

## Evaluation of smart village strategies and challenges

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### Abstract

**Purpose:** Rural communities around the world are searching for solutions to upkeep, restore and improve local services that are deteriorating. They are exploring the potential of a digital transition along with the opportunities and threats created by new patterns of mobility and closer links with urban areas. The expansion of information and communication technologies (ICT) enhanced applications enable rural communities to improve their quality of life. The concept of Smart Village is primarily about how rural communities make best use of both ICT and social innovation by responding to the ongoing and emerging challenges. Therefore, the aim of this paper is to investigate strategies for adoption of smart villages along with the challenges faced.

**Design/methodology/approach:** A quantitative research methodology was adopted in this research. A web-based questionnaire survey was conducted to collect data. In total, 110 fully completed and usable questionnaires were received. Statistical analyses were undertaken using the Statistical Package for Social Sciences (SPSS).

**Findings:** The results indicate that lack of budget, lack of clear strategies for development of sustainable 'smart villages', lack of collaboration between stakeholders, and lack of knowledge related to 'smart villages' are the most debated challenges for implementing smart villages agenda. Whereas, smart energy, smart healthcare, smart transport, smart education, and smart water are the top five most important smart villages strategies.

**Originality/value:** Research on smart villages development is rare. This paper presents a theoretical basis on the concept of smart villages. In addition, to the rich insight into the understanding and awareness of the current smart villages strategies along with the key challenges encountering organisations implementing smart villages initiatives. This research has implications towards informing professionals and policymakers on key lessons learnt during the implementation of smart village strategies. Also, this paper contributes to the academic debate on smart village development and provides useful recommendations to both policymakers and practitioners.

**Limitations:** Despite the novel insights provided by this study, it has some limitations. Given that the research reported in this paper is based on literature review and small-scale survey, results presented are only tentative and not generalizable. The findings of this paper are limited to the UK context only. Although generalizability outside of this context may be limited, we infer that the results are relevant to other comparable developed countries.

**Keywords:** Smart villages, rural development, challenges, strategies, ICT.

### Introduction

Over the last decade, researchers have been working on developing a smart world where everything will be operated with smart technology powering up better living and efficient-sustainable resources consumption (Haider et al., 2018). The need to develop rural communities in terms of productivity and convenience to curb urban migration has received much attention in the last decade (Adesipo et al., 2020). With urbanisation on the rise with people migrating to cities and away from countryside and other peripheries for better livelihood, there is an eminent and urgent need for strategies to improve lives and livelihood in rural communities to reduce this negative urbanisation trend which has been continuing and expected to reach 96% by 2030 (Kantenbacher and Shirley, 2018; Holmes, 2017). This method of urbanisation is described as detrimental and that it should therefore not be the only option to better lives since half the world's population live away from cities, further emphasising the need for an alternative, Smart Village initiatives (Garai et al., 2015).

Smart cities aim to integrate all its infrastructures and services into interrelated whole system to incorporate intelligent devices for monitoring and controlling various services to ensure sustainability and efficiency (Abdalla et al., 2019). This enables smart cities to use their resources in a smart and restrained manner. On the other hand, the life of people in villages is even tougher compared to their city counterparts when compared to the infrastructure and services. This calls for extending and implementing the concept of “smart cities” to the “smart village” context. Smart village initiatives aim to improve quality of life and make people lives easy and comfortable by deploying Internet of Things (IoT) and digital solutions (Vaishar and Šťastná, 2019; Kaur, 2016). For example, the use of cameras and sensors in streets for surveillance, sensors for healthcare etc. On the other hand, there are certain sectors like agriculture, cattle/livestock rearing etc which need some improvised ideas for smart working (Kaur, 2016). Moreover, it is apparent that land development in the second half of the 20<sup>th</sup> century generally contributed to increasing inequality and lead to growing competition between territories, which resulted for the need to resort to strategies that emphasise balance, social cohesion and competition simultaneously (Tang et al., 2017). Although the aims of sustainable development and competition are not parallel and conflict, but it can be successfully integrated in the concept of intelligent development for use in Smart Villages development (Clark, 2018). This pressing demand for new approaches in rural areas actively seek to deal with new challenges ranging from population growth, migration, climate change and lacking the means to keep pace with ICT implementation for the realm of human work and so on (Kimm and Burry, 2019). Smart village is an advanced concept of off-grid community where each and every component of the basic human rights relates to smart technology (Haider et al., 2018).

Designing smart villages strategies that reflect and respond to the needs of rural communities could add value to other policies (ENRD, 2019). For instance, smart villages strategies can offer improved access to sources of knowledge, enhance cooperation, and provide a more flexible finance for local innovation, and improve alignment with other investment policies and funds. However, the current literature reveals the need for more empirical research on the experience of existing smart villages development. This paper investigates the importance of

smart villages strategies that have been developed to accomplish the implementation of smart villages initiatives and the key challenges of implementing smart villages initiatives. A quantitative research methodology was adopted in this research by using a web-based questionnaire survey. In total, 110 fully completed and usable questionnaires were received. This was subjected to Statistical analyses using the Statistical Package for Social Sciences (SPSS). Prior conducting the survey, a thorough review of literature was conducted.

### **Literature review of Smart Village**

The global call to an immediate and sustainable action for bettering rural life is seen when the world met in New York in 2015 and adopted the Sustainable Development Goals (SDGs), which set the benchmarks for defining the global development action for the next 15 years (Holmes et al., 2015). Although the initiative of Smart Villages being relatively a new concept when it comes to EU policy making, more than 340 rural stakeholders got together in 2016 in Ireland to try developing an EU vision for ‘A Better Life in Rural Areas’ with strategies that sets out the expectations and objectives of rural areas (ENRD, 2019b). The notion of smart villages refers to rural areas which build on their existing strengths as well as on developing new opportunities to improve the quality of life and to add value (European Commission, 2016; ENRD, 2018). In smart villages, knowledge, innovation, ICT, IoT and smart technologies are deployed to enhance traditional and new networks. Smart technologies and innovations may support citizens quality of life, public services provision, efficient use of resources, and reduce environmental impact (European Commission, 2016). The concept of smart village aims at integrating ICT and strategies and collecting community efforts and strength of people from various streams to provide benefits to the rural community (Prinsloo et al., 2017; Somwanshi et al., 2016).

According to Adesipo et al., (2020) a “smart village” can be defined as a community that tries to develop current strength and resources, while making futuristic developmental plans on the basis of technology. However, it is community and territorially sensitive, built on the requirements and potentials of each respective territory. The evolving concept of Smart Village signifies to rural territories and communities which shape on their existing strengths and resources as well as on developing new initiatives (Visvizi and Lytras, 2018).

Smart Villages can be described as where conventional and new networks/services are heightened by utilising of digital, innovations, telecommunication technologies with the better use of knowledge to benefit the locals and businesses (Ringenson et al., 2018). Subsequently, introduction of digital technologies and encouraging innovations may help quality of life with higher standards of living, ‘public services for citizens, better use of resources, less impact on the environment, and new opportunities for rural value chains in terms of products and improved processes’ (EU actions for Smart Villages). Meaning that Smart villages are not the only method for the sustainable development of rural territories, but they are certainly an approach that can improve the quality of life and give the youth positive reasons to stay rather than migrate from rural areas (Holmes et al., 2015).). Adesipo et al., (2020) noted that while

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there are several thematic areas of priority within the smart village development framework, agriculture is seen as the most important of them all. Furthermore, the need to bridge the digitization gap between cities and villages, is also an important aspect, so that lives and livelihood can be improved (ENRD, 2019b). The initiative of smart villages offers an answer to the search for ways of applying the concept of sustainable development for rural areas. The initiative is in the first phase of its preparation and implementation. It is envisioned to reinforce the territorial capital of the countryside, at the same time having social and technological innovations as a tool for its application. Some of the barriers to applying this initiative are: reluctant of openness of the rural community to adapt, low innovation capacity and low level of social capital, and low capacity of the local markets, spatial distance, poorly developed transport and communication network (Guzal-Dec, 2018).

The whole essence of developing smart villages is to provide remote communities with sustainable energy, modern information and communication technologies, good education and health care; access to clean water, sanitation, and nutrition; and the growth of social and industrial enterprises to boost incomes' (Holmes et al., 2015). One of the most significant and precise questions that modern societies have to tackle is how to make communities and their settlements more sustainable. An ever-growing number of characteristics of most societies and their economies are inseparably linked to changes carried forward by technological developments that are altering people's everyday practises, insights of the environment, access to the energy, food, health, education and many more. According, to Adesipo et al., (2020) the IEEE smart village program is one of the most popular today. It has a goal of advancing education in off-grid societies and fostering sustainability in the entire value chain of the smart village energy sector. Initially, the initiative sought to provide community solutions in 2009, the current name was coined 5 years later. To correctly approach those changes, the 2030 Agenda for Sustainable Development called Envision2030 was approved by the General Assembly of the United Nations, and it included seventeen Sustainable Development Goals (SDGs). The various aspects of smart village definitions are presented in Table 1 from the year 2015 to 2020 from twelve articles. Nine of the twelve articles focus on digital technologies.

**Table 1:** Literature review summary of smart village definitions

Source	Definition	Focus
Adesipo et al., (2020)	A community that tries to develop current strength and resources, while making futuristic developmental plans on the basis of technology.	<ul style="list-style-type: none"> <li>- Digital technologies</li> <li>- Developing current strengths</li> </ul>
ENRD (2018)	Rural communities which build on their existing assets as well as new opportunities to develop added value and where traditional and new networks are enhanced by means of digital communications technologies, innovations and the better use of knowledge for the benefit of inhabitants.	<ul style="list-style-type: none"> <li>- Digital technologies</li> <li>- Benefits of inhabitants</li> </ul>
ENRD(2019)	Smart villages strategies should add value to other policies by putting in place flexible packages of interventions that respond to the needs of rural communities	<ul style="list-style-type: none"> <li>- Policies/ strategies</li> <li>- Needs of rural communities</li> </ul>

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European Commission (2016)	Using digital technologies and innovations to support quality of life, higher standard of living, public services, better use of resources, less impact on the environment, and new opportunities for rural value chains in terms of products and improved processes.	<ul style="list-style-type: none"> <li>– Digital technologies</li> <li>– Quality of life</li> </ul>
Haider et al., (2018)	Smart village is an advanced concept of off-grid community where each and every component of the basic human rights relates to the smart technology.	<ul style="list-style-type: none"> <li>– Digital technologies</li> <li>– Human rights</li> </ul>
Holmes et al., 2015).	An approach that can improve the quality of life and give the youth positive reasons to stay rather than migrate from rural areas.	<ul style="list-style-type: none"> <li>– Quality of life</li> <li>– Reduce immigration to urban areas.</li> </ul>
Kaur (2016)	noted that the quality of life in villages can be made better using the IoT and Smart village model	<ul style="list-style-type: none"> <li>– Digital technologies</li> <li>– Quality of life</li> </ul>
Prinsloo et al., (2017)	Smart village concept offers a basis for technology development through ideas aimed at the design of new grass-roots level micro-utilities able to act as catalyst for rural development	<ul style="list-style-type: none"> <li>– Digital technologies</li> <li>– Rural development</li> </ul>
Ringenson et al., (2018)	A village where conventional and new networks or services are heightened by utilising of digital, innovations, telecommunication technologies with the better use of knowledge to benefit the locals and businesses.	<ul style="list-style-type: none"> <li>– Digital technologies</li> <li>– Knowledge</li> </ul>
Somwanshi et al., (2016)	Smart village is to collect community efforts and strength of people from various streams and integrate it with information technology to provide benefits to the rural community.	<ul style="list-style-type: none"> <li>– Digital technologies</li> <li>– Collective intellectual capital</li> </ul>
Vaishar and Šťastná (2019)	Smart villages initiative aims to create rural areas where people can and want to live because innovative, digital solutions make their lives easy and comfortable.	<ul style="list-style-type: none"> <li>– Digital technologies</li> <li>– Quality of life</li> </ul>
Visvizi and Lytras (2018)	Refers to rural territories and communities which shape on their existing strengths and resources as well as on developing new initiatives.	<ul style="list-style-type: none"> <li>– Existing strength and resources</li> <li>– New initiatives</li> </ul>

South Asian countries focusing on off-grid electrification for rural electrification, countries like India, Bangladesh, Sri Lanka and Nepal have adopted off grid system for rural electrification and successfully shown good results (Debajit Palit et al., 2011). In India, smart village concept has adopted by state and local governments to focus on holistic rural development derived from Mahatma Gandhi's vision Adarsh Gram (Sinha et.al., 2016). The program called Sansad Adarsh Gram Yojana (SAGY) was launched on 2nd October 2014 on Mahatma Gandhi's birthday for implementing smart village concept through parliamentarians, as each Member of Parliament and Ministers have adopted a rural village to develop it into a model village by 2019 under the SAGY guidelines (Kaushik et.al 2016). The vision of SAGY is integrated village development plan, encompassing Personal, Human, Social, and Economic dimensions (Tomar et al., 2016). Globally, there is pressing demand for new approaches as rural areas actively seek to improve their quality of life.

### **Challenges for implementing smart village initiatives**

Komorowski and Stanny (2020) noted that in the past decade European countries have been undergoing a transformation towards an information society, and the changes taking place depend on global technological development. Rural residents are also a part of this process. Adjusting to the changes is not so much an opportunity as a necessity, as more and more types of activity are performed in the virtual world. This allows distances to be “reduced” and goods and services, especially public ones, to become more accessible. Doloi et al., (2019) noted that the practical implementation of smart village strategies in when a community is identified and suitable demarcation of its geographical border along with gathering of the fundamental demographic characteristics is carried out for understanding the desires, requirements, urgencies, current schemes, and interventions plus involvement of any activities on the ground.

Smart village approach describes location-specific and need-based interferences at a basic level. This information will then form a solid grass-root in planning and implementing strategies and actions essential to meet the target development outcomes. According to Juan and McEldowney (2021) the main assumption of the smart villages’ initiative is that the technological progress, if successfully combined and integrated with other off-urban development initiatives, can provide new opportunities to rise incomes, provide services and reinforce society, which subsequently and significantly better the quality of rural life. In this context, information and communication technologies (ICT) are treated as a chance to overcome development difficulties (Salemink et al., 2017; Nayak et al., 2010). However, their usefulness depends on the availability and quality of the internet. Its absence or poor accessibility deprives a given area of opportunities for smart development (Naldi et al., 2015; Janc and Czapiewski, 2013).

The literature revealed that some researchers believe that the smart-village concept draws upon the equivalent concept of smart cities (Guzal-Dec, 2018; Visvizi, and Lytras, 2018). However, Komorowski and Stanny (2020) argued that the problems faced by urban and rural areas seem to be completely different, therefore the solutions proposed during implementation of these two approaches are also different. Visvizi and Lytras (2018) noted that one of the biggest challenges is how to overcome the migration from rural areas to cities. Zavratinik et al., (2018) noted that smart cities are urban living environment, built or upgraded/renovated to enable the best possible coordination for otherwise fragmented urban sub-systems, and to facilitate everyday lives of inhabitants, making cities more liveable and sustainable. The authors concluded that the most representative features of smart cities are shared ICT structures, time optimization, open government, energy efficient technologies, reduced emissions, and orientation towards green environment. The summary of challenges for smart villages initiatives is presented from technical and non-technical perspectives in Table 2.

**Table 2:** Challenges for smart villages initiatives from literature review

Technical	Non-technical
<ul style="list-style-type: none"> <li>• Digital transformation challenges (e.g., adapted concepts, ICT systems).</li> <li>• Lack of business models to improve the well-being of the rural population.</li> <li>• Multi-disciplinary work challenges.</li> </ul>	<ul style="list-style-type: none"> <li>• Migration from rural to urban areas.</li> <li>• Lack of investment capital.</li> <li>• Complex policy environments.</li> <li>• Financial limitations.</li> <li>• Income generation for the long-term maintenance</li> <li>• Lack of understanding of user expectations, and preferences.</li> <li>• Institutional and regulatory challenges.</li> <li>• Competing with other measures of strategic plans.</li> </ul>

The transition to smart infrastructure is important for urban living environments, this transition is even more necessary and complex in the case of more sparsely inhabited rural areas (Zavratnik et al., 2018). However, digitalization or digital transformation requires adapted concepts, business models and solutions that have to strive to generally improve the well-being of the rural population (Zavratnik et al., 2018). Additionally, Visvizi and Lytras (2020) noted that the research and the development of smart village requires multi-disciplinary work: the integration of sophisticated technology enabled services for social services requires better understanding of user clusters and preferences. The perceptions of users and their expectations from the use of smart villages services need documentation and in-depth analysis.

Heap (2015) noted that improvements in underlying technology systems for decentralised power, combined with new business models, institutional and regulatory support, and ICT systems represent key challenges for smart villages initiatives implementation. The authors further stated that lack of appropriate investment capital also hampers the establishment and expansion of various smart villages initiatives. Furthermore, complex and often perverse policy environments impair entry for clean technologies and entrench incumbent systems. Juan and McEldowney (2021) noted that financial limitations is a key challenge for implementing smart village initiatives. Financing smart village initiatives will have to compete with other measures of strategic plans. The ENRD (2019a) noted that business models for smart villages initiatives, income generation for the long-term maintenance, as well as proposals for launching, growing and maintaining community investment funds represent other barriers for implementing smart villages initiatives. Moreover, Zavratnik et al., (2018) noted that it is necessary to learn and draw on good practices from other countries, but meanwhile it is also necessary to consider local and regional frameworks within which the implementation of the smart village concept will take place. Lacković and Ivanović (2020) highlighted the importance of information and knowledge for successful implementation of smart villages. The authors recommended undertaking the identification of information needs and the construction of an appropriate information system. Hence there is a need to investigate the challenges for smart villages initiatives through empirical study.

### Smart villages strategies

Smart villages strategies aim to help rural communities test new solutions to some of the fundamental challenges they face – as well as exploring the new opportunities created by technological and other forms of innovation (ENRD, 2019). Viswanadham and Vedula (2010) noted that providing quality utility services like power, water, sanitation, and essential services such as education, healthcare, transportation, infrastructure (roads, railways, buildings, equipment) must be the primary strategy for the development of every village. Ram et al., (2020) noted that a variety of ICT including sensors, actuators, cameras, drones, robots, medical devices, and agro-devices can be involved in automating decision-making in the smart village components such as smart mobility, smart energy, smart agriculture, and smart healthcare. For example, Vaishar and Štátná (2019) noted that smart infrastructure, smart service delivery, smart institutions, and smart technology and innovations are the key aspects of smart villages in India. Kaur (2016) noted that the whole idea of smart villages revolves around its people and how efficiently they make use of the components of a smart village. They can be educated to participate in each and every activity of the village leading to a better lifestyle for its people. Therefore, education is a basic means to implement all the advancements in life. Educating people about the use of new technologies facilitates better implementation. It can be the force behind reducing the digital-divide which is far more prevalent in villages than the cities (Kaur, 2016).

According, to the European Network for Rural Development (ENRD, 2019) mobility is potentially a key theme and focus for many future smart village strategies. The future vision for a smart mobility village could consist of several complementary features adapted to local circumstances. For example, shared mobility solutions are core initiatives in smart villages mobility (e.g., demand-responsive transport services and car-pooling offered by a single point/coordination unit) (ENRD). Similarly, Kaur (2016) highlighted that importance of smart homes and buildings. The homes and buildings can be made smart by the use of sensors and cameras. These will produce real-time data which can be analysed to take necessary actions. For example, sensors installed in a home can detect smoke and hence start the water sprinklers automatically to combat the fire. Similarly, the sensors can monitor the usage of electricity in the home or building and switch the lights off when not in use. Smart village is a model in which, energy access acts as a catalyst for a range of development outcomes (Mohanty et al., 2020; Holmes and Thomas, 2015). Renewable and sustainable energy service performs as a facilitator for development in the smart village concept (Haider et al., 2018). Efficient energy management is paramount in villages where the electricity is not available all the time. The security of the building can be monitored using cameras and appropriate alerts can be generated in case of any anomalies. The water levels and pressure can be measured in the water tanks and pipes and used to refill the tanks when necessary as well as detect any faults in the pipes (Kaur, 2016).

Smart health services are needed to improve the quality of life in the villages. The village dispensaries and hospitals need advanced devices which are connected to each other and the doctors. The beds in hospital can be embedded with sensors which can detect various changes



in the patient including its movements, heartbeat, blood flow from the wounds and body temperature etc. These reports along with the data generated by various machines like X-rays, CT scans etc. can be sent to the doctor directly. Such services will upgrade the health care sector of the villages (Kaur, 2016). Accurate weather information can be of great use to the people of the village. The use of environmental sensors to predict weather forecasts can help the farmers to a large extent. Many farming activities like sowing, irrigation and harvesting depend on the weather. Smart irrigation systems can make use of sensors in the fields and remote satellite data to ensure the optimal use of available water resources. For example, if it is going to rain the next day, then watering the fields on that day makes no sense. All this information can be made available to the farmers through message alerts on their mobile phones. The level of water in the dams and canals can also be monitored using sensors and it can be used to predict the future need of water (Kaur, 2016).

Duan (2011) noted that as agriculture is the backbone of all villages, the farmers need to benefit the most from the system of IoT and smart villages. There needs to be the tracking of the farm produce from the farm to the table. The whole chain of activities can be monitored and improved using data from sensors and other sources. The people involved in the process are the growers, processors and packers, storage and transport service providers, distributors, wholesalers and retailers. Kaur (2016) noted that sensors deployed in the fields can help the farmers with information regarding selecting the crop to sow, yield prediction of crops based on the type of soil or climate, watering requirements using smart drip-based irrigation systems, application of fertilizers according to the nutrient content of the soil etc. The crop diseases and pesticides can also be predicted using data from sensors and crop leaf pictures taken by remote satellites. The farmers can get up to-date information on their mobile phones. In case of emergencies, alert systems can be activated and provide immediate actions. For example, consider the case of wheat crop, which is ready to harvest, a small spark can set the whole field ablaze and cause huge losses to the farmers. Environmental sensors can detect smoke on the onset of fire and start the water sprinklers immediately to control the fire and avoid extreme loss. Likewise, sensors can detect the ripening of the vegetables and fruits and alert the transport service providers to avoid any delays. Thereafter, suitable arrangements can be made in the market to sell the produce (Kaur, 2016).

### **Benefits of implementing smart villages strategies**

Mohanty et al., (2020) noted that the smart village is about empowering the villagers with technology and enabling them to create value. Smart village improves its networks and services through digital and communication technologies and embraces innovation and knowledge for its resident. The various aspects of smart villages that have been enumerated suggest that the idea of smart villages can be connected with the concept of sustainability with its three pillars (social, economic and environmental). It indicates a wide interdisciplinary reach of smart village research and its applications (Vaishar and Št'astná, 2019).

Mohanty et al., (2020) noted that if managed correctly, technology 'leapfrogging' could lead to rapid improvements in healthcare, nutrition, education, and economic security in remote

villages. Vaishar and Šťastná (2019) noted that the concept of a smart village should include: precision farming, various digital platforms (e-learning, e-health, e-administration, transport, gastronomy, social services, retail), shared economy, circular economy reducing waste and saving resources, bio-based economy, renewable energy, rural tourism, social innovations in rural services and entrepreneurship. For example, to ensure efficient utilization of energy in a smart village, it requires an intelligent system where each home of the village communicates with the nearest power substation in order to notify its energy status. Ram et al., (2020) noted that smart village concept that combines renewable energy and community-based education can have impact on estimated 940 million population worldwide. The smart villages exhibit certain characteristics which may have some commonalities with smart cities, but also some distinctly different. This motivation leads to the development of an effective communication system for smart village energy distribution that will be intelligent and updated enough to be able to exchange real time information between nearest power substation and local end user's (Haider et al., (2018). Additionally, in smart villages smart classrooms can be built for effective use of leaning materials and sharing of knowledge with experts (Ram et al., 2020). Kaur (2016) noted that the whole idea of smart villages revolves around its people and how efficiently they make use of the components of a smart village. They can be educated to participate in each and every activity of the village leading to a better lifestyle for its people (Kaur, 2016). Moreover, Waste materials can be used to generate energy in the form of gas, fuel, fertilizers, and it helps in generation of revenue (Ram et al., 2020).

Nonetheless, smart technology plays an important role in supporting behaviour change, reducing consumption and increasing efficiency and security of the local energy supply. In the near future, smart meters will deliver the data necessary to facilitate these developments. In some remote communities, the impact of smart technology has been transformational in maintaining a delicate balance between energy supply and demand. In others, smart technology is being seen as playing a key role in potentially altering the balance between renewable and fossil fuel generation (Deshmukh, 2017).

Over recent years, the challenges arising from the social and economic, but also wider changes of people's communities—rural and urban—have been increasingly addressed through the lenses of technological developments and digitalization (Zavratnik et al., 2018). A few years ago, the idea of IoT and smart cities used to be considered as a future possibility. But it has become a reality today, due to the technological advancements. Many countries have deployed the job of turning their cities into smart cities. The optimal use of available resources is the need of the hour. Ever-increasing population has restrained the resources and their usage. IoT combines the benefits of multiple technologies to realise the idea of intelligent devices in a city. This idea can be extended to the villages as well, improving the quality of life of the residents (Kaur, 2016). Improving the lives of rural communities by developing smart villages is a concept analogous to the more familiar smart cities. Thus, revitalising rural communities and making them more attractive and sustainable is possible by using the full potential of information and communication technology (Visvizi et al., 2019).

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The vision for smart villages is that modern information and communication technologies (ICT) can act as a catalyst for development in improvements in access to energy, education, health, food security, productive enterprise, clean water and sanitation, environmental sustainability and participatory democracy (Heap, 2015). The smart villages concept has been proposed and successfully launched to a niche for the sake of rural areas, not only in the EU but also in the global arena as well (Visvizi et al., 2019). A smart village is a number of services implemented effectively to the village residents and businesses in an efficient manner. The services including agriculture, construction, electricity, health care, water, retail, manufacturing and logistics are needed in building a smart village. Information technology will play a major role for design, delivery and monitoring of these services in the village (Muralidhar and Srihari, 2015). Smart village concept focused on the role of technology in building governance and public services. In developing a smart village, the village government must set a goal, what must be developed first and what will become the supporter. Smart village was a solution to improve people's quality of life in rural areas (Aziiza and Susanto, 2020). However, developing and implementing smart village initiatives have encountered various challenges and barrier.

### **Methodology**

Research is defined as the process by which a person attempts to find an answer to a question or a solution to a problem through a systematic methodology with the aid of an evident fact (Leedy and Omrod, 2012). It is important to have a robust research methodology to be able to achieve the research aims and objectives. Hussey and Collis (2003) define methodology as the overall approach to the research process, from the theoretical underpinnings to the collection and analysis of the data, so research methodology in social enquiry refers to far more than simply the methods adopted. It should encompass the rationale and philosophical assumptions that underlie a particular study. These, in turn, influence the methods that are used to investigate a problem and to collect, analyse, and interpret data.

According to Apuke (2017), research methodology can be defined as the holistic steps a researcher employ in embarking on a research work. In this study, the research framework consists of four stages. They are literature review, data collection, data analysis, and reporting findings. A quantitative research methodology was adopted to examine public and private sector perspectives. According to Queirós et al., (2017) quantitative research focuses on objectivity and is especially appropriate when there is the possibility of collecting quantifiable measures of variables and inferences from samples of a population. Quantitative research adopts structured procedures and formal instruments for data collection. The data are collected objectively and systematically. Apuke (2017) noted that a quantitative research method deals with quantifying and analysis variables in order to get results. It involves the utilization and analysis of numerical data using specific statistical techniques to answer questions like who, how much, what, where, when, how many, and how. Thus, it is about explaining of an issue or phenomenon through gathering data in numerical form and analyzing with the aid of mathematical methods in particular statistics. A web-based questionnaire survey allows obtaining information about a given phenomenon, through the formulation of questions that

reflect the opinions, perceptions and behaviours of a group of individuals. Questionnaire survey instruments have many advantages in the data collection process compared to interviews. They provide a larger geographical coverage for the sample population than case studies or semi-structured interviews could provide and are cost-effective, efficient, and permit anonymity (Bourque and Fielder, 1995). Thus, it helps ensure that individuals' responses reflect their true beliefs and feelings, which is especially important in research involving attitudes. Because the researcher is not conversing directly with participants, they are unlikely to influence respondent answers. The questionnaire survey also provides a uniform situation for data collection, because each person is presented with the exactly the same method of inquiry, in the same manner (Bell et al., 2018; Bryman and Bell, 2007). Moreover, web-based questionnaire surveys provide some flexibility and high representativeness of the entire population and the low cost of the method when compared to other alternatives and it is one of the most used quantitative techniques (Queirós et al., 2017).

In the current study, web-based questionnaire survey is deployed to collect quantitative data by sharing online through different apps, email, and text messages to the participants. Before sharing the questionnaire, pre-testing was conducted to understand the flow of questions and getting answers from the participants. Sampling is a process in which a pre-determined number of observations are selected from a larger population. Sampling is of critical importance in research, as in most cases there is a larger population that due to numerous restrictions sampling is the only viable option in obtaining reliable responses that represent the views of the wider population (Saunders et al, 2007). In this study, convenience sampling technique was used in order to achieve representativeness. In convenience sampling, elements for the sample are selected for the convenience of the researcher, hence the researcher typically chooses target respondents who are readily available, nearby, or perceived as willing to participate (Black, 2019). Filling of each questionnaire was around 5 to 10 minutes by the participants. Finally, the analysis of numerical data is performed through statistical procedures, often using software such as SPSS.

Questionnaire variables used in the study were derived from the literature review. The specific questions were written with focus on the response process, the utility of individual questions, and the overall structure and appeal of the questionnaire. The cover page introduced the research project and provided critical information such as a confidentiality statement and important notes for completing the questionnaire. The study included scaled items for opinion questions. The final page of the questionnaire provided an option for respondents to offer any further general comments relating to the area of research. Respondents were also able to request a summary of the survey findings to encourage a higher response rate.

In total, 110 fully completed and usable questionnaire responses were received. The questionnaire was developed based on comprehensive literature review. These web-based questionnaire survey aided in answering the research question: what are the implemented smart village strategies and what are the key challenges encountering smart village development. Through the online survey, respondents were asked to indicate the challenges for implementing smart villages agenda on a 4-point Likert item: "not at all challenging" (1), "fairly challenging" (2), "challenging" (3), "very challenging" (4). Moreover, they were asked to indicate the most important smart villages strategies on a 4-point Likert item: "not at all important" (1), "fairly important" (2), "important" (3), "very important" (4).

After preliminary analysis of the data, the number of usable responses amounted to 58 from public sector organisations and 52 from private sector organisations. Therefore, 53% of the organizations participating in the survey are from public sector and 47% are from private sector. Overall, a total of 110 fully completed and usable questionnaires were received. Saunders et al. (2007) argue that a minimum number (i.e., effective responses) for statistical analysis should be 30. Therefore, 110 responses were deemed appropriate for a survey of this kind. According to MacInnes (2016) SPSS is a powerful and user-friendly software package that offers numerous advantages in all sorts of statistical analysis of data. The software is designed to handle a large set of data with multiple variables associated with it. It has in-depth statistical capacity, along with all the flexibilities of multiple analyses of data and graphical representation. Moreover, it has the unique quality of creating variables from existing information (MacInnes, 2016). Statistical analyses were undertaken using the Statistical Package for Social Sciences (SPSS version 26.0) to analyse the collected data. For the analysis, interpretation and validation of the data the following procedures were conducted: a coding system was created and assigned numbers to each question; all questionnaires were reviewed for accuracy and credibility; data from the questionnaires were directly input into the SPSS 26.0 database; data was quality-checked for entry accuracy; and analysis was then run producing results using statistics techniques in SPSS 26.0.

These included descriptive statistical analysis and the t-test to compare equality of mean responses between public and private sector organizations. This test is appropriate for comparing the means of two large, independent samples; two independent samples of any size; two dependent samples; or a sample mean and a known mean (Weiers 2011). Therefore, the aforementioned tests are suitable for the research because the researcher has compared the responses between public and private sector organizations (Weiers, 2011). Cronbach's  $\alpha$  was calculated as a way of determining the internal consistency, or average correlation of items, in the questionnaire to gauge its reliability (Nunnally 1978). The Cronbach's  $\alpha$  statistics were in the range of 0.80–0.95. This implies a high degree of internal consistency in the responses to the individual measures, as  $\alpha$  values above 0.7 are acceptable indicators in this respect (Nunnally 1978).

### **Findings and discussion**

Through the online survey, respondents were asked to indicate the challenges for implementing smart villages agenda on a 4-point Likert item: “not at all challenging” (1), “fairly challenging” (2), “challenging” (3), “very challenging” (4). Moreover, they were asked to indicate the most important smart villages strategies on a 4-point Likert item: “not at all important” (1), “fairly important” (2), “important” (3), “very important” (4). It is apparent from Table 3 that the five most challenges for implementing smart village agenda are: lack of budget (3.43), lack of clear strategies for development of sustainable 'Smart Villages' (3.27), lack of collaboration between stakeholders (3.26), lack of knowledge related to 'Smart Villages' (3.18), and lack of resilient and robust digital infrastructure (3.17). Whereas the four least challenges for implementing smart village agenda are as follows: lack of technology (2.88), lack of leadership (3.06), lack of business case for 'Smart Villages' (3.09), and lack of incentives and rewards (3.10). Whereas it is evident from Table 4 that the five most important smart villages strategies are: smart energy (3.7), smart healthcare (3.69), smart transport (3.56), smart education (3.55), and smart water (3.54). Whereas the five least important smart villages strategies are as follows: smart housing

(3.23), Smart manufacturing (3.31), Smart community (3.32), Smart banking (3.39), and Smart governance (3.53).

**Table 3:** Challenges for implementing smart villages agenda

Challenges for implementing Smart Villages agenda	Overall	Rank	Public sector	Private sector	$t_{cal}$	Significant value(p)
Lack of budget	3.43	1	3.44	3.42	0.112	0.912
Lack of clear strategies for development of sustainable Smart Villages	3.27	2	3.32	3.21	0.493	0.624
Lack of collaboration between stakeholders	3.26	3	3.32	3.21	0.524	0.602
Lack of business case for Smart Villages	3.09	7	3.18	3.00	0.683	0.497
Lack of resilient and robust digital infrastructure	3.17	5	3.21	3.13	0.405	0.687
Lack of leadership	3.06	8	3.14	2.95	0.599	0.370
Lack of knowledge related to Smart Villages	3.18	4	3.11	3.25	-0.540	-0.143
Lack of incentives and rewards	3.10	6	3.14	3.04	0.415	0.101
Lack of technology	2.88	9	2.96	2.79	0.603	0.173

**Challenges for implementing smart villages agenda**

Degada et al., (2021) noted that smart village design uses smart technology to build viable services to alleviate the hardship of the village community, sustain the social ecosystem, and contribute towards economic growth. The smart village design problem is highly dispersed and often involves many non-hierarchical structures. Further, the resource in the villages are often shared, and a holistic approach is needed for sustainability. The problem of designing the smart village can be complex and it should be addressed at multiple levels.

It is apparent from Table 3 that non-technical challenges such as lack of budget, lack of clear strategies for development of sustainable 'smart villages', lack of collaboration between stakeholders, and lack of knowledge related to 'smart villages' are the most debated challenges for implementing smart village agenda. In this study, overall mean value of (3.43), lack of budget is the most important challenge for implementing smart village initiatives. The business case and budget for the development of smart village initiatives need to be created in first place by the government to attract private investors and then comes the effective strategies which can be thoroughly set out by appraising the local community/area to understand the level of development and the priority of different aspects of development decided by the local inhabitants. According to Juan and McEldowney (2021) lack of budget and financial limitations as a key challenge for implementing smart village initiatives. The authors further explained that financing smart village initiatives will have to compete with other measures of strategic plans. According to Degada et al., (2021), in Europe and the US, villages have a large elder population. A significant portion of the village population is living below poverty. The

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people in the village are often deprived of good medical support and care at a low cost. IoT-based smart healthcare is a potential solution to provide evidence based primary medical care.

The ENRD (2019a) concluded that where appropriate, a business model for the long-term financial sustainability of the smart village strategy should be taken into account from the start. This might include, for example, income generation for the long-term maintenance of a community-owned asset, or proposals for launching, growing and maintaining community investment funds – after the initial injection of public funds. Moreover, overall mean value of (3.27), lack of clear strategies for development of sustainable 'smart villages' is the second most important challenge. A smart village strategy identifies challenges, needs, assets and opportunities (Juan and McEldowney, 2021). ENRD (2019a) stated that the scope of smart villages strategies can be very broad. The main goals of smart villages strategies as seizing opportunities of a rural digital transformation and overcoming the critical gaps in infrastructure, digital skills and the application of digital innovations to rural services (ENRD, 2019a). The overall challenge for national/regional policymakers and implementers of smart villages is to ensure that the right policy tools are made available in the right place at the right time in order to facilitate the development and implementation of smart villages strategies (ENRD, 2019a). With an overall mean value of (3.26), lack of collaboration between stakeholders is the third most important challenge for implementing smart village initiatives.

The success of smart village initiatives involves building platforms and partnerships among relevant stakeholders and, particularly, the active involvement and support of the appropriate local and regional authorities. While the initial idea for smart villages strategies may start at the level of a small village or hamlet, their success often depends upon cooperation with other nearby villages, towns and cities (ENRD, 2019a). In this study lack of knowledge related to 'smart villages' (with an overall mean value of (3.18) is the fourth most important challenge.

Lacković and Ivanović (2020) noted that an insight into the existing supply of structured knowledge and the broadcasting of important information in areas relevant to 'smart villages' shows that there are hundreds of information systems that produce the necessary information for use in the development of local 'smart village' projects. For example, at the national level, authorities issue daily important information on rural development as well as regional institutions and EU institutions and/or networks. In this innumerable amount of information, local stakeholders of 'smart village' will not be able to read or read all that information daily, let alone act on it. Therefore, when designing implementation of 'smart village' concept and structural modelled of implementation units should be undertaken, as well as the identification of information needs and the construction of an appropriate information system (Lacković and Ivanović, 2020).

Moreover, lack of leadership (3.06), lack of business case for 'smart villages' (3.09), and lack of incentives and rewards (3.10) are least important challenges for implementing smart village initiatives. Lack of leadership is the second least important challenge for implementing smart village initiatives with a mean value of (3.06). Zhang and Zhang (2020) noted that leadership in the development of smart village initiatives carries out the strategic design, policy

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formulation, capital investment and construction of major engineering facilities for smart villages. Leadership and managing authorities need to ensure that several conditions are in place throughout their territory to support villages in their digital transformation. Various conditions need to be assessed when developing interventions for supporting smart villages, including access to connectivity, mechanisms for involving stakeholders, facilitating access to digital transition, and ensuring cooperation with digital players (ENRD, 2018).

Lack of business case for 'smart villages' is the third least important challenge for implementing smart village initiatives with a mean value of (3.09). Developing smart villages requires adapted concepts, business models and solutions that have to strive to generally improve the well-being of the rural population (Aggarwal et al., 2018; Zavratinik et al., 2018). Moreover, the European Network for Rural Development (ENRD) (2018) highlighted the role of cooperation and bringing together local, regional and national stakeholders to develop a community vision, with social and business cases for the solutions identified.

Finally, lack of incentives and rewards is the fourth least important challenge for implementing smart village initiatives with a mean value of (3.10). Abdul Razak et al., (2013) highlighted the role of incentives and rewards in implementing smart village initiatives. The authors noted that in order to ensure the success of smart village initiative here is a need to firstly identify who are the stakeholders and major players. This is important as not all are ready to be part of the initiatives due to several reasons such as not having business yet, not involved in farming related activities, low motivation and attitude, too old and not interested and also due to the low information and network needs. However, if more time is given to implement the initiatives the change of mind-set and attitude is a must for all the community to ensure any projects and incentive injected will be well received and successful.

On the other hand, technical challenges such as lack of technology (2.88) and lack of resilient and robust digital infrastructure (3.17) also represent a challenge for implementing smart villages agenda. In the smart villages' initiative, technology is as vital as capitalising on infrastructure, entrepreneurial development, social capital and other society needs. The smart villages concept pays attention to the abilities of using e-skills, that can be providing access to health e-services or other basic services supported by ICT (Chui et al., 2017). However, in comparison to urban areas, rural communities demonstrate lower level or sometimes none with regards to accessibility and openness towards using new innovative information technologies. Hence, it is essential to increase the innovative development of rural territories with major participation of social innovations. This can then become the generator of positive changes follow-on in the generation and development of human or social capital that can contribute to the more effective and sustainable implementation of technological innovations in urban areas (Guzal-Dec, 2018).

Additionally, lack of resilient and robust digital infrastructure (with an overall mean value of (3.17) is the fifth most important challenge for implementing smart village initiatives. Degada et al., (2021) noted that the smart village deployment is often complex and suffers low connectivity. Thereby, no single communication technology can serve all the building blocks.



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The connectivity technology should support a wide area range, low power dissipation, support connectivity in all different climates, and can be set up quickly. Moreover, Park and Cha (2019) defined smart village as “a village where new network base is established to revitalize the local economy and service of the region is improved by utilizing ICT and knowledge”. The authors noted the importance of robust digital infrastructure for the implementation of smart villages. According to Park and Cha (2019) smart village platform is a system that collects, stores, analyses, and displays data on basic services of rural villages through high-tech IoT, cloud, big data, and AI.

### The most important smart villages strategies

Smart energy, smart healthcare, smart transport, smart education, and smart water are the top five most important smart villages strategies (see table 4). This suggests that both environmental and social sustainability are of the core concepts of smart villages development. For instance, in this study, with an overall mean value of 3.7, smart energy is the most important strategy for development of smart villages, supporting the notion that smart energy initiatives and developing renewable energy sources are of the core policy fields and represent an essential requirement for the development of smart villages (Juan and McEldowney, 2021).

**Table 4: Level of importance of smart villages strategies**

Smart Village Strategies	Overall	Rank	Public sector	Private sector	$t_{cal}$	Significant value(p)
Smart energy	3.70	1	3.71	3.69	0.149	0.882
Smart manufacturing	3.31	9	3.29	3.35	-0.285	0.777
Smart governance	3.53	6	3.54	3.52	0.089	0.930
Smart education	3.55	4	3.55	3.54	0.147	0.884
Smart transport	3.56	3	3.50	3.40	0.616	0.540
Smart healthcare	3.69	2	3.79	3.61	0.904	0.370
Smart banking	3.39	7	3.32	3.46	-0.650	0.519
Smart water	3.54	5	3.61	3.46	0.670	0.506
Smart housing	3.23	10	3.43	3.00	1.699	0.095
Smart community	3.32	8	3.48	3.15	1.344	0.185

Kammen (2015) noted that smart villages initiatives aim at evaluating how to deliver energy access to rural communities so as to make smart villages a reality. The strategy of efficient usage and optimisation of energy by using wireless sensors, IoT devices, solar panels, and energy storage grid house are the key parameters of smart energy management systems (Mohanty et al., 2020). The production of and access to renewable energy also form the backbone of the entire developmental process as energy access must be integrated into other initiatives for the development of smart villages (Mohanty et al., 2020). Deploying smart technology successfully in rural community energy projects often relies on overcoming particular challenges that face areas with lower populations. For example, smart technology can also contribute to enabling rural communities to harness their renewable energy assets for the benefit of the local population, increasing energy resilience and spurring economic opportunities (Deshmukh, 2017). Furthermore, Letaifa (2015) noted that the use of innovative

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technologies deployed in smart energy strategies such as solar energy and other renewable sources of electricity, can also enhance the natural environment. Therefore, it is evident that smart energy strategies are significantly important to enhance energy consumption by deploying advanced metering, energy storage, and energy management systems. The utilisation of big data analytics enables optimization of energy use on-demand and enhances stable energy distribution (Abdalla et al., 2020).

In this study, overall mean value of 3.69, smart healthcare is the second most important smart villages strategy. Kaur (2016) noted that smart health services are needed to improve the quality of life in the villages. Mobile health services can provide mobile health diagnoses and corresponding healthcare solutions in villages at a reduced cost. The use of IoT in healthcare helps a large number of patients to be diagnosed, and queue from hospitals can be reduced. Furthermore, collection and analysis of epidemiological data will generate early warnings to prevent the spread of contagious diseases in smart villages (Mohanty et al., 2020). The smart healthcare can be used to reach remote places, and citizens in villages can benefit from it (Ram et al., 2020).

With an overall mean value of 3.56, smart transport is the third most important smart villages strategy. Mobility is a critical factor, and a key facilitator of smart sustainable development (Abdalla et al., 2020). As with other key domains for smart villages, mobility is a highly regulated and complex field (ENRD, 2019). ENRD (2019) noted that mobility' is a basic freedom; it is the possibility to access work, education, services, society and everything else that is part of a person's life. In other words, mobility is one of the vital enablers of any community, especially of rural communities where many essential things are located some distance away. Moreover, providing more sustainable forms of mobility can also make an important contribution to mitigating climate change. In the absence of good public transport or shared mobility services in rural areas, many people cannot get around. This serious gap limits their participation in society, their earning potential and their contribution to the economy (ENRD, 2019). Ram et al., (2020) noted that mobility of residents of smart villages can be enhanced by using smart transportation and logistics infrastructure to link the rural and urban areas.

The findings of this study indicate that smart education with an overall mean value of 3.55 is the fourth most important smart villages strategy. Smart villages aim to increase the time available for students to study and will address prevalent factors that negatively affect the ability of students to acquire the knowledge and skills necessary to achieve economic goals and improve labour productivity. These include eliminating the need to spend time collecting traditional biomass, reducing respiratory illness caused by indoor air pollution, and ensuring that lighting is both safe and of sufficient quality (Kammen, 2015). Smart schools will provide a good level of access to the internet and consequently the world's knowledge base, ending the information isolation experienced by many rural communities. New opportunities will be generated for distance and adaptive learning, reducing the need to move to towns or cities to achieve higher levels of education (Kammen, 2015). In this study, smart water with an overall mean value of 3.54 is the fifth most important smart villages strategy. Rural water supplies

have traditionally been overshadowed by urban ones. That must now change, as the Sustainable Development Goals calls for water for all (Omarova et al., 2019). Similarly, in smart villages, households can consume clean and safe water along with nutritious food while minimising the cost of boiling water for drinking.

### **The least important smart villages strategies**

In this study, smart housing (3.23), smart manufacturing (3.31), smart community (3.32), smart banking (3.39), and smart governance (3.53) are least important smart villages strategies as shown in Table 4. The findings of this study revealed that smart housing, with an overall mean value of (3.23) is the least important smart village strategy. In smart villages the homes and buildings can be made smart by the use of sensors and cameras. These will produce real-time data which can be analysed to take necessary actions (Kaur, 2016). Accordingly, Arasteh et al., (2016) noted that smart homes could be monitored by using the data that are generated by the sensors. For instance, innovative demand response (DR) functions can be implemented or by monitoring the pollution, it will be possible to alert customers if the pollution exceeds its marginal limit.

In this study smart manufacturing is the second least important smart villages strategies with an overall mean value of (3.31). However, Maja et al., (2020) noted that the smart rural village would be attractive to manufacturing firms that are likely to set up factories and unlock the rural economy. Smart community with an overall mean value of (3.32) is the third least important smart villages strategies. According to Maja et al., (2020), it is important to note that the concept for urban smart communities is already very well established - e.g., smart cities, but less so for rural communities as the concept smart village has only recently gained momentum; for example, in the EU, the smart village initiative was launched by the European Parliament in 2017, and the EU Action for smart villages document was published by the European Commission together with the European Parliament. Additionally, in this study, smart banking with an overall mean value of (3.39) is the fourth least important smart village strategies. However, Aggarwal et al., (2010) noted that the benefits of e-banking or smart banking and electronic transacting have an increasingly important role to play in rural areas. However, villagers will not use this new IT systems, unless they are made fully confident that their hard-earned money will be secure and safe. For example, providing financial services to rural areas is often very expensive and complex as distance, limited roads, poverty and literacy comes as obstacle in between. Non-availability and inadequate communication have limited the number of people who have access to and use formal financial services, especially those who are very poor or live in rural or remote areas, have been clearly left out of the formal banking system or financial service. Under the circumstances, many rural folks fall in the trap of local money-lenders and get exploited (Aggarwal et al., 2010). Moreover, in this study, smart governance with an overall mean value of (3.53) is the fifth least important smart village strategies. However, Aziiza and Susanto (2020) noted that smart village concept focused on the role of technology in building governance and public services. In developing a smart village, the village government must set a goal, what must be developed first and what will become the supporter.

### **Conclusion and recommendation**

Over 40% of global population still live in rural areas, cities have attracted more attention than rural communities, largely because opportunities, knowledge and power are concentrated in cities. However, the smart villages model has been highlighted as one of the solutions for curtailing the flow of people towards already overcrowded and unsustainably growing cities. Increased attractiveness for rural villages makes smart transformations in rural areas a necessity for developing sustainable smart villages. Improving the lives of rural communities by developing smart villages is a concept analogous to the more familiar smart cities. Thus, revitalising rural communities and making them more attractive and sustainable is possible by using the full potential of information and communication technology (Visvizi et al., 2019). However, empirical research and intellectual debate required for supporting growth and development of people in rural areas have been limited. Therefore, this research fills this research gap. The findings revealed that lack of clear strategies for development of sustainable smart villages, lack of budget, lack of collaboration between stakeholders, lack of knowledge related to smart villages, and lack of resilient and robust digital infrastructure are the five most challenges for implementing smart village agenda. Moreover, the findings indicated that smart energy, smart healthcare, smart transport, smart education, and smart water are the most important smart villages strategies. It supports the notion that beside environmental sustainability, social sustainability aspects are also of the core concepts and major strategic elements of smart villages. It is surprising to see that smart transport declared to be one of the most important strategies. Smart transport is a critical factor, and a key facilitator of smart sustainable development. It is a vital enabler of any community, especially of rural communities where many essential things are located some distance away.

The paper presented a theoretical basis on the concept of smart villages, the deployed smart villages strategies and the challenges for implementing smart villages initiatives. However, this paper has provided key initial entry points, but wider synoptic overviews and in-depth empirical studies are required to examine existing and potential smart villages development. The study findings both from the literature review and the empirical findings show that lack of budget and financial limitations are challenges that need to be overcome in order to have successful smart villages initiatives. Therefore, more effective measures are required to promote investment funds and income generation for launching, implementation and the long-term maintenance. Therefore, where appropriate, a business model for the long-term financial sustainability of the smart village strategy should be taken into account from the start. It is important to note that policies for digital infrastructure are essential conditions for smart villages development. Additionally, the paper concludes that to successfully implement smart villages initiatives, it is necessary to recognise the most important smart villages strategies that reflect and respond to residents' needs and interests. There is also a need to provide training and capacity-building support to village communities and other public sector bodies beyond the traditional approaches to become amenable to innovative implementation models that can support village transformations at a faster pace to build up a framework for self-sustainable smart villages by adjusting the characteristics of each region.

Research in smart villages development is rare. This paper presented a theoretical basis on the concept of smart villages. It provides rich insight into the understanding and awareness of the current smart village strategies and the key challenges encountering organisations implementing smart village initiatives. This research implications are towards informing professionals and policymakers on some of the lessons learnt during the implementation of smart village strategies. Also, this paper contributes to the academic debate on smart village development and provides useful recommendations to both policymakers and practitioners.

Despite the novel insights provided by this study, it has some limitations. Given that the research reported in this paper was based on literature review and small-scale survey therefore the results presented are only tentative and not generalizable. This paper calls for further mixed methods research, especially on issues related to the transformation of villages into smart villages including the need for a holistic approach on policies and strategies toward smart villages. Furthermore, the findings of this paper are limited to the UK context only. Although generalizability outside of this context may be limited, we suggest that the results are relevant to other comparable developed countries. Future work can focus towards exploring the uptake of the smart village agenda worldwide in order to identify similarities and differences between responses in developed and developing countries. In doing so, this research could generate benchmark data to identify effective practices in implementing smart village strategies to promote sustainable growth, contributing towards the mitigation of the urban-rural divide.

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