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Comprehensive Modernization and Innovative Development of the SMART Economy of the Future

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Abstract: The SMART economy, which uses digital technologies in economic policies, is very important for the future growth of the economy. This research looks at what makes SMART economies work, focusing on digital infrastructure, governance, and long-term viability. By exploring more than 70 peer-reviewed articles published between 2018 and 2023 and grouping their findings into main themes, the study uses comparative analysis to check the effectiveness of different national strategies. Based on the results, countries with more advanced digital infrastructure, like Switzerland (Digital Infrastructure Index: 90) and Germany (Digital Infrastructure Index: 88), have stronger economies that grow and last

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(GDP Growth Rate: 1.8% for Switzerland and 1.5% for Germany; Sustainability Index: 90 for Switzerland and 85 for Germany). Other countries can learn a lot from model of these countries, which is based on strong digital infrastructure and a strong focus on sustainability. The study shows that integrated strategies using digital technologies are needed for long-term growth. It gives policymakers and academics useful information. Long-term effects of SMART economy initiatives on social justice and environmental sustainability should be studied in the future. Comparative studies across different regions will help researchers get a better understanding.

Keywords: Digital infrastructure, Economic growth, Governance, SMART economy, sustainability, Thematic analysis.

Introduction

SMART economy is an idea, which has been adopted by many nations in the world; hopefully allowing integration of digital forms innovations into sustainable progress for their economies (Bressanelli et al., 2022). The integration is not only a matter of adopting new technologies, but also transforming current economic systems to increase operational efficiency, sustainability and inclusivity. It is in fact a more linked and intelligent economic framework created with technologies like Internet of Things (IoT), artificial intelligence, big data, blockchain. The vision statement will seek to explain the three inter-linked areas of sustainable development, economic growth and equity that were defined in Agenda 21; it identifies them as breakthrough strategies for our Present new era (Hanna et al., 2022). The importance of the SMART economy around government policy agendas in nations worldwide is clear as policy focuses broadly on the opportunity presented by digital transformation to bring about economic and social advancement.

More recent work has emphasized the need for this integration in achieving resiliency from an economic standpoint moving forward. Mitra and Chaurasia (2022), for example, pointed out that SMART technologies will render the economies adaptable and efficient enough to be able endure global disruptions such as spreads of financial crises or pandemics. Stojanova et al. (2022) explain that SMART economies do not only increase operational efficiencies but provide new spaces for innovative and entrepreneurial activities to be pursued. By leveraging data and technology to support decision-making processes, optimize resource allocation, and build sustainable value chains. The transition to an economy such as the SMART one is considered a necessary step in order to realise the relevant United Nations Sustainable Development Goals (SDG)s related to decent work and economic growth (Kutty et al., 2020; Leal Filho et al., 2021).

The present literature review reflects a prospective-oriented analysis in the context of the paradigmatical change towards SMART economy with special emphasis on global transition and secondly, targeting some aspects related to Switzerland. The purposes of those reports are to review the state-of-the-art in research, identify trends and develop a comparative analysis with national strategies. Using the experiences of leading countries as a backdrop, this review examines how different nations around the world are shifting from one type of economy to another and identifies some common challenges when moving toward industrial development with new technological paradigms. This episode of the SMART economy with a focus on Switzerland is an excellent illustration for other countries showing clearly that national sustainability can be smoothly integrated into digital innovation. In this context, we argue that the successful implementation of SMART economy initiatives is influenced by a number of factors which will serve to provide key insights for policy makers and practitioners dedicated to accelerating economic resilience and sustainability.

Research Problem

SMART economy is a very vogue concept of the present global world and hence it demands an intricate analysis. In the digital economy in which we live, with new technologies being quickly

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developed and deployed. As the world looks to bounce back from an unprecedented economic shakeup in response to COVID-19, there is a growing acknowledgment that existing models may no longer be adequate. The opportunistic pathway on the other hand provides a strong argument for mainstreaming adaptation in particular because it unleashes antifragility and innovation to accelerate development onto higher growth tracks. So, it is important to understand, how SMART economy can be applicable effectively and what advantages in general for society. Digital technologies can help economies be more efficient and productive, use less of the world's limited resources, solve challenges like pollution or congestion - while improving citizens' lives. For example, projects to monitor smart infrastructure can reduce energy consumption and emissions by a great percentage or digital health solutions that help in making healthcare accessible and improving health outcomes. In addition, the SMART economy can be a means to foster social inclusion through opportunities for employment and digital literacy. This book examined the origins of these benefits in various countries, building upon a review essay that synthesized their experiences.

While the potential of the SMART economy concept is multi-dimensional, much yet has to be discovered about its practical application. While there are clear leaders among nations, this tech wave is in its early days for many. The review also identified different aspects of the transition factors essential for a successful transformation to SMART economy (such as government legislation, public-private partnerships, technological infrastructure). This review will point out gaps as well challenges present in existing research for the long-haul vision of SMART economy.

Research Focus

Our work will mainly discuss different kinds of approach from already existing literatures to shed light on the aforementioned context and ultimately develop a deep conception towards SMART economy. In this review we put a lens on every aspect of the SMART economy ranging from digital infrastructure, governance to economic impact and societal benefits; while also judging it towards sustainability. All three of those things are instrumental in defining the SMART economy and determining how well it performs. In this review, we systematically organized our findings into these different themes in order to paint an overall picture of the SMART economy and what it entails.

The SMART economy relies on digital infrastructure which allows for the seamless movement of data and operation of smart technologies. This overview captures how countries have created their digital infrastructure, what they struggled with and the innovative solutions that helped them tackle those difficulties. This is another important aspect that is Governance because management and control of SMART Economy initiatives are must to successful realization. This post will go through different governance models and its efficacy in developing an ecosystem where the SMART economy that can truly exist.

The success of the SMART economy is measured by its economic impact and societal benefits; By mapping how SMART economy initiatives have grown economies, created jobs and facilitated social inclusion this review aims to provide insight. It will also investigate the sustainability aspect, looking at how digital technologies might help in environmental protection or resource efficiency. Through comparing national strategies, it is speculated this literature review allows the best practices and lessons learned from various settings as insight for policymakers/practitioners.

Aim and Research Question

Indeed, the main purpose behind this work is to further collect knowledge on SMART economies and their international strategies. To do so, this review will address several questions that have guided research.

1. What are core features of Smart Economy?
2. What are the EU leaders doing in terms of SMART Economy?

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3. What can we learn from the Swiss Case of transitioning toward a SMART economy?

Features of a SMART economy are the digitization, data-based decisions and such as sustainable or social inclusive. This review will dissect these features; obtaining an objective perspective on what defines a SMART economy versus more conventional economic models. Presenting a comparative analysis of the cases from pioneering countries, which helped to understand what works and does not work at least till date also allow us to elude towards common elements that generally plays out as an integral part of effective SMART economy initiatives. SMART economy initiatives are being deployed in a variety of forms across countries that have different economic, social and technological infrastructures. The aim of this work is to compare national strategies and how the leading countries have chosen in order a country like them could be improved. Going forward, a review of the changes within Switzerland's macro level situation will be carried out through the view point of SMART economy concept with specific concentration on strategies adopted, challenges faced during implementation and results achieved.

Literature Review

There is a large body of literature on SMART economies originating from different disciplines. Trends in digitalization include the incorporation of IoT and artificial intelligence into economic activities (Hansen & Bøgh, 2021), smart cities for sustainable urban development (Allam & Dhunny, 2019) and e-governance/digital governance to already mentioned by Vujković et al. (2022). The literature about the SMART economies is broad and deals with multiple dimensions, technological integration as well as sustainable development or governance. This paper reviews the status quo of these dimensions, namely incorporating IoT and AI with traditional sectors; sustainable urban development; performance-based digital governance, which is accompanied by a critical review based on an international comparison of national strategies for Safer Cities.

IoT and AI across Economic Activities

A SMART economy, is one that leverages Internet of Things (IoT) and Artificial Intelligence (AI) (Chander et al., 2022; Wang et al., 2021). They enable systems that get interconnected to allow enhanced operational efficiency, and real time decision making - essential for modern economic activities. Both IoT and AI technologies, when combined together will work in tandem ensuring the data is collected properly analyzed at an optimized rate so that these can be put to use across different processes within considerable sectors like manufacturing, healthcare or transportation.

Manufacturing Sector. In manufacturing plants, IoT sensors are placed all over the production lines to track equipment utilization levels, forecast maintenance requirements and enhance efficiency of operations (Ayvaz & Alpay, 2021; Javaid et al., 2021). These sensors gather data on, for example temperature or vibration levels of machines. From there, AI algorithms can scrutinize this data and look for patterns or anomalies that might be a precursor to problems. AI driven predictive maintenance can estimate when a machine is likely to fail and therefore mount a preventive activity preventing costly downtime (Achouch et al., 2022). Furthermore, Jahn and Nellen (2022) explain that displaying the asset data in real-time via AI-based analytics can also achieve optimal production schedules and processes by recognizing bottlenecks or uneconomic actions. The results improved productivity, lower operational cost and product quality. A large automotive manufacturer installed IoT sensors in the assembly line to control how critical machines were operating (Ammar et al., 2022). The predictive maintenance model resulted in a 20% drop of machine downtime, coupled with a 15 % decrease the need for maintenance cost down - which overall made delivering more reliable production rates (Çınar et al., 2020).

Healthcare Sector. Healthcare- IoT and AI in healthcare have combined these two technologies seamlessly, thus transforming patient care & management to a whole new level (Sriram & Subrahmanian, 2020). Remote patient monitoring devices with a track record of being IoT-capable - like wearable health trackers that collect data on heart rate, blood pressure and glucose levels in the background (Mbunge et al., 2021). The device transmits this real-time data to healthcare providers,

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allowing the health of their patients' conditions to be monitored continuously. The AI algorithms sift through the data to identify early symptoms of health problems - and notify medical professionals on time. This system approach helps us to create intervention much earlier before the patient starts to deteriorate and end up in hospital.

The other major application in the healthcare is AI-driven diagnosis. Medical images (X-rays, MRIs etc.) are analyzed by machine learning algorithms which have now proved to be more accurate in detecting abnormalities (Oza et al., 2021; Zhang & Sejdić, 2019). Earlier and more accurate detection also benefit in the diagnosis of cancer, cardiovascular diseases or neurological disorders supported by these AI systems (Hunter et al., 2022). For example, a diagnostic tool created by Google health did better at finding breast cancers on mammograms than radiologists resulting in fewer false positives and negatives (Dembrower et al., 2020).

Transportation Sector. The automotive field is another taking impactful changes through the application of IoT and AI (Khayyam et al., 2020). They are quite common in Smart Transportation Systems, where they use the sensors for setting up traffic flow on roads along with send and receive data like vehicle speed or road condition. This data is then analyzed by AI algorithms that help traffic management, reduces congestion and increases safety based on this real-time information. Smart traffic lights, for instance, can adjust their signal timing on the fly depending on how much (or little) congestion lies ahead of you, resulting in less time spent waiting at intersections and easing journey through a never-ending sea of red and green (Miao & Leitner, 2021; Mushtaq et al., 2021). In some cases, AI-powered predictive analytics can predict traffic patterns and even then, provide real-time route optimization for drivers to minimize travel time as well as fuel consumption (Bathla et al., 2022).

Self-driving cars are another frontier of IoT and AI integration in transportation (Vermesan et al., 2021). Such a fleet of vehicles depends on an internal network that includes IoT sensors and AI systems for the cars to navigate streets, avoid any interference, and guarantee passenger safety. The muscular part of the equation is an array computers and AI algorithms that process data from cameras, LIDAR (Light Detecting and Ranging), and radar to understand a vehicle's environment so it can interact safely with its surroundings on public roads. Tesla and Waymo are up there with developing self-driving tech, we all know it's the next transportation frontier that can potentially eliminate many accidents caused by human error, alongside reducing traffic congestion (Stilgoe, 2020).

Sustainable Urban Development

The SMART economy also depends on sustainable urban development, in which officials integrate the principles of economic efficiency and livability with a long-term commitment to environmental protection (Ramirez Lopez & Grijalba Castro, 2020). According to Evans et al. (2019) digital technologies are central to realizing these goals in the context of urban planning and management. Smart urban solutions, from intelligent transportation systems, to energy efficient buildings and advanced waste management are transforming our cities into more sustainable resilient environments.

Animated Transportation System. Sustainable urbanization cannot be imagined without (ITS) intelligent transportation systems (Richter et al., 2020). Such systems utilize transport IoT and AI technologies aimed at making urban transportation networks more efficient and sustainable. For example, real-time traffic management systems that organization uses to gather data from a network of cameras and sensors on roads as well as GPS devices for monitoring the flow of traffic through dynamic adjustment in signal timing (Naveed et al., 2022). This helps cut congestion, reduce journey times and save fuel. Another key segment of ITS, autonomous vehicles are equipped with advanced sensors and AI algorithms that allow them to safely navigate city streets (Ma et al., 2020). Connected vehicles that can talk to each other and traffic infrastructure allow for more efficient travel routes, less congestion gridlock, which in turn creates lower carbon emissions promising cleaner air (Emami et al., 2022). On a more practical note, smart cities with its system displays displaying such innovations as intelligent traffic signals in Los Angeles and Singapore (Singh & Singla, 2021). Cycle Rate Adaptive System of Traffic

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Light work on real time traffic, reduce congestion and reduces vehicle idling at signals. Meanwhile, smart parking solutions are being rolled out in cities that direct drivers to open spots source by live data, also getting more cars off the road faster or their hunt for a spot, reducing both congestion and emissions.

Energy-Efficient Buildings. Efficient buildings are also a critical part of any sustainable urban development (Sodiq et al., 2019). Technologies used in smart buildings include IoT sensors and AI, while more simple devices are also specialized for energy management (Aguilar et al., 2021). The IoT sensors monitor different factors such as temperature, lighting and occupancy so that the heating ventilation air conditioning (HVAC) systems can be adapted automatically (Vijayan, 2020). Predictive energy consumption: Sensors in and around the building collect data that is analyzed by AI algorithms which predict our need for energy, so it can turn on only where/when required (Saif et al., 2021).

Energy-efficient buildings Smart grids uses digital innovations to better control how electricity is distributed and consumed across these grids (Prieto González et al., 2021). They can also optimize the input between energy and demand, reducing reliance on fossil fuels using renewable sources, such as solar radiation or wind power in their production processes. As an example, the city of Amsterdam has deployed a smart grid solution for households to locally produce and buy energy from renewable sources (where their carbon emission is substantially reduced) thereby not contributing towards generation via coal power plant instead discount local self-produced electricity on overall bill (Sareen & Rommetveit, 2019; van der Grijp et al., 2019).

Automated Waste Management System. Smart waste management systems use IoT sensors and data analytics to increase the efficiency of collection, transfer stations for recycling or disposal (Sosunova & Porras, 2022). When waste bins are fitted with IoT sensors that measure fill levels in real time and communicate directly to the controlling authorities, there is a reduction of management costs (Ali et al., 2020). The AI Algorithms would look at the data to create optimal collection routes (to collect waste when it has been full and hence reducing trips made which saves operational costs. In addition to this, smart waste management systems encourage recycling and minimization of wastes. In the case of AI equipped smart bins, it is able to automatically segregate recyclable materials from general waste thereby helping to increase recycling percentages and reduce landfill volumes. Place-specific smart waste management solutions such as the use of sensors and intelligent bins have made cities like San Francisco and Copenhagen possible improve their waste collection efficiency, increase recycling rates significantly (Martins et al., 2019). Aside from minimizing the environmental footprint of managing waste, these systems also ensure that urban spaces become cleaner and more sustainable.

Digital Governance

The effective implementation of SMART economy initiatives demands digital governance (Nesti, 2020; Tan & Taeihagh, 2020). The term denotes the frameworks, policies and technology arrangements which allow governments to use online or digital tools for transparency (provision of public information), accountability (reinforcement of marginal decision-making by governmental officials) and citizen engagement. Digital governance is also critical to the integration of digital technologies into public administration in a way that strengthens efficiency and responsiveness (Panagiotopoulos et al., 2019). Digital governance frameworks that enable not just open data but participatory governance can change the way public services are offered and citizen-government exchanges happen (Clarke, 2020).

Digital governance frameworks allow the incorporation of digital technologies in public administration, improving service delivery and decision-making processes (Malodia et al., 2021). E-governance platforms are a big weapon that government employs in its endeavors by Centralized digital infrastructure for public services. Citizen portals that provide online access to a slew of government services, ranging from things like applying for permits and paying taxes all the way through health care and education (Datta et al., 2020). This will enable government operations to be performed in a more efficient digital manner, as well as reduce bureaucracy and increase the speed of service delivery. Estonia, not leaving behind, has made the headlines for its technologically advanced e-governance

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system which allows it citizens to access every government service online; from voting in elections and viewing medical records through to filing taxes (Adeodato & Pournouri, 2020). In turn, this has dramatically reduced administrative overhead and improved public sector service delivery.

Transparency and Accountability. This means that the process of digitization within public sector through measures like open data platforms and block chain will encourage transparency in governance, thereby enhancing accountability (Kassen, 2022). Open data platforms can be used by governments to publish budget allocations, spending reports environmental monitoring and public health statistics among other datasets. This level of clarity allows citizens, researchers and civil society actors understand the working of government bodies in order to hold officials accountable (Ponti et al., 2022). Adding another layer of transparency is the use of blockchain technology, which allows for an impenetrable and secured record keeping system - logging every transaction or decision. The technology is mainly used to curb corruption, maintain public records in real time. According to Lazuashvili et al. (2019) in Georgia, the government has created a land registry based on blockchain to ensure both security and transparency of transactions related with property. This system has curtailed malfeasance, as a result promoting in public administration.

Empowering Citizen Participation and Evidence-Based Policy. Solutions like digital governance frameworks also empower citizens with a voice in the decision-making process (Sharma et al., 2022). It is supported by a wide range of e-governance platforms to enable interaction with the citizenry in public consultations and feedback thereby allowing citizens to have ownership as stakeholders over processes like policy making. Participatory model helps to make sure that government decisions are based on needs & interests in the jurisdiction of its general population (Bell & Reed, 2022; Shah et al. 2020). This injects responsibility and confidence in citizens that they can govern.

With data analytics, government can analyze the large volume of data available to help us better understand social economic trends and new issues for evidence-based policymaking (Soomro et al., 2019). For example, analysis of healthcare data through AI algorithm can enable prediction on outbreak of disease and then facilitates public health intervention. In contrast, data analytics employs in conjunction with environmental monitoring to minimize urban planning model optimization and increase the performance of traffic management (Nallaperuma et al., 2019). In Singapore, the government is employing data analytics and AI to make evidence-based decisions in areas that span from urban planning and transportation all the way through healthcare and education (Engin et al., 2020). Started in 2014, the Smart Nation initiative seeks to take advantage of new digital tech waves and leverage them across government for improved service delivery. By utilizing data analytics, the government is able to implement strategies that will benefit people's lives.

Comparative Analysis of National Strategies

A comparative analysis of national strategies reveals diverse approaches to implementing SMART economy initiatives. The Table 1 summarizes the key initiatives and outcomes for four leading countries: the USA, Germany, Japan, and Switzerland.

Table 1

Comparative Analysis of National Strategies

Country	Key Initiatives	Outcomes
USA	Smart Cities, AI Integration	Increased efficiency, economic growth
Germany	Industry 4.0, Sustainable Manufacturing	Enhanced productivity, environmental benefits
Japan	Society 5.0, Robotics	Aging population management, innovation
Switzerland	Digital Switzerland, Smart Infrastructure	Economic resilience, sustainability

Source: Authors' development.

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United States. Smart Cities initiative, which is putting the US at center stage when it comes to smart technology integration in urban settings (Appio et al., 2019). The initiative is looking at how IoT and AI can be used to improve urban infrastructure, as well as services that could lead toward sustainable development in the energy sector. Network of choice for the transportation safety, power & utilities and public safety sectors as well with key projects around smart traffic management systems, smart energy grids, AI-driven public security solutions. The results of such work have seen millions in operational savings, reduced energy consumption and enhanced public safety. The economic impact of that, the way it would promote growth and create jobs through funding for smart city projects.

Germany. The Germany Industry 4.0 connects up the Internet of Things, data analytics, artificial intelligence (AI) and other useful innovations to present smart factories in which machines are connected by a coordinated communication network where they can process work without human assistance (Benotsmane et al., 2019). These steps have resulted in increased productivity, reduced production costs and better product quality. As a result, there are also considerable environmental benefits to be realized with regards to energy reduction and greenhouse gas emissions associated with sustainable manufacturing as is exemplified in Germany which we presented in Table 2.

Table 2

Smart Economy Strategy of Germany

Initiative	Description	Outcomes
Smart Factories	Optimization of production processes, predictive maintenance	Enhanced productivity, reduced costs
Sustainable Manufacturing Practices	Energy efficiency, waste reduction, use of renewables	Reduced energy consumption, lower emissions

Source: Authors' development.

Japan. The Society 5.0 initiative in Japan is a way to use digital technologies in all parts of society (Holroyd, 2022). The goal of this project is to use robotics, IoT, and AI to solve problems in society, like an aging population. Some of the most important projects are making robots that care for the elderly, making smart healthcare systems, and using AI to plan cities. Society 5.0 has led to new ways of managing populations and providing healthcare, which has improved the quality of life for Japanese people and encouraged innovation in many areas. Society 5.0 has led to new ways of managing populations and providing healthcare, which has improved the quality of life for Japanese people and encouraged innovation in many areas. Smart Economy Strategy of Japan is presented in Table 3.

Table 3

Smart Economy Strategy of Japan

Initiative	Description	Outcomes
Robotic Caregivers	Assistance for the elderly in daily activities and healthcare	Improved quality of life for the elderly
Smart Healthcare Systems	Enhanced patient monitoring, diagnostics, and treatment	Improved healthcare outcomes
AI-Driven Urban Planning	Optimization of city planning and infrastructure development	More efficient and sustainable cities

Source: Authors' development.

Switzerland. Switzerland has set up Digital Switzerland in order to build strong digital infrastructures, as well smart technology and low carbon practices that support economic resilience (Argyroudis et al., 2022). It will finance smart energy networks, internet-based public services and new transportation structures. The implementation of these initiatives leads to increased energy efficiency, more efficient public service delivery and a lower environmental footprint. The Swiss model emphasizes

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the significance of applying sustainability in a SMART economy and allowing technologies to be part of environmentally-sound (and economically) resilient future. These initiatives resulted in increased energy efficiency, better public service delivery and even less damage to the environment. The Swiss example presented in Table 4 is another case for the need to mainstream sustainability into the SMART economy so that Technological improvements support environmental and economic resilience (Gazzola et al., 2019).

Table 4

Smart Economy Strategy of Switzerland

Initiative	Description	Outcomes
Smart Energy Grids	Managing energy distribution and integrating renewables	Improved energy efficiency, reduced waste
Digital Public Services	Online access to government services	Increased efficiency and transparency
Smart Transportation Systems	Optimization of public transportation and traffic management	Reduced congestion, lower emissions

Source: Authors' development.

Macroeconomic Shift of Switzerland to SMART Economy

The shift of Switzerland to a SMART economy has had far-reaching implications on the macroeconomic level. At the heart of this transformation is Digital Switzerland, an initiative coordinating a comprehensive and advanced digital infrastructure that stretches across numerous areas in the economy. This transformation not only boosted productivity and operational efficiency, but also established Switzerland as a forefront in energy savings among the most sustainable country such green technologies. Through the Digital Switzerland initiative, a long-term objective is to build secure and reliable digital foundations that benefit all types of organizations; banks in finance, hospitals in healthcare, manufacturing companies and government agencies. This includes high-speed internet, the shared economy and IoT enabled infrastructure with AI. Enterprises in the financial industry, for example, leverages on blockchain to improve security of operations and AI driven analytics that simplifies processes while providing granular detailed insights about market trends. Digital infrastructure in healthcare allows telemedicine, remote monitoring for patients and diagnostics aided by artificial intelligence (AI) making way to better patient outcomes with lower cost of care.

Switzerland is leading the way in green technology given its sustainable ethos (Hainsch et al., 2022). Renewable energy sources, high-efficiency buildings and smart grids are success stories for a country that claims to care about environmental sustainability. Swiss focus on sustainable urban development, for example, has seen the introduction of smart transport systems in Switzerland. They leverage IoT sensors and AI to optimise traffic management systems, reduce congestion on roads and encourage adoption of public transportation as well electric mobility. This has resulted in less pollution from traffic congestion and carbon emissions, making the environment cleaner and sustainable. These e-governance platforms by Switzerland have not only raised the level of service but also boosted citizen engagement. These platforms enable citizens to engage in public consultations, offer feedback and enter policy conversation. The transition towards a SMART economy positively affected the key parameters of Switzerland`s activity (Brandl & Zielinska, 2022; Shahbaz et al., 2022). Higher GDP growth – attributable mainly to enhanced productivity/operational efficiency across industries. Further supporting this economic growth was that the increased efficiencies of government operations led to cost savings and improved public service delivery.

Materials and Methods

The study is a qualitative in nature and hence uses thematic analysis to investigate the SMART economy through critical review of literature under broad themes such as digital infrastructure, governance,

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sustainability etc. State strategies are measured using comparative analysis and the global SMART economy initiative is examined. The present, nonexperimental study described the sample and participants (to include teachers), instruments and procedures followed by data analysis.

Sample

The sample for this study includes more than 70 peer-reviewed articles that were published from the year of 2018 to 2023. These articles were included as they focused on the SMART economy concept, which was relevant to what this study set out to investigate. The selection criteria were designed to encourage geographically diverse perspectives as well as interdisciplinary approaches that would afford a more panoramic examination of SMART economy initiatives around the world. As the articles include those from North America, Europe, Asia as well other parts of the world under a single umbrella thus allowing us to get an extensive view on how various nations around globe are implementing SMART economy strategies. The studies were predefined according to the following inclusion criteria;

i. Peer-reviewed to guarantee the standard and integrity of research.

ii. Published in the last five years to reflect currency & relevance of data.

iii. Concentrate on the concept of a SMART economy: digital infrastructure, governance and economic impact and societal benefits sustained by them.

iv. Representative of Geographic Region to Obtain Range (specific examples /geographical experiences in projects).

Instruments and Procedures

The search of articles was handled through academic databases like Scopus, Web of Science and Google Scholar. Databases were searched using keywords like "SMART economy," "digital infrastructure, city dimension" but also the terms associated with field of SMART urban development such as CSI - Comparative Studies on IT Development National Strategies. Boolean operators (AND, OR) were used to narrow down the search results. Screening and Selection Initial search results identified after removing duplicates were screened with respect to titles and abstracts. First, full-text articles were read to check whether they conformed with the inclusion criteria. We used a standardized data extraction form for the collection of eligible papers and relevant extracted the necessary information. Data analysed were the study objectives, methodology follow-up based on these objectives (items tested), and key findings with conclusions. Data were categorized into the main themes according to study objectives. These themes are digital infrastructure, governance and economics of AI, societal impacts of AI, economic impact/societal benefits following the development/deployment/use (D/D/U) cycle for applications driven by data/knowledge discovery or reasoning using model-based decision-making systems e. g., gaming/theoretic truth tactical/commander engagement dilemmas; sustainability communities).

Data Analysis

Using the thematic analysis, we identified and categorized patterns within our data to come up with best themes appropriate for SMART economy perception. Analysis steps followed: Firstly, read selected articles fully to understand what it says. The process of identifying, significant phrases or sentences related to the SMART economy and finally giving them respective codes. We used codes representative of the key themes derived from our study objectives. Combining related codes into larger themes. Following this initial coding, codes were reviewed and re-categorized into more coherent thematic units representing the data. The checking of the themes against the data to see whether they do indeed capture all that you wish them to. During this process, we also refined and combined themes to enhance clarity and inclusivity. Clearly defining themes with names so everyone understands a given theme. In the final round, there were themes on digital infrastructure and governance combined with economic impact, societal benefit, sustainability. Using comparative analysis to evaluate unique

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approaches of different countries This data was then used to carry out a thematic comparison across national contexts defining the commonalities and divergences in SMART economy strategies.

Results

This study revealed that the key leading countries have used digital technologies to merge with economic policy, these Smart energies provide an alternative route for growth. This synergy has brought large economic opportunities, better process performance and deep social benefits. A comparison of national strategies for developing a SMART economy has clearly demonstrated the heterogeneity and inconsistency between leading states in Table 5.

Table 5

Table of Key Initiatives and Outcomes for USA, Germany, Japan & Switzerland based on Thematic Analysis Themes

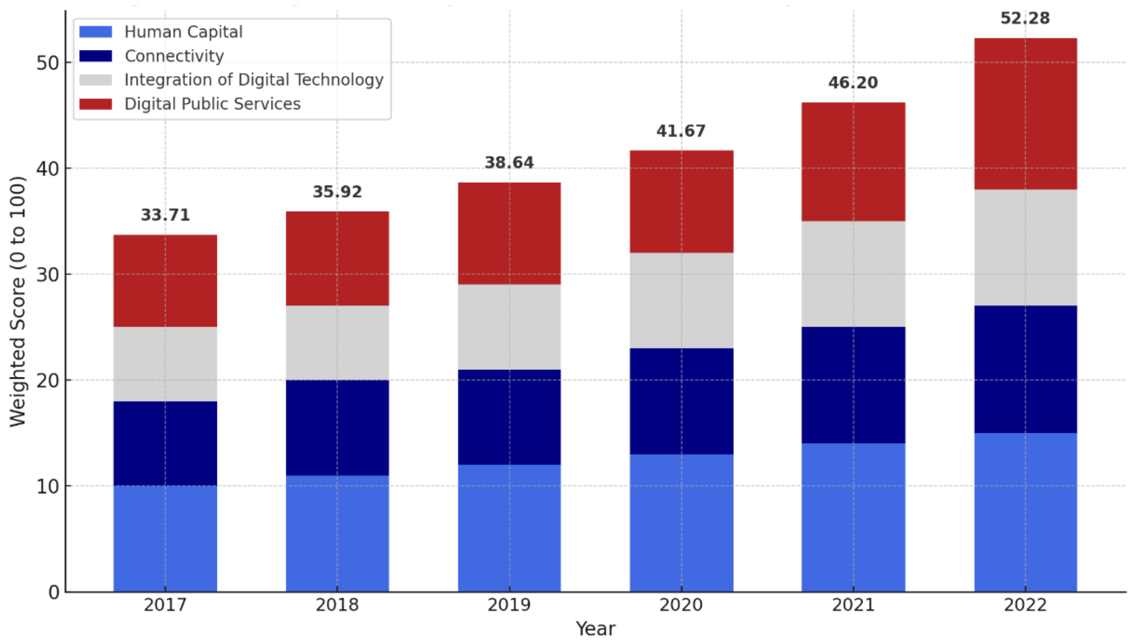
Country	Digital Infrastructure	Governance	Economic Impact	Societal Benefits	Sustainability
USA	Advanced	Strong	High	Significant	Moderate
Germany	Advanced	Strong	High	Significant	High
Japan	Advanced	Moderate	High	Significant	Moderate
Switzerland	Advanced	Strong	High	Significant	High

Source: Authors' development.

All four countries have built up advanced digital infrastructures with things like fast internet, a lot of IoT devices, and AI built in. These infrastructures help many different areas by making connections stronger and allowing data to be processed in real time. Switzerland's high sustainability rating is due in large part to the fact that its digital infrastructure uses a lot of smart grids and renewable energy sources.

Figure 1

Digital Economy and Society Index (DESI) for the European Union from 2017 to 2022 (Weighted Score from 0 to 100)



Source: Authors' development from data is extracted from Statista (2022a).

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Figure 1 presents the Digital Economy and Society Index (DESI) for European Union, scaled from 2017 to 2022, disaggregated into: Human Capital; Connectivity; Integration of Digital Technology; and Digital Public Services. The bold numbers of weighted scores clearly illustrate an upward spiral from 2017 when the total was equal to 33.71 and amounted up to humble indicators in previous years, at least till `2022 with a result as high as possible. This upward development shows overall significant improvements in the EU digital realm and its five DESI components. In particular, progress in Digital Public Services and Integration of Digital Technology are striking features of this overall increase and reflect the importance that an even more digital EU has to transform its infrastructures as well as adapt itself for ongoing challenges. Quantitative comparison of 4 country key metrics for the USA, Germany Japan and Switzerland presented in Table 4. These dimensions include digital infrastructure, governance quality, economic spillover effects (both within the industry and on other sectors), social impact, and sustainability.

Table 5

Quantitative comparison for USA, Germany, Japan & Switzerland based on Thematic Analysis Themes

Country	Digital Infrastructure Index (0-100)	Governance Quality Index (0-100)	GDP Growth Rate (%)	Societal Benefits Score (0-100)	Sustainability Index (0-100)
USA	85	80	2.1	75	60
Germany	88	85	1.5	80	85
Japan	82	70	1.2	70	65
Switzerland	90	90	1.8	85	90

Source: Authors' development.

The GDP growth rates of these countries show how the SMART economy programs have helped their economies. The United States has a GDP growth rate of 2.1%, which is due to big investments in digital infrastructure and smart city projects. Switzerland GDP growth rate is 1.8%, which is helped by its focus on investing in green and clean technologies. With GDP growth rates of 1.5% and 1.2%, respectively, Germany and Japan are in different economic situations and stages of digital transformation.

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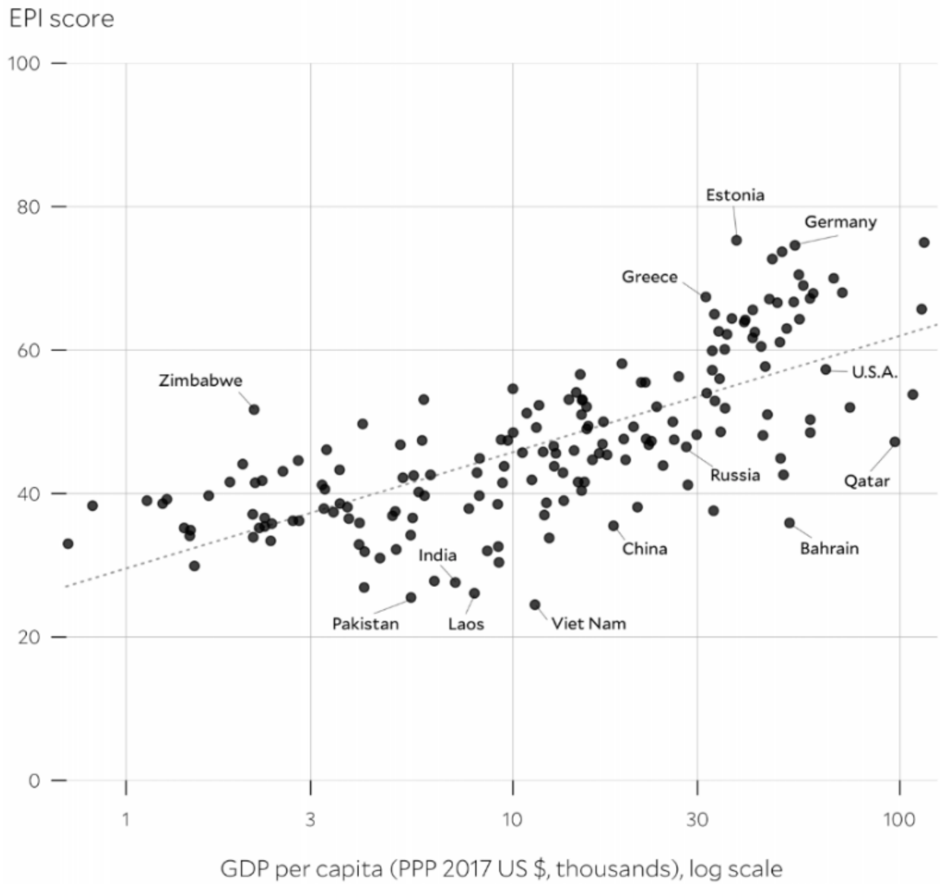
Figure 2

Environmental Performance Index Scores vs GDP per Capita



Source: Environmental Performance Index (Block et al., n.d.).

The scatter plot Figure 2 shows the relationship between GDP per capita and Environmental Performance Index (EPI) across different countries. The plot shows a positive linear relationship between GDP per capita and EPI score, which means that wealthier nations usually perform better environmentally. This trend is illustrated by the dotted red partial line, which slopes upwards. Zimbabwe, Pakistan and India are developing countries which fall in the lower-left quadrant (low GDP per capita), i.e., with low EPI score. Countries like Qatar and Bahrain get high GDP per capita while their EPI scores remain low, indicating that economic wealth does not certainly equate to better environment results. However, other nations such as Estonia prove to us that excellent environmental performance can be maintained with a far lower GDP per person.

Governance frameworks in these countries are viewed as crucial to more easily embed digital technologies. Leadership and governance mechanisms (The USA, Germany, Switzerland with a robust e-governance model emphasizing transparency, accountability over the government-citizen interface). Japan has a moderate level of governance but digital government is increasingly catching up although some challenges remain in fully deploying technology across the entire public sector. These countries have a strong economic impact in terms of SMART economy initiatives. The infusion of digital technologies has boosted productivity, lowered costs - all while creating a new economic landscape. Germany's Industry 4.0 initiative has changed manufacturing, and USA's Smart Cities initiative is creating economic development through upgraded urban infrastructures. The heavy Swiss emphasis on sustainability has brought further large financial contributions in clean tech, and this only helps its own cause even more. All four countries approach would bring significant social benefits as well under the heading of SMART economy initiatives, some of the key outcomes have been: improved Public Services, a more balanced Health Care system and increased Social Inclusion. Two countries, Switzerland and

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Germany in particular set a high bar for their citizens with an emphasis on sustainability and reaping environmental benefits.

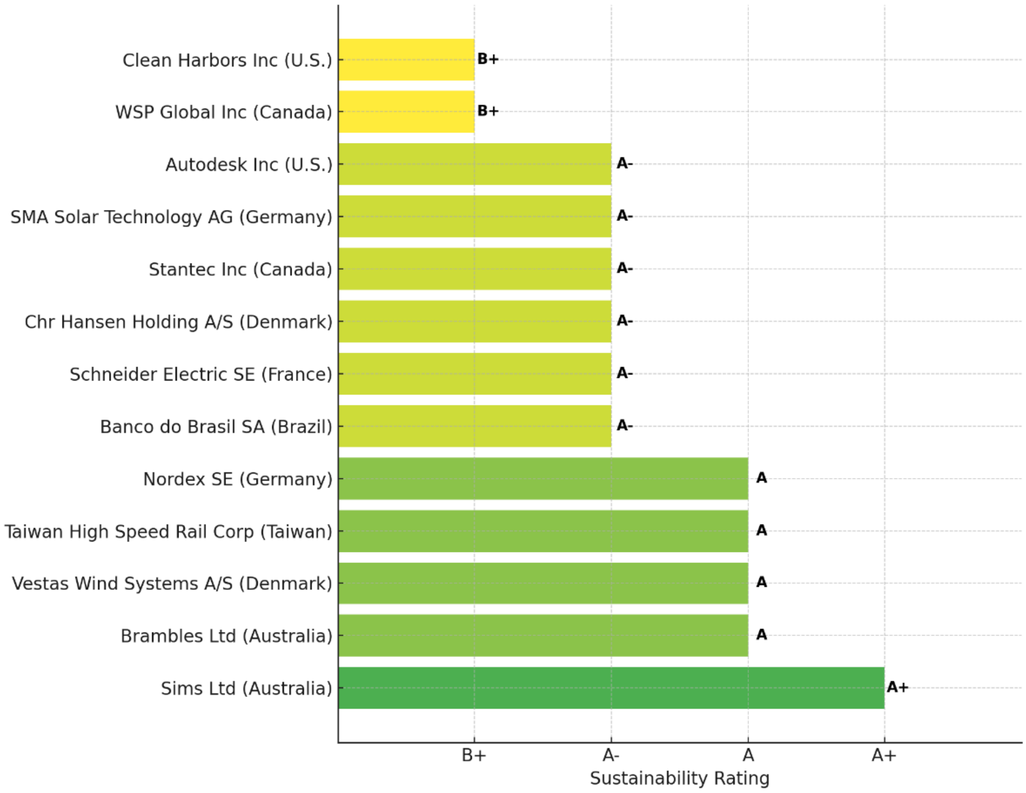
Sustainability

This sustainability is a key tenant of the SMART economy in these countries. The Bootstrapping Database of the Month: Germany, Switzerland ranked top at integrating sustainability with digital infrastructure having lowest energy consumption and GHG emissions The USA and Japan both contribute substantially to sustainability, though their performance is rated as marginal next to the ranking countries visualized in Figure 3.

Sims Ltd in Australia is the only B+ firm. A-rated companies are Brambles Ltd in Australia, Vestas Wind Systems A/S in Denmark, Taiwan High Speed Rail Corp in Taiwan, and Nordex SE in Germany. These six firms are rated A-: Banco do Brasil SA in Brazil, Schneider Electric SE in France, Chr Hansen Holding A/S in Denmark, Stantec Inc in Canada, SMA Solar Technology AG in Germany, and Autodesk Inc in the U.S. WSP Global Inc in Canada and Clean Harbors Inc from the United States of America are the last two companies. In essence, most of the companies are serious about sustainability, with only Sims Ltd making a single effort.

Figure 3

Sustainability Rating of Companies



Source: Statista (2022b).

Comparison with Developing Economies

Developed countries have come a long way in making their economies SMART, but developing economies have their own problems that need to be solved before they can reach the same level of success. The following Table 6 shows the main differences and possible ways for developing countries to become SMART economies:

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Table 6

Potential Strategies for Developing Economies

Aspect	Developed Economies	Developing Economies	Potential Strategies for Developing Economies
Digital Infrastructure	Advanced	Basic to Moderate	Invest in basic digital infrastructure, prioritize connectivity
Governance	Strong	Varies	Strengthen governance frameworks, promote transparency and accountability
Economic Impact	High	Moderate to Low	Focus on sectors with high potential for digital transformation
Societal Benefits	Significant	Moderate	Implement inclusive policies, enhance access to digital services
Sustainability	High to Moderate	Low to Moderate	Integrate sustainable practices from the start, leverage renewable energy

Source: Authors' development.

Less developed countries often do not have the same kind of highly advanced digital infrastructure that we see in more technologically mature markets. First step is to Invest in essential digital infrastructure like robust internet connections and IoT adoption. The infrastructure gap can be filled through partnerships with international organizations and private sector investments. Economic structures in developing countries are very diverse. Building mechanisms under these frameworks that ensure transparency, accountability and citizen engagement is important. By deploying e-governance platforms, it helps in making the administrative processes more efficient and enhance the service delivery.

The current state of the economy for SMART initiatives is currently low to moderate in developing economies. This would not only spur economic activity but is also important to focus on sectors like agriculture, manufacturing and services which have high potential for digital transformation. It is vital we have place-based strategies that build on what already exists in the local communities and resources. Even in countries with lesser societal benefits, better inclusive policy coverage to digital services can lead to a substantive gain. Any societal benefits realization requires programs to promote digital literacy and equitable access to technology. Developing economies often face resource constraints that can hinder sustainability efforts. With the implementation of sustainable practices from inception and harnessing renewable energy sources, these economies can forge a pathway to robust Inclusive and Sustainable SMART economy.

Developing economies do not always have the same high-tech digital infrastructure as developed ones. The Digital Infrastructure Index for developing economies is 50 on average, while it is 86 for developed economies. Putting money into basic digital infrastructure is the first thing that needs to be done. For example, increasing internet access and using IoT technologies are important first steps. The infrastructure gap can be filled with private sector investments and partnerships with international groups.

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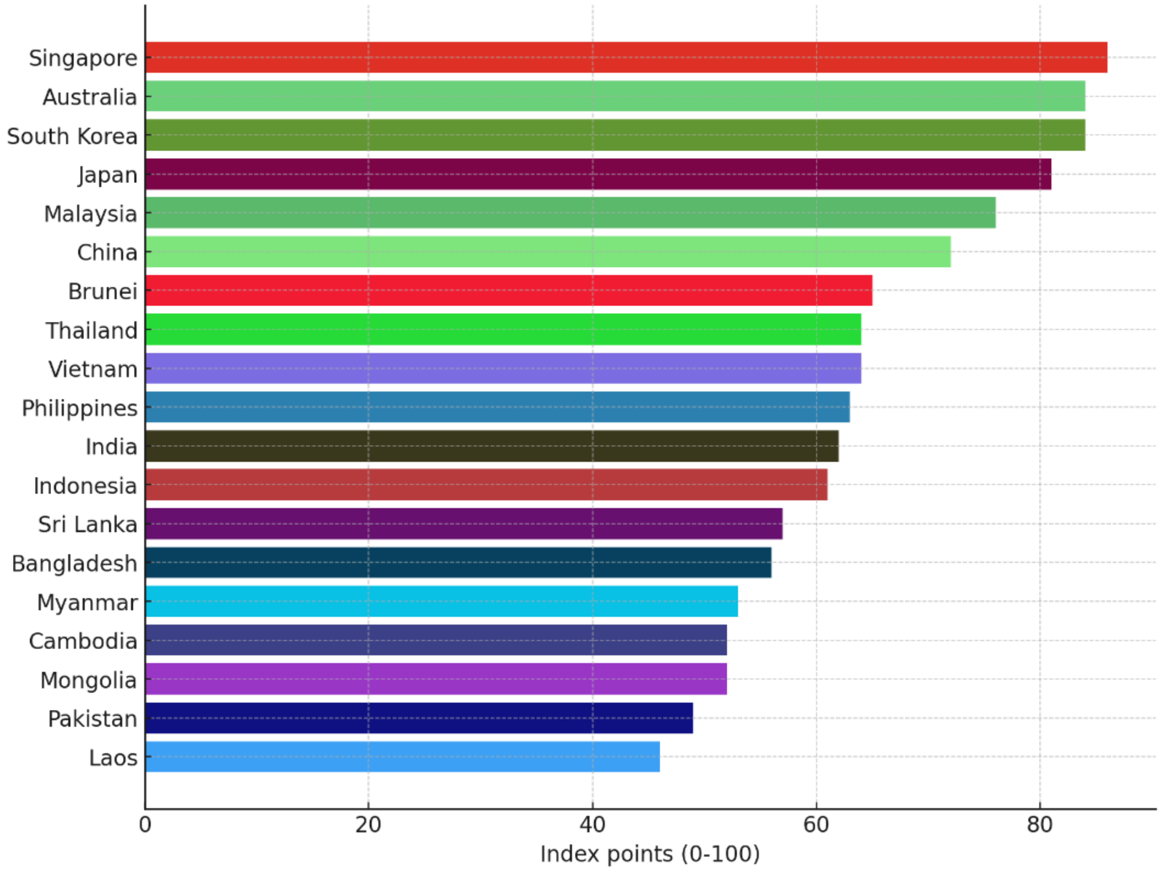
Figure 4

Digital Inclusion Index in the Asia-Pacific Region in 2020, by Country



Source: Statista (2021).

Singapore has the best digital readiness while Australia and South Korea follow, indicating that they have invested in a good digital infrastructure as well with Singapore leading governance. Except for Japan, Malaysia and China have surged ahead due to superior digital technologies along with a supportive policy environment which has helped them jump into the fold of mid-range performers. Medium-performers India, Indonesia and Pakistan have made progress but the countries are challenged heavily. Figure 4 serves as a reminder that the establishment of an economy like SMART Economy is only possible through strategic investment and good policies to move up each step in these dimensions. The second lesson is that developing economies have a huge opportunity to leverage improved performance and learn from the practices of top performers when it comes to digital infrastructure, governance, sustainability. This visualization has commanded as a means of comparison for countries to assess how well they are doing and plan strategies from that point forth.

Developed economies rank an average 81 in the Governance Quality Index, compared to just a rating of 60 for developing ones. The most important thing is to bolster these frameworks in order for them to better drive transparency, accountability and citizen participation. Deploying e-governance platforms can make public administration processes more transparent and efficient as depicted in Figure 5.

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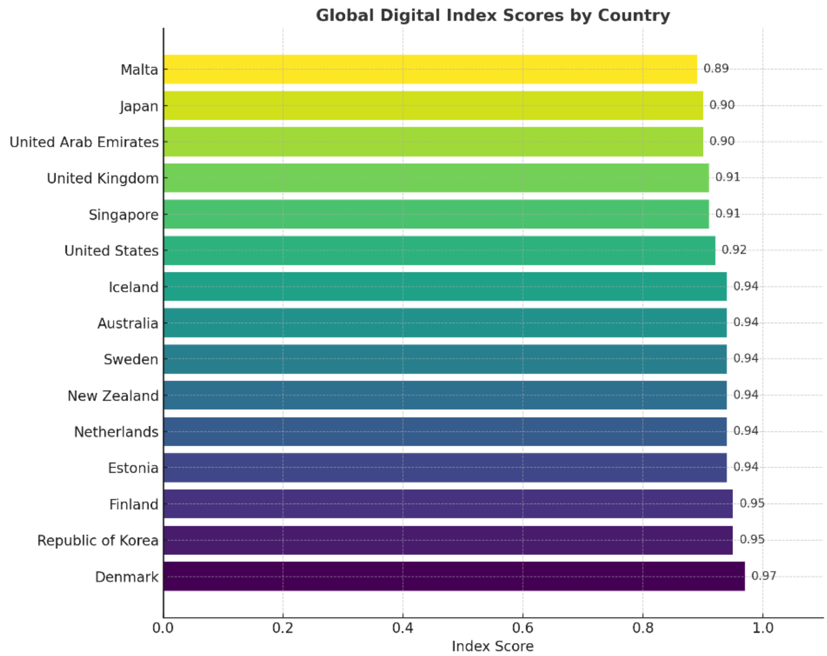
Figure 5

World E-Government Leaders Based on E-Government Development Index (EGDI) in 2022



Source: Statista (2022c).

Themes Identified

1. *Digital Infrastructure*: The foundation of the SMART economy, essential for connectivity and data processing.
2. *Governance*: The role of digital governance in promoting transparency, accountability, and citizen engagement.
3. *Economic Impact*: The contribution of digital technologies to economic growth and productivity.
4. *Societal Benefits*: The social implications of SMART economy initiatives, including improved public services and social inclusion.
5. *Sustainability*: The integration of sustainable practices to enhance environmental outcomes.

These findings from this study underline the interconnected success of digital technologies and economic policies in advanced SMART economies, wherein Switzerland leads as an exemplary model for other nations. The comparative analysis highlights the great role of infrastructure, governance; economic impact and social benefits in a just and sustainable built environment. These insights can be used by developing economies, including Ukraine for designing their own SMART economy strategies through tailored approaches to fit into local challenges and opportunities. This makes it possible for them to have sustainable economic growth, better governance and more quality of life for their people.

Discussion

The discussion provides insights of the key success factors in SMART economy initiatives and three main Siemens lessons learned, deepen to its digital infrastructure standards, comprehensive governance framework as well as great footprint across sustainability focus. All of these are prerequisites for the creation and operation of SMART economies well documented in Switzerland, Germany; USA; Japan. SMART economy is a digital and data-driven online economic system, requiring sustainable and healthy technology based digital infrastructure to drive any modern or future generation connected business ecosystem & existence. The latest study findings align with several previous studies pointing to the immediate or create-time utilization of high-speed internet,

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demonstrable IoT commercial saturation gains, and operational efficiencies through AI integration. In fact, economies with well-developed digital infrastructure - such as Switzerland and Germany - are able to take advantage of productivity growth from technological changes stemming on better from their adoption of new technologies in formulating stable institutions. These are consistent with the outcomes of research by the Trushkina (2019) on how digital competitiveness drives a countries internet generation prospect

Strong governance is another key success factor in the realization of SMART economy initiatives (Chohan & Hu, 2020). Effective governance structures foster transparency, accountability and citizen engagement; without these elements being in place, digital technologies cannot be properly embedded into the administration of public services. Switzerland, with a high Governance Quality Index score (No 3), has strong governance systems that support effective service delivery and build public trust (Keuffer & Mabillard, 2020). Moreover, successful digital initiative implementation and sustainability are correlated with effective governance mechanisms (Tomor et al., 2029). In addition, as shown in Estonia and Singapore, cutting-edge e-governance platforms have the potential to greatly enhance government efficiency while simultaneously engaging citizens (Khan & Krishnan, 2021).

The economy should incorporate sustainability as a separate deliverable; this economy cannot function properly in the long run unless sustainability is woven into its very fabric. One indicator of how successfully renewable energy and energy savings can be integrated into digital infrastructure is Switzerland's high Sustainability Index. Also, according to research out of the International Renewable Energy Agency (IRENA), sustainability policies with a longer time horizon can improve economic competitiveness and energy security while simultaneously reducing emissions and environmental harm (Dahlan et al., 2022). A good example is the ongoing push for a greener digital transformation; it is similar to Germany's Industry 4.0 programme, which promotes eco-friendly production methods. This demonstrates how the two concepts complement one another to produce a more thorough comprehension than either could provide alone. The results from this study are consistent with previous literature on the determinants of success factors in SMART economy-in particular, digital infrastructure (Chauhan et al., 2022), open and collaborative development ecosystem (Clement et al., 2022). The necessity for strong digital infrastructure as an underpinning to SMART economies has been both academically and policy mediated with impunity. Second, according to Gruber (2019) in the Global Information Technology Report; digital infrastructure is important for connectivity and innovation as well as productivity gains for all sectors.

Countries that have invested in digital infrastructure, such as Switzerland and Germany score high points for their information society capabilities. This study also identifies effective governance as a critical success factor, and its importance is reiterated in the literature. According to Waheduzzaman and Khandaker (2022) Local and Regional Governments can support in the effective implementation of digital government initiatives through strong governance frameworks that focus on transparency, accountability and citizen engagement, as was emphasized by the United Nations E-Government Survey (United Nations, 2022).The survey categorises countries depending on their e-governance potential and reflects that those countries with a solid governance system (Estonia or Singapore) have better performances in the digital conversion of public services. Countries characterised by good governance are better able to perpetuate digital transformations - with the end result being far more efficiency and public trust.

We have increasingly realised that sustainability is a foundation for an economy to thrive into the long term, as well. Incorporating sustainability into economic policies and practices is a precondition for addressing some of the most urgent global challenges including climate change, resource scarcity and social inequality (Gasper, 2022; Wolters, 2022). According to their research, countries that put sustainability at the center of development plans experience more stable and inclusive economic growth. Similarly, the Pinkwart et al. (2022) emphasizes that investing in renewable energy can provide both economic and environmental gains. They show that consideration of sustainability in digital

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infrastructure and economic policies as demonstrated by Germany or Switzerland not only reduces environmental damage but also improves energy security and economic resilience (Pinkwart et al., 2022). Such a statement is consistent with the multipart of sustainability that sustains successful SMART economies.

Case Studies

Estonia boasts a full-scale e-governance system where anything from ID applications to voting can be done digitally. The features like Estonia having strong governance and high digital literacy helped them in reducing administrative cost, improved transparency and citizen participation (Kassen, 2019). The Smart Nation initiative in Singapore seeks to harness digital technology for urban living, better public services and more inclusive growth. According to Toh, 2022) comprehensive investments in digital infrastructure and governance enable Singapore, one of the top performers at a global level at building smart economies. The project successfully weaves technology together with urban planning and public services to demonstrate the building blocks of successful digital transformation. Tapping in to its roots, Germany has the industry 4.0 which focuses on connecting traditional production with state-of-the-art technology for a more connected manufacturing world for instance, in smart factories the combination of IoT, AI and advanced robotics has led to increased productivity at workstations as well as reduced operational costs; together with improved product quality. These results correspond with those of previous studies where these factors were identified to play a critical role in the successful implementation of SMART economy initiatives. In an increasingly digital environment, countries must adopt a comprehensive approach that captures these key success factors to ensure sustainable economic growth and resilience.

Perspective on Ukraine

Ukraine therefore depicts a perfect case for promoting the SMART economy, given its recent integration challenges and ambitious development intentions. The smarter the assets, the more efficient solutions will allow for a quicker existing growth of economy as well as transformed governance and societary results in Ukraine. Although Ukraine has already made some significant progress in digitalization of its infrastructure, there is still a long way to go. High-speed internet, IoT and AI technology is also a significant investment that can facilitate link between different economic sector. Ukraine can develop its digital infrastructure faster if it will have international partners and funding.

Digital governance is becoming increasingly important for Ukraine. E-governance platforms that can address these issues and promote transparency, anti-corruption initiatives and democracy. Leveraging governance frameworks of successful SMART economies would be beneficial for Ukraine to shape its digital governance strategies SMART economy projects in Ukraine can have such a strong economic impact. Digitalization of manufacturing and services, on the other hand, can increase productivity leading to new economic opportunities. For the country, they mean savings of budget funds on administration that will become significant amid current problems in public services (education, health), as well as a breakthrough for Ukrainian IT. Inclusion policies promoting digital access for every citizen will improve social cohesion and quality of life.

Conclusions and Implications

The study suggests that the SMART economy concept is an important factor for future economic development. It is an in-depth roadmap that combines policies on digital technologies and sustainable economic systems needed to boost productivity, promote innovation, while building long-term resilience. This finding underlines a number of important issues for policy-makers and researchers alike. Incorporation of digital technologies including, IoT, AI and blockchain within different sectors of the economy is at the heart of this concept known as SMART economy. Real-time data processing increasing operational efficiency and brings innovation in industries using these technologies. A use case example is, for the fourth industrial revolution known as smart manufacturing (Industry 4.0) or

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towards developing a concept of Smart cities uses these technologies to significantly reduce resource consumption and environmental impact without compromising service delivery. Policymakers are required to develop enabling environments that allow technologies to flourish by investing in digital infrastructure and rewarding innovation

The foundation for any SMART economy initiatives is an effective governance framework. Such frameworks can then be used to support transparency, accountability and citizen engagement. Linking citizens with Government services online, e-Gov plays a vital role in the delivery mechanisms and trust making process for people towards public institutions. For scholars, the examination of how different forms of governance impact on effectiveness and efficiency in SMART economy initiatives may provide deeper understanding to these frameworks. Sustainability is a key element in the SMART economy. Renewable energy sources, as well as improvement of the efficiency in using that methane for example through combined heat and electricity production (cogeneration) at high temperature have the potential to cut most emissions associated with natural gas extraction including fugitive methane leaks. Integration of nature conservation policies into rural planning is essential for reducing climate change impacts. The swift approval process seen in Korea to adopt digital technologies stands in stark contrast with countries like Switzerland and Germany, where sustainability is integrated into digital infrastructure design, as well as economic policies generating both environmental but also positive macroeconomic effects. In turn, sustainability should feature prominently in those SMART economy strategies of the policymakers if they hope to secure both long-term resilience and buy-in toward global environmental goals.

Another important aspect of the SMART economy is maintaining and/or developing societal functions for public goods, like healthcare or education. This can mean a perfect middle point to bridge the digital divide and provide services in equitable manner improving quality of life over all. These may include remote monitoring and personalized treatment plans in case of smart healthcare systems or access to learning resources for everyone through digital education platforms. SMART economy initiatives have considerable economic impacts that improve the GDP, provide employment and increase competition. Increased integration of digital technologies improves both employee productivity and operational efficiency, with a commitment to innovation fostering new business opportunities. Policy should be designed with an eye to leveraging these economic benefits so that digital transformation can align with other important goals in broader development strategies.

Suggestions for Future Research

More in-depth studies are warranted to investigate long-term implications postulated here and guide optimal implementation of SMART economy interventions. An important issue for further research concerns the long-term effects of SMART economy projects on social equability. How does digital transformation reach, or not different socio-economic groups; What the differentiated impacts it might have on them and What strategies are needed to ensure inclusive growth? This may include, but is not limited to: The impact of digital literacy programs accesses to digital infrastructure How government policies are promoting social equity Moreover, another direction in future research could be investigation regarding the lasting effect of SMART economy initiative towards environmental sustainability. In addition, we learn from the comparative analysis of countries in Europe and other continents how different types of sustainability effects can be achieved by integrating sustainability into digitization strategies. Efforts that may made up this family are the introduction of smart grids, renewable energy integration and sustainable urban planning in city territories; its environmental impacts as well resource efficiency shall have to be evaluated by researchers.

Comparative researches in a wider and diversified geographical spectrum could shed light on the practice or effects of SMART economy initiatives. These types of studies should take into account regional socio-economic, cultural and political characteristics to identify best practices in these issues throughout the world. By taking this comparative perspective, policymakers can deliver a more precise

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and sustainable outcome on which to base their SMART economy strategies. Researchers must also examine the impact of SMART economy initiatives on concrete business sectors (healthcare, education manufacturing and transportation). The policy implications of this sectoral breakdown can help inform the design of targeted interventions that capture the gains from digital transformation.

We build upon these policy frameworks to argue that SMART economy initiatives require new models of governance. Thus, it is imperative for future research on the topic to address this need towards effective investment and implementation opportunities involving various aspects including partnerships within society (i.e., government-citizen partnership, firm-firm collaboration), showing both level specific effects as well contextual relevance.). This extends to looking at the role of public-private collaborations, regulations and funding models in facilitating digital technology adoption. Knowing which governance models work best can help public policy makers create the stronger innovation ecosystem, develop transparent and reliable frameworks while building & retaining trust from people.

Researchers should stay informed of the latest technological developments and trends that might shape new generation SMART economies. Policymakers and businesses must be able to forecast what opportunities and challenges lie ahead so they can design policies that are relevant, timely, effective. The SMART economy enables future economic development and provides useful lessons for using digital technologies to drive sustainable growth. Policymakers and academics can create holistic strategies that not only contribute to its resilience, but also satisfy other societal benefits without hampering economic impact by concentrating on digital infrastructure, governance effectiveness, sustainability. Further research can build upon these dimensions contributing to more specific knowledge and evolution in the direction of SMART economies globally.

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Conflict of Interest

None.

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