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Agricultural and rural digitalisation in regional sustainable development: A comparative study between China and the European Union

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Abstract
Since the turn of the twenty-first century, digitalisation has gained widespread acceptance as a powerful tool for socioeconomic and environmental progress. Agricultural and Rural Digitalization (ARD) has been less researched than urban digitalisation, which received the most public interest. In this study, I addressed the advantages and significance of Agricultural and Rural Digitalization for regional sustainable development; and how our work can address the present implementation-related issues. The Digital Economy and Society Index (DESI) is an important indicator utilised to summarise digital performance in the European Union, and it is used in this research to assess the development of digitalisation. I made a comparison study to address the current issue and underline the relevance of agricultural and rural digitalisation by analysing official documents. Digitalisation proved to impact sustainable rural development positively, and a monitoring system can be used to produce policy-oriented recommendations. Our research aided people's understanding of China's program for smart and digital rural areas and provided policymakers with alternative strategies between China and the European Union when they needed a reference on the development of digital rural areas.

Keywords
Agricultural and rural digitalisation, Regional Development, Rural areas, Sustainability, Comparative analysis, Agricultural and Rural Digitalization, Digital Economy and Society Index

1. Introduction

Digitalisation refers to transforming every aspect of our economy, government, and society based on the widespread use of established and developing digital technology (*Randall et al., 2018*). In general, it is also referred to as the use of digital technologies to alter a business strategy or a conventional rule to reduce expenses or add value. Digital transformation, innovation, and sustainability are related to each other, and the increasingly complex problems such as climate change, environmental pollution, and pandemics are enhancing the importance of inter and transdisciplinary (*Ordieres-Meré et al., 2020; Szalmáné Csete, 2019*). Moreover, digital technologies, big data, Information and Communication Technologies (ICTs), and the Internet of Things (IoTs) are influencing our daily life (*Meneghello et al., 2019*). Policymakers and decision-makers also use digital tools to stipulate suitable and promising strategies (*OECD, 2019; Papageorgiou, 2020*). In practice, the European Commission included a section on the digital transition in its *Declaration on European Digital Rights and Principles* (*EC, 2023b*) to encourage the spread of digitalisation by 2030. Regarding the significance of digitalisation, 127 billion Euros are set aside for digital-related reforms and investments in each EU member state's *National Recovery and Resilience Plan* (*EC, 2022c*). In China, digital development has been recognised as one of the key elements to realising the national strategy (*Government of China, 2022*).

Digitalisation has been used in various industries to increase social production and optimise resource allocation. During the Covid-19 pandemic, the most prominent and practical digital technology was used in pandemic management to stop and control the spread of the virus (*Whitelaw et al., 2020*). Numerous insignificant concerns in governmental activities can be resolved with a few clicks on a mobile device, significantly reducing labour and time costs. Since most application scenarios are found in urban settings, Agricultural and Rural Digitalization (hereafter ARD) has not gotten much attention. However, ARD is essential for regional sustainable development. One of the 17 Sustainable Development Goals, the 10th (Reduce Inequality), is the reduction of inequality within and between countries. Inequality can endanger social cohesiveness and political stability, but according to Iammarino's research (*Iammarino et al., 2019*), increasing internet access can also be effectively addressed. Similarly, digitalisation has played an essential role in policymaking, especially in the sectoral and spatial development programs in various scales of regions (*Buzási et al., 2021; Salvia et al., 2021; Szalmáné Csete, 2020; Nagy, 2021*), for example, study about the Visegrad Group of Central European Countries confirmed the strong relationship between digitalisation transformation and sustainability (*Esses et al., 2021*).

Sustainable development, acknowledged as humanity's inevitable path, is "*development that meets the needs of the*

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present, without compromising the ability of future generations to meet their own needs" (*Brundtland, 1987*). Additionally, because our planet has limited natural resources, sustainable development is crucial because it promotes the equal development of the environment, society, and economy. The United Nations created 17 Sustainable Development Goals (SDGs), often referred to as the *2030 Agenda* (*DESA, 2016*), which were expanded from the previous 10 Millennium Development Goals (MDGs). To see the relationship between agriculture and sustainability, Kinga Biró and Ottó Toldi have already analysed the impact of GHG emissions from the agricultural sector and stated the importance of agricultural innovation for sustainable development (Biró & Toldi, 2022). Therefore, to reach SDGs in the agricultural and rural sectors, the EU and China have taken action (*EC, 2022b; Government of China, 2022*) in ARD.

Moreover, as a new concept and valuable tool, Cognitive Sustainability helps us conduct interdisciplinary research on agricultural and rural digitalisation in the EU and China, where cognitive tools also serve digital development (Zöldy et al., 2022). Also, within five critical areas of Cognitive Mobility, cognitive sustainability supports understanding the interaction between mobility and economic processes. Cognitive mobility optimises using ICTs, including digital development (*Zöldy and Baranyi, 2023*). In this context, digitalisation in rural and agricultural areas turned into a preferred and essential tool for the European Commission and the Central Chinese government to promote sustainable development.

To assist the effective digitalisation of agriculture and rural regions in Europe, 26 European nations signed a Declaration of Cooperation on April 9, 2019, titled *A smart and sustainable digital future for European Agriculture and rural areas*. It acknowledges the potential of digital technology to address significant and critical economic, social, environmental, and climate concerns facing the EU's rural areas and agri-food sector. On September 3, 2021, the *Digital Rural Construction Guide 1.0* in China was published. It offered guidelines for promoting digital rural construction throughout the nation. The Ministry of Industry and Information Technology, the National Development and Reform Commission, the Ministry of Agriculture and Rural Affairs (MARA), and other departments collaborated to establish this document. The basic framework for the coordinated work schedules created by the various ministries and commissions to advance the digital village has emerged. The ARD's top-down discipline for regional sustainable development would be this rule.

China has the second-largest GDP in the world (14.7 trillion USD/country), whereas the European Union produces 15.3 USD trillion. According to the results of the 7th National Census in 2020 (National Bureau of Statistics of China, 2021), China, one of the largest developing nations, has a population of 1.4 billion, of which 510 million (36.11%) live in rural areas. In comparison, the EU, the largest developed region, has a population of 447.7 million, of which 30.6% (137 million) reside in rural areas (*Eurostat, 2022*). It is worthwhile to compare the digitalisation of agriculture and rural areas between China and the EU, given that they are both in similar but distinct developmental stages. On the one hand, some studies examine ARD in the EU or its member states, such as Popescu's case study of Romanian universities (*Popescu et al., 2020*), Dyba's study that focuses on financial support in the EU (Dyba et al., 2020), Garske's solution for digitalisation and AI in European agriculture (*Garske et al., 2021*), and Lioutas's research, which tried to solve the food problem by the use of digital technologies (*Lioutas et al., 2021*).

On the other hand, topics relating to ARD were also discussed in China. For example, Xia discussed the initiatives and policies of rural digitalisation in China (*Xia, 2022*), Xie discussed a case study about how smallholder farmers are involved in digital agriculture (*Xie et al., 2021*), Qu examined how to promote agricultural modernisation through ICT in China (*Qu et al., 2018*), and Chen discussed how data helps the efficiency (*Chen et al., 2022*). To our knowledge, the digitalisation of agriculture and rural areas in the EU and China has not yet been thoroughly studied.

This study explores the following questions to help people better and more insightfully understand China's agricultural and rural digitalisation and to provide alternative options/strategies for policymakers by comparing China and the EU.

1. *What are the benefits and the importance of agricultural and rural digitalisation to regional sustainable development in China and the EU?*

2. What are the current general problems that need to be solved during the implementation processes, and what needs to be done to solve these problems?

2. Importance of agricultural and rural digitalisation

From the economic perspective, a region's innovation and digital transformation level correlates with its economic position (*Afonasova et al., 2019*). The higher the level of digitalisation and innovation, the higher the level of economic development. According to the results of seven years of data, *Van Gaasbeck (2008)* discovered that broadband access has helped to increase overall economic growth and employment. Information and communication technology (ICT) also

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contributes to the development of rural areas (*Salemink et al., 2017*).

One of the main drivers of economic development has been recognised as digitalisation, and the European Commission recognised the importance of technological development and digitalisation for regional development in Europe as early as 2014 (*EC, 2014*). Despite this, rural areas continue to lag behind urban areas in terms of access to both private and public services (*Roberts et al., 2017*). The importance of agricultural and rural digitalisation in the EU has grown since publishing *A Better Life in Rural Areas: The CORK 2.0 Declaration* (*EC, 2016*) and *Shaping Europe's Digital Future* (*EC, 2020*). To narrow the gap between rural and urban areas and foster regional growth, two illustrative case studies were done in rural areas: one in Lippe/Höxter, Germany, and the other in Västerbotten, Sweden (*Löfving et al., 2022*).

The most well-known EU policy is the cohesion policy, which positively impacts regional development (Barbero et al., 2022). In contrast, the Trans-European Transport Network (TEN-T) project (*EC, 2022d*) aims to construct a Europe-wide transport network connecting all the central European cities as nodes by 2030 and all European regions by 2050, which will significantly improve the implementation of digitalisation in the EU. Along with the Recovery and Resilience Facility (*EC, 2022c*), which the European Commission put in place in 2022 to aid the EU in hastening its recovery from the pandemic, it stressed that member states must use at least 20% of the money to promote the digital transformation.

2.1 What effort has China made to improve rural digitalisation?

In ancient China, agriculture served as the pillar of society. Agriculture has traditionally been seen as the nation's cornerstone because of the enormous population that has to be fed (*Chen et al., 2021*). This resulted from a long-term economic strategy emphasising agriculture and suppressed trade. Furthermore, agricultural operations are often conducted in rural regions, which are subject to high obligations and duties and have less favourable regional development. Since the 1950s, rapid urbanisation and early digitalisation have led to a significant regional development imbalance in China between urban and rural areas (*Lin and Chen, 2011*). To tackle this problem, the 19th National People's Congress adopted the Rural Revitalization Strategy to lessen urban-rural inequities and boost agricultural and rural growth. This tactic made it clear that the issue of farmers in agricultural and rural regions is a significant issue affecting the national economy and people's means of subsistence (*Government of China, 2018*).

Immediately after the Rural Revitalization Strategy was set as the primary national strategy, the *Digital Agriculture Rural Development Plan (2019–2025)* was published to clarify the tasks and objectives of agricultural and rural digitalisation in regional development. "Smart village", as a critical concept in rural digitalisation, has been applied in sustainable development, and it has been approved that it has a positive effect in rural areas through smart village strategic planning and practice in China (*Zhang and Zhang, 2020*). In 2021, the Big Data Center of the Ministry of Agriculture and Rural Affairs (MARA) was established, the National Development and Reform Commission, the Ministry of Industry and Information Technology, the Central Network Information Office, and other departments collaborated to develop the *Guidelines for Digital Rural Construction 1.0*, which was made public on September 3, 2021. This document drew a general "construction map" for promoting digital rural construction nationwide.

2.2 Problems existed during agricultural and rural digitalisation development

There are still many problems with how agricultural and rural regions grow digitally. Salemink found that there are other problems, such as cultural, organisational, and technological ones, in addition to the fact that individuals in rural regions do not have the infrastructure or digital skills required to access services (*Salemink et al., 2017; Tolstykh et al., 2017*). When digital agriculture is considered for environmental sustainability, negative environmental consequences may also happen if digital technologies are not used properly due to a lack of strict regulations (*Soma and Nuckchady, 2021*).

Another notable concern in ARD is data ownership. Data is a type of valuable resource, and it is available on digital platforms that can be accessed by multi-national corporations that operate them (*Fraser, 2019*). Even though farmers agree to the terms and conditions of using digital agriculture platforms, they have little influence on determining consent rights to their data as agricultural companies remain unclear about data ownership and whether the data is used for other purposes, such as data sharing agreements with third parties (*Custers, 2016; Wiseman et al., 2019*). The collected data may threaten small and medium size farms with economic and environmental consequences (*Clapp and Ruder, 2020; Wiseman et al., 2019*).

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Digital applications are ineffective because of workers' lack of e-skills. Artificial intelligence may use big data and real-time information from distant sensors to forecast potential social actions in various situations, but this raises serious concerns about privacy, data ownership, and usage (*Rolandi et al., 2021*). Some papers emphasise how digitalisation may be seen as a brand-new monitoring technique that exacerbates social disparities by prescribing and detailing a specific set of rules for what social interactions should look like (*Klauser, 2018*). Investing in agricultural digitalisation may discourage private capital from this industry due to the nature of agriculture, where the operational cycle is sometimes one year or even longer in animal husbandry. For some specific species, the return on investment carries a more significant risk (*Belhadi et al., 2021*). Specific brand or system of agricultural digital technologies requires significant capital investment, which forces the farmer to loan (*McMichael, 2013; Rotz et al., 2019*), and these debts will be a potential risk for farmers, especially in the 21st century when extreme weather is more frequent (*McKinnon, 2019*).

The main issue in China is the lack of comprehensive planning and design. China is currently in the bottom-up phase of independent investigation by various areas for developing smart villages (*Zhang and Zhang, 2020*). The problem of regional imbalance and significant rural heterogeneity is another noteworthy one. There are varied foundations for rural information technology in different parts of China. The eastern part of China has a reasonably strong foundation for information technology, but the middle and western regions are largely underdeveloped due to the varying rates of economic development.

3. Methodology

Although comparative analysis has clear uses, there is no universally accepted definition. For instance, the comparative analysis may compare the benefits and drawbacks of two or more study objectives and their differences and similarities. Furthermore, interpreting useful data by establishing the link between study objectives is another crucial and beneficial function of comparative analysis. Additionally, one of the key components of comparative analysis is articulating the justifications for analysing a particular feature and the inferences that may be drawn from the comparison (*Pickvance, 2001*). Therefore, a comparative analysis is used in our research in order to determine the differences and similarities in ARD between the European Union and China. Additionally, I analyse the key sectors and their benefits and drawbacks between the EU and China using official papers and publications as our sources of information.

3.1 Compare the reasons and aims of ARD between the EU and China

Information was gathered on the motivations and objectives of ARD in the EU (*EC, 2022b*) and China (*MARA, 2020*). Table 3 illustrates each country's stance toward ARD graphically. Since all ensuing initiatives and policies are built on this concept, I would want to compare their initial points of thought and work priorities in this manner.

3.2 Compare the Digital Economy and Social Index (DESI) compass targets between the EU and China

Since 2015, the European Union has built a comprehensive and successful indicator system to assess and track the digital growth associated with sustainable development in the EU. There is already research that utilised DESI 2022 (*EC, 2023a*) as an indicator to assess the development level of digital transformation in Europe and summarised clearly and useful results (*Esses et al., 2021*). The regularly updated DESI report supports our comparison study inside our framework since the classifications of these indicators could fully reflect the level of digitalisation. It is scientific and professional (Appendix.1). Official reports and materials released by the government or relevant ministries were examined to match each indication in the DESI assessment method even though China does not have the same DESI report as the EU (*MARA, 2020; CAICT, 2022*). This will allow us to compare the ARD levels in the EU and China (*Figure. 1*) and examine those numbers' discrepancies. The digital compass targets in DESI 2021 concerning the four dimensions of the index were also used to simplify the DESI indicator system for easier comparison between the EU and China. These targets (*Table 1*) are used to evaluate the digital development of the EU and China and conduct a comparative analysis.

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Table 1: Digital compass targets in DESI

Human Capital	At least basic digital skills ICT specialists Female ICT specialists
Connectivity	Gigabit for everyone 5G coverage
Integration of digital technology	SMEs with a basic level of digital intensity AI Cloud Big data
Digital public services	Digital public services for citizens Digital public services for businesses

Source: (EC, 2022a: 13)

3.3 Other methods applied in our research

Essentially, this secondary research incorporates data collecting, reading, and analysing policies and articles. To further highlight the ARD of the EU and China, I also created a SWOT analysis (*Table 3*) based on in-depth literature readings, policy interpretation, and data processing.

4. Results

4.1 Comparison of the reasons and aims of ARD between the EU and China

The comparison result of reasons and aims of ARD between the EU and China (Table 3) shows consistent attitudes and different approaches to the digitalisation of agriculture on both sides. For instance, the EU and China are pursuing sustainable rural development since protecting the environment has already become a consensus, and both want to apply digital technologies to increase efficiency in agricultural production. Another similar reason is the labour losses in rural areas since people living there have no attractive and lucrative job opportunities. Obviously, the reasons why the EU and China want to develop ARD are the same, as the differences are minimal, so I will not discuss them here.

As a multi-ethnic, multicultural, and multi-national organisation, the European Union must consider each member state's unique capabilities and developmental stage when adopting policies like the Common Agricultural Policy (CAP). Similarly, China is a multi-national and multicultural country with 56 nations and a spacious territory. There are comparatively less developed places in the Northwestern and Central portions of China, where there is uneven urban and rural digitalisation development, in addition to developed regions in the Southeastern part of China, where there is a high degree of digitalisation in both urban and rural areas. The ARD difference between the EU and China is that the EU emphasises innovation more than China. On the contrary, as a developing country, China focuses on developing infrastructure and ending poverty in rural areas, while most EU regions are developed.

Table 2: Comparison of the reasons and aims of ARD between the EU and China

European Union	**China**
Reasons	
1. Farmers lack precise and sustainable instruction. 2. Insufficient science in agricultural decision making 3. Conventional agriculture is unsustainable. 4. Labours outflow from rural areas 5. Digital technologies are needed to make rural communities more attractive, intelligent and sustainable. 6. Improving access to remote services	1. Rural infrastructure is weak. 2. Current agriculture is outdated. 3. Urban-rural development disparities 4. Agricultural production is unsustainable. 5. ARD is an essential part of achieving the rural Revitalization Strategy (Liuet al., 2020) 6. The young generation does not want to work in the agricultural sector.

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Aims	
Strengthen research support. ◆ Smart farm ◆ Stimulate the use of digital tech ◆ Keep EU at the forefront of progress in smart farming ◆ Support RDI actions ◆ Give priority to SMEs in digital farming	**Sustainable rural development** ➓ Develop creative sightseeing agriculture ➓ Increase the construction of rural Internet of Things (IoT) ➓ Establishment electronic traceability supervision system for agricultural inputs
Establishing an innovation infrastructure ◆ Identify large-scale experimentation and testing facilities ◆ At least one digital innovation hub in each Member State ◆ Develop a network linking the dedicated agri-food digital innovation hubs ◆ Make the rural population involved in digital transformation ◆ Promote AI and IoT development in rural areas ◆ Achieve full deployment of broadband connectivity in rural areas ◆ Strengthening synergies between funding instruments	**Urban and rural common prosperity** ➓ Upgrade rural network facilities ➓ Improve information terminal and service supply ➓ Accelerate the digital transformation of rural infrastructure ➓ Coordinate the development of digital villages and smart cities
Creating a European data space for smart agri-food applications ◆ Promoting cross-border platforms and databases ◆ Make use of European space programmes	**Convenient public service** ➓ Promote rural construction and planning management information technology ➓ Improve the convenience of the masses
Maximise impact ◆ Drawing up the CAP (Common Agricultural Policy) Strategic Plans ◆ Designing the financial structure of the CAP Strategic Plans ◆ Increase CAP administration	**Increase rural region's income by ICT** ➓ Promote the integration between ICT and agricultural production ➓ Enhance the development of smart agriculture ➓ Innovative rural logistic service system

Sources: EC, n.d.; MARA, 2022.

4.2 The level of infrastructure and economic development

These results are consistent with China's and the EU's distinct economic progress and advantages. According to the *Digital China Development Report 2021* (CAC, 2022), China has 1.032 billion Internet users, approximately 73.7% of the population, and 74.4% of these users have at least basic digital abilities, compared to 55% of the people in the EU (*Figure 1a*). Due to the developed infrastructure and government subsidies, China has 100% 5G coverage and gigabyte for everyone, compared to 14% and 59% in the EU, respectively. Furthermore, China has Internet giants like Tencent, Baidu, and Alibaba, which offer significant technological assistance. The results of SMEs with basic levels of digital intensity and big data are 82% and 90%, respectively, higher than the corresponding figures for the EU, 59% and 35.6%.

Nonetheless, the EU has a higher rate of development in AI and cloud technology, with 25% and 25%, respectively, compared to China's 8.6% and 16%. In addition, despite having a population of 447.7 million and 1.4 billion populations, the EU has 8.6 million ICT professionals compared to China's 4.87 million (*Figure 1b*). In addition, there are 2.37 million female ICT professionals in China compared to 1.6 million in the EU. In order to conclude from this finding, *Figure 1b* shows that the EU has a more significant percentage of ICT professionals than China, but fewer women. The EU receives a score of 75 on digital public services for citizens and 82 for businesses, whereas China receives a score of 90.5 on these services for individuals and 73 for corporations, as shown in the final figure (*Figure 1c*):

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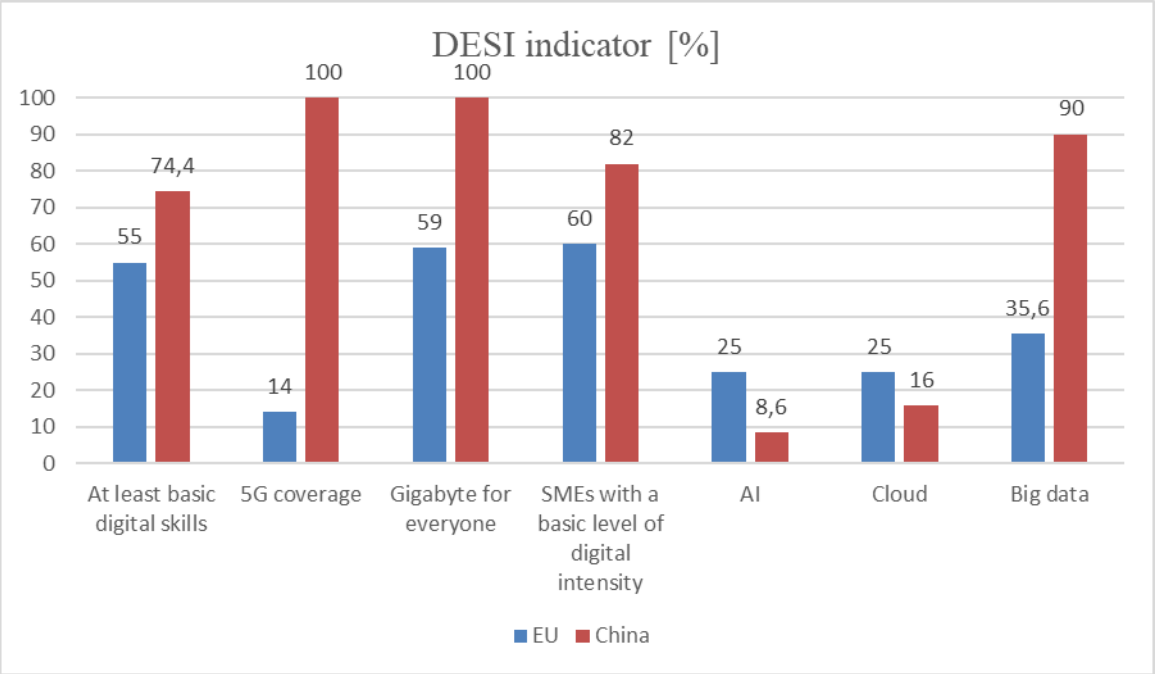

Figure 1a. Achievements of ARD of the EU and China

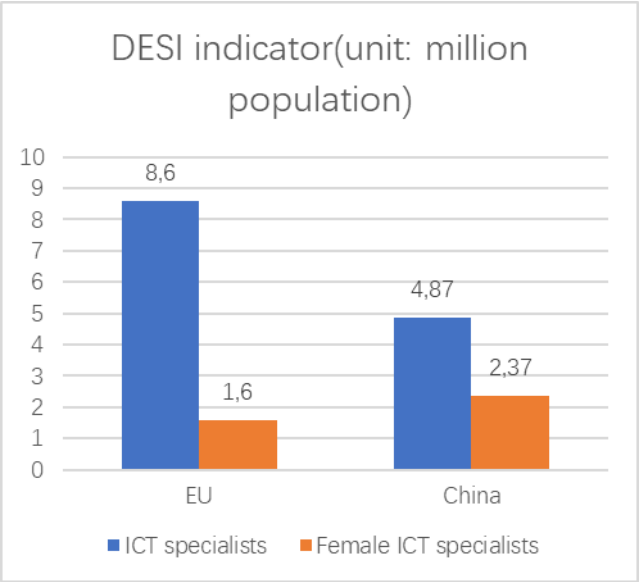

Figure 1b: Achievements of ARD of the EU and China [%]

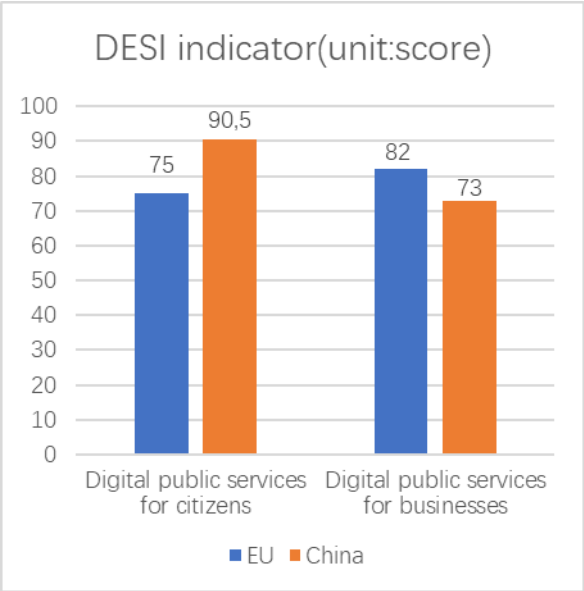

Figure 1c: Achievements of ARD of the EU and China (unit: score)

Sources: Figure.1a, b, c are compiled from the following documents: "CAICT, 2022; CAC, 2022; National Bureau of Statistics,2021; MARA, 2020; The Digital Economy and Society Index (EU, 2022), Thematic Chapters

4.3 China's Long-term plan for ARD

The central government of China has created several programs from diverse angles concerning the long-term development of ARD (*Table 4*). Big data, one of the most significant resources in the Internet era, can be applied efficiently in rural regions for agricultural production and rural life. Thus, China wants to develop a database that contains as much information as possible to assist in data utilisation. Digital technologies are gradually being implemented in practice to raise the standard of agricultural produce. The long-term plan must include two crucial components: strengthening important technologies and creating cutting-edge equipment. Moreover, monitoring and evaluating how the entire plan is executed is the key to ensuring success. In the end, it was also written in the plan.

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Table 4. China's long-term plan for ARD

Build a basic data resource system
■ Building big data on:
1) Agricultural, natural resources,
2) Significant agricultural germplasm resources, Rural collective assets
3) Rural residential bases
■ Complete big data on farming households and new agricultural business entities.
Promote the digital transformation of management services
■ Establishing a sound technical system to support agricultural and rural management decisions
■ Establishing monitoring and early warning systems for the whole industrial chain of important agricultural products
■ Build digital agriculture and rural service system
■ Establish an intelligent monitoring system for rural habitat environment
■ Build a rural digital governance system
Accelerate the digital transformation of production and operation
■ Planting industry informatisation
■ Intelligent animal husbandry
■ Intelligent fisheries
■ The digitalisation of the seed industry
■ Diversification of new business mode
■ Quality and safety control throughout the process
Strengthen key technology and equipment innovation.
■ Strengthen critical standard technology research and development
■ Strengthen strategic frontier technology layout in advance
■ Strengthen technology integration application and demonstration
Accelerate the application of agricultural artificial intelligence research and development

Source: Own compilation from MARA, 2022.

5. Discussion and limitation

Based on the discussion, I would like to make a few recommendations. In order to assist scholars in gaining a convenient and thorough knowledge of China's digital progress, it would be a good idea for the Chinese government to build an indicator system akin to the DESI in the EU. Second, it is helpful to develop an assessment system to determine whether policymakers need to adapt and improve the program after implementing digitalisation. In addition, I developed a SWOT analysis (Table 2) to illustrate more clearly how ARD is now developing in the EU and China. On the one hand, the EU has the European Network for Rural Development (ENRD) and the European Agricultural Fund for Rural Development (EAFRD), while China has the Rural Revitalization Strategy, representing the most significant opportunities. While China has particular geographical resources that may have enormous potential, the EU has its advantage in the abundance of ICT professionals. On the other hand, complicated interpersonal ties in rural regions are China's most significant deficit.

There is still a long way to go until this issue is fixed since many Chinese communities, especially those in rural areas, are too traditional to embrace or encourage digitalisation. The EU has flaws regarding member-state conflicts of interest and regional development gaps between Northwest and Middle Eastern Europe. The refugee crisis impacts the EU's economy and society, the energy crisis, and the possibility of conflict. According to an old Chinese proverb, "The Chinese do not suffer from lack but from unevenness," China faces an unanticipated threat from the rising regional disparity in development. Therefore, a SWOT analysis is required in this article since it can effectively highlight ARD's positive and negative aspects. This SWOT analysis is beneficial because it enables ARD's stakeholders to capitalise on their strengths, learn from others, and distinguish between potential dangers in the future so they may effectively avoid them.

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Table 3. SWOT analysis of ARD in the EU and China

European Union	China
Strengths	
A large number of ICT specialists	Unique regional resources
Mature policy support (CAP)	Agricultural-related universities, research institutes, and vocational schools
Abundant financial capital	Well-established infrastructure
Advanced development experience	100% Internet coverage
Experienced societal operation	
Weaknesses	
Disputes of interest between member states	Weak information infrastructure
Regional development disparities	Limited digital literacy levels in rural areas
Scattered funding landscape of SMEs	Complex interpersonal relationships in rural areas
Relying on resource import	Vase less-educated population in rural areas
High labour cost	Fewer job opportunities in rural areas
Low ratio of digital skills education	Disparate population density gap
Weak transportation channels	Complex geographic
	Complex geographical environment
Opportunities	
Policy support	Policy support
5G network installation	5G network construction
Emerging of AI, IoT, big data	The Rural Revitalization Strategy
Threats	
Extreme weather	Low level of digital governance in rural areas
Covid-19	Poor adaptability of smart equipment in agriculture
Regional war/conflict	Imbalance of digital development between urban and rural areas
Energy crisis	Fewer talents study agricultural science
Refugee crisis	Talent's Loss in rural areas
Cybercrimes	Cybercrimes
Inconsistent policy execution	Lockdown due to Covid-19
Dependent on foreign technologies	

Source: Self compilation

I want to underpin the scientific importance of this work and the components that can support subsequent research in light of the SWOT analysis. This article researched agricultural and rural digitalisation in China and the European Union and conducted a comparison. Our studies offer alternate recommendations for policymakers and other researchers and demonstrate ARD's significance in regional sustainable development. In the future, I hope this study will be a helpful resource and contribute to more fruitful and beneficial scientific research.

There are some limitations of this research. Since the DESI data for China is approximative, there is no standard method of evaluation for the Digital Economy and Social Index (DESI) between the EU and China, which results in some bias. Due to a lack of time and funding, I could not conduct an empirical study on digital development in rural areas of the EU and China. Aside from that, there are still many flaws and weaknesses regarding problem-solving and detail processing because of the author's inadequate scientific quality and understanding. Additionally, further research can be done about starting a Life Cycle Cost (LCC) assessment on applying digital technologies in agricultural production to conduct a comparative benefit-cost analysis between digital and conventional agriculture.

6. Conclusion

Our goals for this research have been accomplished based on the result section. I provided a complete introduction to the central government of China, its successes in agricultural and rural digitalisation, and the long-term goals of ARD. In the analysis above, I offered recommendations for further development tactics that the comparative research between China and the EU may refer to. Additionally, from an economic, social, and environmental perspective, agricultural and rural digitalisation favours regional sustainable development.

To answer the question, "*What are the benefits and the importance of agricultural and rural digitalisation to regional sustainable development in China and the EU?*" our research indicates that the most significant advantage is reducing

regional development inequalities, which may lessen social disputes. In order to attain as many SDGs in rural regions as feasible, ARD is also important in fostering economic and sustainable development. I conclude that ARD is crucial and the best path to achieving wealth for all Chinese citizens. Additionally, ARD supports agricultural output growth, a key component of the entire food supply chain. The more developed and sophisticated agricultural digital technologies are used, the better and more food can be produced in terms of quality and quantity.

Moreover, I have several issues with related solutions to answer, "What are the current general problems that need to be solved during the implementation processes, and what should I do to solve these problems?". The construction of broadband and signal base stations is a top-to-bottom infrastructure development program spearheaded by the government. In some isolated and undeveloped places, the central government can finance digital knowledge teaching and professional support to help those without formal education acquire essential digital skills (often in rural areas). A comprehensive legislative framework should be built to control the management of personal information related to the use of digital technology to address the problem of privacy-violence. The government should encourage banks to loosen the limits on SMEs participating in digital agricultural production to solve the issue that major firms often do not participate in agricultural digitalisation owing to the nature of agriculture. The absence of comprehensive planning and design in China may be remedied by encouraging the development of smart villages. If comprehensive, unified smart village planning and design are urgently required, the rural areas can carry out pilot work on smart villages with the cooperation of the central government. Additionally, given that China has difficulty balancing economic growth with digital development, I propose that various smart towns concentrate on particular subsectors. For instance, some towns may have somewhat advanced agriculture suitable for smart agriculture, while others may have a richness of tourism resources suitable for smart rural tourism.

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Appendices

Appendix.1: DESI indicator system

	Human Capital
❿	At least basic digital skills (% individuals)
❿	Above basic digital skills (% individuals)
❿	At least basic software skills (% individuals)
❿	ICT specialists (% individuals in employment aged 15-74)
❿	Female ICT specialists (% ICT specialists)
❿	Enterprises providing ICT training (% enterprises)
❿	ICT graduates (% graduates)
	Digital Public Service
❿	e-Government users (% internet users)
❿	Pre-filled forms (Score 0 to 100)
❿	Digital public services for citizens (Score 0 to 100)
❿	Digital public services for businesses (Score 0 to 100)
❿	Open data (% maximum score)
	Integration of Digital Technologies
❿	SMEs with at least a basic level of digital intensity (% SMEs)
❿	Electronic information sharing (% enterprises)
❿	Social media (% enterprises)
❿	Big data (% enterprises)
❿	Cloud (% enterprises)
❿	AI (% enterprises)
❿	ICT for environmental sustainability (% enterprises having medium/high intensity of green action through ICT)
❿	e-Invoices (% enterprises)
❿	SMEs selling online (% SMEs)
❿	e-Commerce turnover (% SME turnover)
❿	Selling online cross-border (% SMEs)
	Connectivity
❿	Overall fixed broadband take-up (% households)
❿	At least 100 Mbps fixed broadband take-up (% households)
❿	At least 1 Gbps take-up 1.3% (% households)
❿	Fast broadband (NGA) coverage (% households)
❿	Fixed Very High-Capacity Network (VHCN) coverage (% households)
❿	4G coverage (% populated areas)
❿	5G readiness (Assigned spectrum as a % of total harmonised 5G spectrum)
❿	5G coverage (% populated areas)
❿	Mobile broadband take-up (% individuals)
❿	Broadband price index (Score 0-100)

Source: The Digital Economy and Society Index (DESI) 202, Thematic Chapters