that the targeted population feels ready for the change. The government needs to be able to do scenario planning for the concept of the smart city." R8: The expert stated that "The ggovernment should act as a supporting pillar initially and after a certain point the local authorities must take care of it."
Lack of budget for operational and maintenance costs (EB4)	R2	R2: The expert stated that "The way to address these issues is by understanding how much percentage of GDP is involved in them. Government has a prominent role in recognizing and encouraging these economies to have more income competent areas."

Lack of laws and regulatory frameworks (EB5)	R7, R10	R7: The expert stated that "The government has to take responsibility for the guidance, regulations and bear most of the cost. The government can take the lead and execute local governance policy-making by collaborating with the local councils." R10: The expert stated that "There could be two ways: The government can support the impulses that come from private companies. Alternatively, the government can propose frameworks that the company would require to execute their tasks."

Appendix 4.11. Key solutions associated with transforming super smart nations based on challenges identified under sustainability category.

Challenges under the sustainability category	**Experts**	**Experts' suggestions on overcoming the challenges (Solutions)**
Lack of innovation integrated education system(S1)	R2	R2: The expert stated that "Taking leadership to provide insights on governance and budget allocation to promote sustainability is needed."
Lack of sufficient natural resources(S2)	R1, R3, R5, R6, R7, R8, R11, R12	R1: The expert stated that "It is essential to develop a culture that imbibes these values within the society. For example, the Waterloo region has reinvented itself five times over the last century and a half. It transformed from heavy industry to lighter industry. It switched from international trades to domestic trade. It worked under the free trade agreement with the United States. The common word used in waterloo is the capacity to reinvent. If such practices are part of the local culture, they sustain it. What is going on in Israel can also be as an example" R3: The expert stated that "Collaboration is the answer. When a country lacks some resources, it can invest or collaborate with other nations to leave its footprints and make a difference while also benefiting from the process." R5: The expert stated that "Excess resources sometimes leads to much wastage when old devices are discarded. So recycling is a good idea." R5: The expert stated that "There is a need for all kinds of regulations, taking leadership, and uncertainty reduction."

		R6: The expert stated that "Electric vehicles run on lithium which is an additional resource. However, to be sustainable, they need to be recycled. Otherwise, there is a risk that we run out of lithium, and it fails to be sustainable." R7: The expert stated that "The governments will have to work more closely in international trade. If countries like China that control resources shift to monopolizing, there is a chance for many industries to collapse. Therefore, international cooperation, and local cooperation, are essential in large countries. There needs to be a central regulatory body, irrespective of the different state's councils' districts. Cross-border trades should be more streamlined. For example, when discussing space exploration and related work, all countries work together without restrictions. India works with France, Russia, but that is a rare thing to see. There is no barter system involved. Whereas in trade today, China says, Australia has banned coal, and we will ban Australian wine. If we are looking at super-smart nations, the government needs to leave behind all such prejudices." R8: The expert stated, "Different countries with enough resources need to collaborate to overcome the issue. The exchange of resources and technologies helps in developing and empowering their societies." R11: The expert stated that " The bio-economy is about an economic model based on sustainability. Moreover, it focuses on using sustainable sources of energy efficiently." R12: The expert stated that the "Australian government is pushing solar panels on the roofs

		of all the houses in Australia and had subsidies for that. On the other hand, many countries are doing is having solar farms and wind farms. This could be a way of producing sustainable energy.
Lack of energy-efficient devices(S3)	R2, R3, R5, R6	R2: The expert stated that “There has been systematic research into getting more and more energy-efficient devices. The solution is to allow more funding towards research and focus on the development of sustainable goals.” R3: The expert stated that "There is Progress towards energy-efficient devices. A classic example can be the increased battery life in phones. It will not be a challenge because Tesla and others have come up with alternative solutions. The next couple of years may bring a lot more options.” R5: The expert stated that "We have to reduce energy consumption at all levels, including our efficiency in lightening the computing.” R6: The expert stated that "We have to find better ways to minimize the use of energy by using more efficient devices in the so-called smart nation.”
Lack of energy supply(S4)	R5	R5: The expert stated that “People would be willing to invest more on solar cells when they are assured it has good returns within seven to eight years or a maximum of ten years."

Appendix 4.12. Demographic data of respondents.

Respondents	**Country**	**Expertise area**	**Work profile**	**Years of work experience (Classification)**
R1	Canada	Super-smart society	Academia	Greater than 20 Years
R2	Denmark	Digitalization, Blockchain, Big data analytics, Machine learning	Academia and Industry	Greater than 20 Years
R3	India	Futurist and Digital transformation	Industry	16 to 20 Years
R4	India	Futurist, Digitalization and Big data analytics	Industry	16 to 20 Years
R5	Netherlands	Digital Nation, ICT and Governance	Academia	Greater than 20 Years
R6	Singapore	Smart Nation	Academia	Greater than 20 Years
R7	Singapore	Digital transformation	Industry	16 to 20 Years
R8	South Korea	Blockchain, Cybersecurity, AI, Internet of things, Smart cities, Industry 4.0	Academia	5 to 10 Years
R9	South Korea	Futurist	Industry	Greater than 20 Years
R10	Switzerland	Artificial Intelligence, Machine learning and Blockchain	Academia	5 to 10 Years
R11	Turkey	Human Robot Co-working and Industry 5.0	Industry	Greater than 20 Years
R12	United States	Blockchain, Cybersecurity, Digital identity, and E-Residency	Academia	Greater than 20 Years

Appendix 4.13. Questionnaire

Section [A]: General information

Please highlight only one choice in each question as follows:

1. What is your professional qualification?
    a) Graduate
    b) Postgraduate
    c) Doctorate
    d) If any other, please specify_____

2. What is your work experience?
    a) Less than 5 Years
    b) 5 to 10 Years
    c) 11 to 15 Years
    d) 16 to 20 Years
    e) Greater than 20 Years

3. What is the size of your organization?
    a) Less than 50 Employees
    b) 51 to 250 Employees
    c) 251–500 Employees
    d) 501–1000 employees
    e) 1001–5000 employees
    f) Greater than 5001 employees

4. How will you classify your work profile?
    a) Private Sector
    b) Public Sector
    c) Multinational Corporation

d) Regulatory Bodies

e) Mixed public and private ownership

f) If any other, please specify.

Section [B]: To what extent do you agree or disagree with the following stakeholders for building a Super Smart Nation for 2035.

S. No.	Stakeholders	Response [In 7-Point Likert Scale]
5.	Stakeholders	
	1. Citizens	
	2. Companies	
	3. Government	

Would you please add any other element (in your opinion)

Section [C]: To what extent do you agree or disagree with the following characteristics for building a Super Smart Nation for 2035.

S. No.	Characteristics	Response [In 7-Point Likert Scale]
6.	Characteristics	
	a) Smart economy	
	b) Smart environment	
	c) Smart governance	
	d) Smart living	
	e) Smart mobility	
	f) Smart people	

Would you please add any other characteristics (in your opinion)

Section [D]: To what extent do you agree or disagree with the following challenges for building a Super Smart Nation for 2035.

S. No. Challenges Response [In 7-Point Likert Scale]

8. People and Society (PS)
    a) Digital literacy and divide (PS1)
    b) Changing nature of work (PS2)
    c) Poverty (PS3)
    d) Social and economic disparities (PS4)
    e) Aging population (PS5)
    f) Generation divide (Difference of opinions between younger people, their parents and grandparents) (PS6)
    g) Lack of citizen participation (PS7)
    h) Decreasing workforce (PS8)

9. Robots (R)
    a) Education and training to work with robots(R1)
    b) Safety(R2)
    c) Evolution of organizational workflows(R3)
    d) Privacy and trust in a human-robot co-working environment(R4)
    e) Acceptance of robots in the workplace(R5)

10. Technology (TE)
    a) Interoperability(T1)
    b) Lack of user-friendly applications(T2)
    c) Lack of technical support(T3)
    d) System integration(T4)
    e) Access to latest technologies(T5)
    f) Lack of data availability(T6)
    g) Information technology standards(T7)

11. Research and Development (RI)
    a) Lack of funding (RI1)
    b) Education system (RI2)
    c) Focus on research and development on new technologies (RI3)
    d) Research into smart applications (RI4)
    e) Innovation ecosystem (RI5)
    f) Investment in disruptive technologies (RI6)
    g) Increased cost of research and development (RI7)

12. Digital infrastructure (DI)
    a) Security and privacy (DI1)
    b) Power reliability (DI2)
    c) Internet reliability (DI3)
    d) Lack of interactive public services (DI4)
    e) Poor data availability and scalability (DI5)
    f) Lack of internet connectivity (DI6)
    g) System failures (DI7)
    h) Lack of network and telecommunication infrastructure (DI8)
    i) Lack of access to computers and technologies (DI9)

13. Data (D)
    a) Security(D1)
    b) Veracity (Managing the data quality, uncertainty, and trustworthiness of data) (D2)
    c) Privacy(D3)

d) Value (Data is worthless until it is converted into value) (D4)

e) Velocity (Speed at which data needs to be analyzed) (D5)

f) Human dynamics (Human's role in data collection, data analysis and decision making) (D6)

g) Volume (Huge amount of data) (D7)

h) Variety (Unlimited heterogeneous data) (D8)

14. Politics

a) Political cooperation between countries(P1)

b) Political leadership(P2)

c) Political stability (P3)

d) Common goals, vision, and mission(P4)

e) Lack of government support(P5)

f) Lack of governance and trust(P6)

g) Coordination, collaboration, and consultation(P7)

h) Corruption(P8)

i) Lack of investment(P9)

j) Lack of public-private partnership(P10)

15. Governance

a) Lack of regulatory frameworks and policies(G1)

b) Lack of transparency(G2)

c) Lack of accountability(G3)

d) Lack of standardization(G4)

e) Lack of stringent civil and criminal law(G5)

f) Ethical practices(G6)

g) Culture(G7)

16. Economics and business

a) Know-how in use of smart applications for business (EB1)

b) Lack of financial resources (EB2)

c) Lack of sustainable revenue (EB3)

d) Lack of budget for operational and maintenance costs (EB4)

e) Lack of laws and regulatory frameworks (EB5)

17. Sustainability

a) Lack of innovation integrated education system(S1)

b) Lack of sufficient natural resources(S2)

c) Lack of energy-efficient devices(S3)

d) Lack of energy supply(S4)

5 Conclusion and Future Research Directions

A framework for building a super-smart nation was developed that will help overcome the projected challenges countries will face owing to decreasing birth rates and workforces, multinational trade wars, poor socio-economic development, and ease of doing business, unequal access to public services, and weak international cooperation.

The concepts of digital nations and smart nations are considered an evolutionary model to create a super-smart nation once the appropriate stakeholders, characteristics, and challenges, solutions, and pillars are identified. Figure 5.1 illustrates the evolutionary transformation of digital, smart, and super smart nation with its key stakeholders, concepts, characteristics, and pillars from past to future for building a framework.

5.1 Conclusion

In chapter 2, The digital nation framework is presented. Nations worldwide are increasingly seeing a need for digitalization, i.e. to offer better services, increase efficiency, collaboration, transparency, communication and reduce bribery and corruption, making digitalization critical. This transformation has been the best solution for improving living standards, ease of doing business, and public service access in the past. A successful super-smart society entails cooperation among digital governments, digital businesses, and digital societies underpinned by a strong foundation of people, technology, institutions, policy, economics, and sustainability.

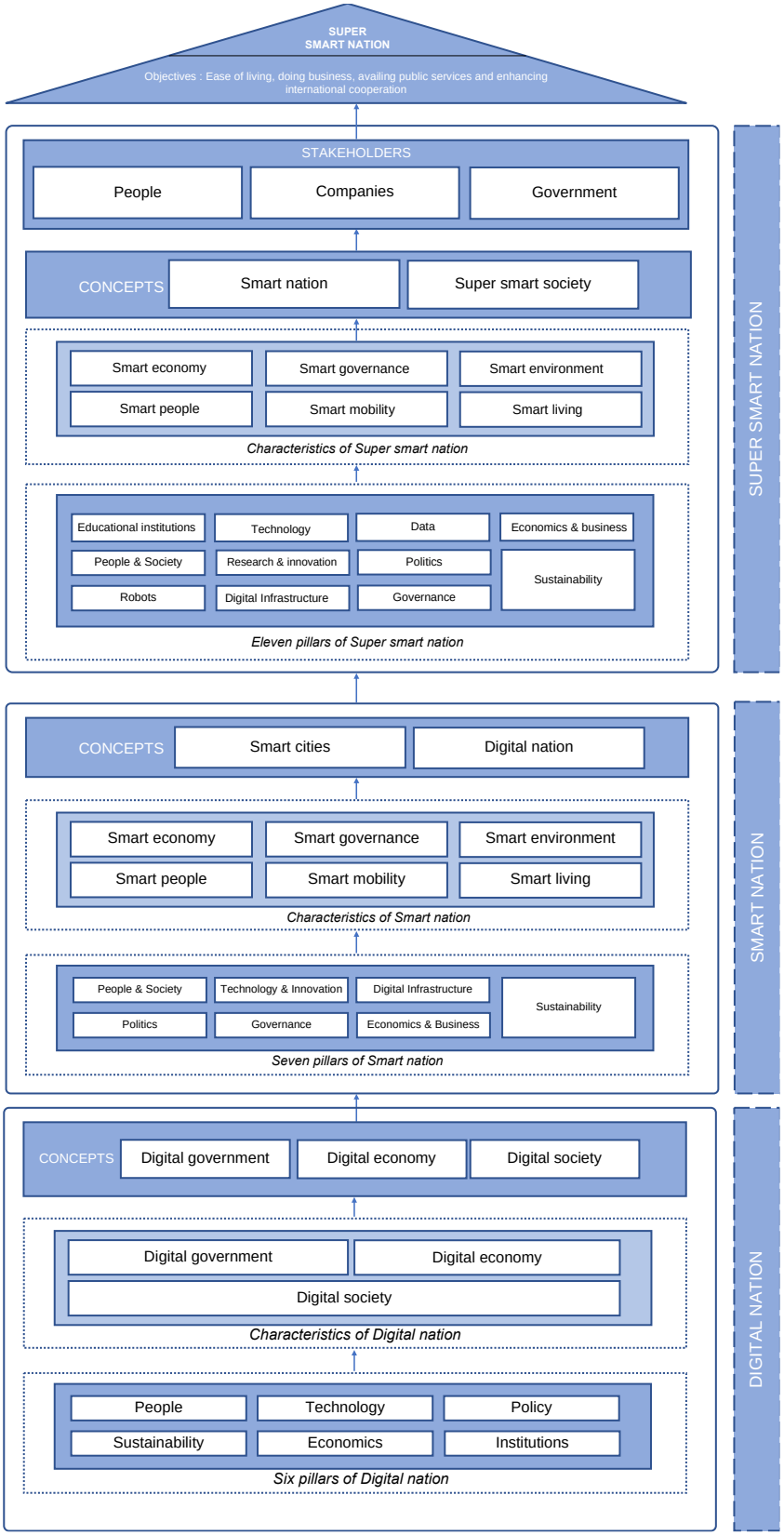

Figure 5.1. An Evolutionary Model: Digital, Smart and Super Smart Nation

In chapter 3, The smart nation framework is presented. As noted earlier, global megatrends are compelling nations to digitize their governance, business, and society much faster than before. Furthermore, Smart nations are intended to resolve endemic urban problems such as aging, energy crises, pollution, safety, and crime using advanced technologies. The increasing numbers of pandemics since the last century, the spread of the Internet, and the growth of advanced technologies (e.g., blockchain, Internet of Things, artificial intelligence, big data, and cloud computing) are ushering in a paradigmatic shift in how societies can exist and grow through development of smart societies. It comprises three stakeholders—government, economy (companies), and society—and is characterized by smart people, governance, mobility, environment, and living and seeks to overcome challenges relating to people and society, technology and innovation, digital infrastructure, politics, governance, economics and business, and sustainability.

In chapter 4, A super-smart nation framework is presented. The systematic literature review and Delphi method employed corroborate extant findings on the stakeholders, characteristics, and challenges to create a super smart society using advanced technologies, such as artificial intelligence, augmented reality, big data, blockchain, cloud, drones, edge computing, Internet of Things, 3D printing, mobile, machine learning, public key infrastructure, 5G, sensors and robots, and virtual reality. It has the same three stakeholders as any formulation of a smart nation, namely, government, businesses, and people, and is characterized by a smart economy, smart people, smart governance, smart mobility, smart environment, and smart living. It is also seen as a step towards the direction of developing the digital movement of people and work using the novel

systems like e-residency and digital identities. It opens digital borders worldwide through a hybrid model of centralized and decentralized techno-governance structures through international cooperation among developed, developing, or emerging countries by interconnecting the virtual (cyber), the physical space and humans.

The scenario planning technique using Delphi method was employed to identify people and society, robots, technology, research and development, digital infrastructure, data, politics, governance, economics and business, and sustainability as the 10 challenges for 2035 and people and society, educational institutions, robots, technology, research and innovation, digital infrastructure, data, politics, governance, economics and business, and sustainability as the 11 pillars of a future super-smart nation.

5.2 Future research directions

This dissertation opens up several future research directions. The primary objective of a super-smart nation is to overcome future challenges arising from issues of socio-economic development; free movement of goods, people, and services; ease of living and doing business; access to public services; and international cooperation among developing or emerging nations. A super-smart nation will allow the digital movement of people and goods as well as the creation of novel systems like e-residency and digital identities, such as what is in Estonia, which has opened its digital borders so that anyone located anywhere in the world can work remotely. As developed nations grapple with declining populations, aging, and trade wars, solutions such as e-residency present a shift in how one can live and work. It is recommended that future studies delve deeper into virtual existence as

a new frontier of doing business and living.

It is also important to understand how countries at the national and continental level (e.g., the EU and ASEAN) can cooperate and collaborate in the race toward building a super-smart world. The six characteristics outlined in this research can be insightful for countries to work toward common objectives in trade and commerce, education, technologies, research and innovation, public services (sharing data), digital identity, digital currency, policies, regulations and standards, mobility, human talent, telecommunications, health, and digital connectivity. Future studies can also narrow their focus to common characteristics at the national–regional, national, continental, or global levels under different contexts.

Further, this study can help in further research on the pillars for building a super-smart nation framework.

5.2.1 People and society

This study identified people and society as one of the pillars for building a super-smart nation framework. Creating more awareness programs using promotional channels, such as media, to motivate people to learn technology and about the benefits of robotics and automation will assist in making people understand the positive benefits of technologies and improve their confidence. We also identified that people and employees can work fewer hours by using robots for less productive activities. This can allow persons to have more time for social and personal life with family and help change perceptions toward the use of robots. It is recommended that future discussions focus on creating awareness programs on the positive benefits of advanced technologies.

Further, this study identified that poverty, digital literacy, digital divide, and generation divide are challenges. The government needs to be more proactive to motivate citizens to be better with the use of technology. Correspondingly, this study identified that aging population are seen as challenges. The issue could be solved automatically with the use of robots. Theoretically, robots and technology can prove helpful to the elders with medical issues that come with age. They can help via tracking devices for people who get lost or alert people during an emergency.

Based on the above findings, it is recommended that future studies delve deeper on the above suggestions and recommendations.

5.2.2 Educational institutions

Notably, this study helped in identifying educational institutions as one of the pillars for building a super-smart nation framework. It shows that developing uniform global education standards to meet industry skill requirements is necessary, as most nations' education systems are similar, except for one or two country-specific courses. Future studies must consider developing uniform global education standards. More literature reviews on understanding the education system in top countries such as Finland, Estonia, and South Korea, as well as systematic interviews with futurists, industry experts, and subject matter experts, are needed.

5.2.3 Robots

Robots were also identified as one of the pillars for building a super-smart nation framework. Learning from cases of successfully adopted robotics in countries may be one solution. Thus, future studies should study

such cases of successfully adopted robotics in countries for transformation into smart nations. Automation and the use of robots can help overcome challenges in nations. For example, the Amazon Go store in America has no human employees, except those who are tasked with managing the store.

It also identified that safety in working with robots is seen as a challenge. A legal framework that addresses people's concerns of the safety and reliability of robots, insurances in case of damages, and accountability if a robot harms a human is needed. It is recommended that future studies delve deeper into solutions on a legal framework that addresses people's concerns of the safety and reliability of robots.

Over and above that, this study identified that acceptance of robots in the workforce is seen as a challenge. Robots so far have been developed as some kind of technical infrastructure that works in isolation. That means they are usually in chemical factories with dangerous materials. There is a need for more research on introducing robots in the regular workplace and bringing humans to interact with them in a user-friendly manner.

Based on the above findings, it is recommended that future studies delve deeper on the above suggestions and recommendations. More studies on above suggestions and recommendations including literature reviews and systematic interviews will be helpful.

5.2.4 Technology

In addition, this study helped in identifying technology as one of the pillars for building a super-smart nation framework. It identified the need for the integration of a single and straightforward platform, as interoperability does not currently exist. For example, we have many

passwords for personal, medical, bank, and children's education profiles. A single and simple platform will change the perception and adoption of technology. Thus, future studies delve deeper into the design, development, and integration of a single platform for interoperability.

5.2.5 Research and innovation

This study identified that it crucial here to involve governments, companies, researchers, and citizens to build ecosystems that facilitate research, experiments, and new technologies. An innovation ecosystem should be built such that students and companies are in the same building and work closely together to solve social problems and resolve smart nations' future challenges.

It identified that research into smart applications and innovative ecosystems are seen as challenges. It is essential to develop an innovation ecosystem that allows governments, companies, citizens, and researchers to work together. Education also becomes a part of it by making internships compulsory. Consider the example of a professional education institute and the company co-existing in a building. Such ecosystems would work to allow purposeful innovation. These kinds of developments need to be combined into smart nations.

Based on the above findings, it is recommended that future studies delve deeper on the above suggestions and recommendations. More studies on above suggestions and recommendations including literature reviews and systematic interviews will be helpful for further research.

5.2.6 Digital infrastructure

Digital infrastructure was also identified as one of the pillars for building a super-smart nation framework. Digital infrastructure that uses secure protocols is critical for overcoming the challenges of Internet reliability; even if the Internet goes down, other parts of the system should still function safely and securely.

Likewise, it identified that national governments' top priority should include building a digital infrastructure, taking inspiration from, or following the lead of Central Africa. One of the best examples is how digital infrastructure has been developed in Central Africa. The steps taken by the governments of these nations have helped citizens access banking, retail operations, and political movements using the Internet. This region deserves further study as a result.

Additionally, Internet reliability was identified as a challenge. Progress in infrastructure development is necessary to ensure that the processes keep running in auto mode even when issues occur in one part of the Internet. Further, Internet reliability can be improved using dominant protocols such as IPv4 and IPv6. It is recommended that future studies delve deeper into infrastructure development that is necessary to ensure these processes.

Based on the above findings, it is recommended that future studies delve deeper on the above suggestions and recommendations. More studies on above suggestions and recommendations including literature reviews and interviews will be helpful.

5.2.7 Governance

This study has identified that the need to develop policies,

regulations, and laws with regard to organizational workflows, accountability of robots, places to keep robots, certification of robots, and rules and regulations that every robot, machine, and person should follow besides a need to develop separate divisions for robots. Governments should develop a policy on robot use such that it helps employees and companies simultaneously. There is a need for developing new labor laws by considering the regulations of robots and for a governance system, which could balance technology and resources equally, such as by establishing a board of control. Currently, there are no regulations regarding malpractice or mistakes in the use of robots because there is no accountability for robots.

Moreover, it identified that government must allow more innovation in low-energy consumption devices and account for complementary industries and technologies. Accepting that standardization is essential (e.g., COVID-19 vaccine certification), there is a need to have global standards for the use of global technologies. However, it is crucial to set the standard and interoperability from this point of view as well.

Based on the above findings, it is recommended that future studies delve deeper on the above suggestions and recommendations for further research.

5.2.8 Economics and business

Economics and business was also identified as a pillars for building a super-smart nation framework. This study argued that that the government could devise a formal way to engage with startups, which will contribute to the growth of societies by incentivizing startups on the road to building a super-smart nation. In other words, it is crucial to facilitate the

growth of startups as opposed to selling the firms to cash in on a popular idea. Furthermore, the government must develop economic policies to increase funding for micro, small, and medium enterprises; develop special economic zones to set up startup shops in the region; fine-tune the banking system by encouraging entrepreneurship; and take risky steps that may be helpful for promoting entrepreneurship.

Thus, it is recommended that future studies delve deeper on the above suggestions and recommendations, including more literature reviews and interviews with experts.

5.2.9 Sustainability

Finally, this study identified sustainability as one of the pillars for building a super-smart nation framework. It argued that sustainable energy sources can be a solution, since we have abundant natural sources; here, bioeconomy, such as solar energy, is a promising and sustainable option. Similarly, recycling is a good measure. The present oil prices are relatively cheaper, but they are damaging our planet.

Further, it identified the lack of energy efficient devices as a challenge. There is progress toward energy-efficient devices; a classic example is the increased battery life in phones. In this regard, companies such as Tesla have introduced alternative solutions. The next couple of years may see more such options in energy-efficient devices.

Thus, it is recommended that future studies delve deeper on the above suggestions and recommendations, including more literature reviews and interviews with experts.

Profile

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Murali Krishna Penmetsa is a PhD student at University of Jaen, Spain and Lucerne University of Applied Sciences and Arts (HSLU Luzern), School of Computer Science and Information Technology, Switzerland. His research is in the areas of Blockchain Nation, Digital Nation, Digital Sustainability, Digitalization, Information Security, Smart Cities, Smart Nation, Super Smart Societies and Sustainable Societies. He is presently acting as Chief Recruitment Officer for Recruitment of students at HSLU Luzern and working as advisor for universities in Europe. His expertise is in areas of Strategic planning, University cooperation's, Student recruitment, Admission management, Research and Teaching working in various capacities in roles such as Dean, Director, Senior Advisor for reputed universities and organization in Europe and Asia. Murali Krishna Penmetsa can be contacted at: krishna.penmetsa@hslu.ch