

CHAPTER 1

INTRODUCTION

1.1 Introduction

Implementation of rural roads is one of the important priorities of developing nations, as a mechanism in the direction of poverty alleviation and development of rural areas. They assist in the improvement of social and economic well-being of rural people. Improvement in rural roads reduces travel time while increases access to education, health facilities, markets, and jobs. It reduces the cost of transportation for both passengers and freight along with vehicle operating cost. All-weather rural roads bring out development in underdeveloped rural areas and fuel their economic and livelihood transformation through numerous equitable opportunities. Keeping in view that rural road connectivity plays a significant role in enhancing the quality of rural habitations, Government of India initiated Pradhan Mantri Gram Sadak Yojana (PMGSY) program in the year 2000. Recently Government of India has further initiated the process of launching Pradhan Mantri Gram Sadak Yojana-III (PMGSY-III scheme) to connect habitations to Gramin Agricultural Markets (GrAMs), Higher Secondary Schools and Hospitals by consolidating 1,25,000 Km road length distributed across different States (PIB, 2019). The PMGSY program has emphasized on connecting rural areas of the country by all-weather roads to the nearest market/economic centre. The main aspect of PMGSY roads is to effectively reach a sector of the population that has been persistently marginalized from the benefits of the aggregate economic growth of the country.

It can be put forth that rural road infrastructure plays a significant role in the improvemnet of rural areas by instigating positive (socio-economic) impacts. These impacts are immediate, mid-term or long-term in nature. However, the newly constructed rural roads along with positive impacts may induce some negative impacts. Consequently, this creates apprehension about the inclusion of the impact assessment process that enables concerned authorities to achieve sustainable rural development through such infrastructure interventions. Assessment of impacts (positive or negative) due to the deliverance of rural roads is a continuous planning process which aims in integrating road development with sustainable rural development. It assists in exploring the unintended impacts either positive or negative on the target population. It is also a significant

aspect from the viewpoint of policy-oriented executions as it imparts the necessary knowledge of possible impacts, which can be used as a significant input for designing future projects and programs appropriately.

Impact (positive and negative) assessments of rural roads involve several criteria (i.e., qualitative and quantitative) and their assimilation. It is a counterfactual process and has to be performed in a comprehensive manner, which can demonstrate how the availability of all-weather rural road infrastructure has promoted both direct and indirect benefits to the society. To accomplish this several methodologies can be employed which can be broadly divided into two categories: quantitative and qualitative methods. Conventionally quantitative methods, viz., double difference, reflexive comparison, matching, randomization, etc. have been employed. Although these methods are capable of providing a necessary understanding of the impacts incurred, they reach generalized solutions and require skills and expertise to perform. They also lag in accommodating the problem of biases arising from real life data. Qualitative methods, on other hand, provide significant insights and proper understanding of impacts incurred from the viewpoint of the target population.

Qualitative methods are more perceptible and can handle the complexities associated with the evaluation process with ease. These methods can also be tailored according to the need of assessment process using open-ended questions. Qualitative methods are rapid and less time-consuming. However, these methods are highly dependent upon the skills of the enumerator. Though available literature specifies the need of application of qualitative and quantitative methods, there is a significant trade-off in employing one method over the other. Considering this facts, there is a growing consensus of employing an integrated approach which amalgamates these two methods. It would possibly be the best instrument to meet the requirements of the impact assessment process so that evaluation process can be performed effectively from different perspectives. The mixed-method approach is one such integrated approach which takes into account both quantitative as well as qualitative methods for a comprehensive assessment. It provides an enhanced understanding of such problems than either of quantitative or qualitative techniques alone.

Moreover, assessment of impacts (positive and negative) instigated due to the deliverance of rural roads involves multi-attributes along with their interdependencies, making it complex to be

addressed singularly. It is a real-life problem which involves the target population as decision makers. This enables the impact assessment process to be defined as fuzzy multi-criteria decision making (F-MCDM) problem. The F-MCDM approach provides a framework which involves proper mapping out of impacts (data collection); rigorous evaluation; appropriate interpretation. It also considers the uncertainty and vagueness associated with the perception of rural inhabitants, which makes the impact assessment process more perceptible, comprehensive and easy to handle. Moreover, it is also perceived that computational intelligence approaches also provides secure grounds for assessing impacts instigated by the deliverance of rural roads. They provide the results with a tolerance of ambiguity, uncertainty, and can handle complex social and human systems comprehensively.

This research attempts to investigate the impacts (positive and negative) of rural road construction on the target population for selected habitations. It also explores conditioning factors for the realization of the benefits of rural masses. A methodology proposed herein is a combination of fuzzy multi-criteria decision approach, computational intelligence, and geographical information systems (GIS) to have spatial comprehension about the impacts. An attempt has been made to evaluate and quantify the impacts for 27 selected rural roads constructed under the PMGSY program in six divisional blocks of Jhunjhunu district of Rajasthan state of India. It reflects impacts on five basic attributes which contribute to the social and economic well-being of rural inhabitants. Moreover, it also attempts to identify negative consequences that influence rural life. The study will not only be able to tell the program whether they are having positive impacts but also find ways to improve their contribution to poverty alleviation and other issues by informing about the conditions that are required for those positive effects to materialize for the neediest.

1.2 Objectives of the Research

This research proposes a methodology to assess the impacts (positive and negative) due to deliverance of rural roads on the target population. Rural road interventions facilitate enhanced access to various services thereby improving rural life. Though a few studies have already been carried out to study the impact of rural (PMGSY) roads, no in-depth study has been reported in the literature on quantification of impacts (positive and negative) of these roads on the rural population. Therefore, this study has been undertaken using participatory approach to assess the

impacts of PMGSY roads by considering their quantitative and qualitative nature. Accordingly, the main objectives of this research study have been set to:

- a) assess the impacts of PMGSY roads on transport facility, income, health, education and quality of neighbourhood of rural households.
- b) assess the diversification of livelihood opportunities in terms of the reduction of the dependence on agriculture and increase of wage employment and non-farm independent economic activities.
- c) assess unintended negative effects of PMGSY roads have on the social lives of villagers and environment such as air pollution, noise pollution, safety and security, and road accidents.
- d) determine short-term impacts by conducting panel surveys of rural inhabitants around a few selected PMGSY roads.
- e) suggest management options/recommendations to the policy makers and implementing agencies for better development of the concerned community.

1.3 Scope of the Research

Sustainable rural development has become a major concern in developing nations. This is achieved through proper monitoring on the status of scheme/program delivered, and by identifying and mitigating the concerns that arise. Assessment of impacts (positive and negative) instigated by the deliverance of rural road intervention is one such kind. It helps to identify the desired outcomes as well as helps to recognize their scope. This study deals with assessment impacts (positive and negative) of all-weather rural roads. The study initially focuses on the identification of criteria/sub-criteria that contributes to the change in the socioeconomic status of rural habitation. Further, it concentrates on the assessment of the impacts on five basic attributes, viz., transport facility, income status, education status, health facility, and quality of the neighbourhood (social environment). Moreover, it also tries to capture the impacts of roads on income diversification as well as it also accounts for the negative impacts instigated. It employs the concepts of mixed-method approaches, fuzzy multiple-attribute decision-making methods, and computational intelligence. Furthermore, it also incorporates GIS application to identify the extent of impacts.

To assess the impacts of rural road construction, this study develops an innovative methodology which is divided into four models. The results have been compared by employing different methods to have refined comprehension. The effectiveness and applicability of the proposed methodology have been demonstrated as a case study of habitations connected by all-weather rural roads in six different divisional blocks of Jhunjhunu district of Rajasthan state of India. Focus group discussions have been conducted for selected habitations to collect necessary data. The data collection has been performed using a questionnaire which has been designed keeping in view with the ground conditions and consists of open-ended questions. This enables the enumerators to capture the necessary data/information in a précised way. Moreover, to have refined information feedbacks in the form of satisfaction achieved after the instigations of rural roads has also been considered.

1.4 Organization of the Research

Chapter-1 establishes the background and the need for the impact evaluation process due to construction of rural road. The chapter also highlights on the objectives and scope of the present research work. It underscores the importance of the study by taking into consideration of salient factors, which were critical to employ for further analysis.

Chapter-2 deals with a comprehensive literature review of the earlier methods about impact assessment in consideration with theoretical aspects especially corresponding to quantitative and qualitative approaches. The chapter covers mainly four aspects, viz., need and significance of impact assessment, exploration of the existing structure of investigation and methodology followed for impact assessment by various researchers, challenges and research gaps of existing impact assessment studies, and finally, motivation attended for the present study. This chapter essentially emphasizes on review of conventional methods and techniques along with their shortcomings, so that research gaps are recognized in context to impacts of construction of rural roads on the target population. The chapter concludes with the further need of investigating the long-term impacts to assess the effectiveness of the implementation of rural roads and to formulate remedial action plan so that the quality of rural life can be enhanced.

Chapter-3 introduces a novel approach to ascertain and explore the attributes that contribute to the change in socio-economic status (SES) of the rural habitants. An improved rural road

infrastructure often leads to direct or indirect positive socio-economic impacts on the target population and society. To identify such change, there is a growing emphasis on impact assessment studies. Impacts incurred due to the deliverance of rural road infrastructure are both qualitative and quantitative. It poses a wide range of challenges in ascertaining and assessing them. Although, the literature suggests several techniques (experimental and quasi-experimental), yet they lag in accommodating the problem of biases arising from real life data. Thus, the identification of the attribute is a significant aspect. Chapter 3 illustrates the ascertaining of criteria/sub-criteria by considering the variance caused by each of them as well as based on their relative significance. Moreover, the chapter also demonstrates the effectiveness of the proposed approach by employing a case study of rural roads constructed under the PMGSY program in Jhunjhunu district of Rajasthan state, India. Total of 5 criteria and 33 sub-criteria have been identified, which contribute to the change in the socioeconomic status of rural inhabitants after the construction of rural roads.

The approach presented herein is system-oriented and holistic, which identifies criteria/sub-criteria contributing to the change in SES. It provides insight with the necessary knowledge to the concerned decision makers, which will assist them in taking necessary initiatives to improve the quality of rural life sustainably. In this chapter, a mixed-method approach has been applied to ascertain and explore the socio-economic indicators, which have been impacted by the construction of rural roads. It integrates principal component analysis (PCA) with fuzzy Technique Order Preference by Similarity to Ideal Solution (fuzzy-TOPSIS) technique. PCA takes into account quantitative data whereas fuzzy-TOPSIS accounts qualitative data. The proposed approach accommodates the advantages of mixed-method design, which adds value to socio-economic impact assessment (SEIA) methodology in the form of reliability, ease and assists in deepening the understanding of impacts to be perceived by decision-makers and stakeholders.

Chapter-4 deals with the assessment of impacts on transport facility, income status, education status, health facility, and quality of neighbourhood (social environment) criteria which contribute to a socioeconomic change of rural inhabitants. Initially, the computational intelligence approach, Adaptive Neuro-Fuzzy Inference System (ANFIS) has been employed to assess the possible impacts. The results obtained are later compared with fuzzy Delphi method (FDM). In addition to this, ArcGIS tool has been employed to identify the scope and extent of these impacts. Total 27 habitations connected with all-weather rural roads constructed under Pradhan Mantri Gram Sadak

Yojana (PMGSY) scheme in Jhunjhunu district of Rajasthan state of India have been considered for the assessment. The findings of the methodology proposed in this chapter demonstrate that ANFIS technique performs well in comparison to the FDM technique. Moreover, it also illustrates that income status and quality of neighbourhood criteria show significant change. However, the health facility and transport facility status criteria show moderate impacts.

Chapter-5 deals with the assessment of the impacts of rural road construction on the livelihood of rural households and its diversification. It demonstrates the application of Fuzzy Shannon's entropy measure of diversification along with econometric modeling for assessing the livelihood diversification. Moreover, the chapter also illustrates the percent change in the degree of diversification achieved before and after the deliverance of rural (PMGSY) roads. Data about transport infrastructure and demographic characteristics, which influences the rural household earnings have been collected for a total of 27 habitations selected in Jhunjhunu district of Rajasthan state, India. Furthermore, the chapter also illustrates application ArcGIS tool to identify the extent of livelihood diversification achieved after the deliverance of PMGSY roads. It also highlights how all-weather roads have influenced farm and non-farm activities. The study presented in this chapter has provided a basis to adopt effective schemes and action plans, which will add up as assistance to the delivered rural road infrastructure, in enhancing the earnings of rural households effectively by concerned policy-makers.

In **Chapter-6**, the negative impacts (degradation of both physical and social environment) instigated by improvised rural road infrastructure have been assessed. In this chapter, an attempt has been made to identify and explore the negative impacts of rural road construction on the target population. Total of 6 attributes (qualitative and quantitative) concerning both physical and social environment have been identified after a preliminary survey. These attributes, viz., the status of road accidents, the status of transmissible diseases, the status of ill habits/behaviour, the status of safety and security, the status of air quality, and status of noise pollution have been accounted for the study. It has been observed that road accidents attributes have been found as significant factors contributing to the negative impacts. The data has been collected through focus group survey using questionnaire, which allowed enumerators to capture the status of the attributes before and after the construction of all-weather roads in an effective manner. This chapter employs interactive F-MCDM approach in assessing the various attributes that contribute to the negative impacts.

The approach employed herein can address effectively the intrinsic uncertainties involved in the overall assessment process, which are beyond the scope of traditional techniques. The study presented in the chapter will provide the groundwork for the concerned decision makers to focus on mitigating the impacts induced by the deliverance of roads in achieving their intended goal of sustainable rural development. The chapter describes the methodology adopted for the research; it illustrates the process of selection attributes and data collection along with the assessment techniques employed.

Chapter-7 concludes the research and summarizes the in-depth analysis, outcomes, and findings. The comprehension gained through the present work is believed to provide a broader view as well as strategic groundwork in assessing the impacts instigated by the deliverance of all-weather rural roads. It will also reiterate how impact assessment process is both quantitative and qualitative and would provide an insight that the outcomes based on imprecise techniques are contentious. Future scope of present research work along with the limitations and assumptions has also been enlisted in this chapter.

The objectives set for this research work is very essential for rural development which are explored further through comprehensive literature review as discussed in subsequent chapter of this Thesis work.

1.5 Bibliographical note

Parts of Chapter 5 appear in the following journal paper:

- Wagale M., Singh A. P., Sarkar A. K. “Impact of rural road construction on the local livelihood diversification: Evidence from Pradhan Mantri Gram Sadak Yojana in Jhunjhunu district, India”. *GeoJournal*. 2019, 1-18. <https://doi.org/10.1007/s10708-019-10007-3>.