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Determinants of the Formation of China's Smart Economy

Abstract
The development of China's smart economy has been heavily influenced by the government's strategic policies and investments in key technologies. One of the key technologies driving China's smart economy is the Internet of Things (IoT), which involves connecting machines, devices and sensors to the Internet for real-time data collection and analysis. This enables the optimisation of production processes and improved efficiency in industries such as manufacturing. The Chinese government has actively promoted the adoption of IoT technologies in manufacturing through policies such as the Made in China 2025 plan and the Internet Plus strategy. Another essential technology for China's smart economy is big data, which enables intelligent decision-making in various industries such as finance, healthcare and transportation. The government has encouraged the development of big data infrastructure, including data centres and cloud computing, to support the growth of the industry. Initiatives such as the National Big Data Comprehensive Pilot Zone have been established to promote the development of the big data industry. Artificial intelligence (AI) is also a key technology for China's smart economy, and the government has made significant investments in AI research and development. In 2017, China announced its plan to become a world leader in AI by 2030, with the aim of building a domestic AI industry worth $150 billion. The government has launched initiatives, such as the AI Development Plan, to build an AI ecosystem and promote the integration of AI with traditional industries. Robotics is another critical technology for China's smart economy, particularly in manufacturing. The government has encouraged the use of robots in manufacturing through tax incentives and subsidies, making China the world's largest market for industrial robots. The government aims to further develop the robotics industry to meet the needs of China's smart economy. In conclusion, China's smart economy is driven by strategic policies and investments in key technologies such as IoT, big data, AI and robotics. The government has launched various initiatives to support the development and integration of these technologies with traditional industries, with the aim of building a sustainable and innovative smart economy. These technologies play a critical role in China's industrial upgrading and transformation, and their continued development and adoption are expected to shape the future of China's economy and global competitiveness.

Keywords
smart economy, innovation clusters, technology development, development and research

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1 Introduction

The concept of a smart economy has gained significant attention in recent years as countries around the world seek to harness the power of technology and innovation to drive economic growth and sustainable development. A smart economy refers to an economic system that uses advanced technologies, data-driven decision-making and innovation to optimise productivity, competitiveness and societal well-being. In this context, innovation clusters, technology development and research play a crucial role in shaping the trajectory of a smart economy.

Innovation clusters, also known as innovation ecosystems or innovation hubs, are geographical

concentrations of interlinked companies, research institutions and other stakeholders that collaborate and co-create to foster innovation and economic growth. These clusters serve as hotbeds of creativity, knowledge sharing and collaborative research, driving the development of cutting-edge technologies and solutions. Innovation clusters can span different industries and sectors, from technology and manufacturing to healthcare and agriculture, and can have a significant impact on the development of a smart economy.

Technology development, including research and development (R&D), is a fundamental pillar of a smart economy. Technological advances, such as the Internet of Things (IoT), big data, artificial intelligence (AI) and robotics, have the potential to revolutionise industries and create new economic opportunities. Technology development involves the creation, diffusion and adoption of new technologies and requires investment in R&D, infrastructure and talent. In a smart economy, technology development is crucial for improving productivity, enhancing competitiveness and fostering innovation.

Research, both basic and applied, plays a central role in the development of an intelligent economy. Research generates new knowledge, insights and ideas that drive innovation and technological progress. It contributes to the development of new products, processes and services and informs evidence-based decision making. Research can take place in a variety of settings, including universities, research institutes, government laboratories and private sector R&D centres. In a smart economy, research is essential for creating a knowledge-based economy, fostering innovation and driving economic growth.

In summary, the concept of a smart economy is based on the synergistic interplay of innovation clusters, technology development and research. Innovation clusters foster collaboration, knowledge sharing and co-creation, while technology development drives advances in advanced technologies. Research generates new knowledge and insights that drive innovation and economic growth. Together, these elements contribute to the development of a smart economy, where technology and innovation are used to optimise productivity, competitiveness and societal well-being. In the following sections, we will take a closer look at each of these areas and explore their importance in the context of a smart economy.

2 The Essence of China's Smart Economy

Smart economy is a multidimensional and dynamic concept that focuses on the quality of life, standard of living and well-being of individuals and communities. The concept of a smart economy is an evolutionary process that adapts to contextual situations and is characterised by three interrelated dimensions: economic, social and psychomotor. It is based on a set of moral, cultural, traditional, political and democratic principles and aims to continuously improve the quality of life of people through the efficient distribution of economic resources and the reduction of social and economic phenomena such as poverty, hunger, discrimination, inequality of opportunity, unemployment and violence. It is the process by which a person makes choices and decisions about how to use limited resources with unlimited needs (Apostol et al., 2020).

The change of the modern paradigm of the development of the world economic complex is characterised by the strengthening of the processes of intellectualisation, digitalisation, socialisation and environmentalisation, which form the general trend of the development of the smart economy. The main driving force of this new economy is the transformation of the management process, which includes new mechanisms for involving all actors and stakeholders in decision-making. The development of collective intelligence is essential to ensure that all solutions contribute to the formation of a smart global ecosystem. The main factors in the development of a smart economy are: technological innovation, resource optimisation, entrepreneurial initiatives, social welfare (Tsymbal et al., 2021).

One of the countries on the road to smartization and actively implementing smart economy technologies is China, which has developed a strategic plan to achieve innovation and stimulate its economy through science and technology. The country has created high-tech zones and clusters for the implementation of technological innovations (Irfan, 2010). Managing technological innovation). In recent years, China has made significant progress in building an intelligent economy. The country has succeeded in creating an innovative economy, using technology and science to promote sustainable development and economic growth. Smartization technologies are most actively developed in China through innovation clusters and technology parks, the most famous of which are Zhongguancun, Guangzhou, Zhangjiang, Haidian and others.

Zhongguancun is China's Silicon Valley and has become the country's leading technology centre. The science park is home to more than 20,000 high-tech companies, including many startups and unicorns. The park has a dynamic ecosystem that supports innovation and entrepreneurship, with access to funding, resources and talent (Zhongguancun..., 2023).

Guangzhou International Bioisland is a biomedical centre in Guangzhou, China. It is a biotechnology industrial park that supports the development of new drugs, medical devices and biotechnology services. Bioisland has attracted more

than 250 companies, including international players such as Pfizer, Roche and GSK (Guangzhou..., 2023).

The Shanghai Zhangjiang National Innovation Demonstration Zone is a technology park that has become the centre of innovation and entrepreneurship in China. It has attracted a range of industries including biotechnology, artificial intelligence and clean energy. The park has also become a centre for international cooperation with leading universities and research institutes around the world (Shanghai..., 2023).

Haidian Artificial Intelligence Industrial Park is a technology park located in Beijing, China. It is dedicated to the development of artificial intelligence (AI) technologies and programmes. The park has attracted more than 200 companies and has become a centre for AI research and development (Inside Haidian..., 2018).

Technoparks and technoclusters are an important mechanism for forming an integral system of China's smart economy, and as the practice of developed countries shows, they are quite successful. Innovation clusters become the driving force behind the promotion of technologies to the market, their implementation and effective introduction into the economic system. These initiatives have helped to create an ecosystem that supports innovation and entrepreneurship, attracts investment and fosters collaboration among various stakeholders. Building a smart economy in China requires a transformation of the management process and new mechanisms for involving all stakeholders in decision-making. Important values of the smart economy are sustainable development, human perception and environmental protection. Accordingly, it can increase productivity, improve product quality, reduce costs and improve the environmental situation.

Analysing China's approaches, it can be seen that the key to the process of creating an intelligent economy is a strategy of economic development based on science and technology aimed at increasing the use of the latest achievements of science and technology in production. China has an ambitious "Made in China 2025" strategy, which aims to increase the use of Chinese components and equipment in production from 40% to 70% by 2025 (Made in..., 2023.). Smart technologies such as the Internet of Things (IoT), artificial intelligence (AI), data analytics and blockchain are being actively used to achieve this goal.

3 Key Challenges in Implementing the Strategy and Developing the Smart Economy

The key problems in implementing the strategy and developing the smart economy are piracy, a lack of skilled resources, environmental pollution and a large shadow economy. To overcome these challenges, China must first develop education, the financial system, training for entrepreneurs and managers, minimise the negative impact on the environment, strengthen control over intellectual property rights, and formulate a comprehensive government policy to support the smartization of economic activity.

The smart economy has been identified as the future of economic development and innovation, and China has been working towards realising this goal. However, there are several key issues that need to be addressed before China can fully implement its smart economy strategy. One of the most important issues is piracy, which is widespread in China's digital economy. Piracy is a threat to the growth and development of the smart economy because it discourages innovation and violates intellectual property rights.

The Chinese government has taken several steps to combat piracy. One of the most important was the establishment of the National Copyright Administration of China (NCAC) in 2018. The NCAC is responsible for protecting intellectual property rights and combating piracy. The government has also introduced tougher penalties for copyright infringement and launched public awareness campaigns to promote copyright protection. However, despite these efforts, piracy remains a significant challenge that needs to be addressed (National Copyright..., 2023).

Another challenge China faces in developing its smart economy is the lack of skilled resources. The development of the smart economy requires a highly skilled workforce that is proficient in technology, innovation and entrepreneurship. However, the current education system in China focuses primarily on traditional subjects such as maths and science, and there is a lack of emphasis on technology and innovation. To address this, the government has introduced several policies aimed at improving education and training programmes in technology and innovation. These policies include increasing funding for technology research, establishing innovation centres in universities, and promoting vocational education (Yang L., 2021).

Environmental pollution is another challenge China faces in developing its smart economy. As China transitions to a more innovative and technology-driven economy, it must also address the negative impacts of industrialisation on the environment. Pollution is a major challenge for the smart economy because it not only harms the environment, but also affects public health and reduces economic productivity. To address this, the Chinese government has taken a number of measures to reduce pollution, including investing in renewable energy, reducing carbon emissions and promoting green technologies.

The large size of the shadow economy is another challenge China faces in developing its smart

economy. The shadow economy consists of businesses that operate outside the formal economy and are often involved in illegal activities such as tax evasion, money laundering and corruption. The shadow economy undermines the development of the formal economy and reduces government revenue, making it difficult for the government to invest in the development of the smart economy. To address this challenge, the Chinese government has implemented measures to reduce the size of the shadow economy, including cracking down on illegal activities and promoting the formalisation of enterprises.

In summary, developing a smart economy is a complex process that requires the government to address several key challenges. China needs to tackle piracy, a lack of skilled resources, environmental pollution and a large informal economy. To do so, China needs to develop education, the financial system and training for entrepreneurs and managers, minimise negative environmental impacts, strengthen control over intellectual property rights, and formulate a comprehensive government policy to support the smartization of economic activity. By addressing these challenges, China can successfully develop a smart economy and continue its economic growth and innovation.

4 Economic Clusters as an Example of the Implementation of the Smart Economy in China

One of the most effective ways of implementing the smart economy in China is through the creation of economic clusters. Economic clusters are geographical concentrations of interconnected enterprises, suppliers and related institutions in a particular field that compete and collaborate at the same time. They are widely recognised as an important tool for promoting the development of a smart economy in China.

The concept of economic clusters has been widely discussed in China's national strategies, including 'Made in China 2025' and the "Internet Plus" action plan. The idea behind this approach is to facilitate the exchange of knowledge and technology among enterprises, promote innovation, improve efficiency and productivity, and strengthen collaboration between industry, academia and government. Economic clusters allow firms to share resources, reduce costs and access the latest technologies, enabling them to innovate and develop high-demand products (Made..., 2023; Wang, 2016).

The development of economic clusters has been a key element of China's economic growth over the past decades. Today, China has become one of the world's leading centres of innovation, largely due to the development of economic clusters in sectors such as information technology, biotechnology and renewable energy. For example, the Zhongguancun Science and Technology Park in Beijing is one of the most successful examples of a business cluster in China. This technology park brings together thousands of companies, research institutions and universities, creating a thriving ecosystem of innovation and entrepreneurship (Zhongguancun..., 2023).

Economic clusters have many advantages over other models of economic development. First, clusters allow firms to share risks and resources. By working together, firms can pool their resources and share the risks associated with research and development, which can be costly and time-consuming. This can lead to a more efficient use of resources and a faster pace of innovation.

Second, clusters foster innovation and creativity. The proximity of businesses, researchers and universities encourages the exchange of ideas, technologies and knowledge, leading to the creation of new products, services and processes. This in turn fosters innovation and a culture of creativity that drives economic growth.

Third, clusters enhance competitiveness. By concentrating related industries in one geographical area, clusters create a critical mass of talent, technology and resources that can give firms a competitive advantage over those operating alone. This can lead to greater efficiency, higher productivity and lower costs.

Fourth, economic clusters promote regional development. By creating clusters in specific geographical areas, economic development can be targeted to specific regions, promoting regional development and reducing regional disparities. This can lead to more balanced and sustainable economic growth.

China has a long history of creating economic clusters, starting with the development of special economic zones in the 1980s. Since then, China has continued to develop and refine its approach to economic clusters. The government has launched a number of policies and initiatives to support the development of economic clusters in key sectors, including infrastructure development, tax incentives and government support for research and development.

An example of the successful implementation of economic clusters in China is the automotive industry. China's automotive industry has experienced significant growth in recent years, thanks in part to the development of economic clusters. The city of Wuhan, for example, has become a hub for the automotive industry in China, with a cluster of more than 150 automotive-related companies. This cluster has attracted major car manufacturers, including General Motors and Honda, and created a thriving ecosystem of suppliers, research institutions and universities.

Since 2009, China has remained the world's largest automotive manufacturing country and market. Annual vehicle production in China accounted for more than 32 per cent of global vehicle production, which is more than the European Union or the United States and Japan combined.

In the early years of the People's Republic of China (PRC), the country's automotive production focused on commercial vehicles for industrial and military use. It was not until the 1990s that the Chinese automotive industry began to gain momentum. The domestic market experienced rapid growth, further driving the development of the Chinese automotive industry. Vehicle sales also experienced a reversal of the rising trend from 2018, with the COVID-19 pandemic exacerbating the decline. It was not until 2021 that the growth rate started to increase slightly to 3.8%.

The above-mentioned facts are confirmed by the following statistics (Figure 1).

The statistics clearly show that China's automotive industry has experienced significant growth in recent years. The average growth rate of China's auto sales over the past two decades was 10.7%, with a record high of 369.4% in Feb 2021. Despite a record low of -79.1% in February 2020 due to the pandemic, the industry has managed to bounce back with a growth rate of 13.7% in February 2023, following a decline of 34.8% in the previous month. As China is the largest automotive market in the world, this growth trend is expected to continue and the industry will play an important role in the country's overall economic development (China Motor..., 2023).

To further promote the development of economic clusters and the implementation of the smart economy in China, several measures could be taken. First, the government should continue to invest in the infrastructure of the areas where the clusters are located, such as transportation, communication and energy. This will facilitate the movement of goods and information, and lower the cost of production and communication for firms within the clusters.

The Chinese government's need to invest in infrastructure is confirmed by the following. According to BBVA Research (formerly known as Research Service), there is a clear correlation between infrastructure growth, property market growth and China's GDP growth (Figure 2).

It is clear from the data that infrastructure investment has played an important role in driving China's economic growth. The correlation between infrastructure growth, property market growth and GDP growth shows that infrastructure is a critical component of a strong economy. As China's infrastructure investment growth has been gradually declining since 2018 due to tighter restrictions on local government debt and increased scrutiny of infrastructure projects, it is important that the government continues to invest in infrastructure to sustain economic growth. The low average growth in infrastructure investment in 2021 highlights the need for fiscal policy stimulus to ensure a strong and sustained economic recovery from the pandemic. Therefore, the government should continue to invest in infrastructure to create jobs, stimulate economic growth and improve the overall quality of life for its citizens (Dong, Xia, 2022).

Second, there needs to be more cooperation and coordination between firms within the same cluster. This can be achieved through the creation of industry associations or councils that can

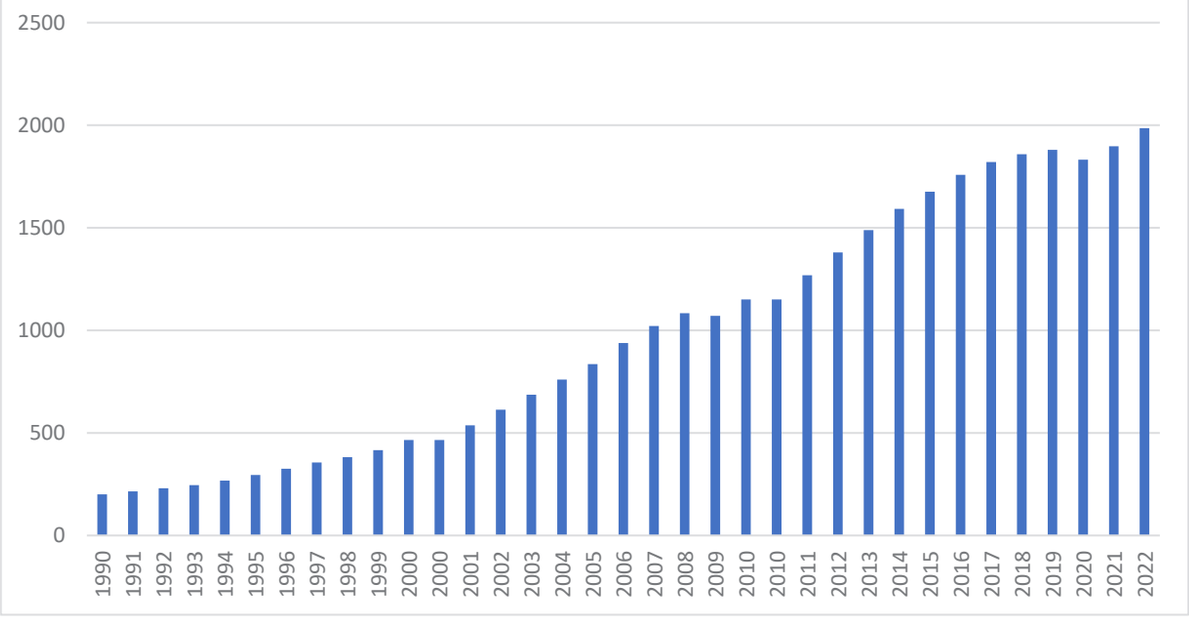

FIGURE 1 China's motor vehicle sales growth from Jan 2001 to Feb 2023 (China Motor..., 2023)

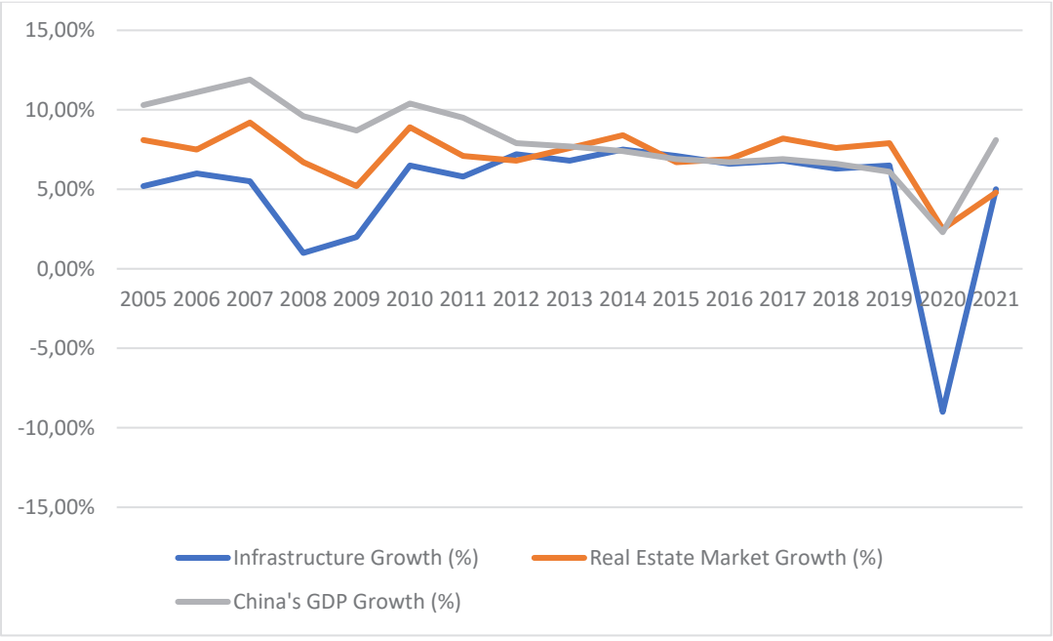

FIGURE 2. The correlation between infrastructure growth, real estate market growth and China's GDP growth (Dong, Xia, 2022)

facilitate communication and collaboration between companies. In addition, government policies could be introduced to incentivise collaboration, such as tax breaks for companies involved in joint research and development projects.

Third, the government should focus on developing a highly skilled workforce to meet the demands of the smart economy. This can be achieved by investing in education and training programmes and implementing policies to attract and retain talent. For example, the government could offer subsidies or tax incentives to companies that provide training and development programmes for their employees.

China has invested heavily in education, with a particular focus on pre-school, higher education, vocational training and compulsory education. Over the past decade, preschool education has been made available across the country, with a gross enrolment rate of 88.1% in 2021 and government financial support of RMB 253.2 billion in 2020, a sixfold increase from 2011. In higher education, China has the world's largest system, with over 44.3 million registered students, a gross enrolment rate of 57.8% in 2021, and over 52,500 MOOCs with 370 million registered users. Vocational education has also improved, with more than 10,000 vocational schools enrolling 5.57 million students by 2021 and partnerships with foreign institutions. In compulsory education, there are 207,000 schools with 158 million students and 10.57 million teachers, with government spending on compulsory education increasing from RMB 1.17 trillion to RMB 2.29 trillion between 2012 and 2021. The net enrolment rate in primary schools nationwide has increased from 99.85% to over 99.9% (Education in..., 2022).

Fourth, more emphasis needs to be placed on innovation and entrepreneurship within economic clusters. This can be achieved through the establishment of incubators and innovation centres that provide resources and support to start-ups and small businesses. In addition, the government could provide funding or tax breaks for companies that engage in innovative activities, such as research and development or the introduction of new technologies.

Finally, it is important for the government to maintain a comprehensive policy framework to support the smartization of economic activity within clusters. This framework should include policies related to education and training, innovation and entrepreneurship, infrastructure development, environmental protection and the protection of intellectual property rights. By implementing such policies, the government can create a supportive environment for businesses to thrive and for the smart economy to flourish.

In conclusion, economic clusters are a promising way to implement the smart economy in China. By bringing together companies from related industries and promoting cooperation and collaboration, economic clusters can help drive innovation, increase efficiency and boost economic growth. However, there are several challenges that need to be overcome, including the need for better infrastructure, a skilled workforce and a greater emphasis on innovation and entrepreneurship. By addressing these challenges and implementing supportive

policies, the government can help ensure the success of economic clusters and the broader implementation of the smart economy in China.

5 The Role of Technology in the Development of China's Smart Economy

The development of China's smart economy has been driven in large part by advances in technology. It is therefore important to understand the role that technology has played in this process. This section examines the ways in which technology has contributed to the development of China's smart economy.

China has invested heavily in technology, with a focus on emerging technologies such as artificial intelligence (AI), big data and the Internet of Things (IoT). These technologies have been instrumental in the development of China's smart economy, enabling new forms of innovation and improving productivity.

Artificial Intelligence:

Artificial intelligence (AI) is a key driver of China's smart economy. Chinese companies have invested heavily in AI research and development, and the Chinese government has made AI a national priority. This has led to the emergence of a vibrant AI ecosystem in China, with a number of startups, universities and research institutions working on cutting-edge AI applications.

AI has been used in a range of industries, including healthcare, finance and manufacturing. For example, AI-powered medical imaging tools have helped improve the accuracy of cancer diagnoses, while AI algorithms have been used to improve credit risk assessments in the financial industry. In manufacturing, AI has been used to optimise production processes and reduce waste.

Big Data:

Big data has also played an important role in the development of China's smart economy. With its large population and vast amount of data, China has become a global leader in big data analytics. Chinese companies have developed sophisticated algorithms and tools for processing and analysing large data sets, enabling new forms of innovation and improving decision-making.

Big data has been used in a number of industries, including healthcare, finance and retail. For example, big data analytics has been used to identify patterns in healthcare data, leading to more effective treatments and better patient outcomes. In finance, big data has been used to detect fraud and improve risk management, while in retail, big data has been used to personalise marketing campaigns and improve customer engagement.

Internet of Things:

The Internet of Things (IoT) is also a key driver of China's smart economy. With its large population and rapidly growing urban areas, China has become a major market for IoT devices and applications. Chinese companies have developed a range of IoT technologies, including sensors, devices and platforms that enable new forms of connectivity and automation.

IoT has been used in a number of industries, including transportation, manufacturing and agriculture. For example, IoT sensors have been used to monitor traffic flow and optimise transport networks, while in manufacturing, IoT devices have been used to track inventory levels and improve supply chain efficiency. In agriculture, IoT technologies have been used to monitor soil moisture and temperature, leading to more efficient irrigation and improved crop yields.

Technology has played a crucial role in the development of China's smart economy. Advances in artificial intelligence, big data and the Internet of Things have enabled new forms of innovation, improved productivity and enhanced decision-making. As China continues to invest in these technologies, it is likely that the country will continue to lead the world in the development of smart technologies and applications.

Under the "Made in China 2025" plan, technology plays a critical role in the development of China's smart economy. The plan highlights the importance of key technologies such as the Internet of Things (IoT), big data, cloud computing, artificial intelligence (AI) and robotics. These technologies are seen as critical enablers for China's industrial upgrading and transformation (Made in..., 2023).

For example, IoT is seen as a key technology for smart manufacturing, where machines, devices and sensors are connected to the internet to enable real-time data collection and analysis, which can help optimise production processes and improve efficiency. The government has encouraged the adoption of IoT technologies in manufacturing through various policies, such as the Made in China 2025 plan and the "Internet Plus" strategy.

Similarly, big data is seen as a key enabler for intelligent decision making in various industries such as finance, healthcare and transportation. The Chinese government has encouraged the development of big data infrastructure, such as data centres and cloud computing, to support the growth of the industry. In addition, the government has established initiatives such as the National Big Data Comprehensive Pilot Zone to promote the development of the industry (Guizhou..., 2021).

Artificial intelligence (AI) is another key technology for China's smart economy. The country is investing heavily in AI research and development, with the aim of becoming a global leader in the industry. In 2017, the Chinese government announced its plan to become a global leader in AI by 2030, with the aim of building a domestic

AI industry worth $150 billion. To achieve this goal, the government has launched various initiatives to support AI research, such as the AI Development Plan, which aims to build an AI ecosystem and promote the integration of AI with traditional industries (Webster et al., 2017).

The development of robotics is also seen as critical to China's smart economy, particularly in the manufacturing sector. The Chinese government has encouraged the use of robots in manufacturing through various policies, such as tax incentives and subsidies. The country is already the world's largest market for industrial robots, and the government aims to further develop the industry to meet the needs of China's smart economy.

In conclusion, technology plays a crucial role in the development of China's smart economy, especially in the context of the Made in China 2025 plan. Key technologies such as IoT, big data, cloud computing, AI and robotics are seen as critical enablers for China's industrial upgrading and transformation. The Chinese government has launched various initiatives to support the development of these technologies and their integration with traditional industries, with the aim of building a sustainable and innovative smart economy.

6 Conclusions

A smart economy, driven by advanced technologies and innovation, has become a focus for countries seeking to achieve economic growth and sustainable development. Innovation clusters, technology development and research play a crucial role in shaping the trajectory of a smart economy. Innovation clusters, which are geographical concentrations of interconnected firms and stakeholders, foster collaboration, knowledge sharing and co-creation to drive innovation and economic growth. Technology development, including research and development (R&D), is essential for the creation and adoption of cutting-edge technologies that can revolutionise industries and create new economic opportunities. Research generates new knowledge and insights that drive innovation, inform decision-making and contribute to economic growth.

Innovation clusters, technology development and research are interrelated and synergistic elements of a smart economy. Innovation clusters provide the collaborative ecosystem necessary for technology development and research to flourish. Technology development, in turn, drives advances in technologies such as IoT, big data, AI, and robotics, which are critical enablers of a smart economy. Research generates new knowledge and insights that inform technology development and innovation, contributing to the growth and competitiveness of a smart economy.

A smart economy is characterised by a knowledge-based economy, productivity optimisation and innovation-driven growth. It requires strategic investments in innovation clusters, technology development and research to foster an enabling ecosystem for technology-driven economic growth. Governments, academia, industry and other stakeholders need to work together and coordinate their efforts to support the development of a smart economy. This includes policies and initiatives to foster innovation clusters, support R&D, promote technology development and foster research collaboration.

In summary, a smart economy relies on the interrelated elements of innovation clusters, technology development and research. Together, these elements drive the development and adoption of advanced technologies, foster innovation and contribute to economic growth. Embracing and nurturing these elements is critical for countries seeking to realise the full potential of a smart economy and achieve sustainable economic development in an era of rapid technological advancement.

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