International Journal of Academic Research
P-ISSN: 2348-7666: Impact Factor: 6.023
Homepage: https://www.ijar.org.in/
Volume-12, Issue-3(4), Jul-Sep-2025

TRANSITIONS TOWARDS SUSTAINABLE AND RESILIENT RURAL AREAS IN REVITALISING INDIA - A FRAMEWORK FOR LOCALISING SDGS AT GRAM PANCHAYAT LEVEL: ISSUES AND INTRICACIES

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Abstract:
Twenty-first century rural development (RD) demands a new paradigm of sustainability capable of addressing the difficulties and leveraging on the possibilities, such as climate change, demographic shift, international competitiveness, and rapid technological progress. Amidst these challenges, it is necessary to have a guiding framework from a long-term perspective that aids the integration of current RD policies while allowing space for location and community-specific innovations for implementing sustainable and resilient development strategies. India has witnessed several schemes and programmes for RD with exclusive objectives, varied focus areas, and separate domains, resulting in compartmentalization in policy frameworks and disjointed implementation. Such initiatives were also often ideated from an urban perspective when it came to peri-urban rural areas or offered a generalist rural perspective (when referring to other rural regions, including those nested in ecological zones, thereby disregarding their local relevance). Accordingly, this study proposes a synchronized SMART village framework to tailor existing RD approaches for sustainable transformations aligned with the sustainable development goals and with a possibility of scaling its applicability in the local context. We initially conducted a bibliometric analysis to gain a comprehensive understanding of the emerging transformative approaches to RD, such as smart village (SV). Though in its nascent stage, the SV initiatives in India primarily envision information and communication technology enabled transformations in rural areas, often forcing villages to establish the relevance of such interventions. The study recognizes key challenges to RD in India by using the problem tree analysis and further defines a SMART village framework that can be catalytic in transforming rural areas towards a sustainable and resilient state**?**
Keywords: smart village; sustainable rural development; rural vulnerability; SMART village framework; PRISMA analysis; problem tree analysis.

1. Introduction

Over the centuries, varying social, economic, and ecological forces have catalyzed numerous transformations in how human settlements are shaped and operated [1]. The ever-exacerbating human actions have impacted the earth's natural resources and outpaced the planet's carrying

capacity [2]. The resultant global challenges such as climate change, resource depletion, environmental degradation, and their local ramifications, such as conflicting resource sharing between regions, differentiated developments of urban and rural areas, unemployment, malnourishment, and poverty [3], make it imperative to search for holistic approaches for the development planning of underdeveloped regions.

Rural regions, particularly in the Global South, are inherently vulnerable due to their persisting poverty traps, social stratifications, population decline, predominant nature based livelihoods, administrative incompetence, weak planning, and geographic isolation [4]. Addressing these androgenic vulnerabilities becomes imperative and calls for an alternative development framework to ensure rural sustainability under rapidly changing risk landscapes. Various platforms have long advocated a need for synergetic frameworks emphasizing natural resource conservation and well-being to achieve sustainable development. In the year 2015, the global community adopted three ground-breaking agreements, namely the '2030 Agenda for Sustainable Development' [5], the 'Paris Climate Change Agreement' [6], and the 'Sendai Framework for Disaster Risk Reduction 2015–2030' [7,8], to promote the assimilation of sustainable development principles into policy. Although efforts are being made, the far-distanced goal of localizing these frameworks and converting them into actionable plans for rural areas remains challenging [9]. In addition, there is a need to promote a consistent approach to the three global agendas' planning, execution, and reporting that will allow for more efficient use of resources, improved planning, and enhanced impacts of various initiatives. It will also assist in reducing future conflicts and ineffective execution of policies, allowing for the more efficient and productive achievement of shared agenda goals.

Against this backdrop and in line with sustainability and resilience, this research aims to define a framework for the future-ready development of rural regions, particularly at the Gram Panchayat level, which is a basic governing institution in Indian villages. This is in response to the country's rapidly transforming economy and the sustainability challenges faced by rural settlements. India's large and expanding economy, expected to become the third largest in the world by 2030 [10], is based on government economic reforms over the past three decades that promoted growth through liberalization, privatization, and deregulation [11]. Additionally, India has a thriving start-up environment with innovations and technology and is home to some of the world's most pioneering and dynamic companies in the IT, pharma, and renewable energy sectors. Thus, science and technology (S&T) and information and communication technology (ICT) has helped transform the country's economy from a traditional agrarian-based economy to a knowledge-based one. These efforts are also touching the transformations in rural sectors through government policies leveraging S&T innovations for safe and alternative livelihood, better service delivery, and improved quality of life for the rural populace.

Over the years, the Indian government's objectives for RD have changed from survival to safety and in recent times are focused towards sustainable development [12] across multiple sectors, including agriculture, infrastructure, micro finance, community, and environmental conservation. Resultantly, to bring the vision of sustainable RD to reality, the government of India recently suggested many policies, schemes, and programme initiatives [13]. The smart villages (SV) approach is one of them. According to different institutions and organizations, such as the United Nations Development Programme (UNDP), International Telecommunication Union (ITU), and European Union, the SV concept primarily relates to the use of S&T and ICT along with essential local assets to improve the provision of rural amenities in a highly effective

manner [14]. For instance, Digital India, 2015 and the Shyama Prasad Mukherji Rurban Mission (SPMRM), 2016 are two initiatives that seek to promote sustainable RD by leveraging ICT and S&T. These initiatives aim to enhance economic, social, infrastructure, and environmental dimensions in rural areas, while also striving towards achieving the SDGs [15]. Along with the central government's initiatives, several state governments have indicated an interest in SVs, as further elaborated in Section 2.4, and are working to make them a reality through public-private partnerships [16].

The notion of SV has evolved into a globally accepted approach for enhancing the rural quality of life and addressing growing developmental concerns [17]. While SV is not a novel concept, it lacks a widely acknowledged definition. However, the concept of SV states that "local resources and technology should function as drivers for development [18], allowing education and local business possibilities, increasing health and welfare, promoting democratic involvement, and boosting the standard of living for people of rural villages" [19]. Accordingly, the innovative aspects of development are often correlated with other elements, such as the SDGs [20].These address, individually, sustainability, well-being, access to green energy, education, management of water resources, women's and girls' empowerment, sustainable economic growth, dignified employment, ensuring resilient infrastructures, supporting innovation, and reducing inequities [21]. Thus, at its core, SV intentionally increases participatory democracy, security, and gender equality while providing clean water, sanitation facilities, a nutritional diet, and establishing efficient jobs [14].

However, applying scientific and technological instruments to transforming rural regions in India poses several challenges towards its implementation and sustenance. Several studies have expressed concern for the urbanization of rural regions as a spin-off effect of the intrinsic benefits of improved infrastructures [22, 23], drawing rural populations to metropolitan areas for better jobs, and infrastructure [24], thereby straining urban resources [25] and employment opportunities [26]. The current approach to SV solely emphasizes the application of technological solutions for rural infrastructure development and fails to address all aspects of rural life comprehensively. A more holistic approach that encompasses all dimensions of rural development, such as agriculture, environment, economy, social welfare, infrastructure, and governance, is necessary; thus, intending to prevent rural-urban migration and bring rural communities toward self-sufficiency, eventually. This study postulates a SMART village (SMART-V) framework that encompasses various dimensions such as sustainable environment, manageable economy, adaptive society, responsive governance, and technological infrastructure. The SMART-V thus provides a multi-dimensional evaluation framework for establishing the local relevance of sustainable development strategies and one that can provide a basis for enhancing the performance and capacities of the local governing units at rural scale.

India is a culturally diverse and geographically expansive nation; centralized planning could only work up to a point with its one-size-fits-all approach [27]. Thus, it is required to understand what 'SMART development' is in the local community context. This research contributes to the sense perceptions of the SV by positioning it within broader conceptual experiences in sustainability and illustrating its practical implementation across several Indian villages. Subsequently, this study addresses the following research questions (RQ): RQ1: Why is there a need for a synchronized framework to address sustainable rural development (SRD)? RQ2: What are the challenges and their implications for SRD?; RQ 3: How does the SMART-V approach aid in achieving SRD? Accordingly, the key objectives of this study are (1) to provide a

guiding framework that supports the synchronization of current policies while exploring new possibilities based on local characteristics, (2) to overview the thrust area of existing RD initiatives, and (3) to highlight the role of SV in addressing the emerging challenges for SRD in developing countries such as India. By contextualizing SV within the broader conceptual framework of sustainability research, this study significantly contributes to existing knowledge on the subject. The study involves a literature survey based on a systematic review depending on the scope and objectives of the study. Along these lines, the paper is organized as follows: Section 2 sheds light on the need for innovative approaches to RD and provides an overview of the SV paradigm in the context of India's RD mission. It also explains the methodology used for literature analysis and uses problem tree analysis to explore the significance of sustainability in resolving growing challenges for RD. Section 3 proposes the synchronized SMART-V framework for achieving sustainability through objective analysis and discusses the results and recommendations in Section 4. Substantially, Section 5 summarizes the key conclusions and research limitations. Finally, the paper concludes with acknowledgements and references.

2. Materials and Methods

This section outlines the methods and overview of existing literature on RD. In this section, there are four subdivisions. The first section explains how the PRISMA analysis method conducted the literature review. The second section reviews the literature on emerging concerns in SRD and the necessity for new RD paradigms. Furthermore, the concept of SV in the context of global and Indian initiatives is discussed. Likewise, in the last subdivision, problem tree analysis (also known as situational analysis) has helped map out the drivers of causes and their effects on rural issues.

2.1. Literature Analysis

Although overview papers in the domain of smart SRD are few, there are papers from allied disciplines that review the literature in their fields. In this study, referring to RQs, a systematic review was conducted using the preferred reporting items for systematic reviews and meta-analyses (PRISMA) method guidelines proposed by Liberati et al. (2009) [28]. Following the PRISMA guidelines, the study primarily executed search queries in the Web of Science (WOS) database, and additional high-quality online sources such as books and conference proceedings. The results of the WOS basic search are depicted in Figure 1. In this case, two independent searches were conducted in the "ALL" category using the keywords "Rural Development" and "Smart Villages". Using our set search keywords, we initially retrieved 128,276 (Rural Development: RD) and 419 (Smart Villages: SV) papers from WOS. In the context of RD, the study then modified the documents focusing on SV to filter out the search question to 'RD + SV', through which we identified 88 research documents. Secondly, to identify research studies focusing on framework formulation in the context of SV, the study applied another search query with the keywords 'SV + Framework', which identified 74 research documents. After the manual screening, the study extracted the literature database titles, and the relevant literature was determined, regardless of the field of study, year of publication, type of document, etc. Furthermore, in the next step of short listing research documents, the study selected 67 documents for assessment. In addition to the WOS database search, the study considered 27 other research materials and grey literature-like reports, conference papers, working papers, books, and websites for this study.

2.2. Paradigm Changes in Rural Development

RD refers to the comprehensive development of rural regions to enhance the quality of life of rural populations [30]. In this respect, it is a broad and multidimensional notion that includes the growth of agricultural and related activities, traditional crafts, cottage industries, community services and amenities, socioeconomic infrastructure, and, most importantly, human resources in rural regions [9]. Conventionally, India's policies were centered on improving the economic and social conditions of agrarian society's vulnerable groups [31], particularly emphasizing agricultural productivity [32]. However, the most recent and significant RD paradigm emphasizes the multifunctional structure of rural regions and the need to ensure the sustainability of their growth [33]. Even though there are many government efforts at all levels—central, state, and local—the growth rate has not kept up with the rising requirements [34]. Separate flagship initiatives focused on various sectors, such as health (NRHM) [35], education (SSA) [36], and livelihood (NREGA, NRLM)[37,38], have already been established but have had limited success as highlighted in Table 1. If conventional rural development initiatives had been more effective, rural poverty would have been significantly reduced [39]. Perhaps, one of the rationales for the R Dinitiative's inadequacy has been an absence of a comprehensive emphasis on the village as a unit. Thus, conventional approaches must be redefined, and new perspectives for RD strategies must be established. The concepts and methods for assessing and managing rural change need to shift from theoretical, managerial, and centralized approaches to more constructionist, participatory, and decentralized rural change perspectives [40].

Accordingly, several researchers, agencies, and international organizations have de veloped effective frameworks for reducing rural poverty, human slavery, and inequality, besides achieving sustainability [32]. Table 2 summarizes the progression of rural development thinking and a technique, highlighting the old paradigms based on prior policies and a scheme [31], further emphasize some of the new challenges and opportunities, and outlines some of the core characteristics of the new rural development approach for emerging villages [44].

2.3. Global Interpretations on SV

S&T and ICT have demonstrated substantial opportunities for humanity's benefit in various disciplines, such as food security, livelihood potentials, energy, and capacity building, with the potential to address and serve the developing needs of locals [46]. Research in various developing countries worldwide has emphasized the potential of these technologies for RD through the SV approach, thus they will play an essential role in achieving rapid and sustainable RD in the subsequent years. For instance, the primary goal of the IEEE Smart Village: Empowering Off-Grid Communities [47] program, started in 2010, aims to adopt more comprehensive and inclusive approaches to delivering access to energy in rural areas, with the key consideration being how renewable energy sources are integrated with ICT [48]. In addition to promoting their sustainability and scalability, this initiative also educates communities on constructing and designing off-grid solar power panels. South Asia, South-East Asia, East Africa, West Africa, South America, Central America, the Caribbean, and Mexico are regions where the initiative's activities are ongoing [49].

2.4. SV Initiatives in India

Initiated with the "Digital India" Programme in 2015, the digital transformation played a vital role in improving transparent, efficient, and cost-effective rural governance [54]. The government of India and several public and private, non-governmental organizations are working on developing digital technology for rural areas [16] by providing broadband connectivity, digital literacy, and e-governance services. For instance, the availability of cashless

electronic transactions aids in generating new business [55]. Similarly, India's S&T field has made a substantial contribution to the advancement of the nation's growth [56] by supporting high-level basic research and the development of novel technologies inclusive of addressing the technical needs of the average person by developing relevant skills and technology. Appropriate rural technology utilizes local or regional competence to manage local demands without relying on external influences [57]. It comprises common and affordable technologies to benefit ordinary people and their communities. However, due to the number of challenges, these digital initiatives have had minimal influence on rural people's lifestyles. There is widespread illiteracy, irregular electrical supply, substantial bandwidth concerns, financial concerns in developing ICT infrastructure, a significant shortage of skilled project leaders, and so on [58].

2.5. Problem Tree Analysis (PTA)

Referring to RQ2, this section focuses on the socioeconomic and environmental challenges that rural communities worldwide face. In the current context, rural populations are more vulnerable to extreme poverty, starvation, social marginalization, environmental harm, etc. [62]. The emergence of these challenges and barriers harms the person's living conditions and creates obstacles to their advancement. Accordingly, by adopting problem tree analysis [63], a structural analysis tool, the subsequent study will address some of the inevitable problems for RD and their negative consequence in Stage 1. However, Stage 2, Section 3.2 will further describe how SMART interventions can act as catalysts to overcome the challenges for the same and how further SMART-V will lead to sustainability by achieving SDGs.

3. Results

3.1. Strengthening the Concept of SMART Villages (SMART-V)

Referring to Section 2.5, it is evident that rural communities face complex and inter related challenges that a single sector cannot effectively address. Adopted by this study, Figure 3 depicts the core concept of the "SMART" approach, which uses an abbreviation instead of a prefix for the word "Village". The figure showcases how the SMART approach will address the five dimensions of rural development: environment, economy, social, gov Referring to Section 2.5, it is evident that rural communities face complex and inter related challenges that a single sector cannot effectively address. Adopted by this study, Figure 3 depicts the core concept of the "SMART" approach, which uses an abbreviation instead of a prefix for the word "Village". The figure showcases how the SMART approach will address the five dimensions of rural development: environment, economy, social, governance, and infrastructure. The SMART approach is sustainable, measurable, adaptable, responsible, and technological and will promote holistic development. This new approach justifies the need for more SDGs because it recognizes the inter connectedness of the various aspects of sustainable development in a coordinated manner. As mentioned above, the SMART abbreviation stands for: governance, and infrastructure. The SMART approach is sustainable, measurable, adaptable, responsible, and technological and will promote holistic development. This new approach justifies the need for more SDGs because it recognizes the interconnectedness of the various aspects of sustainable development in a coordinated manner. As mentioned above, the SMART abbreviation stands for:

- Sustainable Environment: Environmental sustainability should be included in RD in itiatives because rural communities rely heavily on natural resources for livelihoods and growth, and because of their susceptibility to climate change and risks from en ergy, water scarcity, and food [70]. Likewise, increased concern about climate change and growing recognition of the necessity for low-carbon development paths should

emphasize boosting access to modern energy services through renewable energy technologies [71].

3.2. Achieving Sustainability through SMART Interventions

PTA: Stage 2: Objective Analysis

From Stage 1: Problem Analysis, as described in Section 2.5, the study reframed each identified problem into a desirable positive result. Accordingly, as Figure 4 discusses, an objective tree representing future SMART solutions, referring to Section 3.2, to the issues. These SMART interventions transform root causes and effects into root solutions and identify influencing entry points [63]. Thus, leveraging SMART interventions can help to address the challenges facing rural communities and promote sustainable development by achieving desired SDGs that can benefit both present and future generations.

3.3. Proposed SMART-V Framework (SMART-VF)

As mentioned in Section 2.2, there is a need for a synchronized framework to address SRD because rural areas face unique challenges and opportunities that require tailored solutions. Additionally, RD initiatives often involve multiple stakeholders, each with their priorities and goals, resulting in fragmented efforts and a lack of coherence. A synchronized framework can help to align these diverse efforts and ensure a more integrated approach to SRD. It can also help to avoid gaps, identify synergies, and promote a more holistic understanding of sustainability, leading to more effective and impactful outcomes.

4. Discussion

4.1. Justification for the Need for SMART-V

Conventionally, above other sectors, agricultural production and resource allocation have been emphasized as the primary drivers of rural growth. While agriculture is undeniably essential in RD, the growth of non-farm industries and services can retard rural-urban migration, relieving stressors on urban centers and contributing to a more equitable allocation of resources. Thus, regarding Section 2.2, traditional practices of RD still need to address some of the most critical issues in rural regions. However, SMART-V will design to be sustainable, inclusive, and resilient, focusing on improving the quality of life for rural residents through technology and innovation. There are several fundamental reasons why SMART-V are needed:

Closing the Digital Divide: SMART-V aims to address the digital divide between urban and rural areas by providing access to technology and digital services to rural communities. This access helps to ensure that rural residents are included in the digital age and can participate fully in the digital economy.

4.2. A Way Forward: Identifying Entry Points to Achieve a Sustainable SMART-V

By addressing the entry points, it is possible to create a sustainable SV that is inclusive, resilient, and able to promote economic and social development in rural areas, to mention a few:

- Access to Technology and Digital Services: Providing access to technology and digital services is a crucial entry point for achieving a sustainable SMART-V. This access includes the installation of infrastructure, such as broadband internet, and the development of digital services and applications that can improve the delivery of essential services, such as healthcare, education, and energy.
- Skill Development: This includes training programs for rural youths in areas such as digital literacy, entrepreneurship, and innovation, as well as the development of technical skills related to technology and digital services.

5. Conclusions

This study has gone some way toward enhancing our understanding of the SV approach. The literature review of this study indicates that over the past decades, RD programmes have seen significant changes in scope and substance, ranging from addressing food security issues to a more integrated approach to RD that includes community empowerment and natural resource preservation and management. Furthermore, this study contributes to existing knowledge of SV by providing the strategies under SMART-VF, which is a multi-dimensional approach and emphasizes not just one axis of development but also all the sustainable dimensions of RD, such as environment, social, and economy, in parallel. Moreover, the formation of the SMART-V framework guides the integration of well-established concepts in sustainable development, such as green energy, circular economy, livelihood diversification, and regulating e-governance, among others. However, conventional individual approaches to RD tend to focus on specific aspects of RD, which results in ignoring their inextricable linkages. Furthermore, the research has highlighted the need for many questions of further investigations, such as identifying key entry points for the establishment of SMART-V.

The research framework proposed in this paper offers the foundation for examining different research domains' knowledge bases. However, the study would like to highlight certain limitations. For instance, one such limitation is the potential challenge of implementing the framework in rural communities with limited resources and technological expertise. Future studies should use different analysis techniques to broaden this investigation and validate the results. Thus, this study will become an essential reference, allowing academicians and practitioners to comprehensively understand the concept of SV.

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