Chapter 5
Assimilating Fuzzy Logic in Smart City and Village Development for Sustainable Futures With Green Energy Solutions

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ABSTRACT

Virtually every place doing business with us is in the throes of rapid change: smart cities and villages are replacing traditional communities; urbanization is transforming social systems that were once localized phenomena; sustainable growth, one integral tenet for achieving more equitable Sustainable Development Goals (SDGs), has long proven easier conceived than enacted. The problem of the traditional planning and decision-making methods lies in their qualitative comprehension; these techniques cannot provide an adequate solution for organizing complex self-regulating mechanistic systems. The relevancy of the proposed approach is evidenced through a set of smart cities and villages case studies, which shows that it can indeed maximize sustainability outcomes with an impact over SDGs goals. This

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study provides a reference for the researchers, urban planners and decision-makers to implement fuzzy logic for sustainable development.

1. INTRODUCTION

The concept of the smart city or village applies technology, data and innovation to social, economic and environmental challenges in order to improve the quality of life for residents. After briefly introducing the SDGs and fuzzy logic, this research paper suggests that incorporating fuzzy logic as an essential instrument will improve smart city/village sustainability in a manner which adheres to these goals. Since the logic of fuzziness (fuzzy logic) can be used to process information that is not accurate and precise, it significantly expands its ability to leverage other aspects in the area where smart city and village are developed. The data also shows a great interest in the application of fuzzy logic to urban planning, resource management processes within transportation and energy systems (Saha & Roy, 2024). The concepts of fuzzy logic can be injected into the process to allow stakeholders to make more comprehensive decisions, taking into account how balancing economic drivers with social and environmental factors could demand a fairer management approach (Xu & Sun, 2024). This paper is an integrated fuzzy framework to develop smart city and village. This system proposes the sustainability compass framework including specifying a set of key performance indicators for sustainability, establishing fuzzy inference systems and employing optimization algorithms via environmental models by exploiting an advanced soft computing tool like Fuzzy Logic. Given that the world is on track to be at least 50% urban by 2050, we are experiencing an era of unprecedented growth in how cities develop sustainably and efficiently (Zou & Chen, 2024). Fuzzy logic has turned into a well-suited mathematical apparatus for smart city/village under uncertain and imprecise information available to government policymakers. Fuzzy planning and implementation, using the inherent ambiguity of urban systems to become an advantage rather than weakness in decision-making around smart initiatives (Tripathi & Mishra, 2024). This is especially true for developing nations, which are often facing more-invisible challenges in their cities and villages at a time when resources may be scarce. Fuzzy logic, as a technique of multi-criteria decision-making enables to reconcile and aggregate many (mutually exclusive) criteria. Take a new transportation system for example, cost of the infrastructure which contributes to efficiency in travel is being weighed against accessibility and environmental implications. This way of doing things is more likely to provide a fuller and less biased picture than one that reflected only the most easily quantified factors, while keeping everything in their fuzzy-fluffy range allows for including such diverse aspects into an integrated framework which supports humans in making decisions based on reason. Fuzzy logic, on the other hand, is a science which enables theory and practice of smart city garden development to work in cooperation (Sun & Wang, 2024).

The results of this study support the need for new technologies, such as fuzzy logic to tackle urban and rural sustainable development problems. If smart city and village planning should be applied with the fuzzy logic, policy makers as well practitioners will have a chance to make significant moves towards creating livable, equitable and green cities or villages (Dutta et al., 2024). Fuzzy logic, by offering a systematic framework to include stakeholder input and local knowledge downstream in the planning process can support calibrated tailoring of SMART initiatives at community specific level. This is essential to ensure the smart city and village projects run sustainably in long term (Tan & Xu, 2023). Although the application of fuzzy logic in developing smart city and village can yield positive results, there are