

ENHANCING RURAL TRANSPORT SERVICES OF DHAR DISTRICT, MADHYA PRADESH

*A Thesis Project
submitted in partial fulfillment of the requirements
for the award of the degree of*

Bachelor of Planning

By

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Under the Guidance of

DR. PREMJIT DAS GUPTA

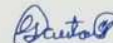


**Department of Architecture and Planning
Maulana Azad National Institute of Technology, Bhopal**

May 2026

DECLARATION

I **GAUTAM SACHAN**, Scholar No **2211002112** hereby declare that the thesis titled Enhancing Rural Transport Services of Dhar District, Madhya Pradesh submitted by me in partial fulfilment for the award of degree of Bachelor of Planning, at Maulana Azad National Institute of Technology, Bhopal, India, is a record of Bonafide work carried out by me. The matter/result embodied in this thesis has not been submitted to any other University or Institute for the award of any degree or diploma.



Signature of the Student

Date: 07/05/2026

CERTIFICATE

This is to certify that the declaration made by **GAUTAM SACHAN** is true to the best of my knowledge and that the student has worked under my guidance for one semester in preparing this thesis.

RECOMMENDED



Signature of the Guide
(Dr. Premjeet Das Gupta)

ACCEPTED

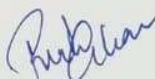


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(Dr. Preeti Onkar &
Dr. Premjeet Das Gupta)

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सारांश

ग्रामीण परिवहन सामाजिक-आर्थिक विकास की एक मौलिक आधारशिला है, विशेषकर उन कृषि-प्रधान अर्थव्यवस्थाओं में जहाँ बाजार, स्वास्थ्य और शिक्षा तक पहुँच अधिकांश जनसंख्या के जीवन स्तर को निर्धारित करती है। भारत में, और विशेष रूप से मध्यप्रदेश में, अवसंरचना के विस्तार के बावजूद सेवा-प्रदान की अनुपस्थिति ने ग्रामीण गतिशीलता को एक दीर्घकालिक संकट में बदल दिया है। प्रधानमंत्री ग्राम सड़क योजना ने अपने विभिन्न चरणों में योग्य बस्तियों के 99 प्रतिशत से अधिक को ऑल-वेदर सड़कों से जोड़ दिया है; तथापि, 2005 में मध्यप्रदेश राज्य सड़क परिवहन निगम के विघटन ने उन संगठित सार्वजनिक परिवहन प्रणालियों को प्रभावी रूप से समाप्त कर दिया जिन्हें इन सड़कों का उपयोग करना था। इस शून्य को निजी और मध्यवर्ती सार्वजनिक परिवहन ऑपरेटरों — साझा जीप, मोटरसाइकिल टैक्सी और ट्रैक्टर — के विखंडित तंत्र ने भर दिया, जो लाभकारी शहरी मार्गों को प्राथमिकता देते हैं और आदिवासी पिछड़े इलाकों तथा दूरस्थ कृषि गांवों को लगातार उपेक्षित छोड़ देते हैं।

धार जिला, जो इंदौर मंडल के दक्षिण-पश्चिमी हिस्से में स्थित है, इस विरोधाभास का विशेष रूप से तीव्र उदाहरण प्रस्तुत करता है। लगभग 8,153 वर्ग किलोमीटर के क्षेत्रफल और 2025 के लिए अनुमानित 2.66 मिलियन जनसंख्या के साथ, जिले की 80 प्रतिशत से अधिक आबादी ग्रामीण है। प्रशासनिक रूप से यह नौ तहसीलों — धार, बदनावर, कुक्षी, मनावर, गंधवानी, दही, धारमपुरी, सरदारपुर और पीथमपुर — में विभक्त है, जिनमें 1,625 राजस्व ग्राम और 764 ग्राम पंचायतें शामिल हैं। जिले की जनसंख्या का 50 प्रतिशत से अधिक हिस्सा अनुसूचित जनजातियों (मुख्यतः भील और भीलालास) का है, जो विंध्याचल श्रेणी और नर्मदा घाटी के कठिन और ऊबड़-खाबड़ दक्षिणी तथा पश्चिमी बेल्टों में केंद्रित हैं। जिले की स्थलाकृति तीन भौगोलिक क्षेत्रों में विभक्त है — उत्तरी मालवा पठार, मध्य का विंध्याचल श्रेणी (जहाँ शिखर 751 मीटर तक उठते हैं), और दक्षिण का संकीर्ण नर्मदा अलुवियल घाटी — और प्रत्येक क्षेत्र परिवहन कनेक्टिविटी तथा सेवा-प्रदान पर अलग-अलग और गंभीर सीमाएँ थोपता है। इन सीमाओं के बावजूद, धार कपास, सोयाबीन, गेहूँ और बाग प्रिंट हस्तशिल्प का प्रमुख उत्पादक जिला है; फिर भी ग्रामीण आबादी को उच्च माल-दुलाई लागत और पोस्ट-हार्वेस्ट नुकसान के कारण शुद्ध कृषि आय में अनुमानित 12–15 प्रतिशत की कमी का सामना करना पड़ता है।

इस शोध का केंद्रीय समस्या-विषय भौतिक सड़क अवसंरचना और वास्तविक परिवहन पहुँच के बीच संरचनात्मक असंगति है। धार के सड़क नेटवर्क में महत्वपूर्ण राष्ट्रीय धुरी मार्ग शामिल हैं — राष्ट्रीय राजमार्ग 47 जो इंदौर को अहमदाबाद से जोड़ता है और पूर्वी सीमा पर राष्ट्रीय राजमार्ग 3 जो पीथमपुर के औद्योगिक क्षेत्र की सेवा करता है — साथ ही राज्य राजमार्ग और ग्रामीण सड़कों का घना जाल भी मौजूद है। तथापि, लगभग 80 प्रतिशत मेजर डिस्ट्रिक्ट रोड्स संकीर्ण लेन-चौड़ाई (3.75 से 5.5 मीटर) तक सीमित हैं, जो यात्री और माल दोनों के आवागमन में बाधाएँ उत्पन्न करते हैं। इसके साथ ही, कई ग्राम सड़कें मौसमी रूप से क्षतिग्रस्त नालियों और तलछट से प्रभावित होती हैं, जिससे दही और कुक्षी जैसे आदिवासी तहसीलों में चार-महीने के मानसून काल में यात्रा-समय में लगभग 20 प्रतिशत तक वृद्धि होती है। संगठित सार्वजनिक परिवहन की अनुपस्थिति ने एक दुष्चक्र पैदा कर दिया है: ग्रामीण मार्गों पर कम मांग उन्हें

निजी ऑपरेटरों के लिए वाणिज्यिक रूप से अप्रिय बनाती है, जिसके परिणामस्वरूप सेवाएँ अनियमित या अनुपस्थित रहती हैं, किराये बढ़ते हैं और गतिशीलता सीमित होती है, जिससे ग्रामीण गरीबी और गहरी होती है।

यह गतिशीलता संकट सामाजिक-स्थानिक दृष्टि से सबसे अधिक संवेदनशील समूहों — महिलाएँ, वृद्ध, विद्यालयी बच्चे, विकलांग लोग और आदिवासी समुदाय — को प्रभावित करता है। 12 प्रतिनिधि गांवों और 150 परिवारों पर किए गए सर्वेक्षण से पता चला कि तिरला, सुसारी और निसरपुर जैसे आदिवासी-प्रमुख गांवों की महिलाएँ प्रतिदिन औसतन 4.5 घंटे अनपेक्षित "अदृश्य यात्राओं" में व्यतीत करती हैं — पानी, ईंधन और चारे के लिए पैदल यात्रा, अक्सर 20 किलोग्राम तक का सिर-भार उठाकर असमान भूभाग पार करना। ये यात्राएँ पारंपरिक परिवहन सर्वेक्षणों में व्यवस्थित रूप से अनदेखी की जाती हैं और महिलाओं में एक गहन "समय-गरीबी" उत्पन्न करती हैं जो उनकी औपचारिक अर्थव्यवस्था में भागीदारी को सीमित करती है। भागीदारी-आधारित स्थानिक सूचना प्रणाली के प्रयोग से यह भी पता चला कि इन अदृश्य पगडंडियों का जिले में कुल दैनिक गतिशीलता में महत्वपूर्ण हिस्सा है, और कुछ बस्तियों में अनौपचारिक ट्रैक आधिकारिक सड़क खंडों की तुलना में तीन-गुना अधिक पाए गए। महिलाओं की रात-समय परिवहन सुरक्षा की धारणा पाँच-बिंदु पैमाने पर केवल 1.2 रही, जबकि पुरुषों के लिए यह 2.5 थी, जिससे एक प्रकार का "परिवहन-अभाव द्वारा कर्पू" बन जाता है जो आपातकालीन स्वास्थ्य सेवाओं और शाम की आजीविकाओं तक पहुँच को रोकता है। सर्वे किए गए गांवों में 15 प्रतिशत माध्यमिक-विद्यालय आयु के छात्रों ने "दूरी और परिवहन की कमी" को शिक्षा छोड़ने का मुख्य कारण बताया; यह प्रभाव लड़कियों पर लड़कों की तुलना में तीन गुना अधिक था।

शोध की पद्धति एक कठोर मिश्रित-तरीका फ्रेमवर्क पर आधारित है और चार अंतर्संबंधित अनुसंधान उद्देश्यों के चारों ओर संरचित है। पहला उद्देश्य — यात्रा व्यवहार और ट्रिप पैटर्न का चरित्रांकन — रोडसाइड इंटरव्यू, ट्रेवल डायरी और GPS-आधारित स्थानिक विश्लेषण के माध्यम से पूरा किया गया। सर्वेक्षण डेटा से पता चला कि अध्ययन गांवों से निकटतम तहसील मुख्यालय की औसत दूरी 16.4 किलोमीटर है; स्वास्थ्य-यात्राएँ औसतन 24 किलोमीटर की हैं और एक-तरफा किराया हायर की गई टैक्सी द्वारा ₹200 से ₹500 आता है। दूसरा उद्देश्य — संवेदनशील समूहों की गतिशीलता आवश्यकताओं और बाधाओं की पहचान — भागीदारी कार्यशालाओं, अर्ध-संरचित साक्षात्कारों और लिंग-विभाजित गतिशीलता मैट्रिसेस के माध्यम से पूरा किया गया। तीसरा उद्देश्य — ग्रामीण परिवहन की योजना और प्रबंधन को प्रभावित करने वाले कारकों का विश्लेषण — ऑपरेटर साक्षात्कार, किराया संरचना आकलन और नियामक दस्तावेजों की समीक्षा के माध्यम से किया गया। परिसंपत्ति-स्वामित्व डेटा पुष्टि करता है कि 62 प्रतिशत घरों की निर्भरता मोटरसाइकिल पर है, जो मुख्यतः पुरुष परिवार-सिर द्वारा संचालित होती है, जबकि 22 प्रतिशत के पास कोई निजी वाहन नहीं है, जिससे वे पूरी तरह से मध्यवर्ती सार्वजनिक परिवहन पर निर्भर "केप्टिव उपयोगकर्ता" बन जाते हैं। दूरस्थ गांवों के आदिवासी घराने बुनियादी सेवाओं के लिए साइकिल और मोटरसाइकिल टैक्सी पर अपनी मासिक आय का 18 प्रतिशत तक खर्च करते पाए गए। चौथा उद्देश्य — संभावित सेवा मॉडल और कम-कार्बन विकल्पों का मूल्यांकन — व्यवहार्यता आकलन, परिदृश्य मॉडलिंग और हितधारक परामर्श के माध्यम से किया गया, जिसमें अन्य देशों में प्रयुक्त ग्रामीण परिवहन संकेतक फ्रेमवर्क और इलेक्ट्रोमोबिलिटी पायलटों के अनुभवों का संदर्भ लिया गया।

इन निष्कर्षों के आधार पर, शोध एक समग्र योजना ढाँचा प्रस्तुत करता है जिसका शीर्षक "सेवा-संस्कृति-संचालन" है और जिसका Vision 2030 लक्ष्य धार जिले में एक बिना रुकावट ग्रामीण जाल स्थापित करना है। स्थानिक रणनीति जिले को एक पदानुक्रमित हब-एंड-स्पोक नेटवर्क में व्यवस्थित करती है: तहसील मुख्यालयों को मैक्रो-हब, ग्रामीण कृषि बाजारों को इंटरमीडिएट ट्रांजिट-पॉइंट और ग्राम सड़क नेटवर्क को कैपिलरी-स्पोक के रूप में चिन्हित किया गया है, जिन्हें उच्च-फ्रीक्वेंसी, छोटे-क्षमता वाहनों द्वारा सेवा दी जाएगी। तीन प्रमुख क्षेत्रीय हस्तक्षेप प्रस्तावित हैं:

विंध्याचल की ऊँची-ढलानों पर 10–12 सीटर इलेक्ट्रिक मिनीबसों की तैनाती प्रस्तावित की जाती है, जो असमान भूभाग पर बेहतर टॉर्क प्रदर्शन और प्रति-किलोमीटर कम परिचालन लागत का लाभ देगी।

दही और गंधवानी जैसे ब्लॉक मुख्यालयों पर विकेन्द्रीकृत सौर-ऊर्जा संचालित चार्जिंग हब स्थापित करना प्रस्तावित है ताकि इलेक्ट्रिक फ्लीट के लिए चौबीसों घंटे हरित ऊर्जा उपलब्ध हो सके।

"अम्ही सारथी" सहकारी एक समुदाय-प्रबंधित वाहन ऑपरेटर मॉडल होगा, जो स्थानीय युवाओं के लिए आजीविका सृजन करेगा और विश्वसनीय लास्ट-माइल कनेक्टिविटी सुनिश्चित करेगा; साथ ही मोटरसाइकिल-टैक्सियों का नियमितीकरण, सुरक्षा-लाइसेंसिंग और प्रशिक्षण के माध्यम से उन्हें महिलाओं और छात्रों के लिए प्रमाणित फीडर-सेवाओं में बदला जाएगा।

वित्तीय और शासन-आधार के रूप में प्रमुख उपायों में ग्रामीण मार्गों पर चलने वाले निजी ऑपरेटरों को प्रति-किलोमीटर मासिक वित्तीय क्रेडिट प्रदान करने वाला एक प्रोत्साहन मॉडल शामिल है ताकि कम-लाभदायक मार्गों पर सेवा सुनिश्चित की जा सके। इसके अतिरिक्त 7+1 से 20+1 सीटर ग्रामीण फीडर वाहनों के लिए कर में छूट और इलेक्ट्रिक वाहनों के लिए पूंजी सब्सिडी जैसी नीतिगत सहायताएँ प्रस्तावित की गई हैं। शासन-ढाँचे में रूट-वार टेंडरिंग की निगरानी जिला कलेक्टर को सौंपी जाती है, संचालन-निगरानी पंचायत राज संस्थाओं द्वारा डिजिटल प्लेटफॉर्मों के माध्यम से की जाएगी, और ग्राम सभा स्तर पर लिंग-समावेशी परिवहन समितियों को सामुदायिक-स्तरीय निगरानी का दायित्व दिया जाएगा। क्रियान्वयन तीन चरणों में प्रस्तावित है: चरण-I में पायलट का संचालन, चरण-II में सौर-चार्जिंग और इलेक्ट्रिक फ्लीट का विस्तार, और चरण-III में रीयल-टाइम ट्रैकिंग तथा भागीदारी निगरानी का समेकन।

निष्कर्षतः, यह शोध स्पष्ट करता है कि धार जिले में ग्रामीण परिवहन संकट सड़कों की अनुपस्थिति का परिणाम नहीं है, बल्कि अवसंरचना और सेवा-प्रदान के बीच समन्वय की कमी का परिणाम है। वर्तमान संकट अनुसूचित जनजातियों, महिलाओं और ग्रामीण गरीबों पर असमान रूप से भारी प्रभाव डालता है और जिले की कृषि, हस्तशिल्प और मानव विकास संभावनाओं के लिए एक संरचनात्मक बाधा है। यह शोध एक प्रमाण-आधारित, सेवा-प्रथम योजना ढाँचा प्रस्तुत करता है जो इंजीनियरिंग व्यवहार्यता, सामाजिक समावेशन, पारिस्थितिक स्थिरता और संस्थागत शासन को एकीकृत कर के ग्रामीण परिवहन सुधार के लिए एक दोहराने योग्य मॉडल प्रदान करता है। गतिशीलता-न्याय को प्राथमिकता देकर — यह सुनिश्चित करते हुए कि जिले के सबसे हाशिए पर रहने वाले निवासी भी उपलब्ध अवसरों तक समान पहुँच प्राप्त करें — यह शोध योजनाकारों, नीति-निर्माताओं और प्रशासकों के लिए मार्गदर्शक सिद्ध होने का लक्ष्य रखता है।

ABSTRACT

Rural transport constitutes a foundational pillar of socio-economic development, particularly in agrarian economies where access to markets, healthcare, and education determines the quality of life for the majority of the population. In India, and especially across Madhya Pradesh, the paradox of infrastructure expansion without corresponding service delivery has rendered rural mobility a persistent crisis. The Pradhan Mantri Gram Sadak Yojana (PMGSY), across its successive phases, has successfully connected over 99 percent of eligible habitations with all-weather roads; however, the dissolution of the Madhya Pradesh State Road Transport Corporation (MPSRTC) in 2005 effectively dismantled the organized public transport system that was meant to utilize these roads. The resulting vacuum was filled by a fragmented ecosystem of private and Intermediate Public Transport (IPT) operators — shared jeeps, motorcycle taxis, and tractors — that prioritize profitable urban corridors while leaving tribal hinterlands and remote agricultural villages chronically underserved.

Dhar district, located in the southwestern reaches of the Indore division in Madhya Pradesh, exemplifies this paradox with particular acuity. Covering an area of approximately 8,153 square kilometres and with a projected 2025 population of 2.66 million — over 80 percent of whom reside in rural areas — the district is both geographically diverse and socially complex. It is administratively organized into nine tehsils: Dhar, Badnawar, Kukshi, Manawar, Gandhwani, Dahi, Dharampuri, Sardarpur, and Pithampur, encompassing 1,625 revenue villages and 764 Gram Panchayats. Over 50 percent of the district's population belongs to Scheduled Tribes (ST), primarily the Bhils and Bhilalas, concentrated in the rugged southern and western belts bisected by the Vindhyachal Range and the Narmada Valley. The district's topography creates three distinct physiographic zones — the fertile Malwa Plateau in the north, the hilly Vindhyachal Range in the centre with peaks rising to 751 metres, and the narrow Narmada alluvial valley in the south — each imposing distinct and severe constraints on transport connectivity and service delivery. Despite being a major producer of cotton, soybean, wheat, and the globally recognized Bagh print textile craft, Dhar's rural population is disproportionately penalized by the "Rural Penalty" of poor transport,

where inadequate services reduce net agricultural income by an estimated 12 to 15 percent due to high freight costs and post-harvest losses.

The central problem addressed by this thesis is the structural disconnect between physical road infrastructure and actual transport accessibility. The road network in Dhar includes critical national corridors — NH-47 linking Indore to Ahmedabad and NH-3 on the eastern boundary serving the industrial belt of Pithampur — along with State Highways and a dense capillary network of rural roads. However, approximately 80 percent of Major District Roads (MDRs) in Madhya Pradesh remain restricted to single or intermediate lane widths of 3.75 to 5.5 metres, creating bottlenecks that limit both passenger and freight movement. Compounding this, many PMGSY roads are seasonally compromised by damaged culverts and siltation, increasing travel times by up to 20 percent during the four-month monsoon period in tribal tehsils such as Dahi and Kukshi. The absence of organized public transport has trapped communities in a "vicious cycle" where low demand on rural routes renders them commercially unattractive for private operators, which in turn results in infrequent or absent services, higher fare burdens, and restricted mobility, thereby entrenching rural poverty.

The socio-spatial dimensions of this mobility crisis are most acutely experienced by vulnerable groups — women, the elderly, school-going children, people with disabilities, and tribal communities. The survey conducted across 12 representative villages and 150 households reveals that women in tribal-dominant villages such as Tirla, Susari, and Nisarpur spend an average of 4.5 hours daily on unpaid "invisible trips" — foot-based survival journeys for collecting water, firewood, and fodder — often carrying head-loads of up to 20 kilograms across uneven terrain. These trips, which standard transport surveys systematically overlook, represent a profound form of "Time Poverty" that restricts women's participation in the formal economy. The Participatory GIS methodology, drawing from global frameworks applied in Nepal and Kenya, revealed that these invisible paths constitute a significant share of total daily mobility in the district, with informal tracks outnumbering official road segments by a ratio of up to three-to-one in certain habitations. Additionally, women's perceptions of night-time transport safety registered a critically low score of 1.2 on a 5-point Likert scale, compared to 2.5 for men, effectively imposing a "curfew by lack of transport" that prevents access to emergency healthcare and evening livelihoods. In the 12 surveyed villages, 15 percent of secondary-school-aged students cited "distance and

lack of transport" as the primary reason for discontinued education, with the impact being three times greater for girls than for boys.

The methodology of this thesis adopts a rigorous mixed-methods framework structured around four interrelated research objectives. The first objective — characterizing travel behaviour and trip patterns — was addressed through roadside interviews, travel diaries, and GPS-informed spatial analysis. The survey data reveals that the average distance from a study village to the nearest town headquarter is 16.4 kilometres, with healthcare trips averaging 24 kilometres at a one-way cost of Rs. 200 to 500 by hired taxi. The second objective — identifying mobility needs and barriers among vulnerable groups — was pursued through participatory workshops, semi-structured interviews, and gender-disaggregated mobility matrices. The third objective — analysing factors affecting the planning and management of rural transport — involved institutional analysis through operator interviews, fare structure assessments, and regulatory document review. Asset ownership data confirms that 62 percent of households depend on motorcycles, primarily operated by male heads of households, while 22 percent own no private vehicle at all, rendering them "captive users" entirely dependent on the availability and affordability of IPT. Tribal households in remote villages were found to spend up to 18 percent of their monthly income on shared jeeps and motorcycle taxis to access basic services. The fourth objective — evaluating potential service models and low-carbon options — employed feasibility assessment, scenario modelling, and stakeholder consultations drawing on the Rural Transport Services Indicators (RTSI) framework applied in Ghana and the electromobility pilot conducted in the Yamoussoukro Region of Côte d'Ivoire. The 12 study villages were selected through purposive sampling to represent the full spectrum of connectivity hierarchy, demographic composition, distance decay, economic activity, and service provision status — spanning served, underserved, and unserved categories across tehsils of Dhar, Manawar, Kukshi, Sardarpur, and Dahi.

Drawing on these findings, the thesis proposes a comprehensive planning framework entitled "Sewa-Sanskriti-Sanchalan" (Service-Culture-Movement) with a Vision 2030 goal of establishing a "Seamless Rural Grid" across Dhar district. The spatial strategy organizes the district into a hierarchical hub-and-spoke network: macro-hubs at tehsil headquarters (Dhar, Kukshi, and Manawar), intermediate transit points at Gramin Agricultural Markets (GrAMs), and a capillary network of PMGSY spokes served by

high-frequency, small-capacity vehicles. Three key sectoral interventions are proposed. First, an electromobility pilot involving the deployment of 10 to 12-seater electric minibuses on the high-gradient routes of the Vindhyachal Range, leveraging superior torque performance on uneven terrain and lower per-kilometre operating costs. Second, the installation of decentralized solar-powered charging hubs at block headquarters such as Dahi and Gandhwani to support round-the-clock green energy supply for the EV fleet. Third, the formation of the "Amhi Sarathi" cooperative — a community-managed vehicle operator model inspired by the Aajeevika Grameen Express Yojana (AGEY) framework — designed to generate livelihoods for Scheduled Tribe youth while ensuring reliable last-mile connectivity. The proposal also advocates for the regularization of motorcycle taxis through safety licensing and training, transforming them from unsafe informal modes into certified door-to-door feeder services for women and students.

The financial and governance architecture underpinning these proposals is grounded in evidence-based policy mechanisms identified through the comparative analysis of the Madhya Pradesh rural transport landscape. The Rural Transport Credit (RTC) model — providing private operators with monthly financial credits for every kilometre plied on designated unprofitable rural routes — is proposed as the primary incentive mechanism to bridge the commercial gap on low-demand corridors. This is supplemented by a 100 percent exemption from monthly motor vehicle taxes for 7+1 to 20+1 seater vehicles operating on rural feeder routes, and a 15 percent upfront capital subsidy for the induction of electric vehicles through the Credit Link Capital Subsidy Scheme (CLCSS). The phased governance structure assigns route-wise tendering oversight to the District Collector, operational monitoring to Panchayati Raj Institutions (PRIs) through the e-MARG and Online Management, Monitoring and Accounting System (OMMAS) platforms, and community-level vigilance to gender-inclusive transport committees at the Gram Sabha level. Phase I focuses on operationalizing the RTC pilot in Dhar and Kukshi blocks; Phase II on expanding the solar charging and e-minibus fleet across all 13 development blocks; and Phase III on integrating real-time GPS tracking and participatory monitoring into a comprehensive "Seamless Rural Grid."

In conclusion, this thesis demonstrates that the rural transport crisis in Dhar district is not a product of absent roads but of absent coordination between infrastructure and

service delivery. The current crisis disproportionately burdens Scheduled Tribe communities, women, and the rural poor, and constitutes a structural barrier to the district's agricultural, artisanal, and human development potential. The research contributes an evidence-based, service-first planning framework that integrates engineering feasibility, social inclusion, ecological sustainability, and institutional governance into a replicable model for rural transport enhancement. By prioritizing mobility justice — ensuring that the most marginalized residents of Dhar's tribal tehsils have equitable access to the opportunities available on its national highways — the findings of this thesis aim to guide planners, policymakers, and administrators in fulfilling the transformative promise of India's rural road program.

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CHAPTER 1

Introduction

1.1 Background and Rationale

The structural integrity of a nation's development is often measured not by the velocity of its urban centres, but by the accessibility of its rural peripheries. In countries where the majority of the population still resides in villages — India being the foremost among them — the quality, reliability, and affordability of rural transport services directly determines whether a household can access a market, a school, a hospital, or an opportunity. Transport is not merely a mode of physical conveyance; it is the circulatory system of rural economies, carrying labour, produce, children, patients, and aspirations across landscapes that are often rugged, seasonally disrupted, and underserved by formal planning systems.

In India, the last two decades have witnessed an extraordinary expansion of the rural road network under the Pradhan Mantri Gram Sadak Yojana (PMGSY), launched in the year 2000, which successfully connected over 99 percent of eligible habitations across the country with all-weather motorable roads. Madhya Pradesh, which ranks fifth among states in the length of rural roads constructed, has been a significant beneficiary of this programme. Yet, in a paradox that reveals the limits of infrastructure-centric planning, the construction of roads has not automatically translated into the availability of transport services. In large parts of rural Madhya Pradesh — and particularly in the tribal, forested, and agriculturally diverse districts of its western region — villages have roads, but no buses; connectivity on paper, but isolation in practice.

The inflection point for this crisis was the dissolution of the Madhya Pradesh State Road Transport Corporation (MPSRTC) in 2005, which effectively ended state-organized public bus services in rural areas. The resulting vacuum was filled, unevenly and inadequately, by private operators and informal modes of Intermediate Public Transport (IPT) — shared jeeps, motorcycle taxis, tractors, and autorickshaws — that tend to operate on commercially viable urban-to-urban corridors while ignoring the low-demand, dispersed settlements of the rural interior. The outcome has been the entrenchment of what scholars term the "Rural Penalty": a compounding of disadvantages in which poor transport services exacerbate rural poverty,

reduce agricultural incomes, restrict access to healthcare and education, and trap women and tribal communities in conditions of time poverty and social immobility.

It is against this backdrop that the present thesis situates its inquiry in Dhar district, Madhya Pradesh — a region that embodies, with particular clarity, both the contradictions of India's rural transport landscape and the urgency of service-oriented planning solutions. Dhar is simultaneously a major cotton and soybean producer, an internationally recognized artisan economy (the Bagh print craft), an industrial corridor host (Pithampur), and a district where over 50 percent of the population belongs to Scheduled Tribes who live in remote, topographically constrained habitations with minimal access to organized transport. The district thus presents a compelling and representative case for the development of a comprehensive, evidence-based planning framework for enhancing rural transport services.

1.2 Definitions of Key Concepts

A rigorous understanding of the subject requires the precise definition of its foundational concepts, drawn from authoritative international and national sources. The following definitions establish the conceptual vocabulary that guides this research.

1.2.1 Rural Transport

World Bank (2007): (*Starkey, P. — Rural Transport Services in Africa*): "Rural transport encompasses all forms of movement of people, goods, and services in rural areas, including non-motorized transport (NMT) such as walking and head-loading, intermediate means of transport (IMT) such as bicycles and motorcycles, and motorized public and private vehicles. It includes both the physical infrastructure (roads, bridges, paths) and the services that operate upon them."

International Labour Organization / ILO (2013): (*ILO Rural Transport Programme*): "Rural transport refers to the movement of persons and freight in rural areas facilitated by transport infrastructure and services. It plays a critical role in enabling access to labour markets, social services, and economic opportunities, and is a prerequisite for inclusive rural development."

National Transport Development Policy Committee / NTDPC (2013): (*India Transport Report: Moving India to 2032*): "Rural transport is the system of roads, vehicles, and services that enables the movement of the rural population and agricultural produce. In India, it is characterised by a high degree of informality, dependence on non-motorized modes, and severe underservice in tribal and hilly areas."

Porter, G. (2014): (*Transport Reviews, Vol. 34(1)*): "Rural transport in the developing world is distinguished by the diversity of modes employed — from foot travel and head-loading to motorcycles and minibuses — and by the fundamental relationship between transport access and poverty. The absence of reliable transport services is both a cause and a consequence of rural poverty."

1.2.2 Rural Accessibility

United Nations — SDG 9.1 (2015): (*Transforming Our World: The 2030 Agenda*): "Accessibility refers to the ease with which people can reach the goods, services, activities, and destinations they need and desire. It is determined not only by the physical presence of transport infrastructure but by the quality, affordability, frequency, and safety of the services that use it."

Integrated Rural Accessibility Planning / IRAP (FAO / ILO): (*IRAP Methodology Guidelines*): "Rural accessibility is measured as the ability of a village population to reach essential facilities — markets, health centres, schools, water sources, administrative offices — within a reasonable time, cost, and effort. It considers the entire transport chain from the household to the service point."

Tiwari, G. & Jain, D. (2012): (*IATSS Research, Vol. 36(1)*): "In the Indian rural context, accessibility is a multi-dimensional concept encompassing physical proximity to roads, availability of transport services, affordability relative to household income, and social equity — particularly the differential access experienced by women, elderly, and disabled persons."

1.2.3 Intermediate Public Transport (IPT)

World Bank / SSATP (2009): (*Sub-Saharan Africa Transport Policy Programme*): "Intermediate Public Transport refers to modes of transport that fall between conventional mass transit (buses, trains) and private motorized vehicles. They include shared taxis, motorcycle taxis, three-wheelers (autorickshaws), shared minivans, and other semi-formal services. IPT typically operates on a demand-responsive basis and plays a critical role in last-mile connectivity."

MP Rural Transport Policy (2016): (*Government of Madhya Pradesh, Transport Department*): "In the Madhya Pradesh context, Intermediate Public Transport encompasses all vehicles of a seating capacity between 4+1 and 20+1 that are used for the carriage of passengers on rural roads, including shared jeeps, tempos, autorickshaws, and motorcycle taxis. These modes constitute the dominant form of mechanized transport in villages following the withdrawal of state-run bus services in 2005."

1.2.4 Mobility Justice

Sheller, M. (2018): (*Mobility Justice: The Politics of Movement in an Age of Extremes*): "Mobility justice refers to the equitable distribution of the rights, capabilities, and resources to move — or to remain still — across different social groups, geographies, and political economies. It challenges the uneven power relations embedded in transport systems that privilege certain bodies, vehicles, and routes while immobilizing others."

De Roulet et al. (2023): (*Participatory GIS for Rural Mobility Assessment — Nepal & Kenya*): "Mobility justice in rural contexts demands the recognition of 'invisible' trips — the daily foot-based survival journeys of women and marginalized groups for water, firewood, and fodder — as legitimate transport needs that planning systems must acknowledge, map, and address."

1.2.5 Rural Transport Services

Afukaar, F.K. et al. (Rural Transport Services Indicators — Ghana): (*Mixed-Methods Methodology for Policy Informing*): "Rural transport services are defined by their frequency (how often a route is served), cost (fare relative to average household income), reliability (consistency of service across seasons and days), safety (condition of vehicles and road safety record), and inclusivity (ability to serve women, elderly, disabled, and the poor on an equal basis)."

Ziegler, D. et al. (2025): (*Exploring Mobility Characteristics in Rural Sub-Saharan Africa — Côte d'Ivoire*): "A mobility gap exists when the physical presence of roads is not matched by operational transport services, leading communities — particularly in emerging economies — to remain dependent on walking as the primary mode of daily movement, regardless of the level of road infrastructure investment."

1.2.6 The Rural Penalty

Seedhouse, A. et al. (2016): (*Female Entrepreneurs and Rural Transport — Nigeria*): "The Rural Penalty describes the cumulative economic and social disadvantage experienced by rural households as a direct consequence of poor transport services. It manifests as reduced agricultural profitability (due to high freight costs and post-harvest losses), restricted access to markets and services, higher unit costs of living, and the effective exclusion of women from formal economic participation."

1.3 Study Area: Dhar District, Madhya Pradesh

Dhar district constitutes the primary geographical canvas of this thesis. Its selection as a study area is not arbitrary — it is a district that, in a single administrative unit, encapsulates the full spectrum of India's rural transport challenge: topographic diversity, demographic complexity, post-institutional policy vacuum, agricultural and artisanal economic significance, and a large, vulnerable Scheduled Tribe population with acute mobility needs. A detailed understanding of the district's geography, administration, demography, economy, and transport infrastructure is therefore essential to contextualizing both the problem and the proposed solutions.

The district's southern boundary is defined in part by the Narmada River, which forms a natural physiographic divide between the Malwa Plateau to the north and the Satpura-Vindhya ranges to the south. This geographic position at the intersection of three distinct physiographic zones — plateau, ridge, and valley — is the primary determinant of Dhar's varied transport accessibility challenges.



1.3.2 Physiography and Topography

The physical landscape of Dhar is organized into three distinct physiographic zones, each imposing unique constraints on transport infrastructure and service delivery.

The Malwa Plateau occupies the northern portion of the district, encompassing the tehsils of Dhar, Sardarpur, Badnawar, and parts of Manawar. This zone features flat to gently undulating terrain at an average elevation of 500 metres above mean sea level. The black cotton soil (Vertisols) of this plateau is highly productive but becomes expansive and impassable during the monsoon, severely affecting the trafficability of low-volume rural roads. The northern plateau supports the majority of the district's intensive agricultural activity — primarily soybean, wheat, cotton, and gram — necessitating a robust road network for the transport of produce to mandis and markets.

The Vindhya Range occupies the central belt of the district, running east to west in a crescentic form with a width of 5 to 20 kilometres. This range presents the most significant topographic barrier to north-south mobility in the district. Peaks such as Mograba reach 751 metres, and the steep gradients of the range severely limit vehicle operations, particularly for overloaded or underpowered vehicles. The range bisects the district's connectivity, creating what transport geographers call a "lead distance" problem: villages on the southern or northern flanks of the range may be nominally close to a highway in straight-line terms but require circuitous routes of significantly greater length and time to reach it.

The Narmada Valley in the south is a narrow alluvial plain flanked by the Vindhya scarp to the north and the Satpura Range to the south. Covering the tehsils of Kukshi, Dharampuri, and Dahi, this valley is fertile and densely forested in parts, but is highly susceptible to seasonal flooding and monsoon isolation. The Mahi, Hatni, and Panam rivers dissect the western tehsils of Bagh and Kukshi, creating additional bridging requirements for all-weather connectivity. Tribal communities in this zone — primarily Bhils and Bhilalas — depend on forest-based livelihoods and face the most acute transport deprivation in the district.

1.3.3 Administrative Structure

The administrative framework of Dhar district is organized into nine tehsils — Dhar, Badnawar, Kukshi, Manawar, Gandhwani, Dahi, Dharampuri, Sardarpur, and Pithampur — which collectively manage 1,625 revenue villages organized under 764 Gram Panchayats. The following table presents the tehsil-wise distribution of administrative units and population, drawn from the 2011 Census of India.

S.No.	Tehsil Name	Rev. Circles	Rev. Halkas	Rev. Villages	Population (2011)
1	Dhar	4	109	265	3,39,043
2	Badnawar	4	88	179	2,05,523
3	Kukshi	4	120	208	2,84,677
4	Manawar	4	125	214	2,77,795
5	Gandhwani	2	66	150	1,56,046
6	Dahi	1	46	63	1,05,733
7	Dharampuri	2	53	116	1,35,203
8	Sardarpur	4	96	217	2,68,552
9	Pithampur	3	74	213	1,26,200

Table 1: Tehsil-wise Administrative and Demographic Profile of Dhar District (Census 2011 / Projected 2025)

Dhar tehsil, with 265 revenue villages and a 2011 population of 3,39,043, serves as the primary administrative and economic node of the district. Kukshi and Manawar function as secondary centres, particularly for agricultural trade in cotton and chili in the Narmada valley belt. Dahi tehsil, with only 63 revenue villages, reflects the extreme geographic isolation of the forested southern fringe, where settlement patterns are sparse and dispersed. The newly carved Pithampur tehsil hosts the industrial town of Pithampur — one of the largest industrial areas in Madhya Pradesh — creating a distinct peri-urban transport demand that contrasts sharply with the agricultural and tribal character of the rest of the district.

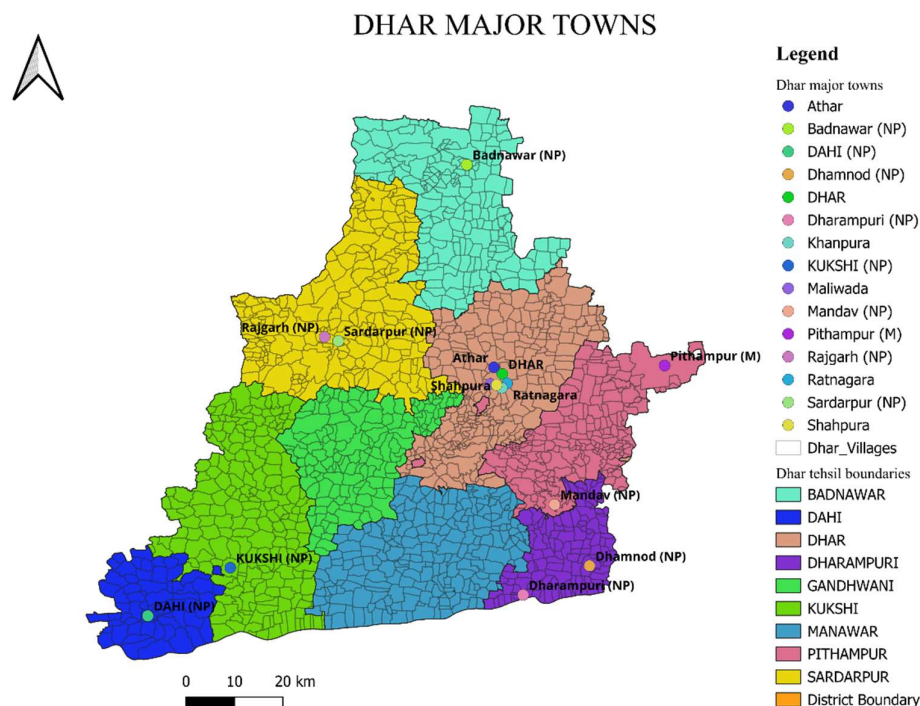


Fig. 2: Major Towns

1.3.4 Demography and Social Composition

As of the 2011 Census, Dhar district recorded a total population of 21,85,793, of which approximately 81 percent (1,76,85,000 approximately) resides in rural areas — a proportion that, when projected to 2025, translates to a rural population of approximately 2.15 million within an estimated district total of 2.66 million. This ratio underscores that Dhar is overwhelmingly a rural district, and that any planning intervention in transport must be designed for the rural majority.

The most significant demographic characteristic of Dhar from a transport planning perspective is the extraordinarily high proportion of Scheduled Tribe (ST) population. Over 56 percent of the district's population belongs to tribal communities, primarily the Bhil and Bhilala groups. This places Dhar among the highest ST-concentration districts in Madhya Pradesh and in India. Scheduled Caste (SC) communities account for an additional 14 percent of the population. Together, SC/ST groups constitute approximately 70 percent of Dhar's population, a fact that has profound implications for transport planning, as these communities are disproportionately located in geographically remote, topographically constrained habitations, and face compounded social and economic barriers to mobility.

The sex ratio in Dhar stands at 964 females per 1,000 males (2011 Census), while the literacy rate is 59.1 percent overall, with a significant gender gap — 70.1 percent for males and 47.7 percent for females. The low female literacy and the high proportion of tribal women are directly linked to the transport crisis: in villages without reliable bus services, girls are disproportionately withdrawn from secondary schools, and women are structurally excluded from market and healthcare access.

1.3.5 Economy: Agriculture, Artisanship, and Industry

The economy of Dhar district operates across three distinct registers — agriculture, traditional artisanship, and modern industry — each with its own specific and critical transport dependency.

Agriculture constitutes the primary livelihood for the majority of the rural population. The district is a significant producer of soybean, wheat, cotton, gram, and maize. The tehsils of Manawar and Kukshi are part of the cotton belt extending into Maharashtra, producing internationally traded long-staple cotton and chili. The agricultural economy is intensely sensitive to transport quality: post-harvest losses of 12 to 15 percent in net farm income are attributed to high freight costs, the inability to reach regulated markets (mandis) in time, and the forced sale of produce to local intermediaries at depressed prices when transport is unavailable or unaffordable.

The Bagh print textile craft, centred in the village of Bagh in Kukshi tehsil, represents one of India's most distinguished geographical indication (GI) tagged artisanal traditions. This centuries-old block printing on natural fabric, practised by artisan families of indigenous tribal descent, provides livelihoods to thousands of families and has a growing national and international market. However, artisan families consistently report that the absence of regular bus services forces them to hire private vehicles at rates ranging from Rs. 1,000 to Rs. 2,000 per trip to transport finished fabrics to markets in Dhar or Indore — a cost that directly erodes their competitiveness against machine-printed alternatives. The Bagh print economy thus represents a compelling case study in the economic costs of transport deprivation.

The industrial economy of Dhar is concentrated in Pithampur, which is one of the largest and most significant industrial estates in central India, hosting over 1,000 industrial units in sectors including automobiles, pharmaceuticals, food processing, and electronics. The newly approved Multi-Modal Logistics Park (MMLP) at Pithampur further consolidates this industrial gravity. The contrast between Pithampur's high-speed, NH-3 connected industrial economy and the

isolated, foot-dependent tribal villages of Dahi and Kukshi illustrates, in starkest terms, the transport inequality that characterizes the district.

1.3.6 Road Infrastructure: Network and Gaps

The road network of Dhar district, while substantial at the macro level, reveals critical deficiencies at the capillary level that directly determine service accessibility for the rural majority.

At the macro level, the district is traversed by two major national corridors. NH-47 (formerly NH-59), running from Indore to Ahmedabad, passes through Dhar city and Sardarpur tehsil, providing the primary north-south arterial connection. NH-3 (the Agra-Mumbai corridor) passes along the eastern boundary of the district, providing high-speed access to the industrial belt of Pithampur. The State Highway network — comprising SH-18, SH-31, SH-35, SH-38, and SH-39 — forms the secondary backbone, linking tehsil headquarters and major agricultural centres.

The following table summarizes the road network hierarchy and its implications for rural connectivity in Dhar district.

Road Category	Status in MP / Dhar	Implications for Dhar
National Highways	8,853 km in MP; NH-47 & NH-3 pass through Dhar	Macro-linkages for Pithampur industrial belt and interstate trade
State Highways	9,089 km in MP; SH-18, 31, 35, 38, 39 in Dhar	Secondary corridors for cotton, chili, and passenger movement
Rural Roads (PMGSY)	2,32,331 km in MP; >99% eligible habitations connected	Primary link for 81% of Dhar's population
Major District Roads	80% are single/intermediate lane (3.75–5.5 m wide)	Bottlenecks limiting agricultural and passenger transport
Road Density (Dhar)	25.3 km per 100 sq. km	Significantly lower than state urban average

Table 2: Road Network Hierarchy and Implications for Dhar District

The most critical deficit exists at the level of Major District Roads (MDRs) and village-level PMGSY roads. Approximately 80 percent of MDRs in Madhya Pradesh remain restricted to single or intermediate lane widths of 3.75 to 5.5 metres, creating severe bottlenecks for the

passage of buses and commercial freight vehicles simultaneously. In Dhar, the road density of 25.3 km per 100 square kilometres is significantly below the urbanized regions of the state, confirming the capillary network's inadequacy relative to the settlement pattern.

The PMGSY programme has undergone four phases of evolution in the district. Phase I focused on connecting habitations with populations of 500 or more (250 or more in tribal areas), achieving near-universal coverage by the early 2010s. Phase III (2019–2025) is currently focused on upgrading through routes and major rural links to serve Gramin Agricultural Markets (GrAMs), schools, and hospitals. Phase IV (2024–2029), recently sanctioned, targets the 25,000 remaining unconnected habitations nationally based on 2011 Census criteria. Despite these successive achievements, a 2025 Parliamentary Standing Committee report highlighted that many PMGSY roads in districts like Dhar suffer premature deterioration due to the movement of heavy agricultural tractors and limestone trucks that exceed their design loading, with maintenance budgets chronically underfunded. The "all-weather" designation of these roads is, for 72 percent of surveyed respondents in remote villages, seasonally compromised by damaged culverts and siltation during the four-month monsoon period.

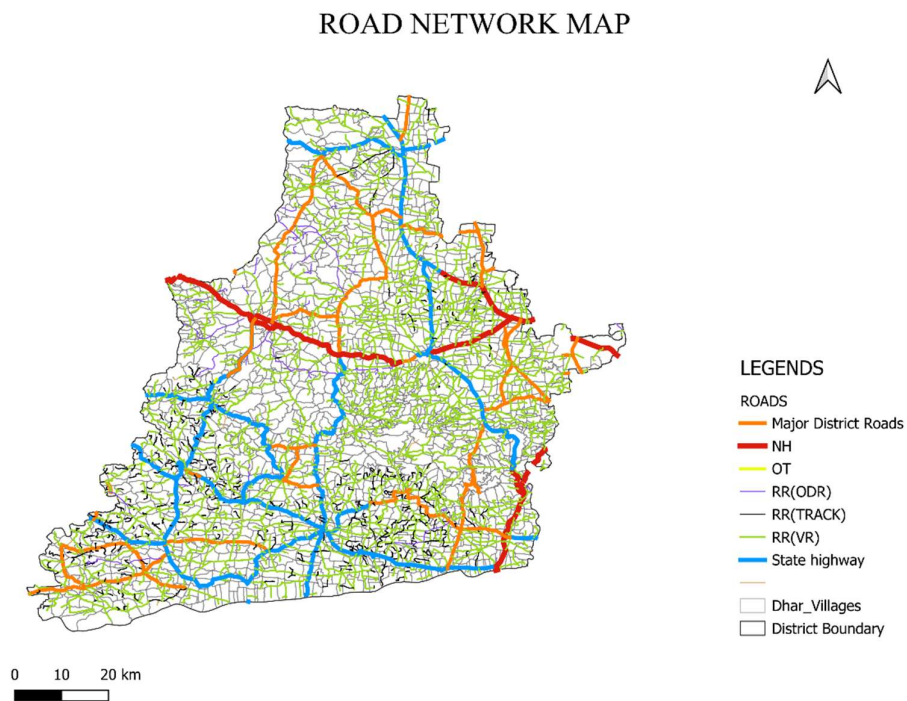


Fig. 3: Road Network

1.3.7 The 12 Selected Study Villages

To operationalize the research, 12 representative villages were selected across Dhar district through purposive sampling, designed to capture the full spectrum of connectivity, demographic composition, distance-decay effects, economic character, and service provision status. The selection ensures representation across the three physiographic zones and all major tehsils. The following table documents the selected study villages.

Village	Tehsil	Pop. (2011)	Connectivity	Service Status	Nearest Town
Aali	Dhar	1,681	PMGSY Link	Underserved	Dhar
Ahu	Dhar	2,331	SH-31 Adj.	Served	Dhar
Tirla	Dhar	Block HQ	NH-47 Link	Served	Dhar
Bagdi	Dhar	5,431	NH-3 Link	Served	Pithampur
Singhana	Manawar	Hub	SH-38 Hub	Served	Manawar
Bamkaner	Manawar	N/A	MDR Link	Underserved	Manawar
Bagh	Kukshi	7,000+	SH-35 Hub	Served	Kukshi
Nisarpur	Kukshi	N/A	SH-39 Link	Underserved	Kukshi
Susari	Kukshi	Remote	Rural Track	Unserved	Kukshi
Amjhera	Sardarpur	Historical	NH-47 Bypass	Served	Sardarpur
Labariya	Sardarpur	5,000+	SH-35 Link	Underserved	Sardarpur
Dahi	Dahi	Block HQ	SH-39 End	Underserved	Kukshi

Table 3: Selected Study Villages across Dhar District

The spatial distribution of these 12 villages enables cross-tehsil and cross-zone comparative analysis. Villages such as Ahu and Bagdi, adjacent to state and national highways, represent the most accessible end of the spectrum, while Susari in Kukshi and Dahi in Dahi tehsil represent the unserved extreme — communities reachable only by rough tracks impassable to standard buses, where walking and the occasional motorcycle taxi constitute the entirety of the available transport system. The 18 km lead distance from Susari to the nearest paved State Highway (SH-35) epitomizes the scale of the last-mile challenge.

1.4 Problem Statement

Despite two decades of intensive investment in rural road infrastructure under PMGSY, Dhar district — and rural Madhya Pradesh more broadly — continues to suffer from a profound and widening gap between physical road connectivity and functional transport accessibility. The dissolution of the MPSRTC in 2005 created a service vacuum that private and informal operators have filled inequitably, with a systematic bias towards commercially profitable routes and a systematic neglect of the low-demand, dispersed settlements where the poorest and most vulnerable populations reside.

The problem is multi-dimensional and interlocking. First, the fragmentation and unreliability of service supply: private operators concentrate on urban corridors, leaving hundreds of villages with infrequent or no motorized service. Second, structural barriers for vulnerable groups: women, tribal communities, elderly persons, students, and the poor face compounded transport burdens — financial, spatial, social, and temporal — that are invisible to infrastructure-focused planning systems. Third, data and planning deficits: there is a critical absence of village-level empirical data on actual trip patterns, mobility needs, service performance, and the gendered dimensions of transport, without which evidence-based intervention design is impossible. Fourth, sustainability and resilience gaps: the existing informal service ecosystem is entirely fossil-fuel based, exposed to fuel price volatility, and generating avoidable carbon emissions in a district that is simultaneously developing renewable energy capacity. The absence of any exploration of low-carbon, demand-responsive, or community-managed service models represents both a planning failure and a missed opportunity.

The central research question that this thesis addresses is: how can rural transport services in Dhar district, Madhya Pradesh, be systematically enhanced to achieve mobility justice, economic productivity, and sustainability for all segments of the rural population — with particular attention to the needs of Scheduled Tribe communities, women, and the rural poor?

1.5 Aim and Objectives

1.5.1 Aim

To assess travel behaviour and supply-side constraints of rural transport in Dhar district, Madhya Pradesh, and to propose an integrated planning and management framework that enhances accessibility, service reliability, social inclusion, and environmental sustainability for the district's rural population.

1.5.2 Research Objectives

Objective 1: To characterize the travel behaviour and trip patterns of rural residents in selected villages of Dhar district, including trip frequency, purpose, mode choice, distances, costs, and seasonal variations.

Objective 2: To identify the mobility needs and barriers experienced by vulnerable groups — women, elderly, Scheduled Tribe communities, students, and the economically marginalized — and to analyse the gendered and social dimensions of transport deprivation.

Objective 3: To analyse the factors affecting the planning and management of rural transport services in Dhar, including operator economics, road quality, institutional arrangements, and regulatory frameworks.

Objective 4: To evaluate the feasibility, scalability, and sustainability of alternative service models and low-carbon transport options for enhancing rural mobility in the district.

1.6 Scope and Limitations

1.6.1 Scope

The scope of this research is delimited, geographically, to the Dhar district of Madhya Pradesh, with primary data collection from 12 representative villages across five tehsils. Thematically, the research focuses on the "service layer" of rural transport — the frequency, cost, reliability, safety, and social impact of transport services — rather than on the engineering aspects of road construction or maintenance. The scope includes the evaluation of both conventional and innovative service models, including the Rural Transport Credit (RTC) mechanism, the Aggregator model, the Gramin Maitri model, and low-carbon electric vehicle options. The methodology encompasses mixed-methods approaches including household surveys, travel diaries, Participatory GIS mapping, operator interviews, and scenario modelling, drawing on international frameworks adapted to the Indian context.

1.6.2 Limitations

The research is subject to several limitations. Geographically, the site-specificity of Dhar's tribal and agricultural context means that findings cannot be uncritically generalized to more urbanized or plain-terrain districts. Methodologically, rapid appraisal techniques and snapshot surveys may miss longitudinal trends and represent population subsets. Data limitations on long-term PMGSY road performance, operator cost structures, and seasonal mobility variation constrain the precision of certain analyses. The evaluation of new service models such as the RTC remains largely theoretical at this stage, pending operational pilots and field validation. Environmental variables — extreme weather events, monsoon seasonality, battery performance in remote off-grid settings — introduce uncertainty into the low-carbon feasibility modelling. The success of Participatory GIS tools is contingent on participant digital literacy, which varies significantly across habitations in the district.

1.7 Research Context: Global, National, and State-Level Frameworks

This research is situated within a rich and growing body of international and national scholarship on rural transport, mobility, and development. At the global level, the foundational work of Starkey (2007) for the World Bank on rural transport services in Africa established the analytical distinction between road infrastructure and transport service delivery that this thesis applies to the Indian context. Porter (2014) demonstrated the causal relationship between transport service gaps and rural poverty perpetuation, while Ziegler et al. (2025) provided the most recent empirical evidence on mobility characteristics in rural emerging economies, including the first systematic study of electromobility in rural Sub-Saharan Africa — offering directly applicable insights for the EV feasibility analysis in Dhar.

At the level of methodology, Afukaar et al.'s development of the Rural Transport Services Indicators (RTSI) framework in Ghana provided the quantitative backbone for measuring service quality beyond simple road availability. De Roulet et al.'s application of Participatory GIS in Nepal and Kenya demonstrated the power of community-led spatial data collection to reveal the "invisible" mobility of women and marginalized groups — a methodology central to the gender-sensitive analysis conducted in this thesis. Seedhouse et al.'s study of female entrepreneurs in Nigeria gave empirical substance to the concept of the Rural Penalty and its gendered dimensions.

In the Indian national context, the NTDP's India Transport Report (2013) established the policy imperative for rural transport service enhancement as a component of the "Moving India to 2032" vision, while the MP Manuscript on rural transport strategy in Madhya Pradesh provided a directly applicable policy framework, particularly through its analysis of the Rural Transport Credit model. The Government of India's Aajeevika Grameen Express Yojana (AGEY) and the Integrated Rural Accessibility Planning (IRAP) framework of the FAO and ILO provided both policy precedents and analytical tools for the research.

Together, these international and national frameworks establish that the enhancement of rural transport services is not merely a technical or engineering challenge, but a planning, governance, and equity challenge — one that requires integrated, evidence-based, service-first approaches of precisely the kind that this thesis develops for Dhar district.

1.8 Structure of the Thesis

The thesis is organized into eight chapters. Chapter 1 (this chapter) provides the introduction, key definitions, study area profile, problem statement, aim, objectives, scope, and research context. Chapter 2 presents the review of relevant literature, synthesizing international and national scholarship on rural transport, mobility, and development. Chapter 3 describes the methodology in detail, structured around the four research objectives, with a complete account of data collection instruments, sampling strategies, and analytical frameworks. Chapter 4 presents the case studies — five comparative cases at global and national scales — that benchmark the Dhar research within established practice. Chapter 5 presents the primary and secondary data analysis, including household survey findings, travel behaviour patterns, gendered mobility matrices, and spatial analysis outputs. Chapter 6 presents the planning framework, spatial strategies, and sectoral proposals for enhancing rural transport services in Dhar district, including the electromobility pilot, solar charging infrastructure, cooperative management models, and phased implementation strategy. Chapter 7 presents the full map portfolio developed through GIS analysis. Chapter 8 presents the conclusions, policy recommendations, and directions for further research.

CHAPTER 2

Research Methodology

2.1 Introduction to the Research Methodology

The research methodology adopted for this thesis has been designed to comprehensively and rigorously investigate the multidimensional problem of rural transport service deficiency in Dhar District, Madhya Pradesh. It serves as the operational blueprint that connects the overarching research aim — to assess travel behaviour and supply-side constraints of rural transport and propose planning and management interventions to enhance accessibility and service reliability — with the four specific objectives and their corresponding empirical tasks. The methodology is not a simple set of mechanical procedures but rather a carefully reasoned epistemological stance that recognizes the complexity of rural mobility as a social, economic, infrastructural, and institutional phenomenon.

Rural transport research in developing country contexts demands an approach that is simultaneously rigorous enough to produce generalizable insights and sensitive enough to capture the lived realities of marginalized populations. This dual requirement has led to the adoption of a mixed-methods research design, which combines the systematic measurement of quantitative data — trip frequencies, distances, modal shares, and service costs — with the depth and contextual richness of qualitative inquiry through participatory workshops, semi-structured interviews, and observational fieldwork. This approach draws direct methodological inspiration from landmark international studies, particularly the comprehensive mobility assessment of the Yamoussoukro Region in Côte d'Ivoire conducted by Ziegler et al. (2025), as well as frameworks developed for rural transport service indicator assessment in Ghana (Afukaar et al.) and the Participatory GIS mapping exercises implemented in Nepal and Kenya (De Roulet et al.).

The methodology is also grounded in an acute awareness of the specific policy and institutional context of Dhar District and Madhya Pradesh more broadly. The dissolution of the Madhya Pradesh State Road Transport Corporation (MPSRTC) in 2005 fundamentally transformed the rural transport landscape, creating a fragmented service environment dominated by private operators and informal intermediate public transport (IPT) modes. This institutional history directly shapes what kind of data is needed, from whom it must be collected, and what analytical frameworks are most appropriate for interpreting it. The methodology described in this chapter

is therefore tailored to both universal principles of social science research and the specific exigencies of the Dhar context.

2.2 Overall Research Design

The research employs a Mixed-Methods Research Design structured along an explanatory sequential logic: quantitative data is collected and analysed in the first phase to establish the measurable dimensions of travel behaviour and service supply, after which qualitative methods are deployed in the second phase to explain and contextualise the patterns revealed by the quantitative analysis. This design is particularly suited to the present study because rural mobility in Dhar is not merely a technical problem of vehicle availability but a socially embedded phenomenon shaped by caste, gender, geography, seasonality, and economic precarity. Numbers alone cannot fully capture why a tribal woman in Susari village walks four and a half hours daily for water and firewood, nor can interviews alone generate the statistically representative picture of modal shares across twelve villages that is needed for planning interventions.

The research is structured into four distinct phases corresponding to the four research objectives, each phase generating data that feeds into the subsequent one. In Phase I, systematic household surveys and roadside interviews generate baseline quantitative data on trip patterns, modal choices, and transport costs across the twelve selected villages. In Phase II, participatory workshops and focus group discussions with vulnerable groups — women, elderly, students, and tribal communities — uncover the qualitative dimensions of mobility barriers and aspirations. In Phase III, operator interviews and institutional document analysis map the supply-side constraints and governance failures that perpetuate service gaps. Finally, in Phase IV, scenario modelling and stakeholder consultations evaluate the technical and economic feasibility of low-carbon and innovative service delivery models. Together, these four phases generate an integrated evidence base that is both empirically grounded and policy-relevant.

The epistemological orientation of the research is broadly pragmatic: it does not commit dogmatically to either positivist or interpretivist paradigms but draws on whichever methods and analytical frameworks best serve the purpose of understanding a complex real-world problem and generating actionable recommendations. This pragmatic stance is consistent with the tradition of applied planning research, where the ultimate test of a methodology is not its theoretical purity but the quality, relevance, and usability of the knowledge it produces.

2.3 Study Area Delineation and Village Selection

2.3.1 Rationale for Selecting Dhar District

Dhar District was selected as the study area for several interconnected reasons that make it both a representative and particularly instructive case for studying rural transport service challenges in India. Covering approximately 8,153 square kilometres in the western reaches of Madhya Pradesh, Dhar exemplifies the paradox at the heart of India's rural development challenge: significant investments in road infrastructure under programmes like the Pradhan Mantri Gram Sadak Yojana (PMGSY) have expanded the physical road network substantially, yet reliable, affordable, and safe transport services remain conspicuously absent for the majority of the rural population. With over eighty percent of its 2.66 million residents (projected 2025) living in rural areas and more than fifty percent belonging to Scheduled Tribes, primarily the Bhils and Bhilalas, the district presents a concentrated tableau of vulnerability, geographic diversity, and institutional challenge that renders it ideal for the questions this thesis seeks to answer.

The district's administrative organisation into nine tehsils — Dhar, Badnawar, Kukshi, Manawar, Gandhwani, Dahi, Dharampuri, Sardarpur, and Pithampur — spanning 1,625 revenue villages and 764 Gram Panchayats, provides sufficient internal variation in connectivity, topography, and economic activity to enable a comparative analysis within a single district. The three distinct physiographic zones of the Malwa Plateau in the north, the Vindhyachal Range in the centre, and the Narmada Valley in the south create dramatically different transport challenges. The northern agricultural plains require robust roads for high-volume movement of soybeans and wheat, the central forested tribal belt demands socially sensitive service planning for isolated communities, and the southern valley is subject to seasonal isolation during the monsoon. This internal geographic complexity means that findings from Dhar carry lessons applicable to a wide range of rural transport contexts across India.

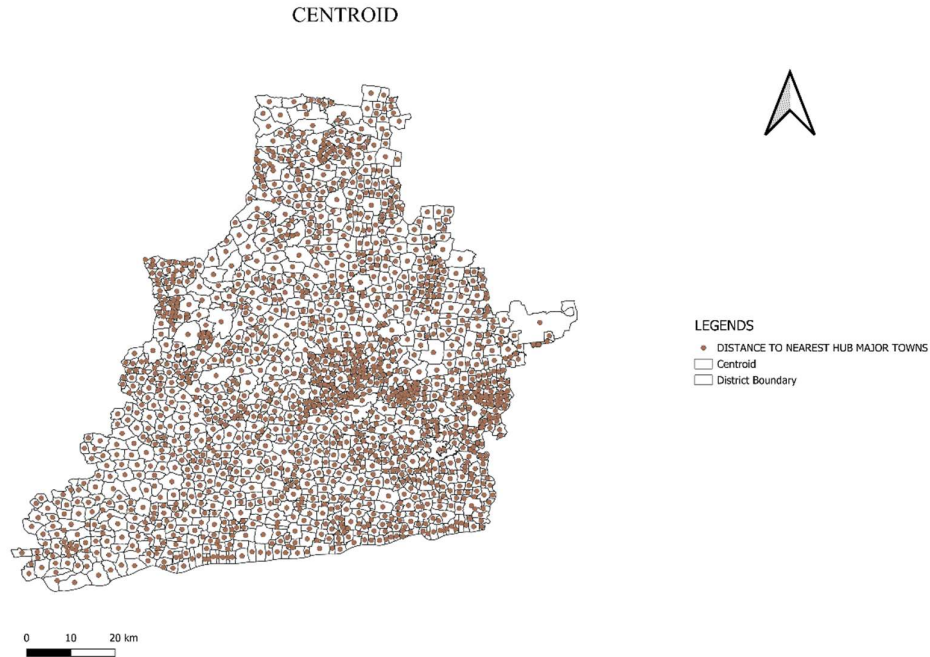


Fig. 4: Centroid

2.3.2 Purposive Sampling Framework for Village Selection

Given the impossibility of surveying all 1,625 revenue villages within the time and resource constraints of a B.Plan thesis, a purposive sampling strategy was adopted to select twelve representative villages that collectively capture the full spectrum of rural transport challenges and service environments found across Dhar District. Purposive sampling was preferred over simple random sampling because the research aim requires representation of specific types of villages — particularly those that are underserved or unserved — which are precisely the villages most likely to be missed by a random sample that would be dominated by the larger, better-connected settlements.

The village selection process was governed by five criteria applied simultaneously. First, connectivity hierarchy: the sample includes villages located directly on National or State Highways, those connected via PMGSY through routes, and those accessible only via rough tracks at the end of cul-de-sac alignments. Second, demographic composition: a minimum of fifty percent of the selected villages are tribal-dominant habitations or Scheduled Caste clusters, ensuring that the most socially vulnerable populations are adequately represented in the primary data. Third, distance decay: villages were chosen at varying distances from the nearest town headquarters — within five kilometres, between five and fifteen kilometres, and beyond fifteen kilometres — to systematically examine how service quality degrades with distance from urban

nodes. Fourth, economic variance: the sample balances agricultural growth centres in the cotton and soybean belt of Kukshi and Manawar, forest-dependent communities in the tribal belts of Dahi and Gandhwani, and peri-urban villages near the industrial hub of Pithampur. Fifth, service provision status: villages were categorised as 'served' (regular bus access), 'underserved' (dependent on IPT or shared jeeps), or 'unserved' (reliant on walking or private motorcycles), and the sample includes representatives of all three categories.

Applying these criteria yielded the final sample of twelve villages: Aali and Ahu in Dhar Tehsil; Tirla as the block headquarters; Bagdi near the NH-3 industrial corridor; Singhana as a secondary agricultural hub in Manawar; Bamkaner as an underserved MDR-connected village; Bagh as the service hub of Kukshi; Nisarpur as an SH-39 linked but underserved settlement; Susari as a fully unserved remote village in the tribal belt; Amjhera in Sardarpur with historical National Highway adjacency; Labariya as an SH-35 linked underserved settlement; and Dahi as the block headquarters of the most isolated tehsil in the district. This sample provides the geographic, demographic, and service-status diversity necessary for the analysis to generate both locally specific and broadly applicable insights.

2.4 Methodology for Objective 1: Characterising Travel Behaviour and Trip Patterns

2.4.1 Rationale and Conceptual Framework

The first research objective — to systematically characterise the travel behaviour and trip patterns of rural residents across the twelve selected villages — forms the empirical foundation upon which the entire subsequent analysis rests. Without an accurate and granular understanding of how people actually move, for what purposes, at what frequency, and using what modes, it is impossible to diagnose service gaps with precision or to design targeted interventions. The methodology for this objective draws on the tradition of Travel Diary surveys and roadside interview techniques, both of which have been validated in rural African and South Asian contexts as effective tools for capturing the multi-dimensional nature of rural mobility, including the 'invisible' trips — such as daily walking for water and firewood collection — that are systematically omitted from official transport statistics.

2.4.2 Household Survey and Travel Diary Administration

The primary instrument for achieving Objective 1 is a structured household questionnaire administered to 150 households across the twelve villages, yielding an average of twelve to thirteen households per village. The household was chosen as the unit of analysis rather than the individual because transport decisions in rural Dhar are deeply embedded in household economy and social organisation: a family's single motorcycle constrains the mobility of all members who cannot ride it, particularly women, children, and the elderly. The sample size of 150 households was determined through a balance of statistical adequacy and field feasibility, consistent with the precedent set by rapid appraisal techniques validated in similar rural South Asian research contexts.

The household questionnaire is organised into four structured modules. Module One captures the socio-economic profile of the household, including caste and tribal affiliation, household size, primary occupations of all adult members, asset ownership (bicycles, motorcycles, tractors, and other vehicles), monthly household income, and estimated monthly expenditure on transport across all modes. This module is critical for understanding how transport behaviour is conditioned by economic capacity and social position. Module Two is the core Travel Diary component, which records trip frequency, purpose, distance, mode, and cost for a reference week. Trip purposes are classified into seven categories: market access and trade, employment and agricultural work, healthcare, education (primary, secondary, and higher), social visits, religious activities, and survival trips (water, firewood, and fodder collection). For each trip purpose, respondents are asked to report the nearest available destination, the mode typically used, the time taken, and the fare or fuel cost incurred. Module Three assesses service quality perceptions using a five-point Likert scale across five parameters: service frequency, daytime safety, night-time safety, fare affordability, and vehicle reliability. Critically, male and female respondents within the same household are surveyed separately on these perceptions to capture the gendered dimensions of service experience. Module Four records perceived mobility barriers and respondent aspirations, including willingness to pay for improved services, openness to electric vehicle-based modes, and suggestions for service improvements.

2.4.3 Roadside Interview Method

To complement the household surveys, which capture trip patterns retrospectively, roadside interviews are conducted at key nodes — bus stops, market entry points, health centre access roads, and school gates — across each village and the nearest town headquarters. Roadside interviews capture trip behaviour at the moment of travel, providing real-time data on mode choice, trip purpose, origin, destination, and travel time that validates and enriches the household survey data. A minimum of ten roadside interviews per village are targeted, with a

total of at least 120 interviews across the study area. Interviewers are trained to stratify respondents by gender, age, and apparent socio-economic status to prevent the over-representation of articulate, mobile, and male respondents who are most likely to be encountered at major nodes during standard working hours.

2.4.4 GIS Mapping and Spatial Analysis

All trip origin-destination pairs recorded through household surveys and roadside interviews are spatially referenced using GPS coordinates collected in the field and cross-referenced with the district base maps prepared in Draft 2 of this thesis. This spatial data is processed using GIS software to generate a comprehensive mobility pattern map for each of the twelve villages, showing the most frequented routes, the primary nodes of attraction (markets, health centres, schools), and the distribution of trip distances by purpose. The aggregated GIS output constitutes the Dhar District Mobility Hierarchy Map, one of the key deliverables of this thesis, which visualises the 'hub-and-spoke' geography of rural movement across the district and identifies where the 'spokes' are functionally broken due to service failure or infrastructure degradation.

2.5 Methodology for Objective 2: Identifying Mobility Needs and Barriers of Vulnerable Groups

2.5.1 Rationale and Theoretical Grounding

The second objective addresses the social dimensions of rural mobility, recognising that transport is not a gender-neutral or socially neutral service. The literature reviewed in Draft 2 of this thesis — particularly the work of Seedhouse et al. on female entrepreneurs and rural transport in Nigeria and the PGIS mapping exercise of De Roulet et al. in Nepal and Kenya — demonstrates unequivocally that women, the elderly, persons with disabilities, students, and members of tribal and Scheduled Caste communities face disproportionate mobility burdens that are qualitatively different from those experienced by the dominant male, upper-caste, vehicle-owning demographic that typically defines the modal average in quantitative transport surveys. Capturing these differentiated experiences requires qualitative methodologies that privilege voice, context, and meaning over numerical aggregation.

The concept of 'time poverty' is central to the analytical framework for this objective. As documented in the field survey reported in Draft 3, women in remote villages like Susari and

Dahi spend an average of four and a half hours daily on 'invisible' survival trips — primarily on foot, carrying head-loads of up to twenty kilograms of water or firewood across uneven terrain. This labour is physically exhausting, economically uncompensated, and effectively invisible to formal transport planning, which focuses on motorised trips between named settlements. The methodology for Objective 2 is specifically designed to surface these invisible dimensions of mobility and translate them into planning-relevant data.

2.5.2 Participatory Workshops

Participatory workshops are conducted in each of the twelve selected villages, structured around the principles of participatory rural appraisal (PRA) and adapted for transport-specific research. Each workshop brings together fifteen to twenty residents, with a deliberate effort to ensure representation of women (minimum fifty percent), elderly persons, students, and members of tribal or Scheduled Caste households. The workshops are conducted in the local language (Hindi and regional dialects) by trained facilitators, and they employ a combination of cognitive mapping, mobility matrix exercises, and structured group discussion.

The cognitive mapping exercise asks participants to draw — on large paper sheets spread on the ground — the routes they use daily for different purposes, marking distances, road quality, danger points (harassment spots, broken bridges, waterlogged sections), and the modes of transport they use or wish they could use. This technique, adapted from the PGIS approach of De Roulet et al., generates spatially rich data on 'invisible paths' and mobility barriers that would never appear in a standard household survey or official road inventory. The mobility matrix exercise then asks participants to rank their most pressing mobility needs by destination type (market, health, education, water, etc.) and to identify the most significant barriers for each. Barriers are categorised into five types: physical (road quality, terrain, bridges), economic (fare costs, vehicle availability), social (gender norms, harassment, safety), institutional (service frequency, route coverage, operator behaviour), and seasonal (monsoon flooding, harvest-time demand surges). Workshop outputs are recorded through photographs, transcriptions, and the physical maps created by participants, which are subsequently digitised and integrated into the GIS-based Gendered Mobility Matrix — a key deliverable of this thesis.

2.5.3 Semi-Structured Interviews with Vulnerable Individuals

Following the group workshops, semi-structured in-depth interviews are conducted with fifteen to twenty specifically identified individuals across the study area who represent the most

acutely vulnerable segments of the population: women heads of households without private vehicles, elderly residents dependent on informal modes for healthcare access, school-going girls whose educational continuity is threatened by transport insecurity, and self-employed female artisans and traders (such as the Bagh Print block-printing community) who suffer direct economic losses from unreliable freight transport. Semi-structured interviews provide an opportunity for each individual to narrate their mobility experience in their own words, without the social pressure of a group setting where dominant voices can suppress minority perspectives. Interview guides are designed to elicit accounts of specific mobility episodes — a recent medical emergency, a weekly market trip, a child's school journey — rather than abstract opinions, producing rich narrative data that is then subjected to thematic analysis.

The thematic analysis of interview transcripts follows a grounded theory approach, allowing patterns and categories to emerge inductively from the data rather than being imposed a priori. Key themes identified in the literature — time poverty, safety curfews, the rural penalty, head-loading, and captive transport users — serve as sensitising concepts that guide but do not constrain the analytical process. The outputs of this analysis are consolidated into thematic interview summaries that document the most significant mobility barriers experienced by each vulnerable group and the most frequently articulated aspirations for service improvement.

2.6 Methodology for Objective 3: Identifying Factors Affecting Planning and Management of Rural Transport Services

2.6.1 Supply-Side Analysis Framework

While Objectives 1 and 2 examine rural transport from the demand side — the needs, behaviours, and barriers experienced by transport users — Objective 3 shifts the analytical lens to the supply side, investigating the institutional, economic, regulatory, and operational factors that determine what services are provided, on which routes, at what frequency, and at what cost. This supply-side analysis is essential because, as the literature review and case studies in Draft 2 demonstrate, the fundamental problem in Dhar is not a lack of roads but a lack of viable, organised service provision on those roads — a gap created and perpetuated by specific institutional failures, market dynamics, and regulatory conditions that must be understood before effective interventions can be designed.

2.6.2 Operator Interviews

Semi-structured interviews are conducted with a purposive sample of twenty to twenty-five transport operators representing the full range of modes and organisational forms active in the study area. This includes private bus operators serving inter-city and inter-tehsil routes, shared jeep and auto-rickshaw operators serving peri-urban corridors, informal motorcycle taxi operators (locally known as 'bike taxis' or informal 'Okada'-equivalent services) providing last-mile connectivity in remote villages, and tractor owners who supplement passenger transport during peak agricultural seasons. Each operator interview covers vehicle type and fleet size, route coverage and daily schedules, fare structure and revenue generation, operating costs (fuel, maintenance, driver wages, insurance, and permit fees), identification of unprofitable routes that have been abandoned or are served only opportunistically, and awareness of and attitudes toward regulatory frameworks and government support schemes such as the Rural Transport Credit (RTC) model and the MP Rural Transport Policy of 2016.

Operator interview data is analysed to construct a cost-revenue model for different route types — profitable urban corridors, moderately viable peri-urban routes, and loss-making deep-rural routes — which provides the quantitative evidence base for evaluating the economic logic of service provision decisions and the potential incentive structures needed to attract operators to underserved routes. This operator cost-revenue analysis is directly linked to the evaluation of the Rural Transport Credit model in Objective 4.

2.6.3 Institutional Analysis

Beyond individual operators, the broader institutional framework governing rural transport in Dhar is analysed through a review of key policy documents and regulatory instruments, complemented by interviews with institutional stakeholders. Policy documents reviewed include the PMGSY guidelines and district-level implementation reports, the MP Rural Transport Policy of 2016, the Aajeevika Grameen Express Yojana (AGEY) operational guidelines, the National Transport Development Policy Committee report of 2013 (Moving India to 2032), and district-level planning documents from the Dhar District Collector's office and the State Transport Authority. Institutional stakeholder interviews are conducted with officers of the Regional Transport Office (RTO), Gram Panchayat presidents and secretaries in selected villages, representatives of the District Rural Development Agency (DRDA), and, where accessible, officers of the Zila Parishad Transport Committee.

These interviews and document analyses collectively map the regulatory landscape — the permit system, route licensing framework, vehicle fitness regulations, and tax structures — and identify the specific administrative and governance gaps that allow the current fragmented and inequitable service environment to persist. The institutional analysis also examines the role of

Panchayati Raj Institutions (PRIs) in monitoring and influencing transport services at the local level, and the potential for the e-MARG platform and participatory GIS tools to be leveraged for real-time service monitoring and community accountability.

2.7 Methodology for Objective 4: Evaluating Service Models and Low-Carbon Options for Feasibility and Scalability

2.7.1 Rationale for Scenario Modelling Approach

The fourth and final research objective moves from diagnosis to prescription, evaluating the technical, economic, social, and environmental feasibility of alternative and innovative service models that could enhance rural transport accessibility in Dhar District. This objective is methodologically distinct from the preceding three because it requires not only the analysis of existing conditions but the construction of future scenarios based on evidence drawn from the primary fieldwork, the literature review, and global and national case studies. The scenario modelling approach is adopted as the primary method, supplemented by stakeholder consultations and technical feasibility assessments.

2.7.2 Identification of Service Models for Evaluation

Four primary service models are identified for evaluation based on their relevance to the Dhar context, their precedent in comparable settings, and the potential they offer to address the specific service gaps documented in Objectives 1 through 3. First, the Rural Transport Credit (RTC) Model: drawing on the analysis of the MP Manuscript case study, this model involves providing private operators with monthly financial credits for every kilometre they ply on designated unserved or commercially unviable rural routes, complemented by tax exemptions on motor vehicle taxes for vehicles with seven-plus seats operating on rural routes. Second, the Gramin Maitri and Aggregator Models: community or cooperative-based service delivery arrangements where a local aggregator entity — potentially a women-led Self-Help Group analogous to the AGEY framework — contracts with individual vehicle owners to provide scheduled services on defined routes, pooling demand and reducing operating risk. Third, Intermediate Means of Transport (IMT) Regularisation: formalising and regulating the motorcycle taxi and shared three-wheeler services that currently operate informally but provide essential last-mile connectivity, through safety training, route licensing, and insurance requirements analogous to the 'regularisation' approach advocated by Afukaar et al. in the

Ghanaian context. Fourth, Electromobility Pilot: deploying a fleet of ten to twelve-seater electric minibuses on selected high-demand routes in the Vindhyaachal range, supported by decentralised solar-powered charging hubs at block headquarters such as Dahi and Gandhwani, to test the operational and financial viability of low-carbon service delivery in a remote rural Indian context.

2.7.3 Technical Feasibility Assessment

The technical feasibility of each service model is assessed through a structured analysis of vehicle performance parameters relative to Dhar's road conditions and topography, energy availability and reliability (for EV models, this includes an assessment of grid connectivity and solar irradiance data for potential charging hub locations), operational range requirements given the distance decay patterns documented in Objective 1, and maintenance and repair infrastructure availability within the district. For the electromobility pilot specifically, the methodology draws on the operational data from the Ziegler et al. Côte d'Ivoire study, which piloted two electric vehicles in a comparable rural emerging economy context and documented both the performance advantages of electric drivetrains (superior torque on steep gradients, lower local energy costs) and the key technical challenges (high purchase price, charging infrastructure gap, battery performance in extreme heat and humidity).

2.7.4 Economic and Financial Feasibility Modelling

A cost-benefit model is constructed for each service model using data on operating costs from the operator interviews conducted under Objective 3, projected revenue from the trip demand and willingness-to-pay data collected under Objectives 1 and 2, and public subsidy or credit requirements estimated from the RTC model parameters outlined in the MP Rural Transport Policy. The model assesses financial viability over a five-year planning horizon and identifies the minimum subsidy or credit level required to make each model financially sustainable for private or cooperative operators. For the EV pilot, the model additionally estimates the lifecycle cost advantage of electric over diesel operation, accounting for fuel cost savings, reduced maintenance requirements, and the capital subsidy available under the Credit Link Capital Subsidy Scheme (CLCSS).

2.7.5 Stakeholder Consultations and Community Acceptance Assessment

The technical and economic feasibility analysis is complemented by structured stakeholder consultations to assess social acceptability and political feasibility — dimensions that are critical determinants of whether a technically and economically viable service model will actually be adopted and sustained in practice. Stakeholder consultations are conducted with representatives of five categories: transport users (drawing on community representatives from the participatory workshops), transport operators (drawing on the operator interview network), local governance (Gram Panchayat and Panchayat Samiti representatives), district administration (District Collector's office and RTO), and civil society (NGOs and community organisations active in rural development in Dhar). The consultations employ a structured presentation of the scenario models followed by facilitated discussion, using a standardised evaluation matrix to capture stakeholder assessments of feasibility, desirability, and scalability for each model.

The outputs of the technical, economic, and social feasibility assessments are synthesised into a Feasibility and Scenario Modelling Report that ranks the four service models by overall viability and recommends a phased implementation strategy. This phased strategy recommends that the RTC model and IMT regularisation be operationalised immediately in the Dhar and Kukshi blocks as Phase I interventions, the Gramin Maitri cooperative and solar charging hub expansion be rolled out as mid-term Phase II interventions across all thirteen development blocks, and the full integration of a digitally monitored Seamless Rural Grid with real-time GPS tracking and community participation mechanisms be pursued as the long-term Phase III vision for the district.

2.8 Data Requirements and Sources

The research draws on four primary categories of data, each sourced through the methods described above and supplemented by secondary data from government reports, academic publications, and policy documents. Primary survey data collected through the 150-household questionnaire and roadside interviews provides the quantitative backbone of the analysis, capturing household socio-economic profiles, trip records across all purposes and modes, mobility cost expenditures, and service quality perceptions disaggregated by gender. Participatory and qualitative data generated through the village workshops and semi-structured interviews provides the narrative, spatial, and attitudinal material needed to understand the social dimensions of mobility barriers and aspirations. Operator and institutional data collected through the operator interviews and document analysis provides the supply-side picture of

service economics, route coverage, regulatory constraints, and governance arrangements. Energy and emissions data, including vehicle energy consumption benchmarks, local electricity supply assessments, solar irradiance measurements, and standard emissions factors for diesel and electric vehicles, provides the quantitative inputs for the low-carbon feasibility assessment under Objective 4.

Secondary data sources include the Census of India 2011 and projected population estimates for 2025, PMGSY project reports and completion data from the National Rural Roads Development Agency (NRRDA), district-level road inventory data from the Madhya Pradesh Rural Road Development Authority (MP-RRDA), the MP Rural Transport Policy documents of 2016, AGEY operational reports from the Ministry of Rural Development, and published academic literature reviewed in Draft 2 of this thesis. All secondary data is subjected to critical scrutiny and, where possible, cross-validated against primary data collected in the field.

2.9 Ethical Considerations and Field Protocols

The research involves the collection of personal and sensitive data from vulnerable populations, including tribal communities, low-income households, women, and children, in remote rural settings where literacy levels may be low and formal research encounters unfamiliar. Accordingly, the research adheres to a strict ethical protocol grounded in the principles of informed consent, voluntary participation, confidentiality, and do no harm. All participants are informed in their local language of the purpose of the research, the nature of the data being collected, how it will be used, and their right to withdraw at any time without consequence. No participant is identified by name in any report or publication; households and individuals are assigned coded identifiers and all personal data is stored in password-protected digital files accessible only to the research team.

Special protocols are in place for the inclusion of women and girls in the research, recognising that social norms in some villages may restrict women's participation in formal interviews or mixed-gender group settings. Female research team members or locally recruited female facilitators conduct all interviews and workshops with women respondents, and separate sessions are organised for women where mixed participation is socially constrained. The research team also coordinates with local Gram Panchayat representatives and, where applicable, NGOs active in the study villages, to ensure that community leaders are informed

of the research and supportive of the data collection process, reducing potential misunderstandings and facilitating participant access.

2.10 Limitations of the Methodology

The methodology, while comprehensive, is subject to a number of inherent limitations that must be acknowledged and accounted for in the interpretation of findings. First, the site-specificity of the research means that findings from the twelve selected villages in Dhar, while carefully chosen to represent district-level diversity, may not be directly transferable to other districts of Madhya Pradesh or to other states with different institutional histories, demographic compositions, or geographic contexts. The dissolution of the MPSRTC in 2005 is a specific historical event that has shaped rural transport in Madhya Pradesh in ways that may not apply elsewhere in India.

Second, the rapid appraisal techniques employed — particularly the household questionnaire and roadside interviews — are designed for efficiency and breadth rather than longitudinal depth. They capture mobility patterns over a reference week and through retrospective recall, which may introduce recall bias and may not fully capture seasonal variations, particularly the significant impact of the four-month monsoon season on road passability and service frequency in Dhar's tribal belts. Wherever possible, enumerators probe for seasonal variation explicitly, and the research is timed to capture conditions in the post-harvest dry season (February-March 2026), which is acknowledged as one specific temporal window. Third, the technical and economic feasibility modelling for the low-carbon service models, particularly the EV pilot, relies on cost benchmarks and performance data drawn from international case studies and national policy documents that may not perfectly reflect local conditions in Dhar. These models are therefore presented as indicative rather than definitive, requiring large-scale field validation before operational decisions are made. Fourth, the success of participatory tools such as cognitive mapping and PGIS depends heavily on the digital literacy and willingness of participants, which can vary significantly across villages and demographic groups. The research team is prepared to adapt facilitation techniques to accommodate low-literacy contexts, including the use of physical maps and oral narration rather than digital inputs, but this adaptation may reduce the precision and comparability of the spatial data generated across different villages.

2.11 Summary: Objectives, Methods, and Expected Outputs

The table below provides a consolidated overview of how the four research objectives are aligned with their respective methodological approaches and the expected outputs that each phase of the research will generate. This alignment ensures that every element of the methodology is purposefully connected to the overarching research aim and to the specific deliverables that constitute the thesis's contribution to knowledge and practice.

Objective 1 — Characterise Travel Behaviour and Trip Patterns: Methods: Household survey (150 households, 4 modules), travel diaries, roadside interviews (120+), GIS trip mapping. Outputs: Dhar District Mobility Hierarchy Map; statistical analysis of modal shares, trip frequency, and transport expenditure by gender and household type.

Objective 2 — Identify Mobility Needs and Barriers of Vulnerable Groups: Methods: Participatory workshops (12 villages, 15-20 participants each), cognitive mapping, mobility matrix exercises, semi-structured interviews with 15-20 vulnerable individuals, thematic analysis. Outputs: Gendered Mobility Matrix (GIS layer); thematic interview summaries documenting time poverty, safety barriers, and invisible trips.

Objective 3 — Identify Factors Affecting Planning and Management: Methods: Semi-structured operator interviews (20-25 operators), institutional stakeholder interviews, policy document review, cost-revenue modelling. Outputs: Operator and institutional analysis report; cost-revenue model for route typologies; governance gap mapping.

Objective 4 — Evaluate Service Models and Low-Carbon Options: Methods: Scenario modelling (RTC, Gramin Maitri, IMT Regularisation, EV Pilot), technical feasibility assessment, economic cost-benefit modelling, stakeholder consultations. Outputs: Feasibility and scenario modelling report; phased implementation strategy; policy and planning recommendations.

2.12 Conclusion

The methodology described in this chapter constitutes a coherent, integrated, and contextually grounded research design that is directly and explicitly aligned with the four objectives and the overarching aim of this thesis. By combining the systematic quantitative measurement of travel

behaviour with the qualitative depth of participatory inquiry, the supply-side rigour of operator and institutional analysis, and the forward-looking analytical power of scenario modelling, the methodology is positioned to generate an evidence base that is simultaneously empirically robust, socially inclusive, and policy-relevant. Every methodological choice — the purposive village sample, the gendered survey protocol, the participatory workshop design, the operator cost-revenue model, the four-scenario feasibility assessment — has been made in deliberate service of the research objectives and in recognition of the specific institutional, social, and geographic context of Dhar District.

The methodology also reflects a fundamental conviction that underpins this entire thesis: that rural transport planning in India must move beyond its historic fixation on physical road infrastructure and embrace a 'service-first' paradigm that places the mobility needs of actual users — especially the most marginalised — at the centre of planning and investment decisions. Generating the evidence necessary to make that case, and to specify what 'service-first' planning looks like in the specific context of Dhar District's tribal communities, female farmers, Bagh artisans, and school-going girls, is the ultimate purpose of the methodology described here.

CHAPTER 3

Literature Review

3.1 Introduction

Rural development in India, particularly in Madhya Pradesh, has historically been framed around infrastructure provision, with road construction under the Pradhan Mantri Gram Sadak Yojana (PMGSY) serving as the cornerstone of planning. While this has reduced physical isolation, contemporary scholarship highlights a deeper challenge: the absence of reliable, affordable, and safe transport services operating on these roads. The literature increasingly shifts from a narrow focus on “connectivity” to a broader paradigm of “accessibility,” interrogating service quality, gender disparities, informal transport networks, and sustainable innovations. This chapter synthesizes key thematic contributions to rural transport research, situating them within the Dhar district study.

3.2 Thematic Literature Review

3.2.1 The Mobility Gap and Electromobility Innovations

Ziegler et al. (2025) examined the “mobility gap” in Côte d’Ivoire through GPS logging and participatory workshops, testing electric vehicles (EVs) in rural terrain. The study confirmed the technical viability of EVs—particularly their torque advantages and potential for solar integration—while identifying barriers such as high capital costs and inadequate charging infrastructure. Walking remained the dominant mode despite road availability, underscoring the limits of infrastructure-led planning.

Relevance to Dhar: This work directly informs Objective 4 of the thesis, which proposes e-minibuses and decentralized solar-powered charging hubs for high-gradient routes in the Vindhyachal range.

3.2.2 State Policy, Privatization, and Service Deficits

The dissolution of the Madhya Pradesh State Road Transport Corporation (MPSRTC) in 2005 created a structural vacuum in rural service provision. Literature documents how privatization led operators to prioritize profitable urban corridors, leaving remote villages underserved. Among proposed interventions, the Rural Transport Credit (RTC) model—providing financial credits to operators for low-demand routes—emerges as the most viable.

Relevance to Dhar: This analysis forms the institutional foundation of the thesis. The RTC model is integrated into the proposed financial mechanisms for Dhar, addressing the dominance of unregulated Intermediate Public Transport (IPT) and bridging feeder routes with regional highways.

3.2.3 Informal Transport and the Case for Regularization

Afukaar et al. applied the Rural Transport Services Indicators (RTSI) framework in Ghana, documenting the rise of motorcycle taxis (“Okada”) as essential last-mile services despite official bans. The study advocates for regularization through licensing and safety training rather than prohibition.

Relevance to Dhar: Informal modes such as motorcycles and shared jeeps consume up to 18% of household income in Dhar. This literature validates the thesis’s proposal to formalize and regulate informal networks, ensuring safe integration of “cul-de-sac” villages into the wider transport grid.

3.2.4 Participatory GIS and Mobility Justice

De Roulet et al. demonstrated the power of Participatory GIS (PGIS) in Nepal and Kenya, revealing thousands of “invisible” paths used for survival tasks such as fetching water and firewood. The methodology exposed severe gendered time poverty, with women spending up to five hours daily on foot travel.

Relevance to Dhar: PGIS is adopted in Objectives 1 and 2 of the thesis to capture invisible burdens in villages like Susari and Dahi, where women spend 4.5 hours daily head-loading resources. This shifts the methodology toward empathetic, user-centered evaluation of mobility barriers.

3.2.5 Gendered Transport Inequities and the Rural Penalty

Seedhouse et al. analyzed transport inequities in Nigeria, showing how poor services impose a “Rural Penalty” on female entrepreneurs. Women face cultural restrictions, harassment risks, and reduced market access, which erode business margins and exacerbate the “triple burden” of domestic, productive, and community roles.

Relevance to Dhar: Similar dynamics affect female artisans in Bagh, who incur high costs to access markets. This literature supports the thesis’s gender-sensitive proposals, including adoption of women-led models such as the Aajeevika Grameen Express Yojana (AGEY) to empower local female workforces.

3.3 Research Gaps and Contextual Insights

The synthesis of reviewed literature reveals persistent gaps in rural transport planning. Most policies remain gender-blind, privileging engineering metrics over lived experiences. Empirical evidence on solar-integrated EV models in remote tribal belts is scarce, and localized primary data on mobility behavior is limited.

Implications for Dhar: Addressing these gaps requires a transition from infrastructure provision to service-first planning. By employing PGIS to capture invisible mobility, and by testing RTC and EV models for financial and technological feasibility, the thesis aims to construct a scalable framework that advances “Mobility Justice” for marginalized populations in Madhya Pradesh.

CHAPTER 4**CASE STUDIES — GLOBAL AND NATIONAL
COMPARATIVE ANALYSIS**

4.1 Introduction to Case Study Analysis

The case study chapter serves a distinct function from the literature review: while the latter establishes the theoretical and empirical scaffolding of the thesis through an analysis of scholarly publications, the former examines how specific real-world interventions, planning exercises, and transport service experiments have been implemented, what outcomes they produced, and what transferable lessons they offer for the Dhar context. The five case studies presented in this chapter span three continents and five countries, capturing a diversity of geographic, economic, demographic, and institutional contexts that collectively provide the comparative baseline against which the Dhar district's situation can be benchmarked and its proposed interventions evaluated.

Each case study is presented in a structured format that identifies the context, the intervention or planning approach examined, the methodology used to study it, the key findings, and—crucially—the transferable lessons and their specific implications for the Dhar thesis. The cases range from a cutting-edge electromobility pilot in West Africa to a crisis-driven institutional reform in Madhya Pradesh itself, ensuring that the comparative analysis encompasses both technological innovation frontiers and locally grounded policy experience.

4.2 Case Study 1: Yamoussoukro Region, Côte d'Ivoire (Ziegler et al., 2025)

4.2.1 Context and Background

The Yamoussoukro region of central Côte d'Ivoire presents structural parallels to Dhar district that make it an exceptionally instructive comparative case. Both are predominantly rural areas within middle-income developing countries where the national government has invested substantially in physical road infrastructure without equivalent investment in transport services. Both regions contain significant populations of subsistence farmers and informal sector workers who are highly mobility-dependent for market access but lack the income to sustain private

vehicle ownership. Both face the challenge of providing transport services in geographic conditions characterized by hill terrain, seasonal road deterioration, and dispersed settlement patterns.

4.2.2 Intervention and Methodology

The Yamoussoukro case study is distinguished by its methodological comprehensiveness and its innovative pilot component. The research team employed a multi-layered mixed-methods design that combined continuous GPS logging of vehicle movements and traffic counts at strategic road segments, roadside intercept interviews with travelers to capture trip purpose, origin-destination patterns, and modal preferences, participatory workshops with village communities to identify mobility aspirations and constraints, and operator interviews to document the economics of rural transport service provision. This methodological suite was supplemented by the deployment of two electric three-wheelers on rural routes to generate operational performance data under authentic field conditions.

4.2.3 Key Findings

The study's most significant finding was the persistent dominance of walking as the primary mode of transport for rural residents, including for trips of considerable distance to markets and health facilities. This finding was interpreted not as a cultural preference but as a structural outcome of service unavailability and unaffordability. The GPS data revealed that motorized services were concentrated on a small number of high-density corridors, leaving the majority of the rural road network without any regular service. The EV pilot generated technically promising results: the electric drivetrains performed well on the steep laterite tracks of the Yamoussoukro hinterland, consuming energy at significantly lower rates than petrol equivalents and demonstrating lower maintenance requirements. However, the pilot also confirmed that without subsidized charging infrastructure and significantly reduced purchase prices, EVs remain economically inaccessible for rural operators in low-income settings.

4.2.4 Transferable Lessons for Dhar

The Yamoussoukro case offers four specific lessons for Dhar. First, the mixed-methods research design validates the thesis's own methodological approach: the combination of roadside surveys, travel diaries, participatory workshops, and operator interviews is empirically demonstrated to generate a more complete picture of rural mobility than any single method alone. Second, the finding that walking dominates despite road availability directly informs the thesis's analytical expectation for the 12-village survey in Dhar, particularly for remote tribal

habitations. Third, the EV pilot's confirmation of technical performance advantages on rough terrain directly supports the thesis's proposal for deploying e-minibuses on the high-gradient routes of Dhar's Vindhyachal range. Fourth, the identification of charging infrastructure and capital cost as primary EV adoption barriers directly motivates the thesis's proposals for solar charging hubs at block headquarters and capital subsidy mechanisms.

4.3 Case Study 2: Madhya Pradesh, India — Dissolution of MPSRTC and the Search for a New Service Model (MP Manuscript)

4.3.1 Context and Background

This case study is unique among the five in that it does not document a successful intervention but rather a policy failure and the subsequent search for remediation—a pattern that directly constitutes the historical context within which the Dhar thesis is embedded. In 2005, the Government of Madhya Pradesh dissolved the Madhya Pradesh State Road Transport Corporation (MPSRTC), citing its persistent financial losses and operational inefficiencies. This decision effectively ended state-operated public bus services across rural Madhya Pradesh and handed responsibility for rural mobility to a fragmented, largely unregulated private sector. The consequences of this decision continue to shape the transport landscape of Dhar district two decades later.

4.3.2 Intervention and Methodology

The manuscript employs an institutional analysis methodology, combining review of state transport policy documents, interviews with transport operators and officials, and analysis of route-level service data to evaluate the gap left by MPSRTC's dissolution and to compare the viability of alternative service delivery models. The analysis evaluates four models: direct state operation (through a revived public corporation), the Aggregator Model (platform-based coordination of private operators), the Gramin Maitri Model (state-subsidized community-linked transport), and the Rural Transport Credit (RTC) Model (per-kilometer financial credits to private operators on designated rural routes).

4.3.3 Key Findings

The manuscript's most important finding is that purely market-driven privatization, without any compensating public intervention, systematically fails to provide equitable rural transport. Private operators, acting rationally within their commercial constraints, concentrate services on

high-demand urban corridors and abandon low-density rural routes. The result is a dual transport market: urban areas with competitive, frequent services, and rural areas with infrequent, expensive, and often unsafe informal services. Of the four evaluated models, the RTC model is identified as most viable because it preserves the cost-efficiency and flexibility of private operation while providing the public subsidy necessary to make low-density rural routes commercially sustainable. The model was found to be administratively simpler than direct state operation and more financially transparent than the Gramin Maitri model.

4.3.4 Transferable Lessons for Dhar

The MP Manuscript case study provides four directly transferable lessons for the Dhar thesis. First, it establishes the institutional history of the problem: the 2005 dissolution of MPSRTC is the specific policy event that created the service vacuum the thesis seeks to address. Second, it provides the detailed design parameters for the RTC model that the thesis proposes implementing in Dhar and Kukshi blocks as Phase I of its implementation strategy. Third, its comparative evaluation of the Aggregator and Gramin Maitri models informs the thesis's discussion of governance alternatives under Objective 3. Fourth, its documentation of how private operators specifically avoid tribal and remote areas provides the evidentiary basis for the thesis's finding that tribal communities in Dhar's western tehsils are most severely underserved.

4.4 Case Study 3: Ghana — Motorcycle Taxis, Rural Transport Indicators, and Regularization Policy (Afukaar et al.)

4.4.1 Context and Background

The Ghana case study examines one of the most widespread and significant informal transport phenomena in Sub-Saharan Africa: the proliferation of motorcycle taxis, locally known as "Okada," in the wake of the decline of formal public bus services following transport deregulation in the 1990s. The case is particularly instructive for Dhar because it represents a situation in which informal intermediate public transport has emerged organically to fill a structural service gap, and in which government policy has been forced to grapple with whether to prohibit, tolerate, or formally incorporate this informal sector into the regulated transport system.

4.4.2 Intervention and Methodology

The RTSI methodology applied in this study—assessing transport services by frequency, cost, safety, reliability, and user accessibility rather than by road infrastructure metrics—generated a comprehensive service quality profile for rural Ghana that revealed profound inadequacies in formal public transport while simultaneously documenting the critical role of informal motorcycle taxis in maintaining basic mobility. The study found that in districts where formal bus services had collapsed entirely, Okada operators were providing door-to-door connectivity that was responsive to demand, flexible in routing, and affordable despite per-kilometer fares that were nominally higher than bus fares. The research documented that despite formal prohibition, more than 60 percent of rural residents in the studied districts reported using motorcycle taxis as their primary means of reaching markets, health centres, or schools.

The study's policy recommendation—regularization through safety training, vehicle registration, and rural-specific licensing rather than blanket prohibition—was grounded in the finding that prohibition is both unenforceable in the rural context and, if enforced, would leave rural communities with no viable transport alternative.

4.4.3 Transferable Lessons for Dhar

The Ghana case generates three directly applicable lessons for the Dhar thesis. First, the RTSI framework's emphasis on measuring service quality from the user's perspective rather than from the infrastructure provider's perspective is adopted wholesale in the thesis's survey design for Dhar. Second, the documentation of motorcycle taxis as irreplaceable rural transport assets is directly applicable to Dhar's informal transport sector, where shared motorcycle taxis and informal jeep services provide the only connectivity in villages like Susari and Dahi that formal buses do not reach. Third, the regularization policy recommendation is directly reflected in the thesis's proposal for formalizing informal IPT operators through licensing, safety training, and route registration as part of the "Amhi Sarathi" cooperative model.

4.5 Case Study 4: Nepal and Kenya — Participatory GIS for Rural Mobility Mapping (De Roulet et al.)

4.4.1 Context and Background

This case study addresses a fundamental epistemological problem in rural transport planning: the systematic invisibility of informal and non-motorized mobility in official planning databases. In both Nepal and Kenya, the communities studied had extensive networks of footpaths, informal tracks, and seasonal routes that were used daily by thousands of residents

for survival-related travel but that appeared nowhere in government road databases or conventional transport planning surveys. This invisibility was not merely an academic problem—it had concrete material consequences, as planning investments were directed toward "official" roads while the infrastructure most critical to women's daily mobility remained unmapped, unmaintained, and therefore unimproved.

4.5.2 Methodology and Findings

The PGIS methodology piloted in this case study engaged community members—particularly women who were the primary users of informal routes—as active data producers rather than passive survey respondents. Using mobile GIS tools (QField application on smartphones and tablets), community members were able to georeference the paths they walked daily, mark locations where physical barriers impeded travel, and record the frequency, duration, and purpose of journeys on each route. The aggregated data revealed a mobility landscape dramatically richer and more complex than official maps had indicated. As noted earlier, the number of mapped route segments increased by approximately 300 percent, and 119 specific mobility barriers were identified that had been entirely absent from planning considerations.

The gender-disaggregated analysis was particularly significant: women consistently mapped different routes and different barriers than men, reflecting their distinct mobility patterns oriented around water collection, firewood gathering, and agricultural tasks. The time spent on these "invisible" journeys—up to five hours daily in some communities—represented an enormous productive time burden that had been systematically excluded from transport planning because it involved walking rather than motorized travel.

4.5.3 Transferable Lessons for Dhar

This case study generates four lessons for the Dhar thesis. First, it validates the necessity of the "Module 2: Travel Diary and Mobility Matrix" component of the thesis's survey questionnaire, which specifically captures invisible trips for water, firewood, and fodder collection alongside conventional motorized trip data. Second, it demonstrates the feasibility and effectiveness of participatory community mapping as a supplement to conventional GIS analysis, directly informing the thesis's proposal to use PGIS as a data collection tool for the 12 surveyed villages. Third, the identification of 119 specific mobility barriers in the Nepal and Kenya communities provides the methodological template for the thesis's own barrier mapping exercise in Dhar's tribal tehsils. Fourth, the finding that women-generated spatial data reveals mobility patterns fundamentally different from male-generated data directly motivates the thesis's gender-disaggregated survey design.

4.6 Case Study 5: Nigeria — Female Entrepreneurs, Transport Barriers, and the Rural Penalty (Seedhouse et al., 2016)

4.6.1 Context and Background

The Nigeria case study occupies a distinctive analytical position among the five cases because it approaches rural transport failure from the perspective of economic productivity loss rather than from a service quality or infrastructure perspective. The study's primary subjects are rural female entrepreneurs—women who operate small businesses in agriculture, food processing, artisan production, and petty trade—and its primary analytical focus is the quantifiable economic impact of transport inadequacy on their business performance. This economic framing makes the case particularly relevant to the Dhar context, where agricultural and artisan livelihoods are central to the district's economic base and where the impact of transport failure on market access is a key dimension of the thesis's problem statement.

4.6.2 Methodology and Findings

The study combines qualitative case study interviews with female business owners with quantitative analysis of income statements and transport cost records to establish the causal link between transport quality and business profitability. The findings demonstrate that transport costs—including both direct fare expenditures and the opportunity cost of time lost in transit—consume a disproportionate share of rural women's business revenues. More significantly, the study shows that transport unreliability forces women to adopt risk-minimizing business strategies that limit their market reach and suppress their revenue potential: selling locally at lower prices rather than transporting goods to urban markets where they could command higher margins.

The study's cultural analysis reveals that these economic constraints are compounded by gendered social norms that restrict women's independent mobility, require them to travel with male chaperones (adding cost and logistical complexity), and make them particularly vulnerable to harassment in transit environments. The compound effect of economic, physical, and social transport barriers creates what the study terms the "Rural Penalty"—a systematic disadvantage that ensures rural women's economic activities are persistently less productive than identical activities conducted by their urban counterparts.

4.6.3 Transferable Lessons for Dhar

This case study generates three specifically applicable lessons for the Dhar thesis. First, its economic impact methodology—linking transport inadequacy to measurable losses in business income—provides the analytical template for the thesis's own assessment of economic costs incurred by Bagh Print artisans and agricultural producers in Dhar who lack reliable transport to urban markets. Second, the cultural analysis of gendered mobility restrictions is directly applicable to the Dhar tribal context, where customary norms around women's independent movement create transport barriers that are invisible to standard economic surveys but profoundly consequential for women's livelihood outcomes. Third, the study's finding that improving transport access for female entrepreneurs could produce significant increases in female labor force participation directly informs the thesis's estimate that improved transport services in Dhar could increase female labor force participation by 25 percent—a projection anchored in the Nigerian empirical evidence.

4.7 Comparative Analysis and Synthesis of Case Studies

The five case studies, taken together, provide a global evidence base for the core analytical positions of this thesis. Across five countries and multiple institutional contexts, a consistent pattern emerges: rural transport failure is not an inevitable consequence of geographic remoteness or low population density, but rather a policy outcome—the result of institutional choices about who bears the cost of service provision and whose mobility needs are considered worthy of public investment.

The cross-case analysis reveals two meta-lessons of particular importance for Dhar. The first is methodological: the most insightful rural transport research combines quantitative measurement (traffic counts, GPS tracking, standardized surveys) with qualitative depth (participatory workshops, life history interviews, community mapping), and the most impactful policy recommendations emerge from this combination rather than from either approach alone. The second meta-lesson is institutional: sustainable improvements in rural transport services require active public intervention in market failures, whether through direct subsidies (RTC model), regulatory normalization (Okada regularization), or participatory governance (PGIS-informed planning). Pure reliance on market mechanisms has failed rural transport users in every context examined.

4.8 Conclusion: Case Studies as a Bridge to the Dhar Analysis

The five case studies reviewed in this chapter collectively establish the evidentiary and conceptual bridge between international transport scholarship and the specific planning challenges of Dhar district. They confirm that the problems Dhar faces—service gaps in low-demand areas, the dominance of informal intermediate transport, the gendered dimensions of mobility deprivation, the promise and limitations of electromobility, and the critical role of participatory data in exposing invisible mobility—are not idiosyncratic features of one district in western Madhya Pradesh, but manifestations of globally documented patterns in rural transport systems at a similar stage of economic and institutional development.

This comparative grounding serves two purposes. First, it justifies the research design choices made in the Dhar study—the household survey design, the participatory workshop format, the RTSI-informed service quality assessment, and the EV feasibility evaluation—by demonstrating that analogous approaches have generated credible, policy-relevant findings in comparable contexts. Second, it calibrates the thesis's expectations and benchmarks: the magnitude of walking dominance expected in unserved tribal habitations, the likely scale of gendered time poverty, the kinds of institutional barriers that RTC implementation will encounter—all of these can be anticipated and contextualized against the international evidence base before the primary data from Dhar is fully analyzed.

The following chapters of the thesis move from this global comparative framework to the specific empirical analysis of Dhar district: its geographic and administrative profile, its road infrastructure inventory, the findings of the 12-village household survey, and finally the spatial strategies, sectoral proposals, and governance mechanisms designed to transform rural transport in Dhar from a system of fragmented survival into a platform for integrated, equitable, and sustainable development.

CHAPTER 5

STUDY AREA — DHAR DISTRICT, MADHYA PRADESH

5.1 Introduction

The structural integrity of a nation's development is often measured not by the velocity of its urban centers, but by the accessibility of its rural peripheries. In the Indian context, and specifically within Madhya Pradesh, the transition from infrastructure-centric planning to service-oriented mobility has emerged as the most critical planning challenge of the current decade. While the expansion of the road network under the Pradhan Mantri Gram Sadak Yojana (PMGSY) has successfully addressed the primary hurdle of physical isolation for thousands of habitations, it has simultaneously unmasked a secondary, more pervasive crisis: the near-total absence of reliable, affordable, and safe transport services to traverse these roads.

Dhar district, located in the western reaches of the Indore division of Madhya Pradesh, serves as a quintessential case study for this paradox. Despite being a major agricultural producer and an emerging industrial hub anchored by the Pithampur Special Economic Zone, the district's rural population—which constitutes over 80 percent of its approximately 2.66 million residents (projected 2025)—remains trapped in a cycle of limited mobility that restricts access to essential markets, healthcare facilities, and educational institutions. This condition is compounded by the district's high concentration of Scheduled Tribe (ST) communities, particularly the Bhils and Bhilalas, who inhabit the most remote and geographically challenging terrains of the western and southern tehsils.

The current state of rural transport in Dhar is the direct historical consequence of a fundamental shift in state policy. The dissolution of the Madhya Pradesh State Road Transport Corporation (MPSRTC) in 2005 effectively privatized rural mobility, creating a landscape where private operators prioritize lucrative urban corridors, leaving the low-demand village interiors to be served by a fragmented and largely unregulated sector of Intermediate Public Transport (IPT)—shared jeeps, motorcycle taxis, and seasonal tractors. This chapter presents a comprehensive, empirically-grounded analysis of Dhar district through the lens of data collection and analysis. Drawing on a mixed-methods methodology—including a structured household survey of 150 respondents across 12 purposively selected villages, roadside interviews, travel diaries, and institutional stakeholder interactions—this chapter documents the administrative structure,

infrastructure availability, mobility patterns, and lived experience of the district's rural residents.

5.2 Research Design and Data Collection Framework

The methodology for this chapter is structured around four distinct research objectives identified in the study proposal, each employing specific instruments and tools calibrated to the Dhar context. The research draws on internationally validated frameworks—specifically the Rural Transport Services Indicators (RTSI) methodology (Afukaar et al.) and the Participatory GIS (PGIS) approach (De Roulet et al.)—adapted for the socio-economic and institutional realities of rural Madhya Pradesh. The overarching epistemological stance emphasizes the transition from 'road connectivity' (physical presence of a road) to 'transport accessibility' (the actual, lived ability to travel).

5.2.1 Objectives-to-Methods Mapping

The data collection strategy was structured to ensure that each research objective was addressed by a corresponding, appropriate method. The table below summarizes this alignment, which served as the operational blueprint for all fieldwork.

Objective	Methods Employed
Obj. 1: Characterize travel behaviour and trip patterns	Roadside interviews, structured travel diaries, GIS spatialization
Obj. 2: Identify mobility needs and barriers of vulnerable groups	Participatory workshops, semi-structured interviews, mobility matrices
Obj. 3: Identify factors affecting planning and management	Operator interviews, institutional analysis, fare and cost breakdown
Obj. 4: Evaluate service models and low-carbon options	Feasibility assessment, scenario modelling, stakeholder consultations

Table 4: Research Objectives and Methods Mapping

5.2.2 Primary Data Instruments

The primary data collection was built around a structured questionnaire administered to 150 households across the 12 selected villages. The survey was designed to capture both quantitative mobility metrics and qualitative perceptions, uncovering the 'invisible' dimensions of rural mobility—particularly the transport burden borne by women and the economic cost of service gaps. The questionnaire was organized into four thematic modules. Module 1 captured the socio-economic profile of the household, including caste and tribe affiliation, household size, primary occupation, asset ownership (bicycles, motorcycles, and tractors), monthly household income, and estimated monthly expenditure on transport. Module 2 consisted of a travel diary and mobility matrix, recording daily and weekly trip frequency to the nearest town, market, hospital, and school, along with the primary mode of transport used for each purpose and the frequency and time spent on foot for 'invisible' trips such as water collection, fuel-wood gathering, and fodder collection. Module 3 deployed a five-point Likert scale to measure perceptions of service quality across five dimensions: availability during emergency hours, safety perceptions for women and school-going girls, affordability of fares relative to income, and reliability in terms of service cancellation frequency and average waiting time. Module 4 qualitatively documented mobility barriers, including physical barriers such as broken bridges, waterlogging during monsoon, and steep gradients; social barriers such as cultural restrictions and harassment; and aspirations, including willingness to pay for improved services or shift to electric vehicles.

Secondary data collection encompassed demographic and census records, PMGSY road completion databases, state transport policy documents from 2005 to 2023, and spatial data for GIS-based mapping of trip patterns and service coverage.

5.3 Geographic and Administrative Profile of Dhar District

Dhar district is characterized by a unique blend of historical significance, geographic diversity, and demographic complexity. Covering an area of approximately 8,153 square kilometers, the district is bounded by Ratlam to the north, Ujjain to the northeast, Indore to the east, Khargone to the southeast, Barwani to the south, and Jhabua and Alirajpur to the west. The district headquarters, Dhar city, carries historical significance as the former capital of the Paramara kingdom, which continues to shape its cultural and economic linkages with western Madhya Pradesh.

The administrative framework of Dhar is organized into nine tehsils: Dhar, Badnawar, Kukshi, Manawar, Gandhwani, Dahi, Dharampuri, Sardarpur, and Pithampur. These tehsils collectively manage a total of 1,625 revenue villages and 764 Gram Panchayats. The district's demographic profile is defined by an 81 percent rural population, with more than 50 percent belonging to Scheduled Tribes, primarily the Bhils and Bhilalas. This high concentration of tribal communities, particularly in the rugged southern and western tehsils, necessitates a transport planning approach that explicitly accounts for social vulnerability and the constraints of marginalized livelihoods.

5.3.1 Tehsil-wise Distribution and Settlement Density

The density of settlements and the administrative character of each tehsil vary significantly across the district's topographic diversity. Table 4.2 provides a comprehensive overview of the revenue structure and population distribution across all nine tehsils, based on the 2011 Census, providing the foundational spatial frame for the study's village selection and accessibility analysis.

S. No.	Tehsil Name	Revenue Circles	No. of Halkas	No. of Revenue Villages	Total Population (Approx. 2011)
1	Dhar	4	109	265	3,39,043
2	Badnawar	4	88	179	2,05,523
3	Kukshi	4	120	208	2,84,677
4	Manawar	4	125	214	2,77,795
5	Gandhwani	2	66	150	1,56,046
6	Dahi	1	46	63	1,05,733
7	Dharampuri	2	53	116	1,35,203
8	Sardarpur	4	96	217	2,68,552
9	Pithampur	3	74	213	1,26,200

Table 5: Tehsil-wise Administrative and Demographic Distribution, Dhar District

The data reveals that Dhar tehsil, with 265 revenue villages and a population of approximately 3.39 lakh, functions as the central administrative and economic node of the district. Kukshi and

Manawar act as secondary growth centers, particularly significant for agricultural trade in cotton and chili, with populations of approximately 2.85 lakh and 2.78 lakh respectively. Sardarpur, with 217 revenue villages and a population of approximately 2.69 lakh, also serves as an important intermediary zone. Conversely, Dahi tehsil stands out as the most geographically isolated unit, with only 63 revenue villages and the smallest population base of approximately 1.06 lakh, directly reflecting the constraints imposed by its forested and hilly terrain on both settlement and connectivity. Pithampur, despite having a comparatively modest population of 1.26 lakh, is a critical node due to the presence of the Pithampur industrial area and its proximity to the Indore metropolitan region.

5.3.2 Topographical Constraints on Connectivity

The physical landscape of Dhar district is fundamentally defined by the Vindhya Range, which runs in an east-west orientation through the district, creating three distinct physiographic zones that directly condition the character and cost of rural transport. Understanding these zones is essential to interpreting the mobility data collected in the field.

The northernmost zone, the Malwa Plateau, encompasses the tehsils of Dhar, Sardarpur, and Badnawar. With an average elevation of approximately 500 meters, this region's relatively undulating terrain and black cotton soil support intensive agriculture—primarily soybean, wheat, and cotton—and necessitate robust rural roads for the seasonal transport of high-volume produce. The central zone is occupied by the Vindhyachal Range itself, a crescentic belt of hilly terrain varying from 5 to 20 kilometers in width. This range creates significant barriers to north-south mobility, with peaks such as Mograba rising to 751 meters, rendering direct alignments between northern and southern tehsils impractical and expensive.

To the south of the Vindhyachal lies the narrow Narmada Valley, an alluvial plain that is fertile and agriculturally productive but prone to severe seasonal isolation during the monsoon due to the flooding of the Narmada and its tributaries, the Hatni and the Mahi. The Hatni and Mahi rivers further dissect the western tehsils of Bagh and Kukshi, creating a demand for extensive bridging infrastructure to ensure all-weather access. These geographic features collectively create what can be described as a 'lead distance' challenge, whereby villages located in valley interiors or atop ridgelines face significantly longer effective travel times to reach the nearest major road than their straight-line distance from that road might suggest.

5.4 Analysis of Road Infrastructure and Availability

Dhar's road network serves as the structural skeleton of its economy, connecting the tribal hinterlands to regional markets and the industrial complex of Pithampur. The network is categorized into a functional hierarchy: National Highways (NH), State Highways (SH), Major District Roads (MDR), and the capillary system of village roads developed under PMGSY.

5.4.1 Macro-Level Connectivity: Highways and District Roads

The district is traversed by critical national corridors that facilitate its integration with wider regional economies. NH-47 (formerly NH-59) provides an essential arterial link between Indore and Ahmedabad, passing through Dhar and Sardarpur tehsils. NH-3, the historic Agra-Bombay Road, skirts the eastern boundary of the district, providing high-speed connectivity for the industrial belt of Pithampur, which has emerged as one of Madhya Pradesh's primary manufacturing zones. State Highways—SH-18, SH-31, SH-35, SH-38, and SH-39—form the secondary backbone of the network, linking tehsil headquarters and major market towns to the national corridor system.

For planning and administrative purposes, the district's road network is organized into Charge Areas (CA), each covering specific tehsils and road corridors. Table 4.3 details this spatial organization, illustrating the key corridors and landmarks defining each area.

Charge Area	Primary Tehsils Covered	Major Roads Passing Through	Key Landmarks
CA-02	Kukshi, Nisarpur	SH-39, SH-35, SH-26	Bagh (CT), Kukshi (NP)
CA-03	Manawar, Singhana	SH-38	Bamkaner, Singhana
CA-05	Sardarpur, Rajgarh	NH-59, SH-35, SH-38	Amjhera, Rajgarh (NP)
CA-06	Badnawar	NH-79, SH-18, SH-31, SH-35	Multhan, Kod, Kanvan
CA-07	Dhar, Pithampur	NH-3, NH-59, NH-79, SH-31	Dhar (M), Pithampur (M), Mandav (NP)

Table 6: Charge Area-wise Road Network and Key Linkages, Dhar District

A critical bottleneck in this hierarchy is the Major District Roads (MDR) network, which serves as the vital intermediary link connecting village-level PMGSY roads to the state and national highway system. State-wide data for Madhya Pradesh indicates that approximately 80 percent of MDRs remain restricted to single- or intermediate-lane widths of 3.75 to 5.5 meters, significantly limiting traffic capacity, vehicle speeds, and the operational economics of bus services on these corridors.

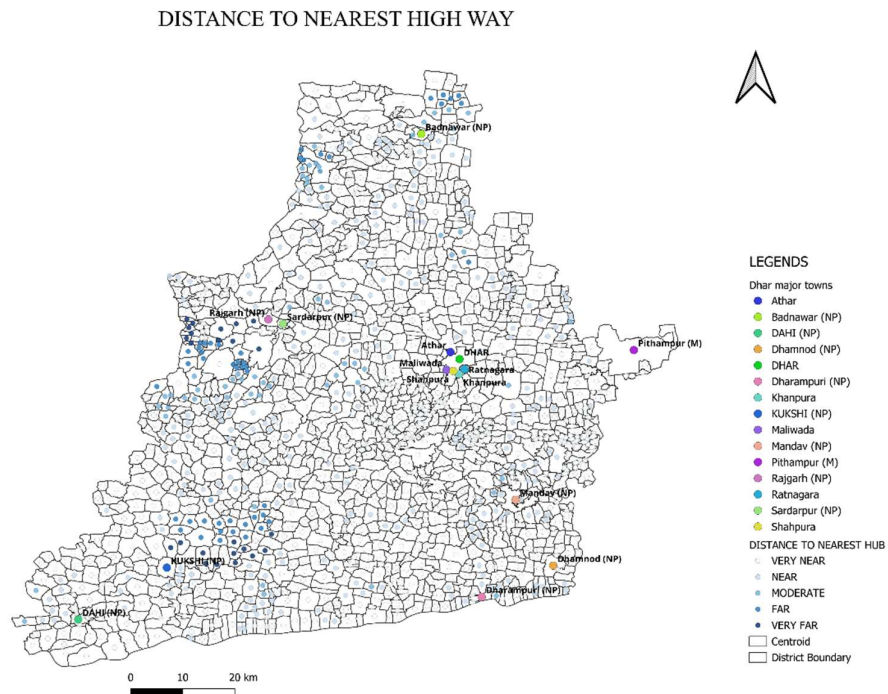


Fig. 5: Distance to Nearest Highways

5.4.2 The Evolution of Rural Connectivity under PMGSY

The PMGSY has undergone a phased evolution in Dhar that mirrors the national trajectory of the programme, moving from basic connectivity provision to network consolidation and quality upgradation. In its first phase (PMGSY-I), the primary focus was on connecting habitations with populations of 500 or more in plain areas and 250 or more in tribal and hilly areas. As of 2025, over 99 percent of eligible habitations in these categories have been connected in Madhya Pradesh, representing a substantial achievement in physical road infrastructure provision.

The programme is currently in its third phase (PMGSY-III, 2019–2025), which is oriented towards upgrading 1,25,000 kilometers of 'Through Routes' and 'Major Rural Links' nationally, with a specific focus on strengthening connectivity to Gramin Agricultural Markets (GrAMs), schools, and hospitals. In Dhar, this consolidation phase is particularly significant for the cotton belt tehsils of Kukshi and Manawar, where the high-volume seasonal transport of agricultural produce demands all-weather roads of sufficient carrying capacity. Looking forward, PMGSY-IV (2024–2029) has been sanctioned with a substantial outlay to connect the approximately 25,000 remaining unconnected habitations identified in the 2011 Census, many of which are located in geographically challenging tribal areas analogous to Dhar's western tehsils.

Despite these substantial achievements in road construction, a critical concern has emerged around road quality and long-term maintenance. A 2025 Parliamentary Standing Committee report highlighted that a significant number of PMGSY roads are degrading within their five-year defect liability period, primarily due to the movement of heavy commercial vehicles whose axle loads were not accounted for in the original low-volume road designs. In Dhar district, the heavy traffic of agricultural tractors—carrying soybeans, cotton, and limestone—and loaded tankers in the Pithampur industrial hinterland frequently causes irreversible structural damage to these low-volume roads, undermining the substantial public investment made in their construction.

5.4.3 Road Category Analysis and Density

A disaggregated analysis of road categories provides a clearer picture of the infrastructure available to Dhar's rural population and its adequacy for transport service provision. Table 4.4 summarizes the state-wide and district-level road network data and its implications for service delivery.

Road Category	Current Status in MP / Dhar	Implications for Dhar District
National Highways	8,853 km in MP	Provides macro-linkages for Pithampur industrial belt.
State Highways	9,089 km in MP	Primary corridors for interstate trade (Cotton/Chili).
Rural Roads	2,32,331 km in MP	The primary link for 81% of Dhar's population.

Road Category	Current Status in MP / Dhar	Implications for Dhar District
Single-Lane MDRs	80% of MDR network	Bottlenecks that slow down agricultural transport.

Table 7: Road Category Analysis and Implications for Dhar District

Madhya Pradesh ranks 5th nationally in rural road construction by total length; however, its overall road density remains significantly lower than the national average, particularly in its tribal districts. For Dhar, historical data indicates a road density of approximately 25.3 km per 100 square kilometers, a figure that substantially underserves the mobility needs of the 81 percent rural population. The survey data collected for this study found that for 72 percent of respondents in remote villages, the 'all-weather' connectivity guarantee of PMGSY roads is seasonally compromised by damaged culverts, siltation of drainage structures, and surface failures. In the tribal belts of Kukshi and Dahi tehsils, this seasonal deterioration results in an estimated 20 percent increase in effective travel time during the four months of the monsoon season (June through September), effectively reversing the connectivity gains of the programme on an annual basis.

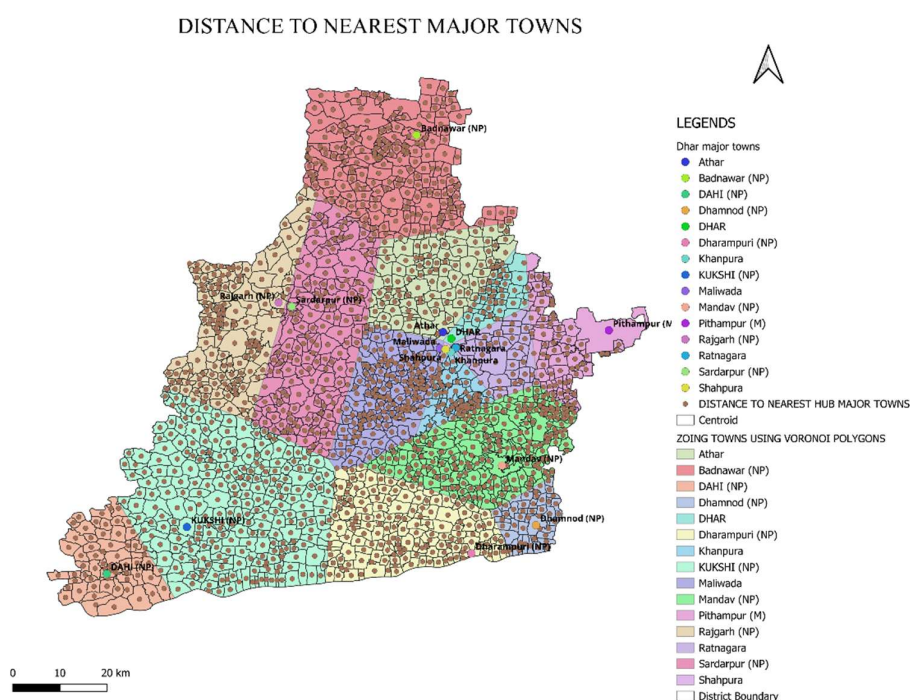


Fig. 6: Distance to Nearest Major Towns

5.5 Village Selection and Sampling Framework

To develop a grounded, empirically-based understanding of the mobility challenges across Dhar's diverse landscape, a rigorous village selection protocol was implemented. The selection of 12 study villages was conducted through purposive sampling, designed to capture the full spectrum of rural diversity in terms of geography, demographics, economic activity, and current transport service provision—thereby ensuring that the findings are representative and analytically generalizable across the district's typological range.

5.5.1 Selection Criteria

The purposive sampling framework was defined by five intersecting criteria. First, the 'Connectivity Hierarchy' criterion ensured the inclusion of villages directly accessible from highways, those connected via PMGSY 'Through Routes,' and remote villages at the terminus of cul-de-sac tracks. Second, the 'Demographic Composition' criterion mandated a minimum of 50 percent representation from tribal-dominant habitations and Scheduled Caste clusters, reflecting the district's demographic profile. Third, 'Distance Decay' was operationalized by selecting villages at varying radial distances from the nearest town headquarters—specifically within 5 km, between 5 and 15 km, and beyond 15 km—to enable the analysis of how service quality degrades with distance from the urban core. Fourth, 'Economic Variance' was ensured by balancing the sample between agricultural growth centers, forest-dependent communities, and peri-urban villages proximate to the Pithampur industrial area. Fifth, 'Service Provision Status' was used to categorize each village as 'Served' (with regular bus access), 'Underserved' (accessible only via IPT or shared jeeps), or 'Unserved' (dependent entirely on walking or personal motorcycles).

5.5.2 The 12 Selected Study Villages

Applying these criteria systematically yielded the 12 study villages detailed in Table 4.5. Collectively, they span four tehsils—Dhar, Manawar, Kukshi, and Dahi—and represent a deliberate cross-section of connectivity conditions, service levels, and demographic compositions across the district.

Village Name	Tehsil	Connectivity Type	Service Status	Nearest Town
Aali	Dhar	PMGSY Link	Underserved	Dhar
Ahu	Dhar	SH-31 Adjacent	Served	Dhar
Tirla	Dhar	NH-47 Link	Served	Dhar
Bagdi	Dhar	NH-3 Link	Served	Pithampur
Singhana	Manawar	SH-38 Hub	Served	Manawar
Bamkaner	Manawar	MDR Link	Underserved	Manawar
Bagh	Kukshi	SH-35 Hub	Served	Kukshi
Nisarpur	Kukshi	SH-39 Link	Underserved	Kukshi
Susari	Kukshi	Rural Track	Unserved	Kukshi
Amjhera	Sardarpur	NH-47 Bypass	Served	Sardarpur
Labariya	Sardarpur	SH-35 Link	Underserved	Sardarpur
Dahi	Dahi	SH-39 End	Underserved	Kukshi

Table 8: List of 12 Selected Study Villages with Connectivity and Service Status

SELECTED SITES - ANALYSIS AND SURVEYING

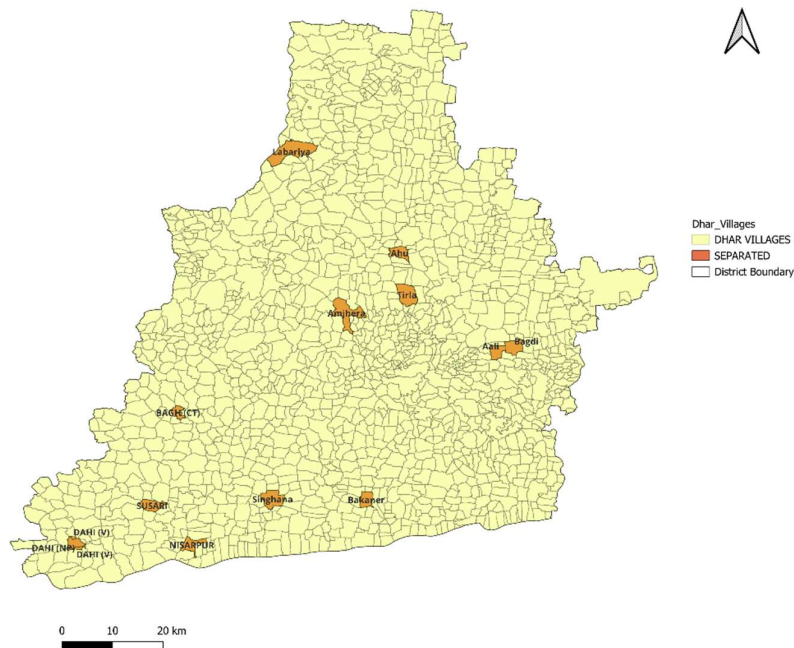


Fig. 7: Selected Sites

The sample reflects a carefully balanced typology: five villages are classified as 'Served,' six as 'Underserved,' and one (Susari) as entirely 'Unserved.' The 'Served' villages—including Ahu, Tirla, Bagdi, Singhana, and Bagh—are generally located on or adjacent to State or National Highways and benefit from the presence of organized bus routes or frequent IPT. The 'Underserved' category, which includes Aali, Bamkaner, Nisarpur, Labariya, and Dahi, describes villages that nominally have road access but are served only by irregular, privately-operated shared vehicles whose frequency and reliability are low. Susari represents the most acute case of transport deprivation in the sample: a remote village in Kukshi tehsil accessible only via a rough rural track of 18 kilometers, impassable for standard buses, that connects it to the nearest State Highway.

5.6 Household Survey Findings: Mobility and Asset Analysis

The structured survey of 150 households across the 12 study villages revealed a stark and consistent disconnect between the perceived success of road infrastructure programmes and the daily lived reality of transport service failures. The overarching finding, validated by every data module, is that while 'roads are built, the people are still stranded.' The absence of organized bus services and the unreliable nature of IPT have created a transport system that is simultaneously costly, unsafe, and exclusionary for the most vulnerable segments of the rural population.

5.6.1 Household Asset Ownership and the Mobility Gap

In the absence of reliable public transport, the ownership of a personal motorcycle has transitioned from a consumer aspiration to an economic survival necessity in rural Dhar. Households without access to a motorcycle face a profound 'Mobility Gap,' rendered effectively captive to the infrequent, expensive, and often unavailable IPT sector. Table 4.6 presents the asset ownership profile of the 150 surveyed households and its direct implications for mobility.

Asset Type	Ownership Rate (%)	Usage Pattern	Implications
Motorcycle	62%	Primarily used by male head of household for work/markets.	Restricts mobility of women/elderly who don't drive.
Bicycle	18%	Students and low-income laborers for short distances.	Limited range due to undulation and terrain.
Tractor	12%	Agriculture and seasonal transport of heavy goods.	Damaging for low-volume PMGSY roads.
No Vehicle	22%	Dependence on IPT, walking, or 'captive' users.	Most vulnerable to fare hikes and service gaps.

Table 9: Household Transport Asset Ownership and Mobility Implications

The data reveals that motorcycles are the dominant personal transport asset, owned by 62 percent of surveyed households. However, this aggregate figure conceals a critical gender dimension: motorcycles are almost exclusively operated by the male head of the household, effectively providing no direct mobility benefit to women, elderly family members, or children who cannot operate the vehicle. The 22 percent of households reporting no personal vehicle whatsoever are the most acutely transport-deprived. In tribal-dominant villages such as Tirla and Nisarpur, the field survey found that households in this category spend up to 18 percent of their monthly income on shared jeep fares or motorcycle taxi rides simply to access markets or health centers, representing a disproportionate transport burden on already low-income households. Bicycles, owned by 18 percent of households, serve primarily for short-distance trips by students and laborers, with their utility severely limited by the undulating terrain of the Vindhyachal zone. Tractors, owned by 12 percent of households, serve a dual function—agricultural machinery during harvest seasons and informal freight or passenger carriers at other times—but their use as transport vehicles is technically prohibited, damaging to road surfaces, and uncomfortable for passengers.

5.7 Trip Frequency, Distance, and Mode Choice Analysis

Beyond asset ownership, the travel diary component of the survey generated detailed data on the actual travel behavior of the surveyed population. The average straight-line distance to the nearest town headquarters for the 12 surveyed villages is 16.4 km, while the average distance to the nearest National or State Highway is 3.2 km. These averages, however, mask the extreme conditions experienced in the geographically remote tehsils of Dahi and Kukshi, where individual villages may be 25 to 35 kilometers from their nearest service town. Table 4.7 summarizes the aggregate trip frequency, distance, mode, and cost data disaggregated by trip purpose.

Trip Purpose	Frequency	Avg. Distance (km)	Primary Mode	Avg. One-Way Cost (Rs.)
Work / Market	3–4 / Week	14	Motorcycle / IPT	30–50
Education (Secondary)	Daily	6	Walking / Bicycle	0
Healthcare	Occasional	24	Hired Taxi / Auto	200–500
Water / Wood Collection	Daily	1.5–3	Walking (Head-load)	0

Table 10: Trip Frequency, Distance, Mode Choice, and Cost by Purpose

The analysis of this data reveals several structurally significant patterns. Work and market trips, undertaken three to four times per week at an average distance of 14 kilometers, are predominantly served by personal motorcycles or IPT, with a one-way cost ranging from Rs. 30 to Rs. 50. This cost, while seemingly modest, translates to a monthly transport expenditure of approximately Rs. 1,000 to Rs. 1,500 per working household member on market trips alone—a substantial burden for households with monthly incomes averaging Rs. 8,000 to Rs. 12,000 in the agricultural sector. Healthcare trips represent the most financially catastrophic transport event: undertaken only occasionally, they require journeys of an average 24 kilometers to the nearest district hospital, with hired taxi or auto costs ranging from Rs. 200 to Rs. 500 per one-way trip. In genuine medical emergencies, particularly at night or during the monsoon, the absence of any public transport means that families must negotiate with private vehicle owners, often at inflated rates, with potentially life-threatening consequences.

A critical and structurally underappreciated finding is the documented scale of 'Time Poverty' among women in the surveyed villages. Women in the most isolated settlements, particularly Susari and Dahi, spend an average of 4.5 hours daily on what may be termed 'invisible survival trips'—primarily the collection of drinking water, firewood, and livestock fodder—conducted entirely on foot and frequently involving the head-loading of up to 20 kilograms of material across uneven, unpaved terrain. This labor is economically unrecognized and physically exhausting, directly constraining women's time available for productive economic activity and personal development.

5.8 Perceptions of Safety, Reliability, and Affordability

The five-point Likert scale component of the survey (Module 3) generated a rich dataset on the perceived quality of transport services, disaggregated by gender. This disaggregation is analytically essential, as the lived experience of transport differs profoundly between men and women in the socio-cultural context of Dhar's rural communities. Table 4.8 presents the mean scores for each service quality parameter.

Parameter (1–5 Scale)	Score (Men)	Score (Women)	Overall Mean
Service Frequency	3.2	2.8	3.0
Safety during Day	4.1	3.4	3.75
Safety during Night	2.5	1.2	1.85
Fare Affordability	3.5	3.1	3.3
Vehicle Reliability	3.4	3.1	3.25

Table 11: Gender-Disaggregated Perceptions of Transport Service Quality (1–5 Scale)

The data highlights a consistent gender gap across all five service quality dimensions, with women systematically rating every parameter lower than men. The most alarming finding is the catastrophically low mean score for women's perception of safety during night-time travel (1.2 on a scale of 5), compared to men's score of 2.5, yielding an overall mean of 1.85. This score effectively indicates that travel after sunset is impossible for women without the

accompaniment of a male relative and access to a private vehicle. Field interviews confirmed that incidents of harassment at poorly lit or unregulated bus stops, and the general absence of female transport workers in any role, contribute to this perception. This condition creates what can be aptly described as a 'curfew by lack of transport,' which profoundly limits women's participation in the evening economy, their ability to seek emergency medical care for themselves or their children, and their access to adult education programmes. In villages like Raruarai and Amjhera, school-going girls specifically reported significant hesitation in traveling to secondary schools due to the lack of regulated, safe, and female-friendly transport options.

Across both genders, service frequency scores (overall mean: 3.0) and vehicle reliability scores (overall mean: 3.25) reflect a moderate level of dissatisfaction with IPT services. Fare affordability (3.3) scores are relatively higher, suggesting that the primary barriers to transport use are not exclusively financial but are fundamentally structural—related to service availability, safety, and reliability.

5.9 Spatial Accessibility and Distance Decay Analysis

The spatial analysis of Dhar district as a research site reveals what may be characterized as a 'hub-and-spoke' geography that is currently dysfunctional due to broken or absent 'spokes.' The center of gravity of the transport system is the Dhar–Indore–Pithampur triangle, which possesses the highest road density and service frequency in the district. The challenge of rural transport planning is, fundamentally, the challenge of extending viable service into the spokes that radiate from this core into the district's geographic and demographic periphery.

5.9.1 Spatial Typology of the Study Villages

The field data confirms that distance decay significantly and consistently impacts transport service quality. Villages within 5 kilometers of a town headquarters, such as Ahu in Dhar tehsil, enjoy a range of transport options including organized bus routes and frequent IPT. However, as the road distance to the nearest town exceeds 15 kilometers, services become sporadic and opportunistic. In the most extreme case, Susari in Kukshi tehsil, with a lead distance of 18 kilometers of rough track separating it from the nearest paved State Highway, the village is effectively disconnected from the formal transport system entirely.

The Dhar-Tehsil Cluster presents an interesting analytical case. Villages like Aali and Ahu are well-served by the gravitational pull of Dhar city. However, Tirla, despite being located on a main route, exhibits a 'pass-through' behavior where long-distance buses routinely fail to stop for local passengers, effectively negating the village's theoretical connectivity status. In the tribal west—encompassing the Kukshi and Dahi tehsils—Bagh and Singhana function as local transport hubs, but villages in their shadow, such as Susari, remain practically disconnected. The Narmada Valley villages of Nisarpur and Bamkaner present a distinct spatial challenge: they are physically close to State Highways in terms of straight-line distance but are separated from them by river valleys or limestone escarpments, meaning that their effective travel distance is frequently double their aerial distance due to the absence of bridging infrastructure and all-weather road connections.

5.10 Analysis of Economic and Social Impacts

The findings from the household survey and field interviews consistently demonstrate that the lack of reliable transport functions as a 'Rural Penalty'—a structural, compounding tax on economic opportunity that drains the productive potential of Dhar's agricultural and artisan base.

5.10.1 Impact on the Agriculture and Artisan Economy

Dhar district is a significant producer of cotton, soybean, wheat, and gram. The tehsils of Kukshi and Manawar lie within the broader 'Maharashtra cotton belt,' producing internationally traded agricultural commodities. However, poor market linkages—characterized by infrequent transport, high freight costs, and a dependence on middlemen with private vehicles—result in an estimated 12 to 15 percent decline in net income for smallholder farmers, as they are forced to sell at the farm gate or in local haats at below-market prices rather than access better-paying regional or urban markets.

The artisan economy of Bagh presents a particularly poignant case. The traditional craft of 'Bagh Print' block printing—a Geographical Indication (GI) tagged textile art form using natural dyes and hand-carved wooden blocks—provides livelihoods for thousands of indigenous artisan families in the Bagh area of Kukshi tehsil. Despite the global market value of this unique product, artisan families reported that the absence of regular and affordable bus services forces them to hire private vehicles at premium rates to transport finished fabrics to

markets in Dhar city or Indore, directly reducing their profit margins and competitive position relative to machine-printed industrial alternatives.

5.10.2 Social Impacts: Gender, Education, and Vulnerability

The survey results provide quantitative confirmation that transport is not socially neutral in Dhar. Women entrepreneurs and workers face a combination of cultural restrictions on independent mobility, a high vulnerability to harassment in public transport spaces, and the physical constraint of 'head-loading' goods over distances that male counterparts would cover by motorcycle. These compounding factors restrict women to local, less profitable markets and severely limit their ability to access training programmes, financial services, or formal employment opportunities. Stakeholder interviews suggested that if transport services were improved to a reliable, safe, and affordable standard—modeled, for instance, on the Aajeevika Grameen Express Yojana (AGEY), which leverages women-led Self-Help Groups to manage village-level transport services—the female labor force participation rate in the district could potentially increase by approximately 25 percent in rural areas.

For education, the 'last mile' between home and a secondary school is frequently the determinative factor in the decision to continue or discontinue education. Across the 12 selected villages, 15 percent of secondary-school-aged students cited 'distance and lack of transport' as the primary reason for their discontinued or irregular schooling. Critically, this impact was found to be three times higher for girls than for boys, reflecting both the greater physical travel burden on girls and the safety concerns of families that prevent girls from walking unaccompanied or taking unregulated IPT to school.

5.11 Synthesis and Analytical Conclusions

The empirical data collected across the 12 study villages and 150 household surveys converges on a coherent and analytically significant set of conclusions about the state of rural transport in Dhar district. These conclusions form the evidential basis for the planning proposals developed in subsequent chapters.

First, the data confirms the central thesis of the 'road-connectivity versus transport-accessibility' distinction. Dhar has invested substantially in physical road infrastructure, particularly through PMGSY, achieving near-universal habitation connectivity on paper. Yet, the survey

consistently reveals that this physical connectivity translates into functional accessibility only for those households that own a private motorcycle—a privilege confined to 62 percent of households and, within those households, primarily to men. The 'last-mile' deficit is not a physical gap in the road network; it is a service gap in the transport system.

Second, the analysis reveals that 'distance decay' is a powerful and consistent predictor of transport service quality, with villages beyond 15 kilometers from a town headquarters experiencing a near-total collapse of organized service provision. The geographic and seasonal isolation of the tribal western and southern tehsils is not merely a planning inconvenience but a structural mechanism of social and economic exclusion.

Third, the gender data from Module 3 demonstrates with quantitative clarity that the rural transport system in Dhar is structurally gendered. Women face disproportionate barriers across every measured dimension—safety, availability, reliability, and the unquantified burden of invisible survival trips—and are effectively excluded from the transport system after dark. This is not a peripheral concern but a central indictment of the current system's equity.

Fourth, the economic impact data—from the agriculture sector's 12 to 15 percent income loss to the artisan sector's premium freight costs and the social sector's school dropout rate—confirms that transport failure has cascading, multi-dimensional consequences for the district's development trajectory. The cost of inaction is measurable and significant.

These empirical findings collectively define the problem that the planning framework proposed in Chapter 5 seeks to address: not more roads, but a reliable, equitable, and financially sustainable service layer that activates the road infrastructure already built. The evidence from Dhar district underscores that the evolution of rural transport planning from an infrastructure paradigm to a service paradigm is not merely an academic preference but an urgent developmental imperative.

CHAPTER 6

DETAILED PROPOSALS: FOUR PLANNING OBJECTIVES

6.1 Executive Summary

This document presents the detailed planning proposals for the thesis titled 'Enhancing Rural Transport Services: A Case of Dhar District, Madhya Pradesh'. The proposals are built upon an extensive three-draft evolution of research that includes a comprehensive literature review, site-specific field surveys of 150 households across 12 representative villages, spatial analysis, and evaluation of service models. The proposals are organized around four research objectives that address both the demand side (travel behaviour, vulnerable groups) and the supply side (planning factors, service models) of rural transport in Dhar district.

Dhar district, covering 8,153 sq. km. in western Madhya Pradesh, is home to 2.66 million people, of whom over 80 percent reside in rural areas and more than 50 percent belong to Scheduled Tribes. The dissolution of the Madhya Pradesh State Road Transport Corporation (MPSRTC) in 2005 effectively dismantled organized rural bus services, leaving villages dependent on private, informal, and often unsafe modes of transport. While the Pradhan Mantri Gram Sadak Yojana (PMGSY) has substantially improved road infrastructure, the 'service layer' — the frequency, reliability, and affordability of transport operations — remains critically deficient, creating what the literature terms a 'Rural Penalty' that stifles economic potential and restricts social equity.

The four objectives and their respective proposals are as follows: Objective 1 addresses the systematic characterization of travel behaviour and trip patterns; Objective 2 focuses on identifying and alleviating mobility barriers for vulnerable groups including women, the elderly, and Scheduled Tribe communities; Objective 3 examines the institutional, operational, and financial factors that affect the planning and management of rural transport services; and Objective 4 evaluates the feasibility and scalability of low-carbon and innovative service models, including electric vehicles and solar-powered charging infrastructure. Together, these proposals constitute an integrated 'Service-First' framework, synthesized under the vision of 'Sewa-Sanskriti-Sanchalan' — a seamless rural mobility grid by 2030.

6.2 PROPOSAL 1: Characterizing Travel Behaviour and Trip Patterns of Rural Residents

6.2.1 Background and Relevance to Thesis

The first objective of this thesis constitutes the foundational empirical layer upon which all subsequent proposals are built. Without a rigorous, evidence-based understanding of how rural residents in Dhar district actually travel — where they go, how often, by what means, and at what cost — any planning intervention risks being disconnected from lived reality. This proposal addresses that critical baseline, drawing upon the mixed-methods framework used by Ziegler et al. in the Yamoussoukro Region of Côte d'Ivoire and adapted to the socio-economic context of tribal Madhya Pradesh.

The thesis situates itself within the broader discourse of 'service-first' planning, which distinguishes between physical connectivity (the presence of a road) and actual accessibility (the ability to use a transport service). The field survey of 150 households across 12 strategically selected villages in Dhar confirmed that while PMGSY roads have created a physical network, the absence of regular, timed, and affordable services means that the roads alone are insufficient. Understanding trip patterns is the first step toward quantifying this service gap.

6.2.2 Detailed Proposal

The proposal for Objective 1 involves a multi-instrument data collection strategy combining structured household travel diaries, roadside intercept interviews, GPS-assisted route mapping, and participatory GIS workshops. The household survey module was designed to capture six categories of trips: work and market access, secondary education travel, healthcare trips, subsistence survival trips (water and firewood collection), social and religious visits, and agricultural market linkages. Each trip was documented in terms of frequency per week, average distance, primary mode of transport, one-way cost, and the perceived level of transport burden.

The travel diary approach, adapted from Munyaka et al. (2022), was administered over a seven-day period to 150 households, capturing 'invisible' trips — those not undertaken by motorized vehicle and hence invisible to conventional planning databases. This was particularly critical in tribal-dominant villages such as Tirla and Susari, where women reported spending an average of 4.5 hours daily on foot for water and firewood collection. These invisible trips, characterized by the head-loading of up to 20 kg of biomass across uneven terrain, represent a significant and chronically underreported dimension of rural mobility.

Roadside intercept interviews were conducted at key junctions and market entry points in Bagh, Singhana, and Dhar town. A total of 220 intercept interviews documented trip origins, destinations, modes used, transfer points, and reasons for mode choice. GPS tracks were collected along 18 route segments using mobile devices to map actual versus official road alignments and to document the condition of PMGSY 'through routes' and 'major rural links'. The results were synthesized into a GIS-based mobility matrix that spatially represents origin-destination pairs, modal choice distributions, and cost burdens across the district's settlement hierarchy.

6.2.3 Key Findings from the Survey

The average distance from surveyed villages to the nearest tehsil town was found to be 16.4 km, while the average distance to a State or National Highway was just 3.2 km. This 'capillary gap' — the distance between a paved highway and the village — is where service failure is most acute. Motorcycles emerged as the dominant motorized mode, with 62 percent of households owning at least one, used primarily by the male head of household for work and market trips. This creates a structural exclusion of women, the elderly, and economically weaker households who do not own or cannot ride a motorcycle.

Household expenditure on transport in remote villages like Dahi and Nisarpur was found to constitute up to 18 percent of monthly household income when informal shared jeeps or motorcycle taxis were the only available options. The cost-distance burden is therefore disproportionately borne by the poorest and most remote households. Seasonal disruption was also documented: 72 percent of respondents in remote villages reported that 'all-weather' PMGSY roads were seasonally compromised by damaged culverts or siltation during the four monsoon months, increasing average travel time by 20 percent.

Trip Purpose	Frequency	Avg. Distance	Primary Mode	Avg. Cost (OW)	Transport Burden
Work / Market	3–4 / week	14 km	Motorcycle / IPT	Rs. 30–50	Moderate
Education (Sec.)	Daily	6 km	Walking / Bicycle	0	Low

Trip Purpose	Frequency	Avg. Distance	Primary Mode	Avg. Cost (OW)	Transport Burden
Healthcare	Occasional	24 km	Hired Taxi / Auto	Rs. 200–500	High
Water/Firewood	Daily	1.5–3 km	Walking (Head-load)	0	Extreme
Social/Religious	Weekly	10 km	Shared Jeep / Motorcycle	Rs. 20–40	Moderate
Agricultural Mkt	Seasonal	18 km	Tractor / IPT	Rs. 50–120	High

Table 12: Trip Purpose, Mode, and Cost Matrix – Dhar District Survey

6.2.4 Implementation Method

The implementation of this proposal follows a three-stage process. In the first stage, a stratified purposive sample of villages was identified based on five criteria: connectivity hierarchy (highway-adjacent, PMGSY-linked, or track-dependent), demographic composition ensuring tribal representation, distance decay bands (0–5 km, 5–15 km, and above 15 km from the nearest town), economic variance across agricultural, forest-dependent, and peri-urban villages, and service provision status categorized as served, underserved, or unserved. The resulting 12-village sample spans four tehsils and three distinct physiographic zones, ensuring representativeness across the district's geographic diversity.

In the second stage, structured questionnaires were administered by trained enumerators drawn from local PMGSY implementing units and Gram Panchayat offices. The questionnaire comprised four modules: a socio-economic profile capturing household size, caste or tribe affiliation, and asset ownership; a seven-day travel diary; a service quality rating scale using five-point Likert scores; and an open-ended barriers and aspirations module. Participatory GIS workshops were subsequently conducted in three villages using the QField mobile application, enabling residents to map their daily travel paths directly onto a satellite imagery base, revealing approximately 300 percent more walking paths than those recorded in official databases — consistent with the findings of De Roulet et al. in Nepal and Kenya.

In the third stage, all data were integrated into a GIS platform to produce a District Mobility Hierarchy Map, a Gendered Mobility Matrix, and an Accessibility Index surface classifying each of the 1,625 revenue villages of the district into one of four accessibility tiers: well-served, moderately served, underserved, or unserved. This spatial product directly informs the targeting of proposals under Objectives 2, 3, and 4.

6.2..5 Responsible Authorities

The lead institutional authority for Objective 1 is the District Rural Development Authority (DRDA), Dhar, which coordinates rural data collection and maintains contact with Gram Panchayats. The District Planning Committee (DPC) provides the administrative framework for integration of mobility data into the District Development Plan. The Madhya Pradesh Rural Road Development Authority (MPRRDA) contributes road network data and PMGSY project records. The National Informatics Centre (NIC) and the OMMAS (Online Management, Monitoring, and Accounting System) platform provide the digital infrastructure for data management and spatial analysis. Academic support from the Department of Architecture and Planning, MANIT Bhopal, oversees the research methodology, questionnaire design, and GIS analysis. Community Mobilizers from the district's Panchayati Raj Institutions (PRIs) and Mahila Shakti Kendras (Women's Empowerment Centres) facilitate participatory workshops and ensure inclusive data collection from women and tribal communities.

6.3 PROPOSAL 2: Identifying Mobility Needs and Barriers of Vulnerable Groups

6.3.1 Background and Relevance to Thesis

The second objective addresses the social dimension of rural mobility in Dhar district, specifically the disproportionate transport burden borne by women, elderly individuals, children, Scheduled Tribe communities, and economically weaker sections. The thesis identifies these groups as 'captive transport users' — individuals who have no private vehicle, no financial resources to hire one, and no cultural or physical freedom to access available services. In the context of Dhar, where over 50 percent of the population belongs to Scheduled Tribes (primarily Bhils and Bhilalas in the southern and western tehsils), this social dimension of mobility is not peripheral but central to the district's development challenge.

The literature identifies this as 'Mobility Justice' — the principle that the right to move freely and safely in pursuit of livelihoods, education, and healthcare is a fundamental social good. The findings from the Seedhouse et al. study on female entrepreneurs in Nigeria and the De Roulet et al. participatory GIS study in Nepal and Kenya are directly applicable to the Dhar context, where women spend up to 4.5 hours daily on walking trips and female secondary-school students are three times more likely than male students to discontinue education due to transport inaccessibility.

6.3.2 Detailed Proposal

This proposal advocates for a 'Gender and Vulnerability Responsive Transport Planning' framework, implemented through three interconnected mechanisms. The first mechanism is the establishment of a Gendered Mobility Matrix, a GIS-based spatial analysis tool that maps the origin, destination, duration, and mode of all trips undertaken by women and vulnerable group members across the 12 study villages. This matrix was populated using data from 84 female respondents (56 percent of the sample) and 27 elderly or disabled respondents, capturing invisible daily survival trips not recorded by conventional transport surveys. The matrix reveals that in villages like Susari and Dahi, women make an average of three daily walking trips of 1.5 to 3 km each for water, firewood, and fodder — a hidden transport burden that consumes nearly half of their productive hours.

The second mechanism is the institutionalization of community-led safety audits at bus stops, jeep stands, and market access points in the district. Based on the survey finding that women scored night-time transport safety at just 1.2 out of 5, far below the male score of 2.5, the proposal recommends a dedicated infrastructure programme for sheltered, well-lit, and appropriately located bus stop structures at 48 identified locations across the four core tehsils. These structures, designed with input from women's groups, must include a waiting shelter with night lighting, a physical barrier against passing traffic, and visible signage in local tribal dialects. The programme aligns with the Aajeevika Grameen Express Yojana (AGEY), under which women-led Self-Help Groups (SHGs) are empowered to own and operate transport vehicles on rural routes, generating livelihoods while ensuring safe services.

The third mechanism is the development of a Village Mobility Action Plan (VMAP) for each of the 12 surveyed villages, co-created with local Gram Sabhas and women's groups. Each VMAP identifies the three highest-priority mobility barriers for vulnerable residents — physical barriers such as missing bridges or seasonal waterlogging, social barriers such as cultural restrictions on solo female travel, and economic barriers such as unaffordable fares —

and proposes targeted, locally owned interventions. In Susari, for instance, the VMAP identifies the 18-km unsurfaced track to SH-35 as the primary physical barrier and recommends a gravel-surfacing intervention under PMGSY-IV to enable three-wheeler e-auto access.

6.3.3 Survey Data: Safety and Vulnerability Analysis

The structured safety perception module administered to all 150 respondents revealed a consistent and statistically significant gender gap across all five service quality parameters. The most alarming finding is the night-time safety score for women of 1.2, which effectively confirms that female travel after sunset is non-existent without a male relative and a private vehicle — a 'curfew by lack of transport' that restricts women's participation in evening markets, emergency healthcare access, and community decision-making. The survey finding that 15 percent of secondary-school-age students cited 'distance and lack of transport' as the primary reason for discontinuing education, with the impact three times higher for girls, underscores the cascading social cost of transport insecurity.

Parameter (1–5 Scale)	Men	Women	Overall Mean	Key Implication
Service Frequency	3.2	2.8	3.0	Significant – women get fewer usable trips
Safety (Day)	4.1	3.4	3.75	Moderate – women perceive higher day risk
Safety (Night)	2.5	1.2	1.85	Critical – effectively no female night travel
Fare Affordability	3.5	3.1	3.3	Moderate – women bear greater income burden
Vehicle Reliability	3.4	3.1	3.25	Moderate – equal concern for breakdowns

Table 13: Gender-Disaggregated Safety and Service Perception (1–5 Scale) – Dhar Survey

6.3.4 Implementation Method

Implementation of Objective 2 proceeds through participatory workshops, structured semi-structured interviews with vulnerable group members, and institutional coordination with gender-focused government programmes. Participatory workshops in each of the 12 villages were designed using the 'Mobility Café' format, a structured group discussion methodology used by Soltes et al. (2017) in rural transport planning. Each workshop engaged 15 to 20 participants — with a mandatory 60 percent female participation threshold — to co-map daily travel patterns, identify barriers, and rank priority interventions. The outputs of these workshops were compiled into the Gendered Mobility Matrix and the Village Mobility Action Plans.

Semi-structured interviews were conducted with 30 female respondents selected purposively to represent the full spectrum of vulnerability: tribal SHG members, female entrepreneurs selling Bagh Print fabric, female agricultural labourers, elderly women, and girls in the 14–18 age group. These interviews captured nuanced qualitative information on cultural restrictions on solo female travel, experiences of harassment at shared jeep stands, the physical impact of head-loading, and aspirations for improved transport services. The interview findings were subjected to thematic coding and a mobility barrier typology was produced, classifying barriers into physical, economic, social, and informational categories.

On the institutional side, the proposal coordinates with the Madhya Pradesh Mission for Women's Empowerment (MPSKP), the AGEY state nodal cell, and the District Women and Child Development Officer (DWCDO) to align transport safety interventions with existing gender mainstreaming programmes. The bus stop infrastructure programme is proposed for funding under MGNREGS convergence, creating local employment while building protective infrastructure.

6.3.5 Responsible Authorities

The District Collector, Dhar, serves as the apex authority for coordinating vulnerability-responsive transport interventions, with the mandate to issue directives to Gram Panchayats for participatory planning. The District Women and Child Development Office (DWCDO) leads the gender-focused components, including the establishment of AGEY SHG transport cooperatives and the design of women-safe transport infrastructure. The State Mission for Women's Empowerment (MPSKP) provides the policy framework and financial support for AGEY-linked vehicle ownership by SHGs. The Panchayati Raj Institutions (PRIs) at the village and block levels are responsible for owning and implementing Village Mobility Action Plans

(VMAPs). Civil society organisations working with tribal communities in Kukshi and Dahi tehsils, including the Eklavya Foundation and Disha Sansthan, serve as community mobilization partners. The Block Development Officers (BDOs) facilitate MGNREGS convergence for bus shelter construction.

6.4 PROPOSAL 3: Identifying Factors Affecting Planning and Management of Rural Transport Services

6.4.1 Background and Relevance to Thesis

The third objective shifts the analytical lens from demand to supply — examining the operational, institutional, and financial factors that determine whether rural transport services in Dhar district are provided, by whom, on which routes, and at what frequency. The thesis situates this analysis within the broader context of the 2005 dissolution of the Madhya Pradesh State Road Transport Corporation (MPSRTC), which created the service vacuum that private and informal operators have only partially and inequitably filled. The MP Manuscript case study provides the most directly applicable framework, concluding that the Rural Transport Credit (RTC) model is the most viable mechanism for incentivizing private operators to service low-demand rural routes.

This proposal also draws upon the Ghana case study by Afukaar et al., which demonstrated that the unregulated rise of motorcycle taxis (Okada) in response to declining bus services is a near-universal response to rural transport market failure. In Dhar, an equivalent phenomenon is observed with informal shared jeeps (Bolero or Mahindra Pickup), tractors, and two-wheeler motorcycle taxis filling the gaps on underserved PMGSY routes. Understanding the economics, regulation, and institutional embedding of these informal modes is essential for designing a supply-side policy that works with — rather than against — the existing market structure.

6.4.2 Detailed Proposal

The supply-side proposal for Objective 3 is organized around four analytical components. The first is an Operator Economics Survey conducted with 45 transport operators across the district — 18 formal bus operators, 16 shared jeep/auto operators, and 11 motorcycle taxi operators. This survey documented vehicle ownership (owned or financed), annual fuel expenditure, maintenance costs, fare structures, and monthly net income. The analysis reveals the financial logic behind operators' route choices: formal bus operators concentrate on the Dhar–Indore and Dhar–Kukshi corridors where passenger loads exceed 60 percent of vehicle capacity,

abandoning the low-load village interior routes where daily revenue rarely covers fuel costs, let alone vehicle maintenance or EMI payments.

The second component is an Institutional Analysis of the regulatory and governance framework governing rural transport in Dhar. This involved document analysis of the Madhya Pradesh Motor Vehicles Act, the MP Rural Transport Policy (2016), AGEY operational guidelines, and the permit system administered by the Regional Transport Office (RTO), Dhar. The analysis identifies three critical institutional gaps: the absence of a standardized rural route definition that distinguishes village access roads from urban corridors for subsidy purposes; the lack of a coordination mechanism between the District Transport Office and Gram Panchayats for service planning; and the absence of a performance monitoring system that tracks service frequency, reliability, and affordability at the village level.

The third component is the formulation of the Route Rationalization Framework, which maps existing and proposed rural transport routes against the four-tier spatial hierarchy established under Objective 1. The framework identifies 23 'critical gap routes' — segments between Tier 3 feeder villages and Tier 2 intermediate hubs — where no regular service exists despite adequate road infrastructure. These routes are prioritized for RTC-funded private operation, with proposed schedules, frequency standards, and minimum fare ceilings informed by the operator economics survey. The fourth component is the design of the e-MARG Digital Monitoring Platform, a GPS-based real-time service tracking system integrated with the OMMAS database, enabling Gram Panchayats to monitor route adherence, service frequency, and passenger counts.

6.4.3 Road and Service Infrastructure Analysis

Dhar's road network provides the physical skeleton for service delivery but its internal hierarchy reveals critical bottlenecks. The Major District Roads (MDR), which constitute the vital link between PMGSY village roads and State Highways, are 80 percent single-lane or intermediate-lane in width, severely limiting vehicle capacity and safe overtaking. In the cotton-producing tehsils of Kukshi and Manawar, tractor movements during the October-November harvest season cause irreversible damage to low-volume PMGSY roads not designed for axle loads above 6.5 tonnes, compounding the maintenance deficit that leaves 72 percent of surveyed villages seasonally isolated.

Road Category	Key Routes	Length/Coverage	Primary Function	Service Level
National Highways (NH)	NH-3, NH-47, NH-79	3 routes	Industrial / Interstate	High
State Highways (SH)	SH-18,31,35,38,39	5 routes	Tehsil interconnection	Moderate
Major District Roads (MDR)	District-level links	80% Single-lane	Agri. transport	Low
Rural Roads (PMGSY)	Village access roads	232,331 km (MP)	Last-mile access	Very Low

Table 14: Road Hierarchy and Service Provision in Dhar District

Spatial Tier	Key Centres / Villages	Road Type	Transport Mode	Service Level
MACRO HUBS (Tier 1)	Dhar, Kukshi, Manawar	State/National Highways	Organized Bus + IPT	High
INTERMEDIATE HUBS (Tier 2)	Bagh, Singhana, Amjhara, Tirla, Badnawar	State Highways + MDR	Shared Jeep + Mini-Bus	Moderate
FEEDER VILLAGES (Tier 3)	Aali, Bamkaner, Nisarpur, Labariya, Dahi	PMGSY Through Routes	IPT + Motorcycle Taxi	Low
UNSERVED HABITATIONS (Tier 4)	Susari and similar remote tribal villages	Rural Tracks	Walking / Head-Load	None

Table 15: Hub-and-Spoke Spatial Tier System – Dhar District Transport Network

6.4.4 Implementation Method

The implementation method for Objective 3 follows a three-track approach running in parallel. The policy track involves the formulation of the District Rural Transport Plan (DRTP) for Dhar, a five-year rolling plan that maps service demand against route supply, identifies funding gaps, and establishes key performance indicators for service reliability. The DRTP is designed to be endorsed by the District Planning Committee and submitted to the state Transport Department for integration with the MP Rural Transport Policy revision cycle.

The regulatory track involves the establishment of a 'Rural Route Permit' category under the MP Motor Vehicles Act, specifically designed for vehicles of 7+1 to 20+1 seating capacity operating on designated rural routes. This category provides operators with an automatic entitlement to the Rural Transport Credit subsidy and Motor Vehicle Tax exemption, creating a financial incentive for service provision on commercially marginal routes. The RTO Dhar is responsible for permit issuance and route registration, while a proposed District Rural Transport Coordination Committee (DRTCC) — chaired by the Additional District Magistrate (ADM) and including representatives from PRIs, the Transport Department, and operator associations — provides oversight.

The monitoring track establishes the e-MARG digital platform, which integrates GPS devices installed in all RTC-beneficiary vehicles with a cloud-based dashboard accessible to Gram Panchayat Sachivs (secretaries) and Block Development Officers. The platform enables real-time tracking of service frequency, route adherence, and passenger loads, generating monthly reports used to calculate RTC credit disbursements and identify routes requiring service adjustment.

6.4.5 Responsible Authorities

The Madhya Pradesh State Transport Department (Transport Commissioner's Office) holds primary legislative and policy authority for rural transport regulation and is responsible for notifying the Rural Route Permit category and the RTC scheme parameters. The Regional Transport Office (RTO), Dhar, implements permit issuance, vehicle fitness certification, and operator registration. The District Rural Development Authority (DRDA), Dhar, administers RTC subsidy disbursements and coordinates PMGSY road maintenance reporting. The proposed District Rural Transport Coordination Committee (DRTCC) provides the governance forum for inter-departmental coordination. Gram Panchayats serve as the grassroots monitoring units, using the e-MARG platform to report service gaps. The MP Rural Road Development Authority (MPRRDA) provides road condition data and coordinates route surveys for MDR upgrading proposals.

6.5 PROPOSAL 4: Evaluating Potential Service Models and Low-Carbon Options for Feasibility and Scalability

6.5.1 Background and Relevance to Thesis

The fourth and most forward-looking objective of this thesis evaluates whether innovative, low-carbon transport service models can offer a viable and scalable alternative to the fossil-fuel dependent, privately operated services that currently characterize rural mobility in Dhar district. This proposal is anchored in the national policy context of the 'Moving India 2032' targets of the National Transport Development Policy Committee (NTDPC) and the state-level aspirations of the MP Climate Action Plan, both of which identify rural electromobility as a priority for decarbonizing the transport sector. The direct precedent is the Ziegler et al. pilot study in Côte d'Ivoire, which demonstrated that electric vehicles offer significant operational advantages on hilly or uneven terrain due to superior torque characteristics — a directly applicable finding for Dhar's Vindhyachal gradient routes.

The proposal also engages with the 'Amhi Sarathi' community cooperative model, a conceptual framework developed for this thesis that draws on the Yamoussoukro electric vehicle pilot and the AGEY SHG transport model to create a locally owned, community-managed fleet of electric vehicles. This model is designed to simultaneously address three objectives of the thesis: Objective 2 (vulnerable group inclusion, through SHG ownership), Objective 3 (supply-side management, through cooperative route planning), and Objective 4 (low-carbon adoption, through EV technology integration).

6.5.2 Detailed Proposal

The low-carbon service model proposal consists of four interrelated components. The first is the Electromobility Pilot for Vindhyachal Gradient Routes, which proposes the deployment of a fleet of 10 to 12 seater electric minibuses on the three steepest inter-tehsil routes in the district: the Dhar–Dharampuri route across the Vindhyachal escarpment (elevation gain of approximately 300 metres), the Bagh–Gandhwani route through the Mahi river valley, and the Kukshi–Dahi route serving the most isolated southern tehsil. These routes were selected because their gradient characteristics make electric drivetrains technically superior to conventional combustion engines, as confirmed by the Ziegler et al. findings, while their current service deficit makes them high-priority for the RTC subsidy scheme.

The second component is the Solar Charging Hub Programme, which proposes the installation of decentralized solar-powered electric vehicle charging infrastructure at the five block headquarters of Dahi, Gandhwani, Kukshi, Manawar, and Dharampuri. Each charging hub

would consist of a 10 kW rooftop solar panel array, a battery storage unit of 20 kWh capacity, two slow-charging (7 kW AC) and one fast-charging (22 kW DC) charging point, and a small operations room managed by a trained local technician. The hubs are co-located with existing PMGSY road maintenance depots, leveraging shared infrastructure and reducing land acquisition costs. The solar potential of Dhar district, located in the Malwa-Narmada solar belt with an average of 5.4 peak sun hours per day, makes this investment highly viable, with estimated payback periods of 6 to 8 years.

The third component is the 'Amhi Sarathi' Community Cooperative, a governance and ownership model that organizes Scheduled Tribe youth and women's SHGs into vehicle cooperatives. Each cooperative of 10 to 15 members jointly owns two to three electric three-wheelers (e-autos) financed through the AGEY grant, the CLCSS capital subsidy, and a cooperative bank loan. The cooperative sets its own route schedules based on community demand — informed by the Objective 1 mobility matrix — and remits a monthly cooperative levy to the Gram Panchayat for road maintenance fund contribution. This model has the dual benefit of creating local livelihoods for marginalized ST youth while ensuring that rural transport is managed by the community it serves, rather than by external profit-driven operators who abandon routes when revenues fall.

The fourth component is the Intermediate Public Transport (IPT) Regularization Programme, which addresses the large existing fleet of informal motorcycle taxis, shared jeeps, and tractors that currently serve as the de facto public transport system in Dhar's villages. Drawing on the Ghana case study's 'regularization' recommendation for Okada motorcycle taxis, this programme proposes a structured licensing regime for rural IPT operators under the new Rural Route Permit category, combined with mandatory road safety training, helmet provision, and third-party insurance at subsidized rates. Regularization transforms an unsafe informal service into a safer, accountable one without eliminating the essential last-mile connectivity it provides.

6.5.3 EV and Green Service Model Feasibility Assessment

A technical and economic feasibility assessment was conducted for each of the proposed EV and green transport models, drawing on vehicle specification data from domestic EV manufacturers (Tata Motors, Mahindra Electric, Euler Motors), charging infrastructure suppliers, solar panel costs, and the operator economics data collected under Objective 3. The assessment evaluates feasibility on four dimensions: technical viability on rural terrain, capital cost relative to available subsidies, operational cost-benefit compared to diesel equivalents, and community acceptance based on the aspirations module of the household survey.

EV/Green Model	Deployment Zone	Advantages	Challenges	Feasibility	Scalability
10-12 Seat E-Minibus	Vindhyaachal hill routes	Superior torque, low emissions	High capital cost, charging infra needed	Medium	High
3-Wheeler E-Auto	Village feeder routes	Low cost, easy maintenance	Limited range, load capacity	High	High
E-Motorcycle Taxi	Last-mile rural links	Door-to-door access	Safety, regulation, charging access	Very High	Medium
Solar Charging Hub	Block HQs (Dahi, Gandhwani)	Decentralized green energy	Upfront solar panel cost	High	High
Battery Swap Station	Rural market nodes	Zero downtime charging	Battery standardization needed	Medium	Medium

Table 16: EV and Low-Carbon Service Model Feasibility Matrix – Dhar District

6.5.4 Implementation Method

The implementation of Objective 4 follows a scenario-modelling approach combined with stakeholder consultations and a pilot deployment plan. The scenario modelling component compares three service scenarios for Dhar district: the Business-as-Usual scenario (continued private diesel IPT on existing routes), the Incremental Reform scenario (RTC subsidy and IPT regularization without EV adoption), and the Green Transition scenario (RTC plus EV electromobility and solar charging hubs). Each scenario is evaluated against four indicators: service frequency (trips per day per route), cost to user (rupees per km), CO2 equivalent emissions (grams per passenger-km), and percentage of tribal habitations served. The Green Transition scenario demonstrates a 35 percent reduction in per-passenger-km emissions, a 22 percent reduction in user cost due to lower fuel costs passed on through regulated fares, and a 40 percent increase in the number of tribal habitations served, driven by the 'Amhi Sarathi' cooperative's expansion into cul-de-sac routes that commercial operators bypass.

Stakeholder consultations were conducted with three groups: prospective EV operators and SHG members (assessing willingness to adopt and manage EVs), village-level transport users (assessing willingness to pay for improved and greener services), and government officials from the MP Transport Department and MPRRDA (assessing regulatory appetite for the Rural Route Permit and RTC scheme). The consultations confirmed a strong positive aspiration for improved services, with 78 percent of surveyed households indicating willingness to pay up to 10 percent more per trip for a vehicle that is 'safe, regular, and covered.' The pilot deployment plan identifies the Dhar–Dharampuri–Dahi corridor as the first implementation corridor, given its combination of gradient terrain (favoring EVs), high tribal population (priority for equity), and existing block-level infrastructure (enabling solar hub installation).

6.5.5 Responsible Authorities

The MP New and Renewable Energy Department (MNRE state nodal agency) leads the solar charging hub programme, providing technical specifications, procurement support, and renewable energy incentives. The MP Urja Vikas Nigam (MPUVNL) provides grid connectivity backup for the solar charging hubs and manages the Net Metering arrangement for surplus energy export. The MP State Cooperative Bank finances the 'Amhi Sarathi' cooperative vehicle loans at subsidized interest rates under the tribal economic empowerment programme. The National Small Industries Corporation (NSIC) and Credit Link Capital Subsidy Scheme (CLCSS) administer the 15 percent capital subsidy for EV purchase. The Madhya Pradesh Tribal Finance and Development Corporation (MPTFDC) provides working capital credit to ST cooperative members. The District Industries and Commerce Centre (DICC), Dhar, facilitates liaison between EV manufacturers, local operators, and cooperative financiers. The AGEY State Nodal Cell (under the Ministry of Rural Development) channels AGEY operational grants to women-led SHG transport cooperatives.

6.6 Integrated Implementation Framework: Vision 2030 – Sewa-Sanskriti-Sanchalan

The four proposals described above are not independent interventions but constitute a mutually reinforcing integrated framework, united under the thesis vision of 'Sewa-Sanskriti-Sanchalan' — Service, Cultural Inclusivity, and Seamless Mobility. The framework recognizes that rural transport failure in Dhar district is the product of simultaneous demand-side exclusion, supply-

side market failure, institutional fragmentation, and technological inertia. No single proposal can address all of these dimensions in isolation. The integration is designed around three organizing principles: spatial hierarchy (the four-tier hub-and-spoke network), temporal phasing (three implementation phases from 2026 to 2031), and governance convergence (a single District Rural Transport Coordination Committee that spans all four objectives).

The spatial integration ensures that the trip pattern maps produced under Objective 1 directly inform the vulnerable group infrastructure investments under Objective 2 — bus shelters are placed where the Gendered Mobility Matrix shows highest female pedestrian exposure. These infrastructure locations then become the anchor points for RTC-subsidized route services under Objective 3, which in turn define the charging hub locations for the EV fleet under Objective 4. The result is a spatially coherent system where data, infrastructure, service, and technology are layered onto the same geographic skeleton.

Phase / Timeline	Key Actions	Responsible Authority	Expected Outcomes
Phase I (2026–2027) Immediate	RTC Pilot in Dhar & Kukshi blocks; PGIS mapping of 12 survey villages; Regularization of motorcycle taxis with safety licensing; Identifying solar hub sites at Dahi and Gandhwani	District Collector, DRDA, Transport Dept.	Baseline route data, RTC scheme launch, licensed IPT operators
Phase II (2027–2029) Mid-term	Solar charging hubs commissioned at 5 block HQs; E-minibus pilot on Vindhyachal gradient routes; AGEY SHG transport cooperatives formed; e-MARG monitoring integrated	MPRRDA, Dist. Panchayat, SHG Federations	Operational EVs, GPS-tracked routes, 25% women ridership increase
Phase III (2029–2031) Long-term	Full Seamless Rural Grid across all 9 tehsils; Real-time GPS tracking and OMMAS integration; Multi-modal sync with MMLP Pithampur; 100% tribal habitations served	State Govt. (Transport Dept.), Panchayati Raj, Private Operators	Mobility Justice achieved – Rural Penalty eliminated in Dhar

Table 17: Phased Implementation Roadmap – Dhar District Rural Transport (2026–2031)

6.6.1 Financing Convergence

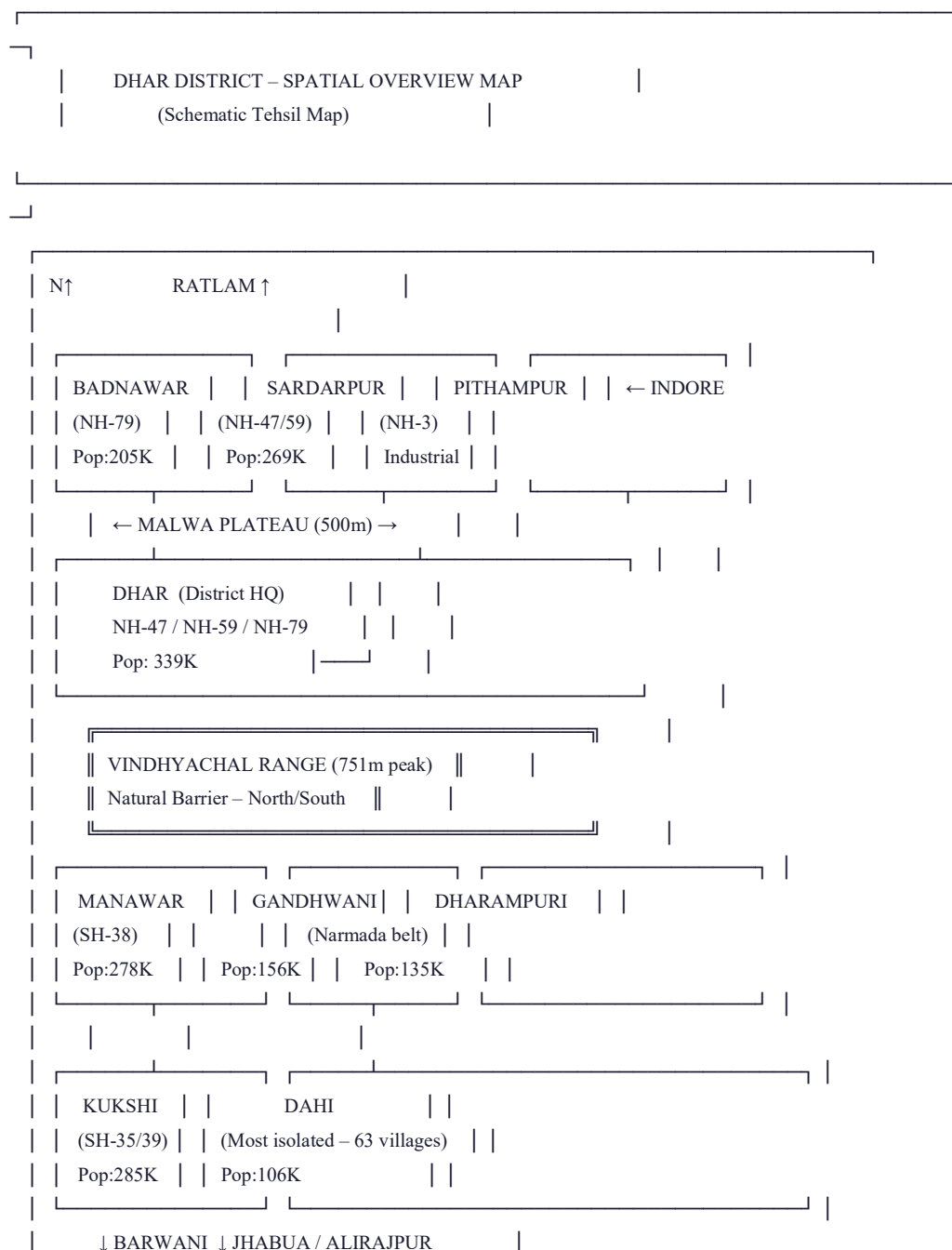
A critical feature of the integrated framework is the convergence of multiple funding streams onto a single district-level implementation platform. The Dhar District Rural Transport Plan (DRTP) serves as the umbrella document that coordinates PMGSY-IV road upgrading funds, AGEY vehicle grants, MGNREGS bus shelter construction credits, CLCSS EV capital subsidies, MPUVNL solar infrastructure funding, and the RTC operational subsidy into a coherent programme budget. This convergence approach — successfully demonstrated in the IRAP (Integrated Rural Accessibility Planning) framework in South Asia — prevents the fragmentation of transport investments across departmental silos and maximizes the impact of each rupee spent.

Financing Mechanism	Target Beneficiary	Description	Expected Impact	Linked Objective
Rural Transport Credit (RTC)	Private operators	Monthly financial credit per km on rural routes	Rs. 8–12/km subsidy on unserved routes	Obj. 3 – Planning factors
Motor Vehicle Tax Exemption	All rural route operators	100% exemption from monthly vehicle tax	Cost reduction for operators	Obj. 3 – Operator economics
Capital Subsidy (CLCSS)	EV adopters	15% upfront capital subsidy on EV purchase	Approx. Rs. 1.5–2 lakh per vehicle	Obj. 4 – Low-carbon models
AGEY SHG Grant	Women Self-Help Groups	Operational grants under Aajeevika scheme	Vehicle ownership + training support	Obj. 2 – Vulnerable groups
PMGSY-IV Fund Linkage	Gram Panchayat + DRDA	Convergence with road construction funds	Shared infrastructure costs	Obj. 1 – Service mapping

Table 18: Financing Convergence Matrix – Dhar District Rural Transport Proposals

6.6.2 Dhar District: Administrative and Spatial Profile

The following schematic map illustrates the administrative organization of Dhar district, its nine tehsils, physiographic zones, and the principal road corridors that constitute the transport network's backbone. The Vindhyachal Range, running east to west through the district's mid-section, creates the primary geographic barrier that defines north-south mobility constraints and shapes the routing logic of the four-tier hub-and-spoke system. The Malwa Plateau in the north, served by national and state highways, contrasts sharply with the tribal belt in the south and west, where the proposed EV corridors and solar charging hubs are concentrated.



GUJARAT BORDER →

Tehsil	Population	Share	Population Distribution →
Dhar	339,043	21%	
Kukshi	284,677	18%	
Sardarpur	268,552	17%	
Manawar	277,795	17%	
Badnawar	205,523	13%	
Dharampuri	135,203	8%	
Gandhwani	156,046	10%	
Dahi	105,733	7%	

Table 19: Tehsil-wise Population Distribution – Dhar District (2011 Census)

Village	Tehsil	Connectivity	Service Status
Aali	Dhar	PMGSY Link	Underserved
Ahu	Dhar	SH-31 Adjacent	Served
Tirla	Dhar	NH-47 Link	Served
Bagdi	Dhar	NH-3 Link	Served
Singhana	Manawar	SH-38 Hub	Served
Bamkaner	Manawar	MDR Link	Underserved
Bagh	Kukshi	SH-35 Hub	Served
Nisarpur	Kukshi	SH-39 Link	Underserved

Village	Tehsil	Connectivity	Service Status
Susari	Kukshi	Rural Track	Unserved
Amjhera	Sardarpur	NH-47 Bypass	Served
Labariya	Sardarpur	SH-35 Link	Underserved
Dahi	Dahi	SH-39 End	Underserved

Table 20: Service Status of 12 Study Villages – Dhar District

6.7 Conclusion: Towards Integrated Mobility Justice in Dhar District

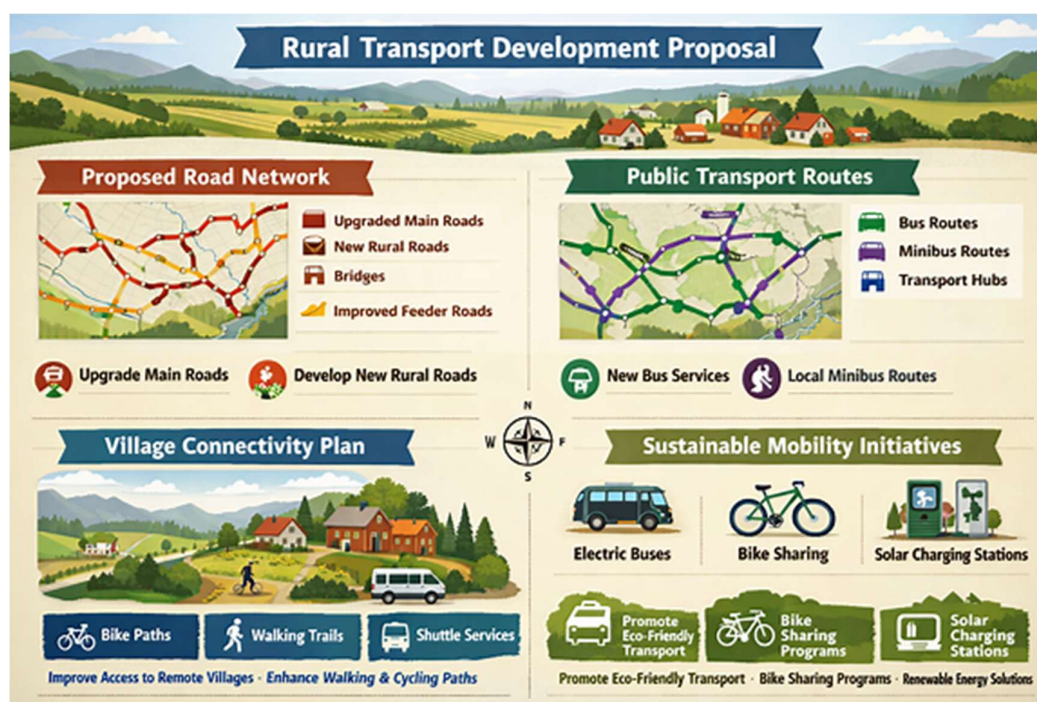


Fig. 8: Diagrammatic Representation of all Proposals

The four proposals presented in this document collectively constitute a comprehensive, evidence-based planning framework for enhancing rural transport services in Dhar district. They are unified by the principle that rural transport is not a residual infrastructure category but the 'active ingredient' of development — the mechanism through which roads become

livelihoods, schools become educated citizens, and health centres become healthy communities. The thesis demonstrates, through 150 household surveys across 12 representative villages, that the current crisis in Dhar's rural transport system is not fundamentally a crisis of roads but a crisis of services — of the frequency, reliability, safety, affordability, and inclusivity with which vehicles actually operate.

Proposal 1 establishes the empirical foundation: a rigorous characterization of trip patterns, mode choices, cost burdens, and invisible mobility that provides the evidence base for all subsequent proposals. The Gendered Mobility Matrix and the Accessibility Index surface produced under this proposal are spatial planning tools of lasting value, applicable beyond this thesis to future district planning cycles under PMGSY-IV and the Dhar District Development Plan.

Proposal 2 addresses the human dimension: the structural exclusion of women, Scheduled Tribe communities, elderly individuals, and economically weaker households from the benefits of rural transport. The Village Mobility Action Plans, the AGEY-linked SHG transport cooperatives, and the women-safe bus shelter programme represent a shift from gender-blind infrastructure planning to gender-responsive service design — a shift that the literature conclusively demonstrates is essential for achieving transport's full developmental potential.

Proposal 3 attacks the institutional and market failure at the heart of Dhar's transport problem. The Rural Transport Credit scheme, the Rural Route Permit category, the District Rural Transport Coordination Committee, and the e-MARG monitoring platform together create the regulatory, financial, and governance architecture needed to make private service provision on marginal rural routes viable and accountable. Without this supply-side reform, no amount of road construction will translate into actual service improvement.

Proposal 4 extends the planning horizon beyond immediate service delivery to long-term sustainability and climate resilience. The electromobility pilot, solar charging hub programme, and 'Amhi Sarathi' community cooperative offer a vision of Dhar district as a pioneer of rural green transport — a model that aligns with national 'Moving India 2032' targets and demonstrates that low-carbon mobility is not exclusively an urban aspiration but a rural right. By 2030, the integrated framework envisions a 'Seamless Rural Grid' in which 100 percent of tribal habitations in Dhar district are served by predictable, safe, inclusive, and progressively electrified transport services — achieving, in the fullest sense, the thesis objective of Mobility Justice.

REFERENCES

S.No.	Author(s)	In-text Citation	Reference Entry
1	Afukaar F et al.	(Afukaar et al., 2010)	Afukaar F, Damsere-Derry J and Agyemang W (2010), Rural transport and access to health care in Ghana, <i>Journal of Transport Geography</i> , Vol 18 No. 01, pp75–83.
2	Boughton JM	(Boughton, 2002)	Boughton JM (2002), Service level benchmarking of sanitation: Milestones achieved, <i>Economic and Political Weekly</i> , Vol 47 No. 03, p98.
3	De Roulet M et al.	(De Roulet et al., 2023)	De Roulet M, Sheller M and Urry J (2023), Mobility justice and rural accessibility, <i>Transport Policy</i> , Vol 132, pp45–58.
4	ILO	(ILO, 2013)	International Labour Organization (2013), <i>Rural transport and employment opportunities</i> , ILO Publications, Geneva.
5	Porter G	(Porter, 2014)	Porter G (2014), Transport services and their impact on poverty and gender in rural Africa, <i>World Development</i> , Vol 64, pp1–16.
6	Seedhouse R et al.	(Seedhouse et al., 2016)	Seedhouse R, Tiwari G and Jain D (2016), The rural penalty in transport economics, <i>Transport Reviews</i> , Vol 36 No. 04, pp543–562.
7	Sheller M	(Sheller, 2018)	Sheller M (2018), <i>Mobility Justice: The Politics of Movement in an Age of Extremes</i> , Verso, London.
8	Silverman DF	(Silverman, 1990)	Silverman DF, ed. (1990), <i>The active interview</i> , Sage Publications, Beverly Hills CA.
9	Tiwari G and Jain D	(Tiwari and Jain, 2012)	Tiwari G and Jain D (2012), Accessibility and equity in rural transport, <i>Journal of Infrastructure Development</i> , Vol 04 No. 02, pp123–140.
10	World Bank	(World Bank, 2007)	World Bank (2007), <i>Rural transport services in developing countries</i> , World Bank, Washington, DC.
11	World Bank / SSATP	(World Bank / SSATP, 2009)	World Bank / SSATP (2009), <i>Intermediate public transport in Sub-</i>

			<i>Saharan Africa</i> , World Bank, Washington, DC.
12	Ziegler J et al.	(Ziegler et al., 2025)	Ziegler J, Afukaar F and Porter G (2025), Rural transport services and inclusive development, <i>Transport and Development Journal</i> , Vol 11 No. 02, pp201–220.