

# Rural Management and Value Co-creation: Rural Areas of Pakistan and the Digital Age

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**Abstract:** This review investigates the application of digital technologies in rural Pakistan, including a co-creation of value and sustainable development. The article discusses the situation in rural management today, drawing attention to the important role of IoT, wireless communication technologies, and digital platforms in changing agriculture, healthcare, education, and economic activities. It recognizes the barriers of rural communities such as lack of infrastructure, digital literacy and the resistance of culture, which is a barrier to the uptake of these technologies. The review carries success stories of digital and renewable energy projects that have empowered the rural communities, enhancing their resource, information and market accessibility. It further talks about how smart agriculture, financial inclusion, and e-governance can be utilized to build a more inclusive, sustainable rural future. The paper ends with recommendations to overcome the obstacles to digital integration and highlights why policy interventions, infrastructure investment, and partnerships between the government and the business sector are required to achieve inclusive digital transformation in rural Pakistan.

**Keywords:** Value Co-Creation, Rural areas, IoT, Smart Agriculture, ICT, E-government.

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## 1. Introduction

Despite the high population that is living in the rural areas, Pakistan is plagued with a problem regarding sustainable development and governance. These regions are usually typified by the lack of resources, underdevelopment of infrastructural facilities and dependence on outdated sectors of the economy such as agriculture and handicraft. However, nowadays, in the digital age, these issues can be seen as a point of innovation and transformation. According to the demographic distribution in the country as provided by the Pakistan Bureau of Statistics (2017), a significant portion of the population continues to live in rural areas. In particular 59.45 percent of the population in Pakistan is rural and 40.54 percent is urban population. This statistic shows the role that the rural areas contribute to the socio-economic life of Pakistan [1]. The years 1998 to 2017 have shown a stable population growth of Pakistan, with the rural population growth rate of 2.23 per annum and the urban population growth rate of slightly higher at 2.70 per annum. Here we can see that the two populations in cities and in rural areas have been growing, but the urbanization process is growing faster which is a sign that there is a present tendency of rural to urban migration [2].

It is anticipated that this trend of rural to urban migration that is present will keep on escalating and it is estimated that by 2025 over 50 percent of total population will be in the urban population. This is a kind of urbanization that has a significant role in defining the economic future of the country as well as the management of resources. According to experts, urbanization is a key factor in the economic growth of such emerging economies as Pakistan. Indeed, the rate of economic growth increases by 1.1 percent when urbanization increases by 1 percent. This relationship highlights the significance of urbanization in economic development since cities are more likely to have access to industries, services and infrastructure. Nonetheless, the rural locality continues to be an important

area in both the economy of Pakistan, specifically in food and agricultural aspect. Agriculture has been a core contributor to the GDP of Pakistan and rural regions are the source of food production that in its turn provides support to not only the local economies, but also the entire national economy [3].

In this context, rural management can be defined as the implementation of numerous strategies, tools, and practices that target the enhancement of the quality of life, economic welfare, and governance in the rural places. It deals with sustainable use of resources, rural entrepreneurship, community building and governance with aim of enhancing rural livelihoods.

### 1.1. Overview of Rural Management

The role of rural development has gained more stress among the global community, as well as governments and organizations, to realize the Sustainable Development Goals. In the recent past, there has been an initiative to solve poverty issues, hunger, health, education and other significant indicators in the rural regions [4].

Rural regions are geographical areas not in the cities and towns, which have a low population density, open expanses, and agriculture or undeveloped land. Those areas usually do not have large masses of people and communities are scattered instead of compact. Rural areas are usually underdeveloped, in terms of infrared infrastructure and services, compared to urban centers, including detailed public transportation, high-speed Internet connectivity, and special medical institutions [5]. By contrast (Table 1) urban areas are defined by large population density/crowding, densely laid infrastructure, and centralization of services and benefits. Cities and towns are suburban areas that have an established road system, transportation, and other commercial, residential, and industrial structures. These regions are economic, cultural and social service centres, offering its residents greater employment options, educational services and medical care options than the countryside [6].

As defined by the U.S Census Bureau, rural areas encompass all population, housing and area not encompassed in an urbanized area or urban cluster. Urbanized places consist of 50,000 or more people and urban clusters consist of between 2500 and 50,000 people. According to the United

Nations, urban areas are considered as those that contain a minimum population density of 1000 people per square mile and rural are considered as those that do not have urban areas [7].

**Table 1.** Key differences between Rural and Urban [8].

| Aspect                   | Rural Areas                                                     | Urban Areas                                                                       |
|--------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------------|
| Population Density       | Lower density, with dispersed settlements                       | Higher density, with concentrated populations                                     |
| Infrastructure           | Limited infrastructure; often underdeveloped                    | Advanced infrastructure; well-developed transportation, healthcare, and education |
| Economic Activities      | Predominantly agriculture, mining, and small-scale industries   | Diverse economy; includes services, manufacturing, and technology sectors         |
| Access to Services       | Limited access to healthcare, education, and financial services | Easy access to a wide range of services and amenities                             |
| Technological Access     | Limited internet connectivity and digital literacy              | High internet penetration and digital literacy                                    |
| Employment Opportunities | Fewer job opportunities; often seasonal or informal             | Abundant job opportunities across various sectors                                 |
| Social Services          | Scarcity of social services and community support systems       | Extensive social services and community support systems                           |
| Governance               | Often characterized by traditional governance structures        | Predominantly formal governance structures with established institutions          |

Conventionally, rural development was defined as the expansion of farmlands and the emphasis was the magnitude of farm production on the preceding year, or rather, before 1970. By the early 1980s, it was being described by World Bank as a strategy that sought to improve the economic and social living standards by a particular group of poor population residing in a rural context (Harrison). It helps the poorest group of people residing in rural areas to be beneficiaries of development” [9]. But the term in the present-day context applies to development in rural areas in general which encompasses the provision of all facilities to high quality healthcare, education and other related services, availability of markets, well established infrastructure, enhanced production and increased job opportunities in the environs [10]. The concept of rural development began to be applied in a broad sense as the paradigm of economic development moved away in meaning and became called development rather than growth.

Development in the rural life context is not just the pursuit of the rate of economic growth, but rather the complete voyage considering the complex strands of social inclusivity, environmental sustainability, and rich culture [11]. Rural development is based on the understanding that the core of a country is not only in the busy cities, but also in the peaceful coexistence of the various landscapes and fertile lands of the rural areas. Rural locations may be a hot spot in terms of development provided that priorities of the individual towns can be well established. In another words, geographical background and even farming potential can make the rural territories the hot spots; tourism, as the general development strategy of the territories, cannot possibly be the sole factor that saves the sustainable rural development. The term hot spot is often used in the ecological sciences and, more recently, in the literature on innovation to refer to a site that is essential to its sustainability and development [12].

Rural management is concerned with the betterment of the living standards and socio-economic conditions within the rural regions through the resolution of different aspects of developmental problems. This includes proper exploitation of natural resources, promotion of sustainable livelihoods and basic infrastructural developmental programs like roads, schools and health facilities. Another aspect of rural

management is empowering the local governments, enhancing the economic positions and forming partnerships that may lead to a more inclusive growth model [13].

The management of rural areas in Pakistan is now further burdened by the population increase, climate change and inability to access modern technology. Digital solution introduction, thus, is a revolutionary instrument that could solve these issues by providing greater access to information, markets, and services [14].

One of the concepts that have actually transformed significantly in the last few decades has been rural development. In the past, rural development was equated to the development of agriculture, and its primary focus was to increase the agricultural productivity. However, in more recent times, there has been dispersal of rural development not only to increase in income, agricultural output and production but living standards have also been developed. Such a broad perspective encompasses health and nutrition gains, education, environmentally safe living conditions, and a reduced number of cases of gender and income inequality [15].

## 1.2. Agriculture and Pakistan’s Economy

Pakistan still depends on agriculture as the basis of the economy. It includes not only the crop output but also the livestock output and remains an important part of the country economy. As of the most recent data. Agriculture provides a contribution of 25 percent of the GDP, which directly employs 44 percent of the total labor force. The industry contributes to almost 65 percent of the national export income and 67 percent of the foreign exchange lives directly or indirectly associated with agriculture. In addition to the direct inputs, agriculture provides the raw material of other domestic agro-based industries such as sugar, vegetables, leather and textiles.

### 1.2.1. Significance of Rural Population and Economic Development

This is especially important in Pakistan, where 67 percent of the population resides in rural regions most of whom directly or indirectly rely on agriculture to sustain their livelihoods. This implies that the agriculture sector not only forms the backbone of the economy but it also serves as a central point in determining the wellness of most people in

Pakistan.

Pakistan has a large agricultural sector which contributes to the overall economic growth. In addition to its direct contribution to increasing income and alleviating poverty, the agricultural sector has an indirect impact on the rural economies by creating non-farm growth. When peasant farmers grow the level of income by growing the agricultural sector, they usually spend a considerable proportion of their increased income on non-agricultural commodities produced locally. Such consumption spurs additional employment and income earning towards the rural localities.

The expansion in the non-farm sector is also directly linked to agricultural expansion because as more goods are needed in the rural regions, the multiplier effect takes place. The resulting impact of this effect is more people are employed thus making it a prime poverty alleviation vehicle (Maqbool & Bashir, 2009).

#### **1.2.2. Connection between Agriculture and Rural Development**

This interdependence of agricultural growth and non-farm growth reiterates the critical importance of agriculture in improving rural livelihoods, as well as, in creating impetus to other economic activities in the rural areas. Agriculture, however, remains central to the rural development process in Pakistan not only as an economic activity but as a way of enhancing the social and economic status of its people [16].

### **1.3. Potential for Digital Transformation in Rural Areas**

With the advent of digital technologies, it is a promising future of rural Pakistan to overcome a portion of its developmental problems and pass to a new level of economical and social evolution [17]. It has the ability to offer new opportunities of economic participation, skills training and rural prosperity. The digital transformation presents certain opportunities like:

**Telemedicine and Health Services:** The challenge of healthcare within rural communities is rather extensive, as there is a lack of access to professional care and healthcare centers. Nevertheless, new digital health technologies like telemedicine will allow rural communities to remotely access consultations, health education, and diagnostic services. This would significantly enhance healthcare delivery in rural areas where hospitals and experts are not easily accessible [18].

**E-Governance and Digital Services:** The integration of digital technologies into governance processes can significantly improve the delivery of public services. E-governance initiatives can help streamline administrative processes, improve transparency, and enable remote access to government services such as healthcare, education, and social welfare programs. Rural residents can also use the digital platforms with ease to interact with the formal economy and

avail government schemes [19].

**Access to Information and Education:** With the digital age information has become more accessible than ever. Online access to educational resources, skills training sessions, and professional training courses can be very useful to rural populations. Through mobile phones and internet connectivity, young people in rural areas will be able to learn new skills, access on-line learning programs, and engage in knowledge economies, which will help them break the poverty trap [20].

## **2. Concept of Value Co-creation**

Another significant aspect of rural development is value co-creation, which contributes to ensuring that not only effective solutions are made, but also sustainable and inclusive [21]. Value co-creation has taken a different dimension particularly in the rural development. The value creation process was traditionally seen as linear in which the company or service provider would create value and the consumer could just consume it. In recent years however, the emphasis has been on a more interactive and collaborative process which involves more than one stakeholder.

In one of the paper Impact of Value Co-creation Behavior among Banking Customers of Pakistan [22] as shown in Figure 1, it is clearly seen that it does have hypothesis testing for the feedback and response.

### **2.1. The Importance of Value Co-creation in Rural Development**

Value Co-creation is described as the process of having different stakeholders including rural communities, businesses, government, and non-governmental organizations (NGOs) coming together to generate common value. Co-creation is also based on mutual participation and collaboration among all parties compared to traditional models where value creation is usually a top-down mechanism. Literature terms Co-creation as the phenomenon to resolve a common problem or an activity that subsequently generates a value to the co-creating partners as a result of constructive sharing of competences, resources, ideas and knowledge by public and private actors [24]. Value Co-creation is one of the most effective ideas that have come up in rural management in recent times. This will entail involving the rural communities in the development, upgrading and realization of value in manners that are mutually advantageous to all parties concerned such as local communities, local businesses as well as service providers. The digital age has brought a special chance to develop this process further with the help of incorporating technology into the rural management systems to develop a more efficient value creation and increase possibilities to develop this area locally [25].

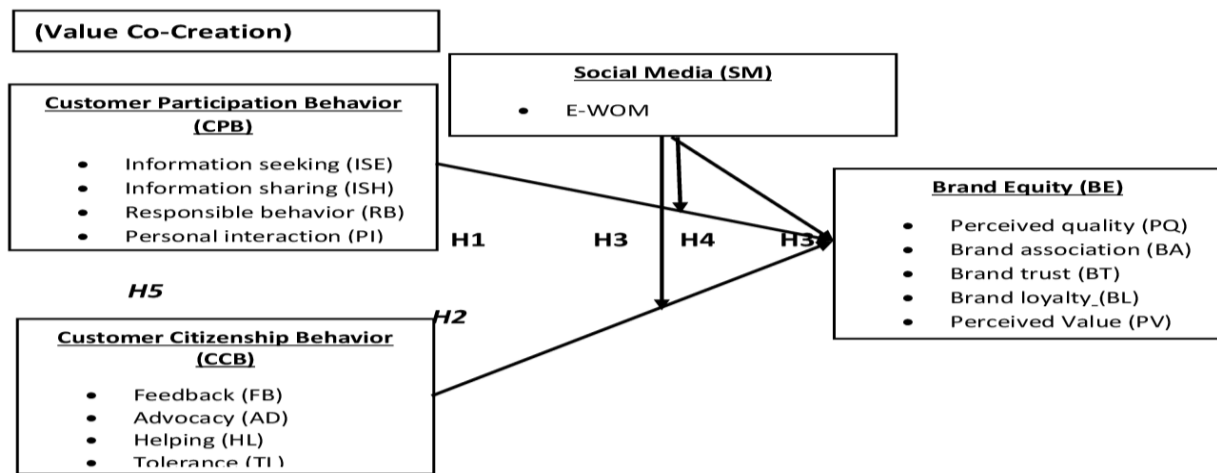


Figure 1. Value Co-Creation for bankers and their feedback [23]

**Empowering Local Communities:** Empowerment of local communities is one of the biggest benefits of value co-creation [26]. Whenever the rural populations are incorporated in the decision-making and implementation processes, they take ownership and responsibilities. This agency increases the levels of participation and sustainability in development projects [27].

**Sustainable and Contextual Solutions:** The co-creation of value can be applied to ensure that solutions that have been implemented are sustainable, and, in addition, they are contextually relevant. Local communities, through their lived experiences, often know the most about their own environment and needs. By collaborating with experts, these insights can lead to the development of solutions that adapt to local contexts, ensuring that they are both feasible and sustainable. For example, a rural community in Pakistan may benefit more from a solar energy solution tailored to its geographic conditions and social structure than from a one-size-fits-all solution imported from abroad.

**Improving Economic Growth and Reducing Inequality:** The rural development co-creation of value can also enhance the economic opportunities and reduce the inequality. Co-creation also fosters local entrepreneurship since local businesses, entrepreneurs and farmers are involved in value creation, and which also spurs up local economies. Moreover, it can be used to narrow income and gender disparities, because marginalized groups are usually able to engage in the process in manners that they would not otherwise be able to do. Co-creation of solutions by rural communities puts them in a better place to keep the benefits within their respective local economies, lessening their dependence on external assistance and driving up long-term development.

**Enhancing Innovation through Collaboration:** Co-creation fosters innovation by bringing together diverse perspectives and expertise. Rural areas, while often lacking in resources, possess rich indigenous knowledge about local agricultural practices, environmental management, and community needs. By combining this with external expertise—such as modern agricultural technologies, renewable energy solutions, and innovative business models—new, more effective solutions can be developed. For example, introducing smart agriculture technologies in rural Pakistan could be more effective if local farmers contribute their knowledge of soil types, crop cycles, and irrigation practices.

## 2.2. The Role of Local Communities in Value Creation

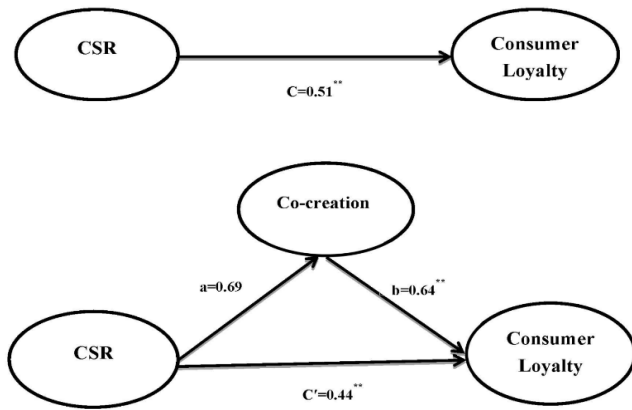
**In rural areas, local communities are the cornerstone of the value co-creation process.** Without their active participation, development efforts are more likely to fail or be unsustainable. Rural populations are not passive recipients but should be seen as partners in development. They are not just the beneficiaries of the projects they are the core of the design, implementation, and success of the initiatives in the long run.

**Community-Based Solutions:** The contribution of the local communities to rural development will result in more specific solutions that are practical and relevant. In other instances, local input is precious in deciding the right technology or infrastructure that should be used in a particular region, e.g., in the implementation of the renewable energy project such as solar or wind power. Local entrepreneurs, farmers and community leaders can see exactly what is needed in their area, be it solar-powered irrigation systems or small-scale wind turbines in unconnected communities.

**Empowering Local Ownership and Accountability:** Co-creation can enable the people in the rural areas to feel a sense of ownership by engaging them in the process of developing an area. This will make the development projects successful and sustainable. In cases where communities participate in the design and implementation of the project, chances are high that they will be responsible in ensuring the maintenance and the project success in the long run. As an example, in rural electrification activities, by engaging the local communities in renewable energy systems installation and operation, renewable energy systems will have a higher maintenance and will be in operation longer.

**Better Quality of Life:** Value co-creation instantly enhances the quality of life of rural population. It guarantees that development is not only focused on boosting the economic production but also on enhancing health, education, living standards and curbing inequalities. Co-creation of value through collaboration results in more inclusive growth which is beneficial to all members of rural communities, particularly women, youth and the marginalized members of the society. In Figure 2 the findings facilitated the suppositions that CSR and co-creation are best connected with consumer loyalty. Past research has demonstrated that involved consumers in the development of value-added products tend to be more loyal to a bank. Loyalty may be readily regarded as high commercial connection between reproduction and purchase of a product/service, which is conditioned by social

conventions and conditions.



**Figure 2.** Direct and Indirect effect models. \*\* means beta values are significant [28]

### 3. The Digital Age and its Impact on Rural Pakistan

The digital age has brought about massive changes in every sector of the society such as agriculture, health, education and governance. In Pakistani rural, where most people continue to depend on the traditional sectors like farming, the digital revolution has enormous potential. Although there are some obstacles to digital adoption in rural settings in Pakistan, the digital transformation potential can contribute to the creation of more inclusive, sustainable, and efficient rural development [29].

### 4. The Role of IoT in Rural Development

The Internet of Things (IoT) is the network of interconnected devices, which collaborate with one another using the internet. IoT technologies can also greatly contribute to the rural development and value co-creation, by offering real time data, managing resources better, and offering an unexploited opportunity in the economic growth. IoT can lead to significant changes in agriculture, infrastructure, and general resources management in rural locations where the conventional systems tend to be inefficient and their accessibility. In this section, the author will discuss two keyways in which IoT can be used to benefit rural development: Smart Agriculture and IoT Infrastructure and Resource Management. In the age of digital technology, the Internet of Things (IoT) is defined as a network of connected devices that can communicate with one another over the internet. These "things" which can include everyday objects, machinery, and even vehicles are equipped with sensors, software, and other technologies that allow them to identify, detect, network, and process data across a network. The goal of IoT is to enable these objects to share data and interact in real-time, thereby achieving specific objectives like improving efficiency, optimizing resource use, and enabling automation.

#### 4.1. IoT for Infrastructure and Resource Management

IoT also plays an important role in the management of infrastructure and resources within the rural setting. Infrastructure is poorly developed in rural regions and access to these amenities like electricity, water, and waste disposal is scarce. The IoT can help address these issues because it can

implement innovative solutions to make resources more efficient, better serve the clientele, and be sustainable enough to develop [30].

**Energy Management:** Smart grids and renewable energy technologies driven by IoT can be of great help in enhancing access and efficiency of energy in rural settings. As an example, the IoT systems based on solar power can track the performance of solar panels, track energy generation, and optimize energy distribution depending on demand. Smart grids can facilitate real-time observation of energy consumption, which enables to distribute the load better and avoid power interruptions. This is especially relevant in off grid rural locations that are highly dependent on renewable sources of energy.

**Water Resource Management:** IoT can be used to enhance water management and conservation in rural communities, especially in areas where there is a shortage of water. Smart water meters and flow sensors would be able to track water consumption in real time, identify the leaks, anomalies, and inefficiencies of the water distribution system. Water can also be managed using IoT-based solutions to facilitate irrigation to ensure that farmers get the correct amount of water at the correct time saving waste and conserving resources.

**Waste Management:** The IoT application can improve rural waste collection and disposal through smart bins that detect fill level and schedule their collection services. This saves on the cost of operation and ensures that the waste is disposed of in a friendly way to the environment. Also, IoT can be used to monitor the kind of waste that is being generated so that improved recycling strategies and less environmental impact due to waste buildup in the rural areas can be realized [31].

**Smart Rural Infrastructure:** Smart transportation systems IoT can be used to streamline the movement of goods and services in rural locations and minimize travel duration and improve connectivity. As an illustration, vehicles with GPS and traffic monitoring systems can give real-time information regarding road conditions and can optimize transportation routes of agricultural products to enhance the efficiency of rural supply chain.

Statista predicts that in the period of 2024-2028, the Internet of Things (IoT) sector in Pakistan will bring an estimated revenue of between \$7 billion and 16 billion annually. This shows the potential that is fast increasing in the country in regards to IoT. Currently, one can find more than 40 startups in Pakistan that offer IoT-based services, both locally and globally, which evidences the growing interest and investment in IoT technologies. In January 2023, a major step towards the development of the IoT field was made after the Pakistan Telecommunication Authority (PTA) required all telecommunications companies operating in the country to switch to the IPv6 protocol to provide internet services. The decision will contribute to the elaboration of the IoT ecosystem in Pakistan since IPv6 provides increased addresses space to devices involved in the interconnection, which is essential in the context of the unstoppable increase in the number of IoT networks [32].

#### 4.2. Smart Agriculture and IoT Applications

The economy of Pakistan relies heavily on agriculture as it is the source of the country GDP and provides jobs to a significant number of rural workers. Nevertheless, the industry is witnessing several challenges such as poor utilization of resources, climatic changes, and labor shortage, which are disadvantageous to its growth and sustainability.

According to estimates by the Asian Development Bank (2017), in 2011, 210 million people were living in Pakistan, with 12.4% of the population in rural areas living in poverty. Families in these rural areas live on subsistence farming, social handouts and remittances sent by their relatives in urban areas or in the mines, and most of their earnings are agricultural. The use of Internet of Things (IoT) technologies may have a significant positive impact on these rural

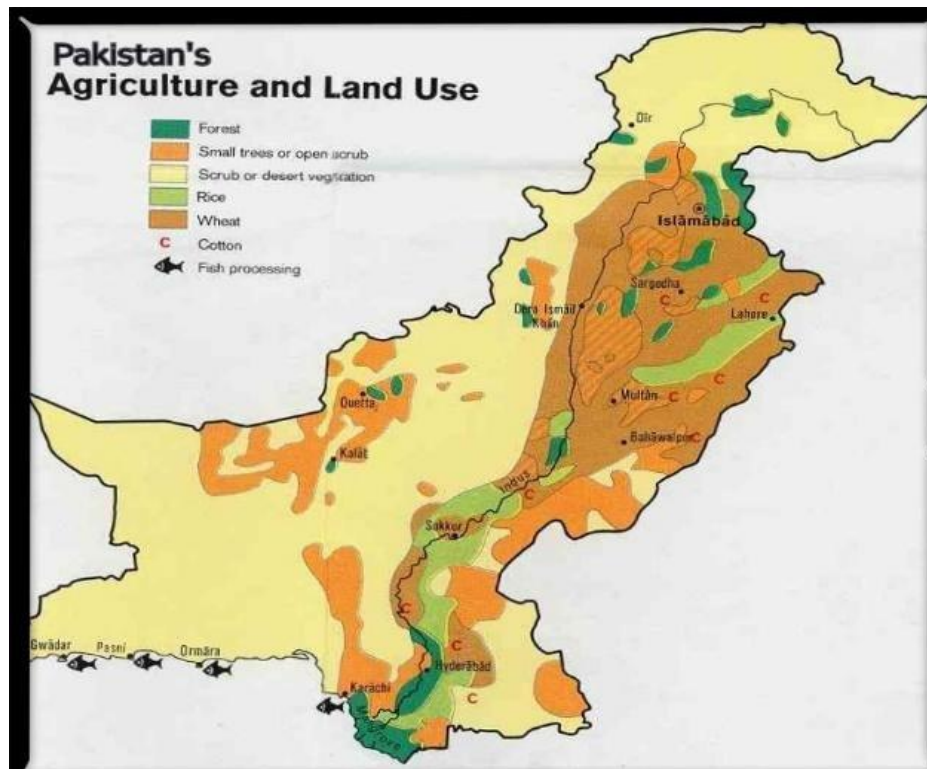
communities by providing access to agricultural supplies, empowering the rural communities to access the marketplace of growing produce, simplifying the management of rural transportation by the farmers, and increasing access to the development services. IoTs can also provide farmers with critical information on agricultural practices and weather forecasts, thereby helping to mitigate agricultural risks and improving overall farming efficiency(Shafique et al., 2019).

**Table 2.** Comparison between livestock in Pakistan and Afghanistan [33].

| Country     | Country's Population | Rural Population (2016 Census Report) | Population of Livestock (Million)     | Revenue Impact on GDP |
|-------------|----------------------|---------------------------------------|---------------------------------------|-----------------------|
| Pakistan    | 210 million          | 60.78%                                | Cattle: 46.1, Goat: 74.1, Sheep: 30.5 | 11.4%                 |
| Afghanistan | 37.2 million         | 72.87%                                | Cattle: 3.7, Goat: 7.3, Sheep: 8.8    | 15%                   |

The emergence of the Internet of Things (IoT) technologies offers a radical chance to solve these issues and improve the performance of agriculture(Khan, 2025). The paper will explain the ways in which the implementation of IoT in

agriculture in Pakistan would lead to smart agriculture systems, which would lead to increased sustainability and productivity in the agricultural sector.



**Figure 3.** Map of Pakistan agriculture and land usage [34]

### 4.3. Key Components of IoT in Smart Agriculture

IoT in agriculture can be implemented through the use of different interconnected devices that have the ability of collecting, monitoring, and analyzing data in real-time. IoT-based smart agriculture systems consist of some important components:

**Sensors:** IoT sensors in the fields or on equipment are used to gather information on a variety of parameters, such as soil moisture, temperature, humidity, and crop health. These sensors give farmers on-going feedback enabling them to make informed decisions.

**Automation Systems:** IoT-driven automated systems can be used to control irrigation, fertilization, and pest control. Such systems work on the information obtained through sensors, and the ability to make the resources efficient minimizing waste and expenses.

**Cloud-Based Platforms:** The data transmitted by the IoT devices goes to the cloud-based platforms where it is processed and analyzed. The farmers can access this data via mobile applications and monitor and have control over their farming practices in real-time.

**Data Analytics:** Advanced algorithms and machine learning models are used to analyze the data that is collected by IoT devices. The analysis will assist the farmers in forecasting trends, e.g. the condition of the climate or the performance of their crops so that before harvest, they can make early decisions that will enable them maximize yield [35].

### 4.4. Challenges to IoT Adoption in Pakistani Agriculture

Nevertheless, despite the many advantages, there are various obstacles that fail to allow the large scale adoption of the IoT technologies in agriculture in Pakistan:

**Infrastructure Limitations:** This is a big challenge to the implementation of IoT-based agricultural solutions because of the poor internet accessibility in most rural regions in Pakistan. IoT in the agricultural field depends on the presence of a powerful telecommunications infrastructure that will facilitate the transmission and processing of real-time data.

**High Initial Costs:** The installation of IoT systems requires significant upfront investment in sensors, devices, and cloud infrastructure. For small-scale farmers in Pakistan, this can be a barrier to adoption, as the initial costs may outweigh the perceived benefits.

**Technical Support and Maintenance:** This is because IoT systems need continuous upkeep and technical support, which might not be easily accessible in rural settings. This deficiency of local knowhow may leave farmers struggling to diagnose problems and keep their systems running.

**Digital Literacy:** Rural farmers in Pakistan lack the digital literacy needed to operate and benefit from IoT technologies. Providing training and support to farmers is essential to ensure they can effectively use these technologies to improve their agricultural practices.

## 5. Case Studies of Digital Value Co-creation in Rural Pakistan

### 5.1. Success Stories of Renewable Energy Initiatives

#### 5.1.1. Muzaffargarh Solar Power Project

A proposed solar power plant in Muzaffargarh, Pakistan is the Muzaffargarh Solar Power Project which has a capacity of 600 MW. It will produce inexpensive and clean power

through solar energy. The project belongs to the governmental initiative to produce 10,000 MW of solar energy in the country, and the first pilot initiative started in Muzaffargarh [36].



Figure 4. Muzaffargarh solar project [37]

#### 5.1.2. Balochistan Renewable Energy Development Study

The Balochistan Renewable Energy Development Study is aimed at the strategic development of the utility-scale solar and wind power in Balochistan, Pakistan. The research will create interest and political dedication to the development of renewable energy resources in the area.

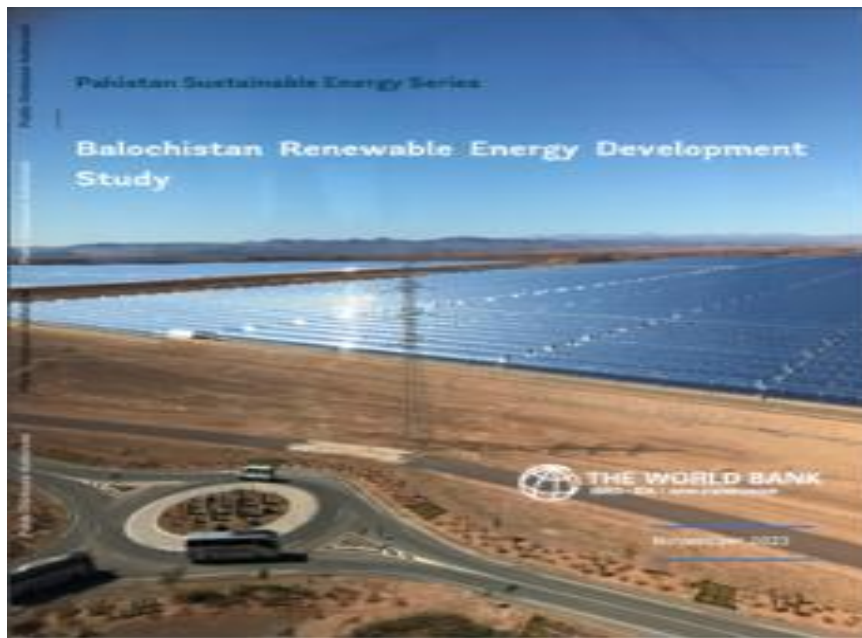


Figure 5. Balochistan power development [38]

#### 5.1.3. Distributed Renewable Energy Systems for Resilient Development

The current research introduces the relevance of energy access by the way of distributed energy systems (DESS) to resilient and sustainable development by using two projects case studies of Pakistan. The projects illustrate how DESS can offer stable and sustainable energy solutions in the rural population, which increases resilience and sustainable development.

#### 5.1.4. Hybrid Renewable Energy Systems in Bannu District

One study is aimed at the development of a rural hybrid renewable energy system (HRES) to deliver a stable power supply to a remote village in the Bannu district in Pakistan. The HRES incorporates solar, wind and battery storage in order to make sure that intelligent energy is readily available, and that there is a sustainable energy source in rural environments to overcome the energy accessibility issue.

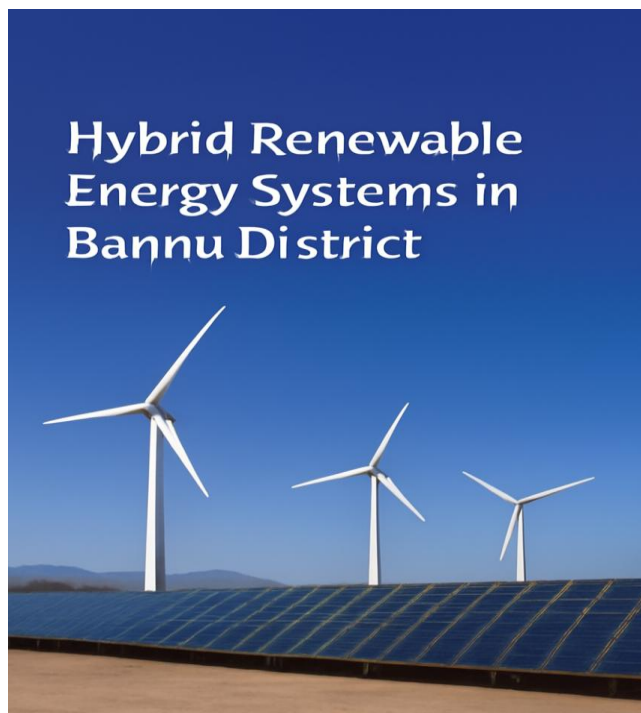


Figure 6. Hybrid system in Bannu district [39]

## 5.2. Innovative Digital Solutions for Rural Empowerment

### 5.2.1. Digital Financial Literacy for Rural Women

One of the studies focuses on the efficacy of a digital intervention based on financial literacy to enhance financial knowledge, confidence, and financial behavior in rural Pakistani women. The intervention applies digital interventions to provide financial education and empower women to make sound financial choices to improve their financial well-being.

### 5.2.2. Digital Literacy for Rural Women's Empowerment

The review discusses the ways in which rural women in Pakistan can be empowered through digital literacy, particularly in relation to infrastructural, socioeconomic and cultural obstacles, which hinder the achievement of such empowerment. The review recommends that digital literacy programmes have the potential to increase economic independence, social interaction and community involvement of women and thus empower them overall.

### 5.2.3. Digital Wallets and Financial Inclusion

A paper examines the connection between digital wallets use and financial inclusion and economic empowerment in rural Pakistan. The results show that digital wallets lead to financial inclusion and deliver financial services to rural populations and support economic empowerment.

### 5.2.4. Mobile Technology for Rural Women Farmers

This research paper explores how mobile technology can empower rural women farmers and how it can be used to facilitate inclusive agricultural development. The paper identifies the role played by the mobile technology, allowing the rural women producers to be more independent in the agricultural sector, participation in the market, enhanced social bonds, and sustainable agricultural development.

## 6. Barriers to Digital Integration in Rural Areas

### 6.1. Infrastructure and Resource Limitations

The rural environments in Pakistan have a high-level digital integration problem because of poor infrastructure and resources. Key issues include:

**Limited Internet Connectivity:** In the rural areas of Pakistan, only 22% of the population has 4G connectivity, and some parts of the country, such as the Thar Desert in Sindh, do not have any internet connection at all.

**Electricity Shortages:** Frequent power outages disrupt digital services and hinder the operation of digital devices.

**High Costs:** The affordability of digital devices and data plans remains a barrier for many rural households.

**Lack of Technical Support:** Limited access to technical assistance and maintenance services for digital devices and infrastructure.

### 6.2. Cultural and Societal Resistance to Technology

Cultural norms and societal attitudes also play a significant role in hindering digital integration in rural areas:

**Gender Norms:** In many rural communities, women face restrictions on technology use due to patriarchal norms. For instance, 40% of female mobile users in rural Pakistan require permission from male household members to use mobile phones.

**Social Isolation:** Inadequate digital infrastructure contributes to social isolation, limiting access to information and communication channels.

**Lack of Digital Literacy:** Low levels of digital literacy among rural populations prevent effective utilization of digital tools and platforms.

**Fear of Technology:** Some individuals perceive digital technologies as complex or threatening, leading to resistance to adoption.

## 7. Conclusion and Future Perspective

In the final section, we will conclude with the main findings on rural development and digital transformation in rural Pakistan and discuss the future perspectives of rural management and value co-creation. To overcome the difficulties of rural communities, the introduction of digital technologies, particularly in such areas as agriculture, health, and education, is critical. It gives them chances to get into the digital economy and avail services hitherto inaccessible.

## 8. Conclusion and Future Perspective

In the final section, we will conclude with the main findings on rural development and digital transformation in rural Pakistan and discuss the future perspectives of rural management and value co-creation. To overcome the difficulties of rural communities, the introduction of digital technologies, particularly in such areas as agriculture, health, and education, is critical. It gives them chances to get into the digital economy and avail services hitherto inaccessible.

### 8.1. Key Findings on Rural Development and Digital Transformation

Technological Advancements in Rural Areas:

The combination of IoT, 5G, LTE, and satellite

communication technologies are transforming rural locations, enhancing connectivity, productivity, and efficiency in agriculture and other places. Digital technologies such as mobile applications and e-commerce tools are empowering rural communities by making markets, education resources and financial services accessible, creating more economic opportunities in rural communities.

#### Increased Agricultural Efficiency:

IoT-based precision farming and automated irrigation systems have shown great promise in optimizing the use of resources like water and fertilizers, reducing costs, and improving crop yields. Smart farming technologies are providing real-time data on weather patterns, soil moisture, and pest management, helping farmers make more informed decisions and increase their productivity.

#### Rural Empowerment through Digital Literacy:

Digital literacy programs have proven that equipping rural citizens and women in particular with the knowledge to utilize digital technologies could result in increased social inclusion, economic and livelihood empowerment. Mobile-based financial services are also enhancing financial inclusion in rural environments where farmers and entrepreneurs have access to credit, savings and insurance services that they could not access before.

#### Improved Access to Healthcare and Education:

Through telemedicine and e-learning platforms, rural regions are being able to access the services and resources that were previously only accessible to them based on geographical or financial barriers. The digital tools are also helping in improving the health of the people by ensuring that information on preventing diseases, immunization dates, and nutrition is delivered to the rural population on time.

#### Barriers to Digital Integration:

Poor internet connectivity, expensive rates, and technical support are some of the infrastructure constraints that continue to pose significant obstacles to the digital revolution of rural Pakistan. This is because cultural and social resistance to technology especially among women still inhibits the maximum use of digital tools in the rural setting.

## 8.2. Future Directions for Rural Management and Value Co-creation

#### Investment in Infrastructure and Connectivity:

To ensure the digital revolution becomes universal, more investment in infrastructure, in particular broadband internet and mobile connections, is necessary. The growth of 5G services and fiber-optic cables will put a stop to the digital divide within the rural areas. Public-private partnerships One solution to bridging the infrastructure gaps may be through investing in rural broadband projects and offering affordable smart devices and data plans.

#### Enhanced Digital Literacy Programs:

The enhancement of digital computers and related things. The programs need to be designed in such a way that they address the needs of rural communities in such a way that they are able to enjoy maximum benefits of digital tools in agriculture, business, and education. Training programs should be also aimed at developing vocational skills so that youth in rural areas could also get better jobs and help to develop the local economy.

#### Policy Support for Sustainable Development:

Policies should be put in place by governments that support sustainable digital solutions in agriculture, healthcare, and education to ensure that digital solutions are utilized in a

manner that is environmentally and economically sustainable. Policy frameworks should also be used to encourage the use of green technologies in the countryside, including agro-based solar-powered IoT and off-grid-based sustainable energy solutions.

#### Promoting Inclusivity and Gender Equality:

Special emphasis is to be put on gender equality in accessing digital. This also involves the digital empowerment of women in the rural setting by means of special training programs and gender-sensitive policies. Here, the strategies should be directed at eliminating cultural hindrances that limit the use of digital technologies by women and create a setting in which women can contribute to digital value co-creation to their fullest extent.

#### Collaboration for Effective Development:

One of the most important success factors to achieve inclusive and sustainable digital transformation is the cooperation of governments, businesses, NGOs, and local communities. It is necessary to cultivate the emergence of digital ecosystems between stakeholders to enable smart rural development, farm-productivity, and economic empowerment.

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