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Review

Influential Factors, Enablers, and Barriers to Adopting Smart Technology in Rural Regions: A Literature Review

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Abstract: Smart Technology is a quickly and constantly evolving concept; it has different applications that cover a wide range of areas, such as healthcare, education, business, agriculture, and manufacturing. An effective application of these technologies increases productivity and performance within complex systems. On one side, trends show a lack of appeal for rural environments as people prefer to move to cities, looking for better opportunities and lifestyles. On the other side, recent studies and reports show that the attractiveness of rural areas as places with opportunities is increasing. Sustainable solutions are needed to enhance development in the rural context, and technological innovation is expected to lead and support the stability for people and organizations in rural regions. While Smart City is progressively becoming a reality and a successful model for integrating Smart Technology into different aspects of everyday life, its effective application in a rural context according to a Sustainable Development approach is not yet completely defined. This study adopts comparative and categorial content analysis to address the different applications and the specific characteristics of rural regions, which often present significant peculiarities depending on the country and the context. The main goal is to investigate and discuss how the Smart City model may be adopted and effectively applied within rural contexts, looking at major gaps and challenges. Additionally, because of the complexity of the topic, we provide an overview of the current adoption of Smart Technology in the different applications in rural areas, including farming, education, business, healthcare, and governance. The study highlights the huge difficulties in rural life and the potentiality of Smart Technology to enhance their Sustainable Development, which is still challenging. While the holistic analysis clearly points out a gap, there is no specific strategic roadmap to re-use or adapt existing models, such as Smart City. The study does not address fine-grained indicators.

Keywords: smart technology; sustainable development; rural regions; smart city

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1. Introduction

There is no unique and universally accepted definition for Smart Technology. It is often understood as the capability to automatically adopt and modify the behavior of a given system to fit with the environment through sensing and analyzing the data to enhance performance [1]. Smart Technology relies on various services, devices, and ICT capabilities [2,3], as well as it supports different applications in a wide range of domains, such as healthcare, education, business, agriculture, and manufacturing [4–6]. In general terms, an effective application of these technologies increases productivity and performance within complex systems. Additionally, it is often associated with an increased quality of life as it contributes to better meeting human needs [7].

Rural regions can be defined as a region located outside the main urban area; they are normally characterized by limited capabilities and resources compared with cities [8]. Rural regions typically present low-density population and relatively high distance from large urban centers [9]. Because of their intrinsic characteristics, such regions present

several specific socio-economic issues, such as, for example, fewer job opportunities and a lower level of service [10]. Despite the development efforts, rural regions still continue facing many challenges [11,12]. Recent studies show a lack of appeal for rural environments as people prefer to move to cities, looking for better opportunities and lifestyle [13]. On the other side, recent studies show an increasing attractiveness of rural areas. Regardless of possible changes in the mainstream trend in the next future, there is currently an appreciable continuous and increasing focus on cities, which is causing additional pressure on the city's resources and infrastructures [14]. Another relevant factor to consider is the generic current digital gap existing between urban and rural regions [15].

Sustainable solutions are needed in order to enhance the development in the rural context and, indeed, technological innovation is expected to lead and support stability in rural regions for people and organizations in the near future [16]. However, while Smart City is progressively becoming a reality and a successful model for integrating Smart Technology into different aspects of everyday life [17], its effective application in a rural context according to a Sustainable Development approach is not yet completely defined. This lack of research means that implementation is even more complicated as the most specific and characterizing features, as well as the challenges of rural regions, are not always properly considered. These features may include socio-economic aspects, further environmental barriers, and government policies, among others [18].

Sustainable development is commonly defined as growth that satisfies the present wants without jeopardizing future generations' capabilities to meet their needs [19]. Sustainable development is currently a key concept when looking at rural regions [20,21]. Many studies suggest that technological innovation plays a critical role in enhancing sustainable rural development, especially in less developed countries [22,23]. Rural regions are expected to somehow adapt models from Smart Cities and convert them into successful strategic solutions [24]. According to United Nations, rural regions may be relevant in a context of global development (United Nations, 2022) and, therefore, specific policies are needed to reach a balance with urban areas to define a more integrated development strategy.

In this study, we address the specific characteristics of rural regions, which often present significant peculiarities depending on the country and context. The main goal is to investigate and discuss how Smart City models may be adapted and effectively applied within rural contexts, considering major gaps and challenges. Additionally, because of the complexity of the topic, we provide an overview of the current adoption of Smart Technology in the different domains in rural areas, including farming, education, business, healthcare, and governance.

As extensively discussed in the paper, this research shows a fundamental lack of studies that explicitly target the rural context. In this paper we identify and discuss the related body of knowledge by providing an overview of rural regions' characteristics and peculiarities. Such distinctive aspects are discussed in context considering the unique challenges for people living and organizations stability. The study implicitly assumes Smart City to be a successful model and, therefore, as a driving factor in defining mainstream to sustainable development. The focus is on influential factors, enablers, and barriers, which are critical to define and implement in strategic pathways.

Structure of the paper. The paper follows with a concise review of key background concepts (Section 2), and then, methodology and approach are briefly discussed in Section 3. The core part of the paper includes Section 4 and 5, which deal, respectively, with an overview of the adoption of Smart Technology within rural areas and the discussion of the main gaps and challenges.

2. Key Concepts and Background

This study explores the nexus of three main concepts: rural region, Sustainable Development, and Smart Technology. In this section, we separately discuss these topics to provide a more comprehensive understanding of the context of the study.

2.1. Rural Regions

The characteristics of rural regions may differ from one place to another, and, indeed, multiple definitions are currently adopted in the literature. For instance, a rural region can be defined as "a region that is located outside the main urban area, normally characterized by limited capabilities and resources if compared with cities" [8]. Alternatively, "a region that has low population density with an open landscape" [25] or "an isolated place from the urban city which makes access to public services not easy" [26].

Generally speaking, each country may have different criteria and indicators to identify rural regions [27]. For example, in the USA, India, and Australia, a rural region is defined by a population threshold: under 2500 people within 2 km for the USA, population under 5000 in India, and a population of 200–1000 people in Australia [28].

Rural regions are usually characterized by limited resources and infrastructure capacities [29], mostly because of their isolation from urban centers [30,31].

Rural regions are also known because of their limited economic and social influence [32,33]. Indeed, from a socio-economic perspective, the primary activities in rural areas are limited to specific sectors [34], such as forestry, agriculture, and livestock, and very rarely include advanced services [35,36]. This focus has a holistic effect on rural areas from a social point of view, defining a specific and relatively simple lifestyle that usually assumes are people living in small communities in scattered areas [37]. Last but not least, demographically, rural regions present a high percentage of older people, who normally appreciate that kind of lifestyle and usually have more traditional values [38]. That clearly contrasts the trends for younger people, who prefer to move to cities for education and better job opportunities [39].

Many empirical studies address rural areas, focusing on the main issues and challenges. These studies provide in-depth information and describe how recently rural areas became unattractive environments for many people, especially the youngest, and for most organizations. These trends defined an apparently unstoppable movement toward cities, looking for better opportunities and lifestyles [14,40]. In clear contrast, recent policies (e.g., Rural 3.0, a framework for rural development [41]) define rural regions as "places of opportunities", shifting the future prospects to a challenge/opportunity vision.

As said, rural regions may differ from one country to another as they present unique characteristics and peculiarities. The United Nations (UN) classifies countries on the base of their population and defines urban areas as places with a population of 5000 or more and a density of at least 400 persons per square kilometer [42–45]. Moreover, the UN adopts macro indicators to classify countries into three main categories depending on the level of development: more developed countries, less developed countries, and least developed countries [43]. Details are provided in Table 1.

Table 1. Country classification.

More Developed Countries	Less Developed Countries	Least Developed Countries
Europe, Northern America, Australia/New Zealand, and Japan [45].	Countries from Africa and Asia, Latin America and the Caribbean, plus Melanesia, Micronesia, and Polynesia [45].	Includes 46 countries located in sub-Saharan Africa (32), Northern Africa and Western Asia (2), Central and Southern Asia (4), Eastern and South-Eastern Asia (4), Latin America and the Caribbean (1), and Oceania (3) [45].

Table 2 provides a concise overview of rural areas' characteristics by examining the classification previously proposed.

Table 2. Overview of rural areas' characteristics.

Indicator	More Developed Countries	Less Developed Countries	Least Developed Countries
Geography and Demography	• High population density (over 78% of the land occupied by human settlements) [43]. • High rate of people moving to urban cities, especially old people who look for better healthcare services [46,47]. • Decreasing population in rural regions, due mostly to limited job opportunities that are usually confined by agriculture [48].	• Lower population density (50–78% of the land occupied by human settlements) [43]. • The migration rate is high due to limited resources [49].	• Limited population density (less than 50% of the land occupied by human settlements) [43]. • Rural regions are the most inhabited [50]
Economy	• Economy tends to be less diverse and includes specific business, such as agriculture and fishing, services and tourism [51]. • Economic growth is limited due to labor shortages [24,52]. • Rural regions usually receive less attention to enhance people's income [53]. • Economy is usually not subject to regulation or taxation, which makes it difficult to develop formal economic sectors [54].#	• Agriculture and handicrafts as the primary source of income [55,56]. • Self-sufficient resources [57]. • Economic activities usually limited due to less developed infrastructure and transportation networks [58]. • Low financial incentivization makes it difficult to develop startups [59].	• A mix of traditional livelihoods, such as agriculture, tourism, and handicrafts [60]. • The lack of facilities and technology is a challenge for rural economic growth [61]. • Infrastructure and services are very limited, which discourages business and investment [62].
Social and Cultural	• Gender roles play an important role in assigning jobs. • People move to urban cities looking for better living standards [63]. • Cultural and ethnic diversity [64]. • Limited access to education, healthcare, and internet services [65].	• Local rural communities have different traditions and values [66]. • Limited income, access to education, healthcare, and modern technology [67]. • Gender roles still less developed [68,69].	• Strong social ties based on family [70]. • Limited income [10,71]. • Limited access to education and healthcare, raising poverty level [72,73].

The analysis of the main characteristics of rural regions intrinsically shape the three pillars of sustainable development (social-cultural, economic, environmental) as defined by the United Nations [74].

2.1.1. Healthcare

Rural regions usually present a limited healthcare infrastructure, including healthcare centers, hospitals, and specialized practitioners [75]. This is a key issue that significantly affects residents who frequently travel long distances for healthcare purpose [76]. This becomes especially critical as rural areas have a higher proportion of aged people who are less likely to follow typical recommendations in terms of prevention [31,77].

2.1.2. Education

The education system presents specific issues that are less likely to affect urban areas and, therefore, present additional challenges [78,79]. In general terms, there is a lack of

specific funding and attention by governments [80–82]. Additionally, as for healthcare, distances may be relevant, and related costs may be significant in the context of the local economy. Furthermore, assuring high-quality educators in rural areas is becoming more and more challenging because of the previously mentioned lack of appeal and resources [83].

2.1.3. Economy

Several factors contribute to generating economic pressure and depression in rural areas, such as the migration of skilled people and young workers and the generally underdeveloped job market, especially in industry and services [84,85]. Agricultural activities are the most significant resource as they do not require specific skills. Such activities typically do not offer high salaries [86,87]. In general, economic growth for individuals, families and organizations is much less likely than in urban areas [88].

2.1.4. Lifestyle and Social Environment

Many factors characterize life in rural settings. For instance, there is some limitation in terms of technology adoption [89], and working conditions may be difficult, if not extreme, especially in developing countries [90,91]. The digital gap between urban and rural regions is affecting the stability of individuals and organizations [92,93]. Indeed, most developed areas are increasingly benefiting from the exploitation of technology in industries [15], while rural regions are not following the same pattern [94,95]. Business experience, knowledge, high qualifications, and technology skills usually are not available within rural regions [96]. Gaining competitiveness is a major need and challenge [97]. Last but not least, the negative stereotype about living in rural areas does not positively contribute to the situation [98], nor do local economic trends, such as the decreasing level of income and job opportunities [15,99].

2.2. Sustainable Development

Sustainable Development refers to "growth that satisfies the present wants without jeopardizing future generations' capabilities to meet their needs" [19,100]. In general terms, Sustainable Development is a global challenge that, by definition, involves all countries, regardless of their current development [101]. According to United Nations, Sustainable Development aims to achieve different goals (Sustainable Development Goals, SDGs): contrast/eradicate poverty and hunger, increase well-being and healthcare, establish high-quality education and gender equality, provide clean and affordable energy, promote economic growth, innovation, and industry infrastructure, establish sustainable communities and cities, promote equality, responsible production and consumption, climate change policies, quality of life, justice, and collaboration [102].

Looking at the agenda and related goal [100], goals 8 ("Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all") and 12 (Ensure sustainable consumption and production patterns) present a clear association with rural areas.

Sustainable Development can benefit individuals and society, as well as organizations, by optimizing resources and capabilities for current and future generations; it becomes a critical driver for less developed countries [103–105] to increase performance and productivity [106]. Many countries are showing progress in attaining sustainable goals by defining strategic plans to achieve the general goals in the next future [107]. Most efforts in that direction usually involve cities rather than rural regions, especially in developing countries [108]. The intersection between Sustainable Development in the specific context of rural regions' is an object of research interest [109]. It can ensure sustainable growth in different sectors, such as agriculture, education, and energy [110].

As previously mentioned, rural regions are characterized by limited capabilities. Recent studies discuss the potentiality of Sustainable Development to attain a growth based

on sustainable principles, such as conservation/preservation, long term, equity, partnerships enhancement, charge capacities respect [111,112].

Sustainable Development is also expected to improve business viability and increase economic efficiency [113]; it is becoming more relevant for both high-populated regions and large rural lands [114]. Sustainable Development is also considered to be a major player in community development [115,116], especially for those communities that have more limited resources and capabilities [34].

Sustainable development is, therefore, seen as a strategic solution to address major challenges, such as poverty, literacy, and unemployment [117]. In this context, many studies predict a major development for rural regions in the next future [118]. These developments should somehow reduce the gap with urban areas to enable the viability and sustainability of rural communities [119].

Sustainable Development largely relies on technology [120,121], as many recent studies demonstrate in different contexts [122,123]. That is similar to urban areas where an effective application of technology contributes to a better education, healthcare, and manufacturing [124–126].

2.3. Smart Technology

Smart Technology provides "the capability to automatically adopt and modify the behaviour of a given system to fit with the environment through sensing and analysing the data to enhance the performance" [1]. In practice, it refers to applications that interact with humans to achieve their goals [127]. Typically, it results from adopting multiple technologies (Artificial Intelligence, Internet of Things, Big Data, and Cloud Services) and networked artifacts connected to the Web [16].

Technology plays a more and more relevant role in our digitalized life [128]. Smart Technology exploits the interaction between humans and technology and is being employed to solve many everyday life problems in different sectors, such as energy [129]. Furthermore, it can be used to improve the performance and the efficiency of many systems [130], for instance providing a competitive advantage for firms [131]. Recent advances are leading to a generic increase in performance for business operations, as well as a reduction in time, labor requirements, and expenses [132].

The following subsections briefly discuss the primary technologies that enable smart systems and their applications [133].

2.3.1. Internet of Things (IoT)

Internet of Things (IoT) refers to devices that operate independently to perform relevant tasks [134]. Typical examples are the dynamic regulation of heating or surveillance and alarm systems [134]. IoT assumes embedded computation capabilities within devices that can communicate autonomously with other devices and systems according to a Machine-to-Machine (M2M) model [135]. Additionally, the IoT paradigm may assume interaction with humans [136]. IoT technology has gained enormous popularity and is becoming a core component for a wide range of applications in several domains, including industry, agriculture, and entertainment, among others [134,137]. Recent advances in IoT ecosystems impact many aspects of modern industry by increasing the performance of typical systems, such as supply chains, asset tracking, and machine operations [138].

IoT is also expected to play a role in Sustainable Development, specifically in the energy and health sectors, and more generally, by enabling more sustainable environments for people and organizations [139–141]. This also applies to rural regions [142].

2.3.2. Artificial Intelligence (AI)

AI is inspired by human intelligence to perform complex tasks that require substantial computational capabilities [143]. AI is becoming increasingly sophisticated [144] to address rising issues, including healthcare, transportation, and manufacturing, among

others. Its capability and consequent application to solving real-world problems are expected to further increase [145,146]. For instance, its integration with robotic technology produces a new generation of services based on drones and fully autonomous vehicles [147]. Of course the potentiality of AI is also contributing to achieving large-scale global sustainability goals [148,149]. Holistically, it contributes to defining new sustainability models according to the United Nations vision for Sustainable Development [148,150,151], and it has a clear impact on rural regions, especially in developing countries [152].

2.3.3. Cloud Computing

Cloud Computing is the ability to remotely access data and computation capabilities hosted or provided by third-party systems [153]. This has led to the progressive affirmation of Software-as-a-Service (SaaS) and on-demand computation [154]. The resulting pervasive system is commonly called the 'cloud' [155]. Overall, Cloud Computing uses high-speed connections to provide high computing capabilities and sophisticated scalable storage systems [156].

In general terms, Cloud Computing may support sustainable solutions [157] in several ways, such as providing centralized data storage services that may result in total cost savings by sharing resources and reducing energy consumption [158,159]. Cloud-based solutions also provide a competitive advantage by providing access to data and services remotely and adding more flexibility to systems [160,161].

2.3.4. Big Data

Big Data is defined as a large amount of data that overcomes the capability of a single database; it is usually complex [162] and difficult to process through traditional methods [163]; it implies the need for advanced storage systems and huge computation capabilities and analytics [164]. Big Data may result from web activity and content [165,166] and is commonly associated with five key characteristics: Volume, Speed, Variety, Variability, and Value [167]. Big Data plays an important role in better understanding people and related social trends, as well as organizations and their businesses. Such value can be converted into innovative, sustainable solutions [168–171]. The United Nations has emphasized the role of Big Data in building a sustainable future by considering different aspects, such as energy, economics, and education [172], as well as healthcare [173].

3. Methodology and Approach

This review has been conducted by adopting categorical content analysis [174] to identify and discuss the body of knowledge related to the complex nexus of Smart Technology, rural regions and Sustainable Development. The method considers different attributes, such as publication type, research field and adopted methodology. This study has been conducted by looking at the most recent contributions to the literature, from 2012 to 2022. Papers have been retrieved from popular scientific databases, such as MDPI (Basel, Switzerland), Taylor and Francis (New York, NY, USA), Google Scholar, IEEExplore, Scopus, Springer link, Wiley Library, and ACM (New York, NY, USA).

We used a combination of keywords related to the background concepts to identify the topic as follows:

- *Smart Technology* (Internet of Things, Artificial Intelligence, Big Data, Cloud Computing)
- *Smart City* (Urban Area, Smart City Model, Open Data, Urban Planning)
- *Sustainable Development* (Sustainability, Green Technology, Environment, Natural Resources)
- *Rural Regions* (Remote Area, Rural Development, Rural Migration, Tiny Community, Farming, Open Landscape)

Finally, 83 contributions were selected out of the 234 retrieved. Selection was based on the studies' relevance to the objectives and on the direct/indirect focus on rural regions. This selection also reflects on the contribution that Smart Technology adoption has contributed to the field, although the relationship to rural areas is not always explicit. Only peer-reviewed papers written in English were considered. As the topic is very broad, the analysis in this paper has been organized according to an application perspective to further increase conceptualization and conciseness.

4. Smart Technology: From Cities to Rural Areas

The main purpose of this section is to address (i) the relationship between Smart City and Rural Areas and (ii) to discuss the application domains, specifically in Rural Areas, by considering a development driven by Smart Technology. Those goals are the object of the following sub-sections.

4.1. From Smart City to Rural Areas

Smart City is commonly defined as an integration of Smart Technology with city elements (people, information, and other technology) to promote sustainable development practices that address the urbanization growth challenges [175,176]. According to this approach, people, information, and technology must be integrated to define a smart ecosystem that enhances quality of life [177–179]. Initially, Smart City was oriented to sustainable urban development with the goal of integrating and optimizing the use of resources [180]. More recently, the Smart City model has been applied more broadly to improve different aspects of life [181].

The Smart City approach has been widely accepted as a successful model for Smart Technology adoption. This model is often considered a reference to be adapted to address different challenges [182]. It is probably the case for rural regions that need to enhance their sustainability and foster development [183]. Therefore, there is a potential for the Smart City model to be adapted in rural regions to address major sustainable development challenges [183–186].

As far as the authors know, there is no application-oriented model that explicitly targets rural regions. Although applications may be considered the same as for Smart City (e.g., [187]), the Smart City model cannot be directly applied to rural regions due to the significant differences and peculiarities. Hence, existing solutions are expected to be adapted and customized to face sustainability challenges, improve quality of life, foster the economy, support social welfare, and enhance the stability in rural communities for people and organizations [185,188–190].

The United Nations reports that over 45% of the world's population still resides in rural areas, so rural development remains a compelling challenge as many macro indicators points out low performance in rural development. For instance, it is estimated that the 80% of the world's poverty comes from the population who live in the rural regions [191]. Additionally, the United Nations explicitly addressed concerning trends looking at the main pillars [74].

4.2. Rural Areas: Application Domains

This section provides an overview of typical applications of Smart Technology in the context of rural region as presented in the literature. As there is not a systematic way to measure the relevance of the different applications in context, the focus is on applications that have been explicit objects of study in recent years.

The target country and the publication year are attributes of interest, as well as the focus on rural regions, which can be explicit or indirect. For each selected contribution, the method adopted in the original study is reported (acronyms are in Abbreviations).

4.2.1. Smart Farming

Smart Farming can be defined as an integration of Smart Technology with agricultural equipment to manage and automate farming activities [192]. Studies on the topic are reported in Table 3. The recent development of Smart Technology has made considerable changes to traditional farm activities, which are usually time and effort intensive [193].

Smart Farming aims to mitigate human intervention by automating the agricultural processes [194]. The significance of Smart Farming has recently increased due to its important role in addressing the global challenges of sustainable food supply [195]. These challenges result from the increased global population and food prices caused by a decreasing number of workers in traditional farms [196].

The applications of Smart Farming can contribute to enhancing sustainable development [197–199]. Smart Farming can provide numerous advantages to the agricultural industry, including increased crop yield, time and labor savings, reduced costs, and improved crop quality and quantity [200–204]. In general terms, adopting Smart Farming can offer unique benefits in rural regions by promoting a sustainable development approach [205]. In this context, Smart Technology in rural agriculture can perform multiple tasks automatically instead of using traditional approaches, which are time and energy intensive [206–208].

Smart Farming impacts different tasks, such as irrigation, fertilization, temperature control, and harvesting [201,209–212]. Moreover, Smart Farming can involve cattle activities by monitoring the nutrition process and health status of the entire herd [213]. In addition, it has the potential to improve e-commerce in a rural context by exploring new markets and enhancing the ability to connect with potential buyers, monitor market patterns, receive real-time pricing data, and gain deeper insights into consumer preferences, enabling the farmers to customize their products accordingly [214–218].

Table 3. Studies on Smart Farming.

Ref.	Country/Year	Contribution	Domain Smart City (SC)/Rural Areas (RA)	Method
[219]	Africa 2012	The influential factors of SF adoption are labor training, assets, economic aspect, awareness, and knowledge.	RA	DA
[220]	Malaysia 2013	Lack of knowledge and educational background are influential factors in ST by farmers.	SC	SI
[201]	India 2018	Application of IoT technology in farming to reduce the cost and increase the quantity of crop	SC	CS
[221]	Brazil 2019	Major factors for SF adoption are educational background, social barriers, and economic aspects.	SC	DA
[222]	Germany 2019	Educational background is an essential factor in SF adoption.	SC	I
[223]	South Africa 2021	Exploring SF applications, benefits and challenges.	SC	LR
[224]	Europe 2021	Technical incentives, financial support, and local and public authorities are factors can impact the adoption of Smart Technology.	RA	Q
[225]	Kuwait 2023	Explanation of how ST improves the productivity of farming with a minimum cost.	SC	LR

As urbanization continues, more people move from rural areas to urban cities in search for better employment opportunities. This trend causes a decrease in the number of farmers [226]. That is likely to happen in more developed countries, where cities are the preferred places for majority of people.

It also causes a decline in the number of farms and a reduction in the amount of land being used for agriculture, which might be converted to non-agricultural uses. The consequences of this action could be reflected in increases in food prices and additional challenges for supply chains [227].

4.2.2. Smart Healthcare

Smart Healthcare is defined as a process of integrating Smart Technology within healthcare to improve the efficiency and quality of services, including better medical solutions and the development of proactive steps, through patient data analysis [228]. A summary of the papers on the topic is reported in Table 4.

Smart Healthcare usually relies on cutting-edge technology [229–232]. The role of this type of technology is oriented to supporting treatment, such as improving the interaction between patients and doctors, monitoring and forecasting the patient's condition, illness prevention and diagnosis, medical decision-making, and minimization of human mistakes in complex operations [229,233–236].

Smart Healthcare is also expected to play a significant role in creating more sustainable systems by improving access to services (telehealth), optimizing healthcare resources and their efficiency, and promoting preventive healthcare [237–239].

There is concrete evidence of effectiveness documented in the literature for opportunities like smart wearable devices [83,191–193] and Cloud solutions for data storage [240,241]. Big Data and AI are advancing the capability of diagnosis and interpretation and, more holistically, to medical research development [242]. Moreover, recent studies show the contribution of AI and Robotics in critical surgery operations [243–245].

The Smart Healthcare model could play a key role in addressing and bridging the gap with cities, given the historical shortage of qualified structures and services [23,246–248]. For example, a solid implementation of remote and more integrated services defines an explicit mainstream for development [249]. Smart Technology can facilitate remote access to patients' data, especially for older people who require periodic check-ups [250,251]. Additionally, it can contribute to healthcare by predicting health developments so that more proactive solutions can be devised [252,253].

Table 4. Studies on Smart Healthcare.

Ref.	Country/Year	Contribution	Domain Smart City (SC)/Rural Areas (RA)	Method
[254]	New Zealand 2013	Challenges of ST integration in the medical operations.	SC	CSY
[255]	Australia 2017	Explore the weaknesses and strengths of ST in healthcare.	SC	S
[256]	Jordan 2019	Role of Cloud Computing in enhancing mobile health services.	SC	CSY
[257]	Italy 2019	Technology acceptance and ease of use are the main challenges for smart healthcare adoption.	SC	S
[258]	India 2019	Internet of Things in patient treatment	SC	ER
[231]	Pakistan 2020	Privacy and security issues are the main challenges for Smart Healthcare adoption.	SC	S
[259]	Israel 2020	Funding and experience are major factors for Smart Healthcare adoption.	SC	R
[260]	Jordan 2021	Exploring the role of ST in the healthcare	SC	R

As people move from rural regions to urban cities in increasing numbers, rural regions are experiencing a further crisis in terms of healthcare facilities, providers, and resources [261]. This is consolidating gaps, especially in more and less developed countries. It reflects a more general focus on populated areas and a consequent lack of attention to rural regions. On the other side, in the least developed countries, rural regions usually receive healthcare services that are comparable to those offered in urban areas [262,263].

4.2.3. Smart Energy

Smart Energy can be defined as the ability to adopt Smart Technology to optimize energy production, distribution, and consumption to create more sustainable and reliable energy systems for both the consumer and the environment [264]. A summary of studies in the field is reported in Table 5. The Smart Energy approach assumes the integration of Smart Technology with the energy system and aims to provide sustainable energy production and consumption at the lowest costs [265,266].

Smart Technology in the energy sector has recently expanded to reduce the construction of power stations that normally cause an increase in pollution [267].

The application of Smart Energy is gradually becoming part of our daily life. For instance, smart meters can dynamically optimize energy consumption [268,269]; electrical appliances can avoid peak hours to reduce costs [270]; outdoor lights can be controlled automatically to adapt to actual needs [271].

Moreover, with the recent increase in global demand, Smart Technology is expected to contribute to sustainable energy systems [272], which should be efficient, affordable, and aligned with environmental challenges [273]. Smart Energy Systems are expected to push the diversification of energy production toward an optimized use of renewable energy systems [274–277] and contribute to a decrease in the number of power stations [278].

From a rural region perspective, the application of Smart Energy is expected to enhance sustainability to provide systems that are clean, reliable, and affordable. Large and open areas normally characterize the ability of rural regions to generate clean energy in a way that is friendly to the environment at a lower cost [279–281]. Solar and wind energy systems are potential applications for Smart Energy to supply rural communities that use smart inverters to optimize energy production [282–285].

The characteristics of rural regions make them suitable for generating renewable energy: firstly, they have a surplus of open spaces, which is often necessary for renewable energy resources. Secondly, there is less obstruction for the sun and wind, allowing for better performance. Thirdly, rural regions have lower population densities than urban areas, meaning fewer concerns about disrupting habitats exist. Fourthly, lower electricity demand makes it easier to meet the local energy needs with renewable technologies [286].

Another example is a smart microgrid, which is a small, self-contained energy system that can operate independently to easily provide minor communities with energy supply. Its primary focus is to provide reliable and sustainable energy access to isolated areas [287,288].

Table 5. Studies on Smart Energy.

Ref.	Country/Year	Contribution	Domain Smart City (SC)/Rural Areas (RA)	Method
[289]	USA 2016	Lack of knowledge and high cost are the main challenges to Smart Energy adoption.	SC	S
[290]	UAE 2018	Lack of knowledge, awareness, and regulationsand high cost are the main barriers to Smart Energy adoption	SC	R
[291]	USA 2018	Role of artificial intelligence in enhancing sustainable operating systems of Smart Energy	SC	S

[292]	Indonesia 2019	Role of IoT to automate operations in the smart energy systems.	SC	ER
[293]	Italy 2020	Individual knowledge, behavior, and resistance to change are main influential factors in Smart Energy adoption	SC	Q
[294]	Turkey 2022	Experiences, cost, political drivers, lack of knowledge, and regulations are the main barriers to Smart Energy implementation.	SC	DA
[295]	Spain 2022	Integrating legacy energy systems with a Smart Energy approach is the main influential factor	RA	R

The migration trends still play a key role as, in general terms, cities are becoming larger and more dense with an intrinsic additional pressure on the urban energy networks. This is particularly evident in both more and less developed countries that are characterized by highly densely populated cities [296]. On the other side, the decreasing population in rural regions might cause difficulties for energy supply over scattered areas and cause rising costs.

This scenario is different in the least developed countries, where rural regions are highly populated, and people live in big communities that are concentrated in a few places. Moreover, rural regions in the least developed countries can have more options for energy supplies, such as the common energy network, renewable energy, and traditional sources [297].

4.2.4. Smart Education

Smart Education can be defined as the ability to adopt Smart Technology in the education system to enhance effective, suitable, and sustainable learning approaches through innovative methods for more efficient outcomes [298]. Studies are reported in Table 6. It focuses on integrating smart learning technology into the education system [299–302]. It can provide an accessible and lifelong learning system with contemporary lifestyles [303–307]. Smart Technology can generate, store, analyze, and visualize massive data from a given domain to provide the best learning content [308,309].

Smart Education is usually characterized by an innovative environment that integrates Smart Technology in its infrastructure to provide interaction in real-time to the learners [310,311]. It also known as a self-directed and self-motivated system that is often enriched by resources that can provide learners with many advantages, such as connection, openness, and independence [312].

Smart Education is an appealing system compared to traditional education because of the novelty in teaching styles. Smart Education usually includes unique learning methods, such as gamification, interactive and collaborative groups, tactile-auditory presentation, and simulations [313,314].

Smart Education systems are expected to contribute to sustainable education systems that should be more efficient and accessible, and providing contemporary teachers with a more sustainable teaching lifestyle and allow for learners to gain the necessary knowledge and skills [315–319].

From a rural region perspective, the application of Smart Education is expected to enhance sustainability to provide accessible, comfortable, and sustainable learning systems that can address the challenges of disparity with urban areas. This is especially true for students with limited access to educational resources or constraints to move rural [320,321].

From a practical perspective, Smart Education can provide an accessible and comfortable way of learning through content and resources accessed via e-portfolio platforms that can be connected to remotely with common devices [309,322–328], enhancing remote activity [309,329–331]. For instance, augmented reality technology (AR) has a specific

potential impact on rural education settings by enhancing actual practices and avoiding expensive travel [332–336].

Table 6. Studies on Smart Education.

Ref.	Country/Year	Contribution	Domain Smart City (SC)/Rural Areas (RA)	Method
[299]	Malaysia 2016	Enablers for Smart Education are group collaboration, smart classrooms, and advanced technology.	SC	CSY
[337]	UK 2016	Role of Smart Technology in managing students and controlling the learning system	SC	QR
[338]	Japan 2017	Role of Smart Technology applications to improve learning efficiency in the education sector.	SC	ES
[339]	India 2018	Artificial intelligence and Cloud Computing are main enabler in E- learning systems.	SC	CS
[340]	USA 2018	Cost, organizational culture, resistance to change, and strategy are barriers of Smart Education	SC	SI
[341]	Vietnam 2019	Strategy, implementation cost, and privacy and security are the main barriers to smart Education adoption.	SC	R
[342]	France 2019	Role of IoT technology in the education sector to enhance the efficiency of teaching and learning.	SC	R
[343]	USA 2020	Required resources, cultural shifts, inclusiveness, and effort are the main barriers to Smart Education adoption.	SC	S
[344]	Korea 2020	Cultural background and social barriers are the main influential factors for Smart Education adoption	SC	DA
[345]	Zambia 2021	Internet access, lack of skills, and lack of infrastructure are the main disablers factors for Smart Education adoption	SC	QI

Education is essential for human life. In both more and less developed countries, most educational resources and infrastructures are in cities [346], while there is a tangible gap with rural areas. The most influential factor in more and less developed countries is the drain of qualified educators to urban areas [347]. In the least developed countries, there is a much less tangible gap as the few resources are normally available in rural regions [80], where the quality of education is comparable to that available in cities [348].

4.2.5. Smart Government

There is no unique and universally accepted definition for Smart Government, as it is still a relatively new and emerging domain. Still, it is often understood as adopting Smart Technology and innovative solutions to enhance the efficiency of government services, performance, and responsiveness [349]. Table 7 provides an overview of studies in the field. Smart Government has also been defined as a set of information technology applications that target public people and organizations to connect, analyze and process a huge volume of data and deliver services in real-time [350].

The Smart Government approach focuses on integrating new, emerging technology into its systems to improve government services and make them more efficient, effective, and sustainable [351]. Smart Government aims to find innovative solutions that allow for easier methods of connecting with the public that are increasingly responsive in the shortest time possible [352–354]. By utilizing Smart Technology, Smart Government can understand the different needs of people and organizations through the analysis of vast volumes

of data from their transactions [355]. This can increase the efficiency of transparency of services and help create policies that are relevant to real-life situations [356,357].

Smart Government is expected to contribute to sustainable development by ensuring the minimum level of quality of life through leverage of Smart Technology to create programs, policies, and services that promote sustainable practices. These practices can become a sociotechnical approach to sustainably address the gap challenges between government and other stakeholders [358–360].

From the rural region perspective, the application of Smart Technology is expected to enhance sustainability by leveraging Smart Technology and innovative solutions to address the connection challenges between rural areas and the government. Therefore, the adoption of Smart Government has a potential impact on rural regions through enhanced online services that may encourage development. Moreover, Smart Government is expected provide accessible ways for rural residents to engage with government decisions making [351,361–363]. Rural people can then challenge to the government to provide better solutions that look to improve the quality of life and increase the prosperity of their regions [364,365].

Table 7. Studies on Smart Government.

Ref.	Country/Year	Contribution	Domain Smart City (SC)/Rural Areas (RA)	Method
[366]	Italy 2014	The political regulations and institutional policies are the main barriers for Smart Government adoption.	SC	BA
[357]	Austria 2018	Digital infrastructure is the main enabler for smart government adoption.	SC	DA
[367]	Switzerland 2018	IT infrastructure, awareness, strategy and leadership are influential factors for Smart Government adoption.	SC	I
[351]	New Zealand 2019	Role of IoT and AI technology in providing high-quality services for citizens, business companies, and organizations.	SC	CS
[351]	Singapore 2019	Data privacy and security, system maintenance, and system scalability are challenges to Smart Government.	SC	CS
[350]	Switzerland 2019	Smart Government barriers include lack of legal foundations, policy, technical infrastructure, innovation, and cost-benefit considerations.	SC	I
[368]	USA 2019	Legislation, cybersecurity, and difficulty in big data analysis are the major challenges for Smart Government solutions.	SC	CS
[369]	Germany 2019	Role of IoT technology in creating significant value to enhance public services.	SC	AS
[370]	Pakistan 2020	Role of IoT technology in improving e-government services to be more responsive and transparent.	SC	QR
[371]	Estonia 2020	Smart mobile applications are the main enabler in the transition phase to Smart Government	SC	CS

Considering the current level of urbanization, in both more and less developed countries, governments can manage and provide services to their citizens in a relatively easy way in major cities [372]. Rural regions require a smart approach to receive a comparable level of service [373]. Again, in the least developed countries, the gap between urban and rural areas is much less evident [374].

4.2.6. Smart SMEs

Small and Medium Enterprises (SMEs) are classified based on business capacity and number of employees [375]. Smart SME can be defined as the approach of a SME business to adopt Smart Technology into its business strategy to optimize the daily business operations, services, and production [376]. A list of studies on the topic is reported in Table 8.

Smart SMEs focus on integrating Smart Technology into business systems to increase the efficiency of business performance [377–379]. This process can improve decision-making that is based on data analytics and help improve weakness of the business and anticipate coming risks [380–383].

The Smart SMEs approach could bring many benefits to traditional business. Smart Technology might address business challenges and optimize business performance, such as cost reduction. It could enhance the quality of services and products and better understand customer needs [384,385].

SMEs are shaping most segments of the global business sector and have a significant impact that directly influences the gross domestic product (GDP). This is particularly true in developing and less developed countries, according to the World Bank [224]. Therefore, the significance of SMEs is growing due to their role as major job creators that require low capital to start the businesses [386]

Smart SMEs are expected to contribute to business sustainability to remain competitive in the market, ensure long-term economic growth, and support national economic growth that can improve the society's social welfare. Moreover, Smart SMEs can efficiently improve resources to maximize production with minimal waste [387,388].

From the rural region perspective, the application of Smart SMEs is expected to enhance business sustainability and economic growth for rural communities [389,390]. For instance, rural SMEs can adopt Smart Technology, such as Cloud Computing, to overcome the unaffordable costs of buying new business software, especially those with limited IT capability [98,391]. Moreover, Smart Technology can help rural SMEs manage their business resources effectively to automate different activities that require more workers. Smart SMEs can also provide stable job opportunities for skilled people and educated people that cause them to remain in rural areas rather than moving away [392–394].

Table 8. Studies on Smart SMEs.

Ref.	Country/Year	Contribution	Domain Smart City (SC)/Rural Areas (RA)	Method
[395]	Kenya 2013	Financial support is the main barrier to Smart SME adoption.	SC	S
[396]	Malaysia 2017	Knowledge and IT infrastructure are the main enablers for Smart SME adoption.	SC	R
[397]	India 2018	Funding, social resistance, and IT infrastructure are the main barriers to Smart SME adoption.	SC	I
[398]	Japan 2019	External pressure and high costs are the main challenges for Smart SME adoption.	SC	S
[399]	Romania 2021	Financial support and skills are influential factors for Smart SME adoption.	SC	Q
[400]	Greece 2021	Managerial support and strategy are the main challenges for Smart SME adoption.	SC	S
[401]	Singapore 2022	Funding, knowledge, skills, and human resources are the main enablers factors for Smart SME adoption.	SC	CS
[402]	Lithuania 2022	Organizational policies, knowledge and digital readiness are the determinants of Smart SME adoption.	SC	SLR

In urban and rural areas, SME presents an intrinsic and significant gap [403]. This is very evident in both more and less developed countries, where SME performance and probability of success in major cities clearly overcomes that in a rural context. This occurs because SMEs can become more competitive in highly populated areas due to larger markets and number of potential customers, the ability to produce goods and services at lower costs, the availability of labor, and the infrastructure required to operate efficiently. SMEs are not likely to have the same opportunities in rural regions [404].

Because of the different characteristics of rural regions, SME businesses might find relatively more favorable conditions in this context in least developed countries [99,405].

4.2.7. Smart Manufacturing

Smart Manufacturing adopts Smart Technology to optimize manufacturing processes and, accordingly, increase efficiency [406]. Identified studies in the field are in Table 9. Smart Manufacturing integrates the different resources to enable connection and collaboration, which results in increased productivity at a lower cost [407,408]. The Smart Manufacturing approach focuses on managing multi-manufacturing activities within the manufacturing ecosystem [409,410], which aims to automate operations, reduce costs, and increase productivity [411–414].

In general terms, Smart Manufacturing fosters a Sustainable Development approach by improving efficiency and driving product innovation [415]. That is relevant in rural regions where a smart approach is expected to contribute to innovative solutions that can overcome current challenges, such as the lack of skilled workers [416,417]. By enhancing industries' performance in rural regions, Smart Manufacturing contributes to enhancing resilience and adaptivity to gain a competitive advantage [418,419].

Additionally, a tangible impact is expected on employment, given the current critical difficulty in attracting people. Smart Technology can play a significant role in automating processes that require or involve a large number of workers [420–422]. Similarly, Smart Manufacturing can holistically improve the socio-economic condition of communities by creating job opportunities for educated people in a more attractive context. It has a direct effect on improving stability and driving economic growth.

Finally, Smart Manufacturing can provide training opportunities for rural residents who graduate from universities or schools and seek training opportunities in the local community [423,424].

Table 9. Studies on Smart Manufacturing.

Ref.	Country/Year	Contribution	Domain Smart City (SC)/Rural Areas (RA)	Method
[408]	Germany 2015	Role of Smart Technology in increasing production in manufacturing industries.	SC	DA
[411]	Germany 2016	Role of Smart Technology in improving competitiveness and sustainable development.	SC	DA
[409]	China 2018	Role of Big Data in enhancing manufacturing production.	SC	CS
[425]	USA 2019	Resource integration, IT skills, regulations, and training are the main enablers for Smart Manufacturing.	SC	LR
[406]	Germany 2020	Artificial Intelligence and Big Data are enablers for Smart Manufacturing.	SC	DA
[424]	USA 2022	Technological awareness, funding, and IT infrastructure are the main challenges for Smart Manufacturing.	SC	SR

In general terms, high population density is favorable to manufacturing [426], and the shortage in the labor market may negatively affect a business, particularly in more developed countries. Smart Manufacturing has an opportunity to become determinant in the rural regions of the least developed countries, where population density is high and labor resources are usually available [427]. Smart Manufacturing solutions are expected to be designed as a function of the population density and other available resources [428].

4.2.8. Smart Living

Smart Living is a generic concept that refers to the application of Smart Technology to improving lifestyle so that it is more convenient, efficient, and sustainable [429]. A summary of contributions on the topic is reported in Table 10. In general terms, Smart Living plays an important role in enhancing sustainable development [430]. It leverages technology for most life aspects to improve the quality of life and sustainability for social communities to make daily life more efficient and more accessible [431,432].

Because of its broad purpose, Smart Living includes different sub-categories/applications, which are briefly discussed in this section.

Smart Homes refers to the application of Smart Technology to domestic environments to better address people's needs [433,434]. For instance, it can involve lighting, heating, and ventilation, as well as energy and security management; automation and remote control are also typical functions [435]. These applications allow residents to control various appliances and devices in their home via smartphones or voice commands. For instance, doors are automatically unlocked using facial recognition, lights are managed through presence sensors, temperature is automatically adjusted to a comfortable level, etc. [436,437].

Smart Waste Management is the corresponding Smart Technology adoption to foster a sustainable approach in this area [438]. Smart Waste Management is a key and central concept for public health, people's well-being, and the environment [439]. An example of Smart Waste Management applications include Smart Bins [440], which can optimize overhead costs. For instance, trucks can collect bins where the waste level is over 80%, and they can be directed via GPS to reach their destination using the shortest possible route to reduce consumption and costs [441].

Smart Safety Systems address general safety issues by incorporating sensor data and data analysis into safety operations to deal with and anticipate threats [442]. The most intuitive example is a smart approach to surveillance [443–445]. Smart Climate and Environment System refers to an advanced use of technology to address the challenges of climate change and environmental degradation by enhancing sustainable development for a livable future [446,447]. In the last decade, climate change and environmental degradation have hugely impacted agriculture, landscape, and natural resources [448,449]. Smart Technology has therefore gained more and more relevance to face sustainability challenges [432], for instance, given the enhanced capabilities in terms of monitoring and analysis [447,450].

Smart Living is evidently a critical concept also in the rural context, where it is expected to play a significant role in enhancing sustainable development and improving the people's quality of life [18,190,451,452].

Table 10. Studies on Smart Living.

Ref.	Country/Year	Contribution	Domain Smart City (SC)/Rural Areas (RA)	Method
[453]	China 2011	Role of Cloud Computing platform in adopting Smart Homes.	SC	ES
[454]	Sweden 2012	Role of IoT in Smart Environmental and Climate Systems.	SC	I
[455]	UK 2013	Security, awareness, and cost are main barriers for Smart Home adoption.	SC	I

[456]	UK 2013	Automation, integration, reliability, cost and security are the main influential factors for Smart Home.	SC	I
[457]	The Netherland 2014	ICT infrastructure, knowledge, and cost are the main challenges for Smart Homes.	SC	I
[458]	USA 2014	Safety and security policies are the main challenges to Smart Safety System.	SC	ES
[459]	India 2015	ICT infrastructure and funding are the main enablers of Smart Homes.	RA	DA
[460]	England 2015	Complexity, funding, and knowledge are the main influential factors for Smart Home.	SC	SR
[461]	India 2016	Role of IoT and data analytics to adopt Smart Safety Systems.	RA	DA
[462]	USA 2016	Reliability and funding are the main influential factors for Smart Safety Systems.	SC	I
[463]	Norway 2016	Legacy systems and ICT infrastructure are the main challenges for Smart Homes.	SC	SR
[464]	UK 2017	Complexity and awareness are the main influential factors for Smart Homes.	SC	S
[465]	West Africa 2018	Information availability, organizational awareness, and lack of technology are the influential factors for Smart Climate Systems.	RA	R
[466]	Sweden 2018	Automation is the main challenge for Smart Home.	SC	MS
[428]	Europe 2019	Demographic factors and knowledge are the main influential factors of Smart Living.	SC	CS
[133]	Canada 2019	Lack of knowledge and awareness are the main challenges of Smart Living.	SC	I
[467]	France 2019	Regulations, funding, privacy and are main influential factors to Smart Safety Systems.	SC	SR
[468]	UAE 2019	Awareness, trust, enjoyment are the main influential factors for Smart Home.	SC	OM
[469]	Lithuania 2019	Awareness, knowledge, and lack of skills are the barriers to Smart Living.	SC	CS
[470]	China 2019	Lack of regulations and financial incentives are the main influencing factors to Smart Environmental Systems.	SC	MM
[471]	Poland 2020	ICT infrastructure is the main barrier to Smart Living.	RA	AS
[472]	Indonesia 2020	ICT infrastructure and funding, and knowledge are the main factors in Smart Living.	RA	I
[473]	Malaysia 2020	Role of IoT in Smart Home.	SC	SMP
[469]	Australia 2021	ICT infrastructure is the main enabler for Smart Living.	SC	QI
[280]	Korea 2021	Complexity and funding are the main barriers to Smart Home.	SC	SR
[474]	Sweden 2022	Privacy and security are the main challenges of Smart Home.	SC	CS

Smart Living is likely to be successfully implemented in the more and less developed countries, where the population density is high in urban areas [475]. More and less developed countries present a generic competitive advantage because of the availability of infrastructure and resources. In contrast, this is perceived to be much more challenging in rural regions of more and less developed countries due to the lack of infrastructure and ICT availability [476]. In the least developed countries, Smart Living could find opposite conditions [477], as mentioned in previous discussions.

5. Gap Identification and Challenges

According to the literature review conducted, the adoption of Smart Technology in rural regions and the associated challenges can be considered an open issue within the more generic body of knowledge related to Smart Technology.

Overall, there is a relatively limited number of studies in the field, as the main focus is on Smart Cities (Figure 1). Indeed, rural regions present some peculiarities that distinguish them from urban environments, resulting in a different lifestyle with specific issues and needs. Therefore, Smart Technology needs to be developed and deployed according to a different strategy that meets the actual requirements.

Because of its relative maturity, Smart City has allowed a critical comparative analysis to identify major gaps and challenges.

Based on the analysis of the 83 selected papers, significant research gaps have been identified as follows:

- Despite their variety and extension, there is a fundamental lack of study in the rural context to investigate how to effectively adopt Smart Technology by looking at the different applications.
- Poor understanding of the determinants for Smart Technology adoption.
- Lack of specific strategies and specialized models for the implementation of smart solutions in the rural context
- Scarcity of comparative studies that address similarities and differences between Rural Regions and Smart Cities. It is a crucial step to convert the experience into a strategic solution to foster sustainable development.
- Most rural studies are conducted in a specific context (e.g., within western economies), and more holistic discussions of results and models that consider different contexts are rare.
- Lack of case studies to identify influential factors, enablers, and barriers.
- Focus is often on Smart Farming, and there is a lack of investigation and discussion on more integrated approaches and different applications.
- Lack of knowledge towards rural motivation, behavior, and attitude to use Smart Technology, especially for those with limited technology awareness.

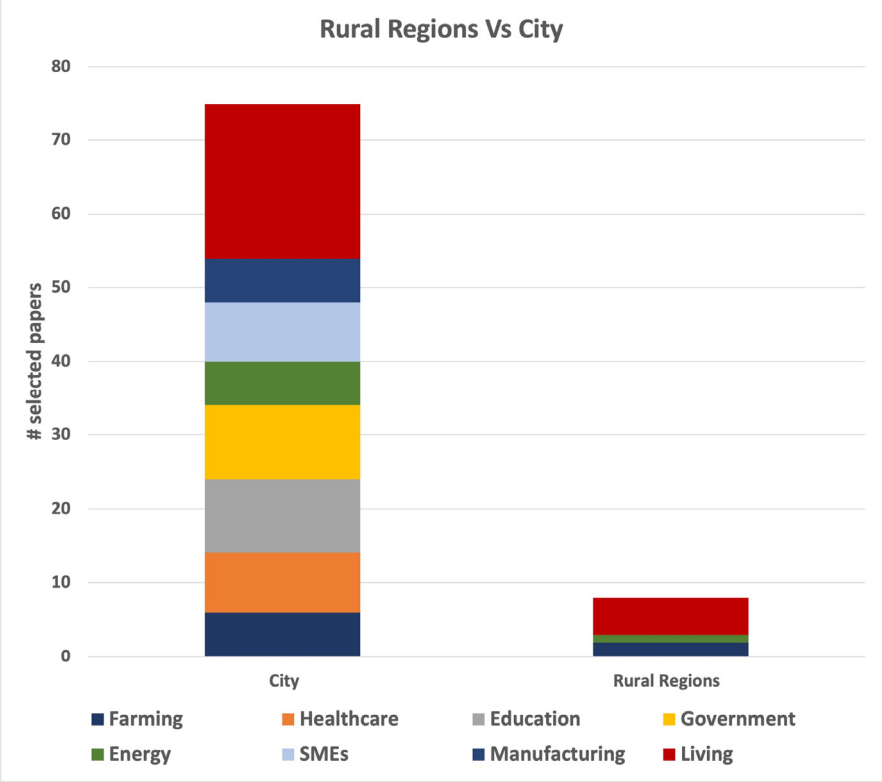

Figure 1. Overview of the selected papers classified by application domain.

A summary of major barriers and limitations is reported in Figure 2. The valuable insight that emerged from the literature review also includes a clearer understanding of major challenges.

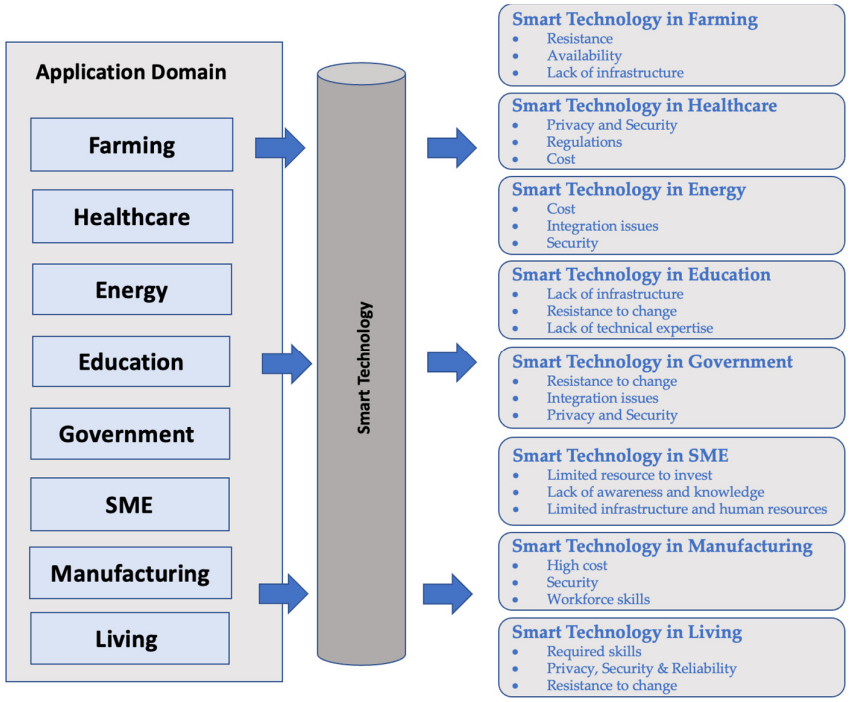

Figure 2. Summary of major barriers and limitations.

Such challenges can be summarized as follows:

- It is difficult to characterize rural regions within different countries and identify their peculiarities, especially in less developed countries. Additionally, there is no universally accepted definition for rural areas.
- It is difficult to directly re-use or adapt models from urban or other contexts to fit rural characteristics.
- As there are no precise determinants for Smart Technology adoption in the rural context, and it is unrealistic to define one single strategy that is effective in general terms and widely accepted.
- Rural organizations seem to perceive Smart Technology as problematic because of the many barriers that do not allow a proper understanding of the potential. This results in resistance to change.
- Understanding and overcoming underlining social and cultural factors may be challenging.
- Key stakeholders in rural regions may have some resistance to sharing information with researchers because of socio-political issues. This may lead to incomplete, if not misleading, information.
- There is a limited understanding of policies and regulations.
- Because of significant heterogeneity, defining and generalizing solutions from the different existing patterns is challenging.
- Studies within a rural context can be time-consuming.

6. Conclusions

In general terms, the adoption of Smart Technology in rural regions is expected to enhance a sustainable development looking at the more consolidated Smart City experience. In the farming sector, Smart Technology is expected to increase production and improve quality by automating processes, thereby reducing the need for human intervention, and providing a sustainable way for high production. In healthcare, the contribution of Smart Technology is mostly to bridge the gap with urban areas in terms of quality of services. In the energy sector, smart grids and renewable energy can be used to enhance a sustainable, reliable, and affordable energy supply to rural communities. Major challenges in education can be addressed by improving the accessibility of rich content. From a governmental perspective, Smart Technology can act as a socio-technical mitigator to address gaps and promote a better involvement and engagement of rural communities by enabling a more effective understanding of actual needs. SME should gain a competitive advance to enhance business sustainability and economic growth by an effective management of business resources. It should result also in creating additional job opportunities for skilled workers in the rural area. In the manufacturing sector, Smart Technology is expected to drive automation for critical processes that traditionally require a large number of employees. This can further foster qualified and specialized jobs. Looking holistically at lifestyle and society, Smart Technology can help to reduce the disparities with urban areas and to improve quality of life within rural communities.

However, the effective adoption of Smart Technology in rural regions is still challenging. Indeed, the limited attention on rural regions results in a difficulty in understanding the real needs, peculiarities, and critical issues in the context of limited resources. While the holistic analysis clearly points out a gap, there is no specific strategic roadmap to reuse or adapt existing models, such as Smart City. On the other side, there is the need to approach challenges according to a specific socio-economic approach that is aimed to establish effective policies that can materialize a positive perception of rural regions.

In summary, this paper suggests two major avenues of investigation to researchers. First, future research might focus on investigating the key challenges faced by rural communities when adopting Smart Technology through the lens of social influence, cultural background, technological orientation, organizational readiness, political drivers, and

technological considerations. Second, researchers might consider exploring how Smart City experiences can be used as a strategic solution to address the challenges of sustainable development in rural regions. By exhausting these key research avenues, researchers might find ways of unlocking the potential opportunities Smart Technology could offer to rural regions.

Additionally, the topic may be considered from different perspectives. For instance, in a context of inequality reduction [478]. Such directions may require fine-grained analysis based on specific indicators.

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Abbreviations

Method	Acronym
Descriptive Analysis	DA
Case Study	CSY
Survey Interview	SI
Qualitative Case Study	QCSY
Literature Review	LR
Comparison Study	**SC**
Survey	**S**
Qualitative Case Study	QCSY
Systematic Literature Review	SLR
Systematic Quantitative Review	SQLR
Measurement	M
Review	**R**
Interview	**I**
Experimental Study	**ER**
Questioner	**Q**
Smart Technology	**ST**
Comparison Analysis	**CA**
Qualitative Interview	**QI**
Quantitative Research	**QR**
Analysis Study	AS
Systematic Review	**SR**
Observations	**M**
Quantitative Methods	**QM**
Exploratory Study	**ES**

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