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Smart technology: Ecosystem, impacts, challenges and the path forward

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ABSTRACT: Smart technologies have become increasingly integral to modern society, bringing many benefits and opportunities. However, they also raise important questions about their impacts on individuals, organisations, and society and how everyone can move forward smoothly in integrating and adopting technology. Therefore, this study analysed and reviewed the literature to address the questions. The study provides an overview of the potential benefits and challenges of smart technologies and applications, including artificial intelligence, machine learning, natural language processing, robotics, and the Internet of Things. The review also explores the key entities involved in a smart technology ecosystem, including governments, businesses, and international communities, and each entity's unique role in developing and implementing smart technologies. Additionally, the review highlights the importance of ensuring a smooth transition to smart technologies, including the need for effective policies, regulations, and ethical considerations. The key takeaways from this review are the need to balance the benefits and opportunities of smart technologies with the challenges and risks they pose. Individuals, society, businesses, and governments must play their respective roles in ensuring that smart technologies are developed, implemented, and used in ways that are responsible, ethical, and sustainable.

KEYWORDS: IoT; blockchain; artificial intelligence; machine learning; impacts

1. Introduction

Smart technology has been a game changer in how we live, work, and communicate. It refers to integrating advanced technology into various aspects of our daily lives, such as homes, cities, and transportation[1]. As a result, it has rapidly emerged as a transformative force in our society and profoundly impacted individuals, businesses, and governments. The technology, which includes artificial intelligence (AI), machine learning (ML), natural language processing (NLP), robotics, and the Internet of Things (IoT), to name a few, is designed to be intelligent, self-learning, and adaptable to changing circumstances[2]. However, despite their many benefits, there are also significant challenges and risks associated with using smart technologies. In light of these impacts and challenges, it is crucial to critically examine the current state of smart technologies and consider the path forward.

While there have been many previous studies and reviews on smart technologies, this review seeks to

address some of the limitations of existing research. For example, many existing studies focus solely on the technical aspects of smart technologies and overlook their deployment's social and ethical implications. Furthermore, previous studies have often failed to consider stakeholders' diverse perspectives and experiences, such as government, businesses, and individual users. Additionally, some studies have been limited in scope, focusing on specific applications of smart technologies without considering their broader impact on society. Therefore, this review addresses these limitations by providing a comprehensive and inclusive examination of the impacts, responsibilities, and path forward for smart technologies. By incorporating diverse perspectives and experiences, this review seeks to provide a more comprehensive understanding of these technologies' potential benefits and risks and the steps that need to be taken to ensure their responsible development and deployment.

Four research questions were developed to guide the study: (1) what are the entities involved in a smart technology ecosystem; (2) what are the impacts of smart technology and applications; (3) what are the challenges of having smart technology implementation; and (4) what are the responsibility or roles of the entities in the smart technology ecosystem to ensure a smooth transition. An analysis of the literature was made to answer the questions. First, this review provides a comprehensive overview of the key players and entities involved in developing, implementing, and using these technologies. Second, further analysis was made on the smart technologies' impacts on the most critical entities in the ecosystem and considered their potential benefits and opportunities. Then, it analysed the field's current state and identified the key challenges and risks associated with using smart technologies. Additionally, the review highlights the roles and responsibilities of different entities in a smart technology ecosystem, including individual users, society, businesses, and government. The findings of this review are intended to provide a comprehensive understanding of the evolution of smart technologies and to encourage informed decision-making regarding their deployment and use. By synthesising a wide range of information and research, the review provides valuable insights into the potential benefits and risks of smart technologies and the steps that need to be taken to ensure their responsible development and deployment.

2. Definition and ecosystem of smart technology

The concept of smart technologies has been around for several decades, with early developments in AI and ML dating back to the 1950s[3]. However, it was not getting attention until the widespread adoption of personal computers and the Internet in the 1990s that the term "smart technology" began to be widely used[4]. The growth of the Internet, combined with advancements in computer processing power and data storage capabilities, has enabled the development of smart technologies on a large scale[5]. In addition, the widespread adoption of smartphones and other mobile devices has played a significant role in developing smart technologies[6]. It is due to the advancement in computing technology at the backend that provides the computing power and connectivity needed to run complex algorithms and analyse vast amounts of data. Later, the rise of the IoT marked a turning point in the history of smart technology[7]. The IoT is a network of connected devices that can collect and exchange data, allowing for the creation of intelligent systems that can make decisions based on that data[8,9].

The rapid pace of technological advancement in recent years has led to the development of new and sophisticated smart technologies, such as robotics[10], text analysis[11], and autonomous vehicles[12]. These technologies can potentially revolutionise many industries, from healthcare and transportation to manufacturing and retail. Smart technology is a term used to describe a wide range of technologies designed to be intelligent, self-learning, and adaptable[13]. These technologies are based on advanced algorithms and data analysis techniques that allow them to process large amounts of data and make predictions or decisions based on that data[14]. In addition, they are designed to be flexible and responsive to adjust to changing circumstances and continue to be effective and efficient. There are many instances

of specific types of technology that make up smart systems. **Table 1** summarises the technologies used for developing smart systems. **Figure 1** illustrates the technology.

Table 1. The technologies used for developing smart systems.

Smart technology	Descriptions	References
AI	Computer systems can perform tasks that typically require human intelligence, such as learning, reasoning, problem-solving, and pattern recognition.	[15], [16]
ML	A subset of AI involves the development of algorithms that can learn from data and improve over time without being explicitly programmed.	[17], [18]
NLP	A field of study focuses on the interaction between computers and humans through natural language. It involves the development of algorithms that can understand and process human language, allowing for more human-like interactions between computers and humans.	[19], [20]
Robotics	Machines that can perform tasks that humans typically perform. Smart robots are equipped with sensors and algorithms to perceive and respond to their environment.	[21]
IoT	A network of physical devices, vehicles, home appliances, and other items are embedded with electronics, software, and connectivity, allowing them to communicate with each other and the Internet.	[8]
5G	Cellular network technology promises faster speeds and excellent connectivity for individuals and businesses.	[22]
Augmented reality (AR) and virtual reality (VR)	Technologies that enhance or create immersive digital experiences for users.	[23]
Blockchain	A decentralised, secure and transparent ledger for recording transactions and tracking assets.	[24]

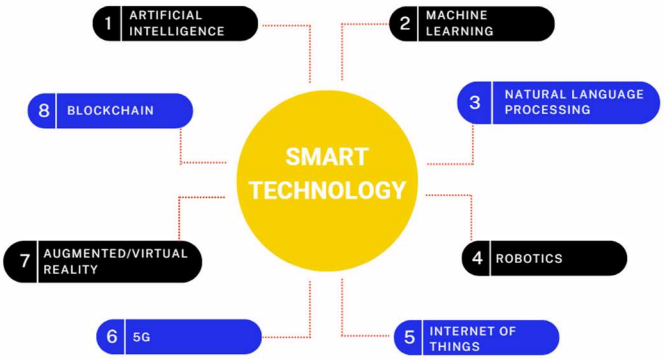

Figure 1. Types of underlying smart technology.

Before discussing the impact of smart technology, it is necessary to discuss the ecosystem of smart technology and applications[25] that involve many entities, including technology companies, businesses, governments, academic institutions, civil society organisations, and end-users. Each entity is critical to the development, deployment, and impact of smart technologies. Technology companies design, develop, and manufacture smart technologies like AI algorithms and IoT devices. Businesses are the primary users of these technologies, incorporating them into their operations to improve efficiency and competitiveness. Governments play a crucial role in regulating and standardising smart technologies and funding research and development initiatives. Academic institutions conduct cutting-edge research to advance the field and train the next generation of experts. Civil society organisations monitor the impact of smart technologies on society and advocate for responsible use. Finally, end-users, such as customers, are increasingly shaping the development of these technologies through their feedback and purchasing

decisions. These entities interact and collaborate to create a dynamic ecosystem that drives the development and deployment of smart technologies and their impact on society. Based on an analysis of various smart technology implementations, this review synthesises the possible entities in the smart technology ecosystem and summarise their roles in **Table 2**. The communication between the entities is illustrated in **Figure 2**.

Table 2. The entities and their roles in a smart technology ecosystem.

Entities	Roles
Government agencies	Regulate and promote the development of smart technologies. They set standards, provide funding, and encourage innovation in this field.
Technology companies	Develop and produce smart technologies. They are responsible for creating new products, services, and applications to impact society significantly.
Researchers and academics	Conduct research, develop smart technologies, and study their impact on society. They also play a critical role in ensuring that new technologies are safe, secure, and ethical.
Businesses and enterprises	The primary users of smart technologies are responsible for implementing these technologies and reaping the benefits. They are also responsible for ensuring these technologies are used ethically and responsibly.
Consumers	The end-users of smart technologies utilise them in their daily life. They are responsible for using these technologies responsibly and making informed choices about how they interact with these technologies.
Industry associations	Promote and regulate the development of smart technologies. They are also responsible for developing standards and best practices for using these technologies.
Non-profit organisations	Promote the responsible use of smart technologies and advocate for their potential benefits. They also provide education and training to ensure individuals can make informed decisions about interacting with these technologies.
Service providers	Deliver the infrastructure, networks, and services that make smart technologies possible. They play a critical role in ensuring these technologies are accessible, reliable, and secure.
Regulators	Ensure that the use of smart technologies is consistent with laws and regulations. They are essential in protecting individuals' and organisations' privacy, security, and safety.
Investors	Provide funding for the development and implementation of smart technologies. They are also responsible for ensuring that these technologies are used ethically and responsibly and deliver a return on investment.
Media	Shape public perception and understanding of smart technologies. They are responsible for providing accurate and balanced information about the impact of these technologies on society.

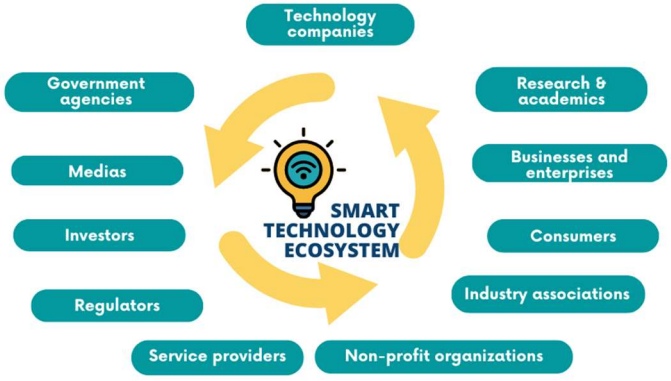

Figure 2. The smart technology ecosystem.

Smart technology applications are designed to automate tasks and processes, reduce human error, and improve decision-making and problem-solving[26]. They are used in various industries and

applications, including healthcare, retail, finance, transportation, and construction. Smart technology applications use advanced technologies, such as AI, the IoT, and cloud computing, to improve various aspects of our daily lives. These applications aim to make tasks more manageable, efficient, and automated. **Table 3** summarises some of the most common areas where smart technology applications are being used, and **Figure 3** illustrates the applications.

Table 3. Some of the most common areas where smart technology applications are being used.

Areas	Description	Examples of studies
Home automation	Allow individuals to control and monitor various aspects of their homes using their smartphones or other connected devices, such as lighting, heating, and security.	[27], [28]
Smart city	Improve efficiency, sustainability, quality of life, safety and security, economic opportunities, and citizen engagement through technology and data-driven solutions.	[29]
Healthcare	Boost efficiency and patient outcomes. Patients can check their health and get medical advice remotely, such as telemedicine software and wearable health monitoring equipment.	[30]
Transportation	Make travel safer, more efficient, and more sustainable. For example, connected vehicles and the infrastructure can communicate with each other to reduce accidents and improve traffic flow.	[31]
Energy	Minimise carbon emissions and increase energy efficiency. For instance, smart grid technology enables suppliers to manage energy supply and demand more efficiently, lowering waste and conserving resources.	[32]
Manufacturing	Boost productivity while cutting waste and increasing efficiency. For instance, predictive maintenance technology may identify potential equipment issues before they arise, minimising downtime and maintenance expenses.	[33]
Retail	Customers' purchasing experiences will be improved, and companies will operate more effectively. For instance, omnichannel retail technology enables customers to effortlessly shop across several channels, such as online and in-store.	[34]
Education	Enhance the learning experience for students and improve educational outcomes. For example, learning management systems and educational apps allow students to access educational materials and resources anywhere, anytime.	[35]
Agriculture	Increase efficiency, reduce waste, and improve the quality of crops. For example, precision agriculture technology can collect and analyse data from sensors and drones to optimise irrigation, fertilisation, and pest control.	[36]
Financial services	Enhance efficiency, lower fraud, and increase access to financial goods and services. For instance, robo-advisors and mobile banking applications let users manage their accounts from their smartphones.	[37]
Government	Improve the delivery of public services and increase transparency and accountability. For example, e-government portals and digital identity solutions can simplify accessing government services and reduce the risk of fraud.	[38]
Environmental monitoring	Monitor and manage the environment, including air and water quality, wildlife, and weather patterns. For example, IoT sensors and drones can collect and transmit data on environmental conditions in real-time, enabling proactive responses to environmental threats.	[39]
Emergency services	Increase the speed of reaction and save lives. For instance, emergency dispatch systems may optimise the deployment of emergency responders using real-time data and advanced analytics.	[40]

Table 3. (*Continued*).

Areas	Description	Examples of studies
Sports	Enhance the viewing experience for fans and improve performance for athletes. For example, wearable technology and performance tracking systems can provide real-time data on an athlete's performance, enabling coaches and trainers to make more informed decisions.	[41]
Media and entertainment	Streamline the production, distribution, and consumption of content. For instance, immersive entertainment experiences are being made possible by VR and AR technology, while streaming services have made it simpler for individuals to access movies, TV episodes, and music online.	[42]
Construction	Enhance the sustainability, safety, and efficiency of construction projects. For instance, wearable technology may be used to increase worker safety on construction sites, and building information modelling (BIM) software can be utilised to simulate and optimise building designs.	[43]
Logistics and supply chain management	Improve the efficiency and accuracy of deliveries and reduce waste. For example, GPS tracking systems and real-time data analytics can be used to optimise delivery routes and reduce the risk of lost or damaged shipments.	[44]
Disaster response	Improve disaster response and recovery efforts, reducing the impact of natural disasters and other emergencies. For example, real-time data analytics and communication systems can be used to coordinate disaster response efforts and provide real-time information to first responders and the public.	[45]

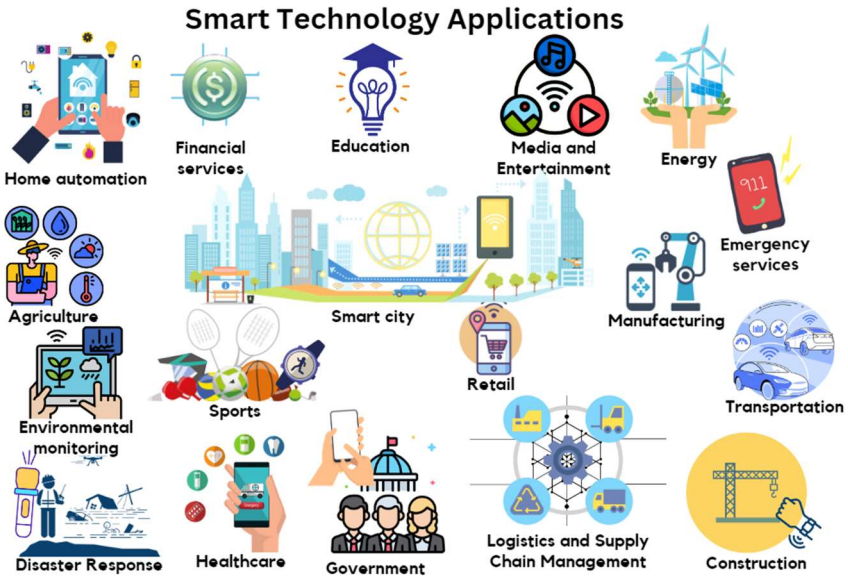

Figure 3. Smart technology applications.

3. The impacts of smart technology and applications

The use of smart devices and applications has the potential to change how we work and live. In many aspects of our lives, they can increase accessibility, boost communication, and promote efficiency. For instance, automation technologies in smart homes can boost comfort, increase security, and improve energy efficiency[46–48]. Another example of smart transportation technologies has the potential to increase road safety overall, decrease emissions, and improve traffic flow. Smart technologies have the potential to enhance patient outcomes in the healthcare industry, save costs, and give people in rural and underserved areas access to care. Smart technologies can increase productivity, lower expenses, and foster better collaboration at work. For instance, businesses can use data analysis and AI to improve operations

and make better decisions. The potential benefits of smart technology can be explored from multiple angles: individuals, society, businesses, government, economy, and the international community. **Figure 4** summarises the impacts.

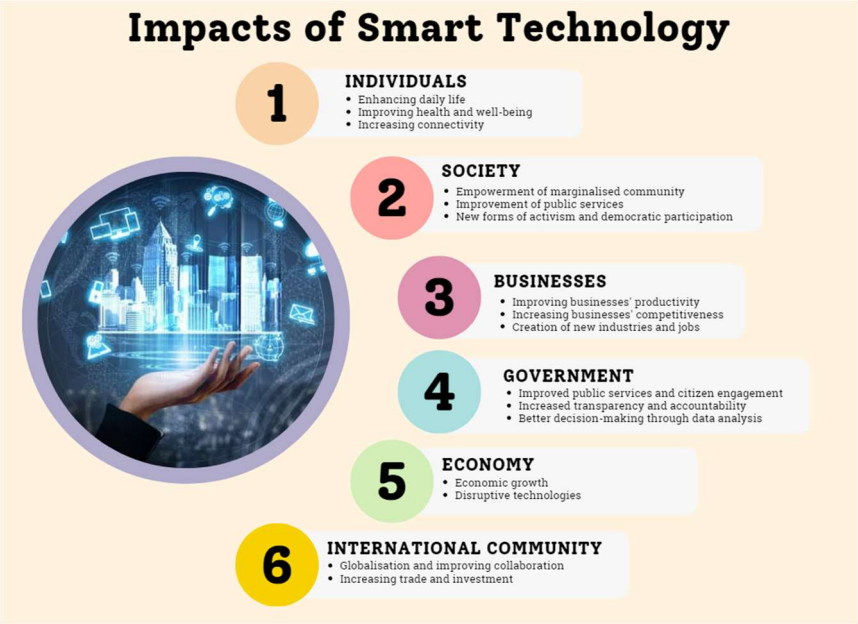

Figure 4. The impacts of smart technology applications.

3.1. Impact on individuals

Numerous facets of life, including communication, entertainment, work, health, and education, have been transformed by smart technology. Understanding these technologies' effects on people and their potential effects in the future is crucial as they continue to develop and penetrate society. In order to make sure that smart technology serves the interests of people and society, this analysis will assist politicians, technology corporations, and individuals in making knowledgeable decisions regarding its development and use. Furthermore, by being aware of the advantages and disadvantages of smart technology, we may collaborate to build a better future where technology improves our lives and allows us to accomplish our objectives. The impacts of smart technologies on individuals are discussed in the following paragraphs.

Enhancing daily life—The increased use of smartphones, portable electronics, and the Internet has improved our daily lives by bringing new conveniences and accessibility[46]. We can stay in touch with loved ones, access information, and accomplish activities while on the go with a button or a few swipes on a screen. Thanks to it, we can live more effectively and take advantage of more chances. For example, streaming services, such as Netflix and Hulu, have made it easier for individuals to watch their favourite shows and movies from anywhere, at any time. It also improved access to information, making it easier for individuals to access news, research, and other forms of knowledge. As a result, it has led to a more informed and knowledgeable population, which is better equipped to make decisions. In addition, the widespread adoption of e-commerce and mobile shopping apps has made it easier for individuals to purchase goods and services, compare prices, and receive recommendations based on their previous purchases. Thanks to smart home systems, people can now more easily operate their houses, keep track of their energy usage, and manage their appliances and devices. Thanks to the growing usage of security cameras and smart home devices, people can now monitor their houses and protect their families more

efficiently[42]. It is now simpler to manage time and complete tasks because of the accessibility of productivity tools like cloud-based storage, online calendars, and project management software. Finally, it has become simpler for people to move around, find their way, and arrive at their destinations more quickly, thanks to ride-sharing apps and guidance systems[49].

Improving health and well-being—Smart technologies have also positively impacted health and well-being. For example, fitness trackers, mobile health apps, and telemedicine have made it easier for individuals to track their fitness goals, monitor their health, and receive medical care. In addition, smart technology has facilitated greater access to healthcare by facilitating patient management of their drugs, tracking their health, and receiving medical attention. For instance, it is simpler for people to receive medical care without leaving their homes thanks to telemedicine and mobile health apps[50]. Additionally, wearable technology and sensors keep track of a person's heart rate, activity level, and sleep patterns, among other elements of their health[51]. After analysis, recommendations for lifestyle modifications that enhance health and well-being can be made. Telemedicine is another method by which smart technology enhances health. Thanks to smart devices and applications, people can quickly contact their healthcare professionals and obtain guidance and treatment without going to a doctor's office. Because of this, people can obtain care more rapidly, which might be crucial in an emergency. It also saves time and money. Access to information and resources made possible by smart technology also helps to promote mental health. For instance, people may now discover services, support groups, and information on mental health disorders quickly to assist them in managing their symptoms. In addition, there are also apps and VR activities made specifically for people who struggle with anxiety and stress[52].

Increasing connectivity—Smart technologies have also increased connectivity, making it easier for individuals to connect with friends, family, and colleagues worldwide. It has led to new communities and support networks that provide comfort and support. For example, instant messaging apps[53] and social media platforms have made it easier for individuals to communicate with friends and family, share updates and news, and connect with others who share their interests. The way we receive news and information has also altered due to smart technologies. For instance, social media sites and online news outlets have made it simpler for people to get news and information from all over the world in real-time. Smart technologies have also increased access to public services, making it simpler for people to acquire information and receive government services[38]. People can now more easily apply for services, check the status of their applications, and get notifications about important updates thanks to web portals and mobile apps, for instance. People can now deposit checks, transfer money, and pay bills using their smartphones via mobile banking and payment apps. Regardless of location or financial status, people may more easily learn new skills and increase their knowledge thanks to online courses and educational apps[2].

3.2. Impact on society

Due to rapid technological innovation, smart systems and technologies are being used in many facets of life, including healthcare, education, transportation, and entertainment. Therefore, understanding the social benefits and drawbacks of these technologies is essential. In order to ensure the responsible use of smart technologies and lessen their harmful effects, policies and regulations can be developed with the aid of the analysis. Additionally, it can aid in addressing any ethical, legal, and social ramifications brought on by the widespread usage of these technologies. The ultimate objective of studying how smart technology affects society is to encourage ethical use and ensure everyone benefits from it fairly.

Empowerment of marginalised communities—Smart technology can empower marginalised

communities and provide access to previously unavailable resources, information, and opportunities. This technology can be especially beneficial for individuals living in rural and remote areas where access to traditional services and infrastructure is limited[54]. Through mobile devices, cloud computing, and other technologies, individuals in these communities can access education, healthcare, and financial services, which can help improve their standard of living. Additionally, smart technologies can provide a platform for marginalised communities to engage in political and social activism, giving them a voice and the ability to effect change in their communities. For example, social media platforms can be used to raise awareness of issues, connect with like-minded individuals, and mobilise action. Smart technology can also help overcome language and cultural barriers, allowing marginalised communities to connect with others and build support networks. Furthermore, smart technology can help to improve economic opportunities for marginalised communities[54]. For example, through e-commerce platforms, individuals in these communities can sell goods and services to a broader market, increasing their income and improving their financial stability. The availability of online job postings and skills training resources can also help individuals in these communities to improve their employment prospects.

Improvement in public services—Smart technology has completely transformed how public services are provided in communities. Public service providers may now provide citizens more effective and efficient services because of cutting-edge technology like IoT, AI, and cloud computing[38]. As a result, communities experience better outcomes and are more satisfied with public services. One of the key ways in which smart technology improves public services is through the use of data and analytics. By collecting and analysing large amounts of data, public service providers can gain valuable insights into how their services are being used and where improvements can be made. For example, data analytics can help identify areas of inefficiency in public transportation systems, allowing for targeted improvements to make the system more efficient and user-friendly[4,12]. Another way in which smart technology improves public services is through increased citizen engagement. By using digital platforms and tools, communities can more easily access information about public services, provide feedback, and participate in decision-making processes. It results in a more transparent and accountable public service delivery system and greater community involvement in shaping services. Finally, smart technology has the potential to improve healthcare service delivery within communities[51] remarkably. For example, telemedicine and remote patient monitoring technologies allow improved healthcare access for those living in remote or underserved areas. By providing patients with the ability to receive care from the comfort of their own homes, healthcare providers can reduce the burden on overburdened hospital systems while still delivering quality care to patients in need.

New forms of activism and democratic participation—Smart technology has fundamentally changed how people engage with and contribute to their communities and society. People may now share information, express opinions, and collaborate with others in novel and creative ways because of the growing adoption of internet-connected devices and digital platforms. As a result, new types of activism and political engagement have emerged, allowing people to make a more significant difference in essential topics to them[55]. One example is social media and online activism, which has enabled individuals to bring attention to important causes, mobilise others, and effect change. From the Arab Spring to the #MeToo movement, social media has provided a platform for individuals to unite, amplify their voices, and demand change. In addition, using smart technology in activism has allowed for more personalised and targeted campaigns, enabling individuals to impact specific issues significantly. Smart technology has also allowed people to learn more about the challenges affecting their communities and participate more actively in decision-making. People may now make better judgments and hold those in positions of power accountable since they have access to a wealth of information. New digital tools have also made it simpler for people to participate in democratic processes, giving them more meaningful influence over the laws and decisions that affect their lives. Examples include online voting systems and digital petitions.

3.3. Impact on businesses

Smart technologies quickly change how organisations operate, communicate, and engage with consumers and staff, so examining their effects on enterprises is vital. For instance, intelligent technologies like AI, ML, and the IoT can aid organisations in automating operations and increasing efficiency and productivity, but they can also lead to privacy and security concerns. Because of this, organisations can reduce possible risks and issues by adopting and using these technologies in a way that considers the effects of smart technology on enterprises.

Improving businesses' productivity—Smart technologies have enhanced efficiency by automating jobs and streamlining processes. As a result, smart technologies have increased productivity, enabling firms to complete more work in less time[56]. For instance, organisations may complete more work in a shorter time because of automation and ML. For instance, AI and cloud computing have enabled businesses to analyse data and make better decisions. The advent of smart technologies also enables employees to work from anywhere, anytime. For instance, cloud computing and technologies for remote work have made it simpler for staff members to work together and be productive from any location. Smart technologies have enhanced cooperation, making working together simpler for teams and people. For instance, cloud computing and collaboration tools have made working together simpler for teams and employees. Smart technology has altered business paradigms, allowing companies to enter new markets and offer new goods and services. For instance, the sharing economy's introduction and the gig economy's expansion have allowed companies to provide new goods and services[57]. Smart technologies have widened access to international markets and made it simpler for companies to connect with clients worldwide. For instance, digital marketing and e-commerce platforms have made it simpler for companies to connect with clients worldwide. Information access has been facilitated by smart technology, making it more straightforward for enterprises to locate the information they require. For instance, cloud computing and search engines have made it simpler for firms to find the required information. Smart technologies have boosted creativity and enabled companies to develop new goods and services. For instance, ML and AI have enabled firms to develop new goods and services.

Increasing businesses' competitiveness—Due to enterprises' enhanced ability to reach a larger audience and provide more services, smart technologies have heightened competition. For instance, digital marketing and e-commerce platforms have allowed businesses to reach a larger audience and provide more services[58]. By enhancing the customer experience, smart technologies have made it simpler for companies to interact with their clients and offer superior services. For instance, customer relationship management tools and chatbots have made it simpler for companies to interact with their clients and offer superior services. Smart technologies have boosted adaptability, enabling organisations to respond quickly to market and consumer needs changes. For instance, mobile work tools and cloud computing have made it easier for organisations to react swiftly to market and customer needs changes. Decision-making has been enhanced by smart technology, making it simpler for organisations to analyse data and make wise judgments. For instance, big data and predictive analytics have simplified data analysis and decision-making for firms. By enhancing supply chain management, smart technologies have made it simpler for companies to run their operations and cut expenses. For instance, sensor networks and radio-frequency identification (RFID) technologies have enabled companies to control their operations and cut expenses. Finally, smart technologies have enhanced marketing and sales, making it more straightforward for companies to connect with their target market and increase product sales[58]. For instance, social media marketing and digital advertising have made it simpler for companies to contact their target demographic and increase product sales.

Creation of new industries and jobs—Smart technology has shifted businesses' operations and opened new economic expansion and job development possibilities. Smart technology integration has given rise to new industries that are now a significant source of employment for many people[59]. These businesses include those who create new software and hardware and install, maintain, and fix smart technology systems. The development of the IoT sector, which involves incorporating smart technology into common objects like smartphones, appliances, and vehicles, is one illustration of this. Software engineers, data analysts, and cybersecurity experts are in high demand. New career opportunities have also been made possible by expanding e-commerce and online shopping, particularly in online marketing, site design, and customer support. Innovative business models like cloud computing and software as a service (SaaS) have also been made possible by smart technology[60]. SaaS is transforming how companies utilise software and creating new industries and employment. As a result, the need for software engineers, developers, and cloud computing experts has grown as more businesses adopt SaaS. Due to the ongoing growth of new SaaS companies, there are numerous opportunities for sales, marketing, and customer support professionals. The growth of SaaS has also opened up opportunities for companies that offer supplementary services, like cybersecurity, data management, and IT consulting. As businesses adopt this cloud-based delivery paradigm and new SaaS startups appear to satisfy the expanding demand, SaaS creates new employment and industries.

3.4. Impact on government

Governments are crucial in influencing and regulating the technological landscape; thus, examining how smart technology affects them is essential. They are in charge of establishing the legal and regulatory framework that controls these technologies' creation, application, and utilisation. They are also in charge of ensuring that these technologies' application satisfies the needs of their inhabitants and is in the public interest. In order to ensure that new technologies are deployed safely, securely, and for the benefit of society, it is crucial to understand the impact of smart technology on governments. Governments must thoroughly understand its potential advantages and threats to make well-informed judgments about adopting and regulating smart technology.

Improved public services and citizen engagement—Smart technologies such as automation, AI, and the IoT can help governments streamline their operations and reduce costs. Smart technologies can help governments engage with citizens innovatively, such as through online portals and mobile applications. Governments can use smart technologies to improve the delivery of public services, such as healthcare, education, and transportation[38]. For example, governments can use AI to analyse data to identify areas of need and target resources more effectively. Smart technologies are also transforming urban areas, with many governments implementing smart city initiatives to improve quality of life, reduce environmental impact, and increase efficiency. Smart technologies are driving a digital transformation in government operations, with many governments moving to cloud-based systems and other digital solutions.

Increased transparency and accountability—Smart technologies can improve accountability and transparency in governmental operations, facilitating public access to information and holding officials accountable[38]. Governments can now more effectively monitor and analyse their performance and the performance of their programmes and projects thanks to the advent of digital communication and the greater use of data and analytics. Citizens can now see exactly how their taxes are being spent and how well government policies and programmes work to achieve their intended goals, promoting greater openness and accountability. Smart technology also makes it possible for governments and citizens to communicate more openly and easily, which makes it simpler for people to give input and hold elected

officials accountable. These developments have elevated citizen engagement and trust in their governments, which has helped raise public service standards and decision-making procedures.

Better decision-making through data analysis—Data and analytics can help governments distribute resources more wisely and make better decisions. The way governments gather, handle, and analyse data has been entirely transformed by smart technology. Governments can now make more informed judgments thanks to the additional data supplied by numerous sources[38]. It results in better public services and more effective use of resources. Governments can now collect, process, and analyse enormous volumes of data in real-time by utilising big data analytics, predictive analytics, and other cutting-edge technology. It enables a more thorough perspective of trends and patterns, allowing governments to predict future events more precisely and spot possible problems before they materialise. The adoption of smart technology has dramatically simplified the process of evaluating the performance of public policies, initiatives, and services. Governments can assess the success of various projects and make the required adjustments to improve their results by combining real-time and historical data. As a result, using smart technology can result in governments making more effective and efficient decisions, enhancing individuals' lives.

3.5. Impact on economy

Since technology is a major factor in today's society and can influence how commerce and business are conducted in the future, it is crucial to examine how smart technology is affecting the economy. AI, ML, the IoT, and robots are examples of smart technologies that have the potential to revolutionise company operations and have a significant impact on the economy as a whole. For instance, smart technology can assist businesses in automating procedures, enhancing efficiency, raising production, decreasing costs, and increasing profits. As a result, smart technology can potentially expand industries, reshape current ones, and spur economic growth on a bigger scale. Because of this, it is essential to comprehend how smart technology might affect the economy so that firms and governments can utilise its advantages while also minimising its possible threats.

Economic growth—Smart technology significantly impacts a nation's economic development. It changes how firms run, boosting production and efficiency[33]. For instance, the time and cost of completing tasks have been considerably lowered by employing automation technologies like AI and ML, freeing up resources for businesses to invest in innovation and expansion. Smart technology has also allowed enterprises to expand their reach and reach new markets and customers by removing geographical restrictions[44]. Furthermore, the widespread use of digital platforms and online marketplaces has made it simpler for enterprises of all sizes to offer their goods and services to a worldwide clientele, opening doors for businesses to expand and add new jobs. Developing new businesses like IoT due to smart technology can significantly boost a nation's economy. For instance, the creation of smart cities is predicted to produce economic value in the billions of dollars, opening up new prospects for firms, entrepreneurs, and workers. In addition, e-commerce is expanding as more people purchase online and companies try to reach new clients through digital channels. Again, this growth is being driven by smart technology. As technology businesses grow increasingly and international and cross-border transactions increase in frequency, smart technologies transform how nations trade and invest.

Disruptive technologies—Disruptive technologies have profoundly impacted the economy by upending traditional business models and creating new ones. For example, the widespread adoption of the Internet has given rise to a new generation of companies focused on digital commerce, such as e-

commerce and online marketplaces[58]. These companies have disrupted traditional retail and wholesale businesses, making it easier for consumers to purchase goods and services online, thereby reducing costs and increasing the speed of transactions. Additionally, the rise of cloud computing and SaaS has enabled companies to access technology more easily, reducing costs and increasing productivity. Smart technology has also led to new industries like data analytics and the IoT. These industries rely on collecting, analysing, and interpreting vast amounts of data, allowing companies to make better, data-driven decisions and respond to changing customer needs more effectively. It has increased competition and innovation[61], driving economic growth and job creation. However, disruptive technologies can also lead to job losses[62] as companies automate processes and replace human workers with machines and algorithms. Therefore, governments need to understand the implications of disruptive technologies and take proactive steps to help individuals and communities adapt to these changes, such as through reskilling and upskilling programs. It can ensure that the benefits of smart technology are shared more broadly, leading to sustainable economic growth and a better quality of life for all citizens.

3.6. Impact on the international community

Because smart technology can change the world in many ways, examining its effects on global society is crucial. Intelligent technologies like AI, IoT, and robotics can significantly alter how goods and services are distributed globally and how trade and business are made. In addition, it may change the global economic environment and the power dynamics between nations. Smart technology can also affect international relations, cross-border cooperation, and how nations interact. In order to guarantee that the advantages of smart technology are distributed evenly across all countries and communities, it is crucial to comprehend the full scope of these consequences and how they might be handled and regulated.

Globalisation and improving collaboration—Globalisation has been profoundly influenced by smart technology, which has also enhanced global collaboration. People from various regions may communicate more readily because of the development of communication and information technology, which has increased global connectivity. Increased international commerce, investment, and information exchange resulted from it, all of which have helped the world economy expand[63]. The increasing use of mobile devices and the Internet has made it simpler for individuals to obtain information, interact with one another, and work together regardless of where they are. Businesses have enormously profited since it has enabled them to connect with a worldwide clientele and access the most remarkable talent and resources the globe offers. Thanks to cloud computing and online project management tools, teams can now collaborate and exchange information more efficiently, no matter where they are situated. Smart technology has also enabled individuals to engage in online communities and has made it easier to create new social networks, improving connectedness and cooperation. Breakthroughs have been created due to the ability to interact and share ideas with individuals around the globe[64].

Increasing trade and investment—Trade and investment have increased due to smart technology, which has significantly influenced the world[65]. Businesses have accessed new and bigger audiences thanks to the growth of e-commerce, online marketplaces, and digital platforms, creating new prospects for trade and investment. Increased cross-border trade has resulted from the ease with which firms can now contact one another and discover new investment prospects. Smart technology has also facilitated better access to financial services for businesses, including loans, investments, and other types of funding. With the growth of Fintech, blockchain, and other financial technology, businesses now have better access to funding and investment options thanks to new tools and platforms[66]. Smart technology has also made it simpler for companies to manage their logistics and supply chains, increasing efficiency and

lowering costs. Businesses now find tracking and managing their supply chains simpler due to digital solutions like tracking and logistics software, which also increases their overall competitiveness and lowers the risk of interruptions. Smart technology has also made it simpler for companies to work with their clients and suppliers. Businesses now have an easier time working together and sharing information in real-time thanks to cloud-based technology like shared documents and project management software. It has enhanced communication and coordination.

4. Challenges in smart technology and applications

This section describes the challenges in smart technologies and applications. Studying the challenges that result from implementing smart technology and applications is important to identify potential problems and develop strategies to address them proactively. Furthermore, understanding these challenges can help ensure that the benefits of smart technology are realised while minimising negative impacts on society and individuals. Three major challenges result from implementing smart technology and applications: (1) privacy and security concerns; (2) social and economic inequalities; and (3) environmental impacts, as illustrated in **Figure 5**.

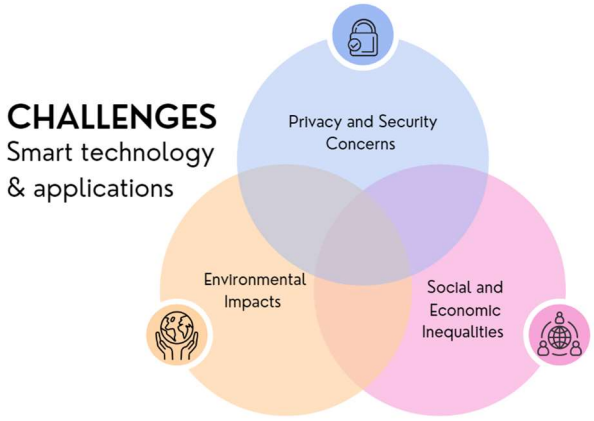

Figure 5. Challenges in smart technology and applications.

4.1. Privacy and security concerns

Data breaches and cyberattacks—Smart technology has revolutionised how we communicate, access information, and live our daily lives. However, this technology also collects vast personal data, which can threaten individual privacy if not handled responsibly. It is the responsibility of individuals to understand the implications of using smart technology and to take steps to protect their personal information[67]. It includes being aware of the terms and conditions of any apps, services, or devices they use and understanding the data types collected and how they are used. It is also crucial for individuals to understand the difference between public and private data and to exercise caution when sharing personal information online. It includes limiting the amount of personal information shared on social media platforms, being careful about what is posted, and ensuring that sensitive information, such as financial data or passwords, is protected. Another aspect of personal responsibility towards smart technology is ensuring that their devices and networks are secure. It includes updating software, installing anti-virus software, and creating strong passwords. Additionally, individuals should be aware of phishing scams, unsolicited emails, and other online fraud and take steps to protect themselves against these threats.

Surveillance and censorship—As smart technology has become more prevalent, it has become easier

for governments and corporations to monitor and track people's behaviour, movements, and interactions. Surveillance has become a growing concern in many countries as governments use smart technology to monitor their citizens, ostensibly for public safety or national security[68]. As individuals are unaware of who is observing them and why, it has resulted in a loss of privacy. Smart technology has made it easier for governments to track individuals, monitor their online activities, and access their personal data. Censorship is another challenge related to smart technology. Governments and corporations can control what information is available to the public, limiting access to information that is critical of them or their policies. It can be seen in how some countries restrict access to certain websites or social media platforms[69]. Smart technology also allows companies to track and limit what content users can access, stifling free speech and limiting the free flow of information.

4.2. Social and economic inequalities

Widening the divide between digital haves and have-nots—On the other hand, smart technologies can also negatively impact the international community, increasing the digital divide between developed and developing countries and exacerbating global economic and social inequalities[70]. For example, in some cases, the rapid development of new technologies in wealthy countries can lead to the displacement of workers in developing countries, as jobs are automated or outsourced to areas with lower labour costs. In ensuring the impact of smart technologies on the international community is positive and sustainable, governments, businesses, and civil society organisations must work together to develop and implement policies and initiatives that promote responsible innovation and equitable access to technology. It includes investing in education and training programs to build a skilled and adaptable workforce and working to close the digital divide between developed and developing countries. Smart technologies broadly influence the global community, with positive and harmful repercussions. For the sake of future generations, we must all work to ensure that the advantages of these technologies are equitably distributed and that the hazards are successfully controlled.

Economic shocks caused by technological change—The rise of smart technology has undoubtedly brought about significant economic changes, but it has also caused economic shocks that have negatively impacted specific sectors and industries. Job displacement is one of the most significant economic shocks caused by technological change[71]. As smart technology and automation become more advanced, many industries are replacing human workers with machines and AI. It has led to significant job losses, particularly in industries like manufacturing and retail. In addition to job displacement, smart technology has also created a widening skills gap in the labour force[72]. Many jobs being replaced by automation require a lower skill level, whereas the jobs being created require more specialised skills, such as programming and data analysis. It has left many workers with limited opportunities for reemployment or the need to return to school to learn new skills, which can be expensive and time-consuming. Another negative impact of smart technology on the economy is the concentration of wealth and power in the hands of a few large technology companies. These companies have access to vast amounts of data and can leverage their resources to gain a competitive advantage, making it difficult for smaller businesses to compete. It has led to the consolidation of markets and the emergence of dominant firms in many industries.

4.3. Environmental impacts

Electronic waste and resource depletion—Smart technology, such as smartphones and other mobile devices, are produced on a large scale and have a relatively short lifespan, generating a significant amount

of electronic waste[73]. The disposal of this waste can pose significant risks to the environment, as it contains hazardous materials such as lead, mercury, and cadmium. Moreover, producing smart technology devices requires using finite resources, such as rare earth metals and minerals, which can be depleted over time. As a result, it can have significant environmental impacts, including land degradation and water pollution, and can result in social and economic impacts on communities that rely on these resources for their livelihoods.

Carbon emissions and energy use—As smart technology has increased, so has the demand for energy to power these devices. As a result, it has increased carbon emissions, contributing to climate change and other environmental problems[73]. In addition, the production and use of smart technology devices require significant energy. For example, producing smartphones, tablets, and other electronic devices requires large amounts of energy, particularly during manufacturing. Additionally, using these devices requires electricity, often produced using fossil fuels, leading to increased carbon emissions. Moreover, smart technology devices have also increased the demand for data centres and cloud storage, which require significant energy[73]. As the amount of data generated and stored continues to increase, the energy demands of these centres and storage facilities will continue to grow.

5. The role of ensuring a smooth transition

Studying the role of different entities in ensuring a smooth transition of smart technology implementation is essential because it requires collaboration among various stakeholders, such as government agencies, technology providers, businesses, and communities. Understanding each entity's unique perspectives and challenges can help identify potential roadblocks to a smooth transition and develop effective strategies to overcome them. Moreover, each entity has a different level of responsibility and influence over the transition process, and studying their role can provide valuable insights into how to coordinate and manage the implementation of smart technology effectively. The major entities include individuals, society, business, and government, as illustrated in **Figure 6**.

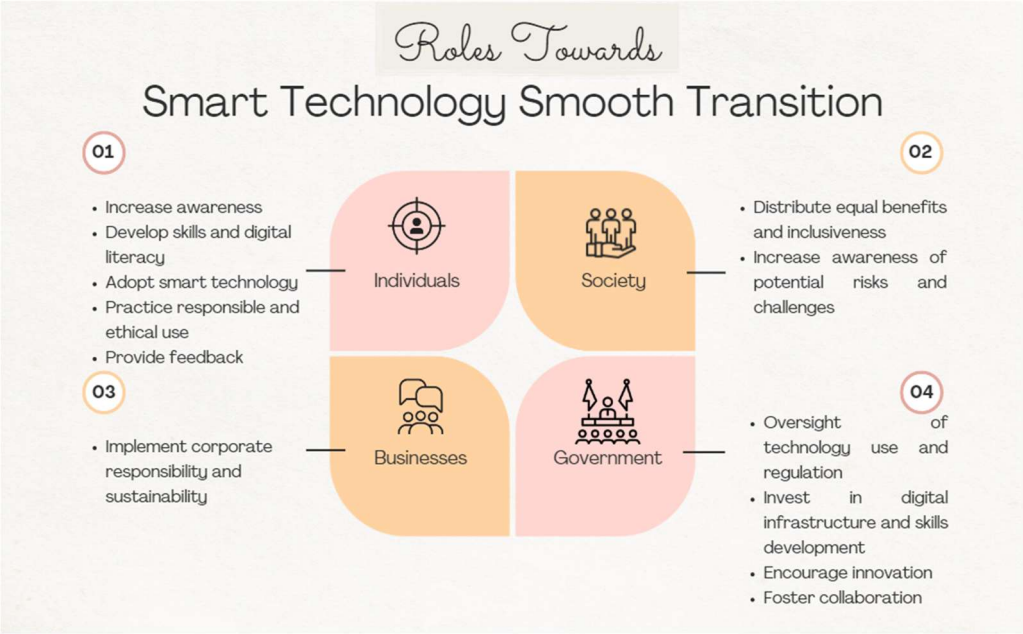

Figure 6. Roles towards smart technology smooth transition.

5.1. Individuals

A smooth transition to smart technology can be materialised when individuals play their role by educating themselves about the benefits and risks of smart technology and being aware of their actions and how they can contribute to the responsible use of these technologies. It can involve participating in public debates about the ethics and governance of smart technology and using their voices to advocate for ethical and responsible policies and practices. Individuals can also support organisations and initiatives that promote the responsible development and use of smart technology and take steps to ensure that their use of these technologies aligns with their values and goals. Additionally, individuals can play an active role in shaping the development of smart technology by providing feedback to technology companies and participating in user testing and research studies. By doing so, they can help to ensure that the technology is developed in a way that meets the needs and expectations of users and that its impacts are positive and well understood.

Increase awareness: Individuals can raise awareness about smart technology's potential benefits and risks by sharing information with friends, family, and colleagues. Individuals play a crucial role in promoting awareness about smart technology's potential benefits and risks[74]. By sharing information with friends, family, and colleagues, individuals can help spread the word about the latest developments in smart technology and its impact on various aspects of our lives. They can also help educate others about the benefits and risks of smart technology and encourage others to adopt it responsibly. Through this type of community outreach, individuals can help to promote a greater understanding of smart technology and foster a more informed and engaged public discourse about the technology and its impact. In addition, by raising awareness about the potential benefits and risks of smart technology, individuals can help ensure that the technology is adopted responsibly and sustainably and serves the interests of society as a whole.

Develop skills and digital literacy—individuals need to stay informed and educated about the advancements and developments in smart technology. This knowledge will enable them to understand these technologies' potential benefits and risks involved in using them. This awareness will allow individuals to make informed decisions regarding the technology they use and its impact on their daily lives. Individuals must proactively seek information and stay up-to-date with the latest developments in smart technology[74]. By doing so, they can make informed choices about how they use and interact with technology, ensuring they maximise its benefits while minimising potential negative impacts. In today's rapidly changing technological landscape, it is more important than ever for individuals to take an active role in educating themselves about the latest developments in smart technology.

Adopt smart technology—Individuals can adopt smart technologies in their personal and professional lives to gain first-hand experience and help drive the development of the technology[74]. Individual adoption of smart technology has become increasingly important as the technology continues to evolve and become more integrated into daily life. By incorporating smart technology into personal and professional lives, individuals can gain valuable hands-on experience that helps drive the development and improvement of the technology. It can range from using smart home devices, such as voice-activated assistants, to incorporate more efficiency and convenience into household tasks to utilising advanced software and technology in the workplace to increase productivity. Moreover, individual adoption of smart technology also plays a vital role in driving innovation and shaping the future of technology. By providing feedback and insights into how the technology is being used, individuals can help shape the development of new and improved technologies that better meet their needs and preferences. Additionally, individuals who adopt smart technology can help to create a larger market for the technology, driving the development and production of new and innovative products and services.

Practice responsible and ethical use—With the increasing prevalence of smart technologies in our daily lives, it is essential to recognise the new obligations that come with their use. It includes the responsibility to

use these technologies ethically and responsibly[75] so as not to cause harm to others or the environment. For example, it can involve protecting personal data and privacy, using technology that does not violate others' rights, and being mindful of technology's impact on one's health and well-being. It is also crucial for individuals to consider the impact of their technology use on the environment and to take steps to reduce their carbon footprint where possible. For example, this may involve reducing energy consumption through efficient device use or choosing eco-friendly options when purchasing new technology. Furthermore, individuals are responsible for educating themselves about the latest developments in smart technology and being aware of the potential risks involved in their use. It includes being mindful of potential security threats, such as hacking and cybercrime, and protecting against them. Additionally, it is essential to be aware of the potential for technology to harm mental and emotional health and to take steps to mitigate this impact.

Provide feedback—Individuals can provide feedback to technology companies on the features and functions they would like to see in smart technologies, helping to shape the future direction of development[38]. Individuals play a critical role in the development and adoption of smart technologies. By providing feedback to technology companies on the features and functions they would like to see in these technologies, individuals can shape the future direction of their development. This feedback can be in the form of direct communication with the companies, participating in surveys, or through online forums and discussion boards. Through this process, individuals can express their preferences and requirements for technology, which can be incorporated into the development process. It not only helps companies understand their customers' needs but also ensures that smart technologies are more user-friendly and better suited to the needs of individuals. By providing meaningful feedback, individuals can help drive the development of smart technologies in a way that benefits them, their communities, and society.

5.2. Society

Distribute equal benefits and inclusiveness—Inclusiveness and equitable distribution of benefits is a critical responsibility that individuals, governments, and organisations must take seriously regarding smart technology[76]. The rapid pace of technological innovation has brought numerous benefits, including increased efficiency, improved access to information, and new opportunities for economic growth. However, it has also created significant challenges for people who have been left behind due to lack of access to technology, lack of the skills to use it, or have been otherwise marginalised. For technology to be truly inclusive, it must be accessible to all, regardless of socio-economic status, race, gender, or other factors. It requires investment in infrastructure and programs that help people develop the necessary skills to use and benefit from technology. It also requires a concerted effort to ensure that technology is designed with the needs and perspectives of all users in mind. Moreover, the benefits of smart technology must be distributed equitably. Finally, it requires that the impacts of technology are carefully monitored and measures are taken to mitigate the potential negative consequences of technology, such as job loss or the creation of digital divides. Governments, organisations, and individuals must work together to ensure that the benefits of smart technology are shared and that everyone can participate in its development and use. It means ensuring that technology is accessible and affordable, investing in education and training programs, and promoting policies encouraging responsible and ethical use.

Increase awareness of potential risks and challenges—Society plays a crucial role in ensuring a smooth transition to smart technology. Society can influence the development and implementation of smart technology by providing feedback, creating awareness, and participating in decision-making[38]. Society can also help create the necessary infrastructure and support systems to adopt smart technology successfully. Additionally, society can help shape the ethical and legal framework that governs the use of smart technology. By participating in the public discourse on smart technology and its impact, society can ensure that the technology is used for the greater good and not for malicious purposes. Furthermore, society can also help promote the development of education and training programs that help individuals and businesses adopt and

use smart technology effectively. In conclusion, the role of society in ensuring a smooth transition to smart technology is crucial and cannot be overemphasised.

5.3. Businesses

Implement corporate responsibility and sustainability—As businesses and companies increasingly adopt and implement smart technology in their operations, they must take on corporate responsibility and sustainability measures[77]. It involves a commitment to sustainable business practices prioritising environmental stewardship, social responsibility, and economic viability. One of the critical roles of businesses and companies in implementing corporate responsibility and sustainability in the context of smart technology is to ensure that their use of technology is aligned with sustainable development goals, such as implementing energy-efficient technologies, reducing waste, and investing in renewable energy sources to power their operations. Additionally, businesses must be transparent and accountable in their environmental and social impact reporting. Another critical role of businesses and companies is to work towards reducing the digital divide, ensuring that their use of technology benefits everyone and does not perpetuate inequality. It means investing in digital literacy programs, providing access to technology in underserved communities, and ensuring that the benefits of technological advancements are distributed fairly. Moreover, businesses and companies must prioritise responsible sourcing and supply chain management, ensuring that their products and services are produced in a way that is ethical and environmentally sustainable[77]. It can involve working with suppliers and partners to establish responsible sourcing policies and practices and implementing measures to reduce waste and emissions. Finally, businesses and companies have a critical role in promoting sustainable innovation, ensuring their smart technology is focused on solving environmental and social challenges. It can involve investing in research and development to create new, sustainable products and services and collaborating with other businesses and organisations to share knowledge and best practices.

5.4. Government

Oversight of technology use and regulation—The government should establish regulations supporting the development and implementation of smart technologies while protecting citizens' privacy and security[78]. One of the key roles of governments in regulating smart technology is to ensure that it is used in a way that protects citizens' privacy. For example, governments can develop regulations and standards that require companies to use encryption and other security measures to protect users' personal information. Additionally, governments can develop laws that limit the collection, use, and disclosure of personal information by companies and other organisations. Moreover, governments can also play a role in regulating the use of smart technology in critical infrastructure[79], such as power grids and transportation systems. Regulations can ensure that these systems are secure and resilient to cyber-attacks and other threats[80]. Another role of governments in regulating smart technology is ensuring it is accessible to all citizens. Governments can work to bridge the digital divide, ensuring all citizens can access the technology and skills needed to benefit from it.

Invest in digital infrastructure and skills development—The government can provide funding for research and development[38] to advance the development of smart technologies and find solutions to the challenges and risks associated with these technologies. In addition, the government can invest in the necessary infrastructure, such as high-speed internet and data centres, to implement smart technologies effectively. In today's world, reliable Internet access is essential for everything from education and healthcare to commerce and entertainment. Governments can work to ensure that all citizens, regardless of their location or socio-economic status, have access to high-speed Internet. Moreover, governments

can also play a role in investing in digital skills development. As the use of technology continues to expand, the demand for workers with digital skills is increasing. Governments can work with educational institutions and businesses to provide training and education programs that help individuals develop the digital skills needed to succeed in today's economy.

Encourage innovation—The government can create a favourable environment for innovation by offering tax incentives and other support to technology companies. One way of doing it is to encourage innovation in smart technology by providing funding and support for research and development[38]. Governments can invest in research programs that focus on creating new technologies and solutions that can address societal challenges. Governments can help spur innovations and encourage entrepreneurs and startups to produce new smart technology solutions by providing funding and support. Moreover, governments can also create policies and regulations that foster innovation. For example, regulations encouraging open standards and data can help promote innovation and competition. Furthermore, governments can also work to create a supportive environment for startups and entrepreneurs. It can include creating incubators and accelerators that provide resources and support for startups in the smart technology space. Additionally, governments can work to streamline the regulatory process, making it easier for startups and entrepreneurs to bring new products and services to market.

Foster collaboration—Governments are critical in facilitating collaboration between various stakeholders in developing smart technology[38]. Collaboration is essential to the success of smart technology since it is multifaceted and complex, requiring cooperation between different sectors and stakeholders. Governments can help create an environment that promotes collaboration between private companies, academic institutions, and civil society. One way governments can encourage collaboration in smart technology is by creating platforms for dialogue and engagement. By bringing together stakeholders from different sectors, governments can facilitate the exchange of ideas and promote collaboration on smart technology initiatives. Moreover, governments can help build stakeholder partnerships to develop and implement smart technology solutions. Governments can also create policies and regulations that promote collaboration. For example, regulations require companies to work together to develop interoperable smart technology solutions. Additionally, governments can incentivise collaboration by providing tax credits or funding opportunities, encouraging businesses and other organisations to collaborate on smart technology initiatives. Furthermore, governments can provide funding and support for collaborative smart technology initiatives. For example, it can include funding public-private partnerships with stakeholders to develop and implement smart technology solutions. Additionally, governments can support the development of open standards and data, promoting collaboration and innovation in the smart technology sector.

6. Conclusion

Smart technology is a rapidly growing field that has the potential to revolutionise the way we live, work, and interact[81]. It encompasses many technologies, such as AI, ML, NLP, robotics, and the IoT. These technologies are designed to be intelligent, self-learning, and adaptable to changing circumstances, and they use advanced algorithms and data analysis techniques to analyse large amounts of data and make predictions or decisions based on that data. The impact of smart technologies on society and businesses is significant. On the one hand, it can lead to increased efficiency, productivity, and cost savings[82]. Nevertheless, on the other hand, it can also lead to job loss, privacy concerns, and new forms of inequality. To mitigate these risks and maximise the benefits of smart technologies, everyone must play their role in ensuring a smooth transition. Everyone must play their role in the smart technology

ecosystem to ensure we reap the benefits of this change and mitigate the risks. It requires a collaboration between government, business leaders, educators, and individual citizens, each of whom has a vital role to play in ensuring that the transition to smart technologies is smooth, safe, and equitable for all.

First, we must know smart technologies' potential benefits and drawbacks. For example, they have the potential to increase efficiency, improve our quality of life, and bring innovations to various industries. However, on the other hand, they also raise concerns about privacy, security, and the impact on jobs and the workforce. Second, it is essential to acknowledge the responsibilities of implementing smart technologies. It includes considering the ethical implications, ensuring privacy and security, and giving everyone access to these technologies benefits. Organisations must consider their actions' impact and ensure that their practices align with their values and goals. Finally, it is crucial to take a collaborative approach to the transition to smart technologies. All parties involved, from individuals to businesses and governments, must work together to ensure a smooth and equitable transition. It includes educating the public about the benefits and drawbacks of these technologies, encouraging responsible use and implementation, and promoting transparency and accountability.

Author contributions

Conceptualization, WANWA and TS; data collection, NK; analysis and interpretation of results, NK; writing—original draft preparation, NK and IA. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare no conflict of interest.

References

1. Murthy Nimmagadda S, Harish KS. Review paper on technology adoption and sustainability in India towards smart cities. *Multimedia Tools and Applications* 2022; 81(19): 27217–27245. doi: 10.1007/s11042-022-12885-1
2. Glukhova LV, Gudkova SA, Korneeva EN, Omarova A. Innovative approach for tertiary education system: The crowdsourcing model. In: Uskov VL, Howlett RJ, Jain LC (editors). *Smart Education and e-Learning—Smart Pedagogy*. Springer Singapore; 2022. pp. 52–61.
3. Kaul V, Enslin S, Gross SA. History of artificial intelligence in medicine. *Gastrointestinal Endoscopy* 2020; 92(4): 807–812. doi: 10.1016/j.gie.2020.06.040
4. Telang S, Chel A, Nemade A, Kaushik G. Intelligent transport system for a smart city. In: Tamane SC, Dey N, Hassanien AE (editors). *Security and Privacy Applications for Smart City Development*. Springer, Cham; 2021. pp. 171–187.
5. Khan WZ, Rehman M, Zangoti HM, et al. Industrial internet of things: Recent advances, enabling technologies and open challenges. *Computers & Electrical Engineering* 2020; 81: 106522. doi: 10.1016/j.compeleceng.2019.106522
6. Katuk N, Zakaria NH, Ku-Mahamud KR. Mobile phone sensing using the built-in camera. *International Journal of Interactive Mobile Technologies* 2019; 13(2): 102–114. doi: 10.3991/ijim.v13i02.10166
7. Mohanty SP, Choppali U, Kougianos E. Everything you wanted to know about smart cities: The Internet of things is the backbone. *IEEE Consumer Electronics Magazine* 2016; 5(3): 60–70. doi: 10.1109/MCE.2016.2556879

8. Jwo JS, Lin CS, Lee CH. Smart technology-driven aspects for human-in-the-loop smart manufacturing. *The International Journal of Advanced Manufacturing Technology* 2021; 114: 1741–1752. doi: 10.1007/s00170-021-06977-9
9. Achouri M, Alti A, Derdour M, et al. Smart fog computing for efficient situations management in smart health environments. *Journal of Information and Communication Technology* 2018; 17(4): 537–567. doi: 10.32890/jict2018.17.4.8270
10. Waheed A, Shafi J. Successful role of smart technology to combat COVID-19. In: Proceedings of 2020 Fourth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC); 7–9 October 2020; Palladam, India. pp. 772–777.
11. Nicolas C, Kim J, Chi S. Natural language processing-based characterisation of top-down communication in smart cities for enhancing citizen alignment. *Sustainable Cities and Society* 2021; 66: 102674. doi: 10.1016/j.scs.2020.102674
12. Fantin Irudaya Raj E, Appadurai M. Internet of Things-based smart transportation system for smart cities. In: Mukherjee S, Muppalaneni NB, Bhattacharya S, et al. (editors). *Intelligent Systems for Social Good*. Springer, Singapore; 2022. pp. 39–50.
13. Shin KY, Park HC. Smart manufacturing systems engineering for designing smart product-quality monitoring system in the industry 4.0. In: Proceedings of 2019 19th International Conference on Control, Automation and Systems (ICCAS); 15–18 October 2019; Jeju, Korea (South). pp. 1693–1698.
14. Marjani M, Nasaruddin F, Gani A, et al. Big IoT data analytics: Architecture, opportunities, and open research challenges. *IEEE Access* 2017; 5: 5247–5261. doi: 10.1109/ACCESS.2017.2689040
15. Ceccaroni L, Bibby J, Roger E, et al. Opportunities and risks for citizen science in the age of artificial intelligence. *Citizen Science: Theory and Practice* 2019; 4(1): 1–14. doi: 10.5334/cstp.241
16. Ho SB, Yang X, Quieta T, et al. On human-like performance artificial intelligence: A demonstration using an Atari game. In: Sun X, Pan Z, Bertino E (editors). *Artificial Intelligence and Security*, Proceedings of 5th International Conference, ICAIS 2019; 26–28 July 2019; New York, NY, USA. Springer, Cham; 2019. pp. 9–12.
17. Panch T, Szolovits P, Atun R. Artificial intelligence, machine learning and health systems. *Journal of Global Health* 2018; 8(2): 020303. doi: 10.7189/jogh.08.020303
18. Rashidi HH, Tran NK, Betts EV, et al. Artificial intelligence and machine learning in pathology: The present landscape of supervised methods. *Academic Pathology* 2019; 6: 2374289519873088. doi: 10.1177/2374289519873088
19. Goel B. Developments in the field of natural language processing. *International Journal of Advanced Research in Computer Science* 2017; 8(3): 23–28. doi: 10.26483/ijarcs.v8i3.2944
20. Cambria E, White B. Jumping NLP curves: A review of natural language processing research. *IEEE Computational Intelligence Magazine* 2014; 9(2): 48–57. doi: 10.1109/MCI.2014.2307227
21. Billard A, Kragic D. Trends and challenges in robot manipulation. *Science* 2019; 364(6446). doi: 10.1126/science.aat8414
22. Painuly S, Sharma S, Matta P. Future trends and challenges in next generation smart application of 5G-IoT. In: Proceedings of 2021 5th International Conference on Computing Methodologies and Communication (ICCMC); 8–10 April 2021; Erode, India. pp. 354–357.
23. Batat W. How augmented reality (AR) is transforming the restaurant sector: Investigating the impact of "Le Petit Chef" on customers' dining experiences. *Technological Forecasting and Social Change* 2021; 172: 121013. doi: 10.1016/j.techfore.2021.121013
24. Katuk N. The application of blockchain for halal product assurance: A systematic review of the current developments and future directions. *International Journal of Advanced Trends in Computer Science and Engineering* 2019; 8(5): 1893–1902. doi: 10.30534/ijatcse/2019/13852019
25. Rotchanakitumnuai S. Barriers to Bangkok as a smart destination with Internet of things technology. *Thammasat Review* 2017; 20(2): 1–17.
26. Obuseh M, Yu D, Yih Y, DeLaurentis P. Smart technologies in healthcare: Overview of human factors and infusion pumps. In: Duffy VG, Lehto M, Yih Y, et al. (editors). *Human-Automation Interaction*. Springer, Cham; 2022. pp. 125–143.
27. Aagaard LK. When smart technologies enter household practices: The gendered implications of digital housekeeping. *Housing, Theory and Society* 2023; 40(1): 60–77. doi: 10.1080/14036096.2022.2094460
28. Seo E, Yang W. Evaluating smart home services and items: A living lab user experience study. *Buildings* 2023; 13(1): 263. doi: 10.3390/buildings13010263
29. Chen Z, Chan ICC. Smart cities and quality of life: A quantitative analysis of citizens' support for smart city development. *Information Technology and People* 2023; 36(1): 263–285. doi: 10.1108/ITP-07-2021-0577
30. DeFrance M, Lang J, Aprigliano C, et al. Understanding patient perspectives regarding remote monitoring devices following total joint replacement. *Arthroplasty Today* 2023; 19: 101056. doi:

10.1016/j.artd.2022.10.006
31. İlhan K, Ünver M. Analysis and examination of the bus control center (BCC) system: Burulaş example. In: Ahmed MB, Abdelhakim BA, Ane BK, et al. (editors). *Emerging Trends in Intelligent Systems & Network Security*. Springer; 2022. pp. 84–96.
32. Nižetić S, Arıcı M, Hoang AT. Smart and sustainable technologies in energy transition. *Journal of Cleaner Production* 2023; 389: 135944. doi: 10.1016/j.jclepro.2023.135944
33. Ejaz MR. Smart manufacturing as a management strategy to achieve sustainable competitiveness. *Journal of the Knowledge Economy* 2023. doi: 10.1007/s13132-023-01097-z
34. Roy SK, Balaji M, Nguyen B. Consumer-computer interaction and in-store smart technology (IST) in the retail industry: The role of motivation, opportunity, and ability. *Journal of Marketing Management* 2020; 36(3–4): 299–333. doi: 10.1080/0267257X.2020.1736130
35. Yan R. Application and analysis of education and teaching mode based on 5G and smart technology. *Scientific Programming* 2022; 2022: 1–10. doi: 10.1155/2022/7861157
36. Sozinova AA, Sofiina EV, Petrenko YS, Bencic S. International features of using smart technology in agriculture: Overview of innovative trends. In: Popkova EG, Sergi BS (editors). *Smart Innovation in Agriculture*. Springer, Singapore; 2022. pp. 167–173.
37. Shang SS, Chiu LS. Leveraging smart technology for user experience personalisation—A comparative case study of innovative payment systems. *Pacific Asia Journal of the Association for Information Systems* 2022; 14(1): 6. doi: 10.17705/1pais.14106
38. Kim S, Andersen KN, Lee J. Platform government in the era of smart technology. *Public Administration Review* 2022; 82(2): 362–368. doi: 10.1111/puar.13422
39. Thirumal G, Kumar C. Multilevel sensor deployment approach in IIoT-based environmental monitoring system in underground coal mines. *Computer Communications* 2022; 195: 1–13. doi: 10.1016/j.comcom.2022.08.002
40. Wang Y, Chen H. Blockchain: A potential technology to improve the performance of collaborative emergency management with multi-agent participation. *International Journal of Disaster Risk Reduction* 2022; 72: 102867. doi: 10.1016/j.ijdrr.2022.102867
41. Xiong S, Li X. Intelligent strategy of Internet of Things computing in badminton sports activities. *Wireless Communications and Mobile Computing* 2022; 2022: 9409151. doi: 10.1155/2022/9409151
42. Rock LY, Tajudeen FP, Chung YW. Usage and impact of the Internet-of-Things-based smart home technology: A quality-of-life perspective. *Universal Access in the Information Society* 2022; 1–20. doi: 10.1007/s10209-022-00937-0
43. Lee B, Park SK. A study on the competitiveness for the diffusion of smart technology of construction industry in the era of 4th industrial revolution. *Sustainability* 2022; 14(14): 8348. doi: 10.3390/su14148348
44. Liu W, Long S, Wei S. Correlation mechanism between smart technology and smart supply chain innovation performance: A multi-case study from China's companies with Physical Internet. *International Journal of Production Economics* 2022; 245: 108394. doi: 10.1016/j.ijpe.2021.108394
45. Bethune E, Buhalis D, Miles L. Real time response (RTR): Conceptualising a smart systems approach to destination resilience. *Journal of Destination Marketing & Management* 2022; 23: 100687. doi: 10.1016/j.jdmm.2021.100687
46. Katuk N, Ku-Mahamud KR, Zakaria NH, Maarof MA. Implementation and recent progress in cloud-based smart home automation systems. In: Proceedings of 2018 IEEE Symposium on Computer Applications & Industrial Electronics (ISCAIE); 28–29 April 2018; Penang, Malaysia. pp. 71–77.
47. Aziz A, Wahab MHA, Mustapha A, Mohsin MFM. Design and development of smart home security system for disabled and elderly people. *Journal of Telecommunication, Electronic and Computer Engineering* 2017; 9(3–7): 135–138.
48. Ghazali TK, Zakaria NH. Security, comfort, healthcare, and energy saving: A review on biometric factors for smart home environment. *Journal of Computers (Taiwan)* 2018; 29(1): 189–208. doi: 10.3966/199115992018012901017
49. Chen X. Smart technologies and aging society. In: Patnaik S, Sen S, Ghosh S (editors). *Smart Cities and Smart Communities*. Springer, Singapore; 2022. pp. 131–146.
50. Gupta S, Sharma HK, Kapoor M. Introduction to smart healthcare and telemedicine systems. In: *Blockchain for Secure Healthcare Using Internet of Medical Things (IoMT)*. Springer, Cham; 2022. pp. 1–11.
51. Thangam D, Malali AB, Subramanian G, et al. Internet of things: A smart technology for healthcare industries. In: Mehra PS, Goyal LM, Dagur A, et al. (editors). *Healthcare Systems and Health Informatics*. CRC Press; 2022. pp. 3–15.
52. Liu R, Menhas R, Dai J, et al. Fitness apps, live streaming workout classes, and virtual reality fitness for physical activity during the COVID-19 lockdown: An empirical study. *Frontiers in Public Health* 2022; 10. doi: 10.3389/fpubh.2022.852311

53. Okunev R. History of Smart devices, video games, and videoconferencing. In: *The Psychology of Evolving Technology: How Social Media, Influencer Culture and New Technologies are Altering Society*. Apress; 2022. pp. 17–23.
54. Randell-Moon HEK, Hynes D. 'Too smart': Infrastructuring the Internet through regional and rural smart policy in Australia. *Policy & Internet* 2022; 14(1): 151–169. doi: 10.1002/poi3.286
55. Dias JA, de Oliveira DB, Ferrer WMH. Democracy in the network society: Citizenship and popular participation in the smart cities context. *Revista Opinião Jurídica (Fortaleza)* 2022; 20(35): 1–20. doi: 10.12662/2447-6641oj.v20i35.p1-20.2022
56. Jiang F, Wang L, Li JX, Liu J. How smart technology affects the well-being and supportive learning performance of logistics employees? *Frontiers in Psychology* 2022; 12: 768440. doi: 10.3389/fpsyg.2021.768440
57. Haleem A, Javaid M, Singh RP, et al. Management 4.0: Concept, applications and advancements. *Sustainable Operations and Computers* 2023; 4: 10–21. doi: 10.1016/j.susoc.2022.10.002
58. Diaz E, Esteban A, Vallejo RC, Navarro DMC. Digital tools and smart technologies in marketing: A thematic evolution. *International Marketing Review* 2022; 39(5): 1122–1150. doi: 10.1108/IMR-12-2020-0307
59. Su CW, Yuan X, Umar M, Lobonț OR. Does technological innovation bring destruction or creation to the labor market? *Technology in Society* 2022; 68: 101905. doi: 10.1016/j.techsoc.2022.101905
60. Lin H, Wu Q. Intelligent logistics technology and big data in the construction and development of smart city. In: Proceedings of 2021 6th International Conference on Communication, Image and Signal Processing (CCISP); 19–21 November 2021; Chengdu, China. pp. 51–58.
61. Nasir A, Zakaria N, Yusoff RZ. The influence of transformational leadership on organisational sustainability in the context of industry 4.0: Mediating role of innovative performance. *Cogent Business and Management* 2022; 9(1): 2105575. doi: 10.1080/23311975.2022.2105575
62. Mukhuty S, Upadhyay A, Rothwell H. Strategic sustainable development of industry 4.0 through the lens of social responsibility: The role of human resource practices. *Business Strategy and the Environment* 2022; 31(5): 2068–2081. doi: 10.1002/bse.3008
63. Siying J, Haoguang L. Whether can RCEP cooperation in digital economy raise new "Tiger Cub" economies. *International Relations* 2022; 10(1): 25–32. doi: 10.17265/2328-2134/2022.01.002
64. Gitelman L, Silbermann V, Kozhevnikov M, et al. Energy engineering and consulting: New challenges and reality. *International Journal of Energy Production and Management* 2020; 5(3): 272–284. doi: 10.2495/EQ-V5-N3-272-284
65. Shah F, Liu Y, Shah Y, et al. A blockchain technique for trade credit maintainability using the role of information and communication technology. *Journal of Mathematics* 2022; 2022: 9621342. doi: 10.1155/2022/9621342
66. He Z, Liu Z, Wu H, et al. Research on the impact of green finance and Fintech in smart city. *Complexity* 2020; 2020: 1–10. doi: 10.1155/2020/6673386
67. Chatfield AT, Reddick CG. A framework for Internet of Things-enabled smart government: A case of IoT cybersecurity policies and use cases in US federal government. *Government Information Quarterly* 2019; 36(2): 346–357. doi: 10.1016/j.giq.2018.09.007
68. Martinus M. Smart city and privacy concerns during COVID-19: Lessons from Singapore, Malaysia, and Indonesia. In: Phan T, Damian D (editors). *Smart Cities in Asia*. Springer; 2022. pp. 33–47.
69. Aslan MF. What means social media in authoritarian regimes and for authoritarian regimes? *Journal of Research in Social Sciences* 2022; 10(1): 1–18. doi: 10.52015/jrss.10i1.145
70. Reverte FG, Luque PD. Digital divide in e-Tourism. In: Xiang Z, Fuchs M, Gretzel U, et al. (editors). *Handbook of e-Tourism*. Springer, Cham; 2021. pp. 1–21.
71. Hogenstijn T. *A New Approach to Sustainability? The Idea of Basic Income as a Solution to Automation-Driven Job Displacement and the Potential Impact on Environmentally Conscious Consumer Spending among University Students in Groningen, the Netherlands* [Bachelor's thesis]. University of Groningen; 2020.
72. Prashar G, Vasudev H, Bhuddhi D. Additive manufacturing: expanding 3D printing horizon in industry 4.0. *International Journal on Interactive Design and Manufacturing (IJIDeM)* 2022; 17(9): 1–15. doi: 10.1007/s12008-022-00956-4
73. Brevini B. Black boxes, not green: Mythologising artificial intelligence and omitting the environment. *Big Data & Society* 2020; 7(2): 2053951720935141. doi: 10.1177/2053951720935141
74. Gerli P, Clement J, Esposito G, et al. The hidden power of emotions: How psychological factors influence skill development in smart technology adoption. *Technological Forecasting and Social Change* 2022; 180: 121721. doi: 10.1016/j.techfore.2022.121721
75. Berendt B, Chee FM, Rockwell G. Introduction to ethics in the age of smart systems. *The International Review of Information Ethics* 2022; 31(1). doi: 10.29173/irie474
76. Sidani D, Veglianti E, Maroufkhani P. Smart cities for a sustainable social inclusion strategy—A comparative study between Italy and Malaysia. *Pacific Asia Journal of the Association for Information Systems*

2022; 14(2): 3. doi: 10.17705/1pais.14203
77. Nitlarp T, Kiattisin S. The impact factors of industry 4.0 on ESG in the energy sector. *Sustainability* 2022; 14(15): 9198. doi: 10.3390/su14159198
78. Mallinson DJ, Shafi S. Smart home technology: Challenges and opportunities for collaborative governance and policy research. *Review of Policy Research* 2022; 39(3): 330–352. doi: 0.1111/ropr.12470
79. Basarudin NA, Yeon AL, Yusoff ZM. Regulating smart home technology devices under Malaysian legal framework. *Commonwealth Law Bulletin* 2018; 44(4): 607–624. doi: 10.1080/03050718.2019.1657031
80. Chao X, Ran Q, Chen J, et al. Regulatory technology (Reg-Tech) in financial stability supervision: Taxonomy, key methods, applications and future directions. *International Review of Financial Analysis* 2022; 80: 102023. doi: 10.1016/j.irfa.2022.102023
81. Becerik-Gerber B, Lucas G, Aryal A, et al. Ten questions concerning human-building interaction research for improving the quality of life. *Building and Environment* 2022; 226: 109681. doi: 10.1016/j.buildenv.2022.109681
82. Marikyan D, Papagiannidis S, Rana OF, Ranjan R. Working in a smart home environment: Examining the impact on productivity, well-being and future use intention. *Internet Research* 2023. doi: 10.1108/INTR-12-2021-0931