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Development of a Rural Roads Planning and Prioritisation Model for the Punjab Province of Pakistan

Final Report

The Urban Unit

PAK2171A

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For further information, please contact: Mr Zuhair Aslam, zuhairmaslam@gmail.com

ReCAP Programme Management Unit
Cardno Emerging Market (UK) Ltd
Oxford House, Oxford Road
Thame OX9 2AH United Kingdom

Cover photo: Adeel, K.

Quality assurance and review table

Version	Author(s)	Reviewer(s)	Date
1.0	Dr Syed Murtaza Asghar Bukhari Muhammad Zuhair Aslam Dr Ghulam Moheyuddin	Maysam Abedin, ReCAP PMU Nkululeko Leta, ReCAP PMU	26.01.2020 31.01.2020
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Abstract

The Planning and Development Department, and other local government entities of the government of Punjab, encounter a daunting task of prioritisation of rural roads at the start of each financial year. This is because there does not exist a robust rural roads planning and prioritisation model which can address the problem of resource allocation on scientific and logical basis. The underlying study funded by UK aid from the UK Government via the UK Department for International Development under the Research for Community Access Partnership (ReCAP) programme aims to facilitate Planning and Prioritisation of rural roads in Punjab of Pakistan through adoption of a robust methodology encompassing various modes of analysis. Various methodologies, indicators and criteria used for the planning and prioritisation model globally and regionally were investigated to establish a baseline model. Focus group discussions and consultative meetings with the key stakeholders in planning of rural roads in Punjab also helped to gauge the significance of each criterion and develop a prioritisation model where rural roads can be tested with respect to its need, cost benefit analysis and potential socio-economic benefits. Two modules of the model are being proposed based on Multi-Criteria Analysis; one for the planning and prioritisation of new rural roads and second for rehabilitation/ improvement of existing rural roads. Indicators are recommended on the basis of global practices and stakeholder's feedback. An Analytical Hierarchy Process was employed to weigh the indicators, results of which indicated that Road Linkages/ Connectivity indicators had the highest assigned weight followed by socio-economic indicators affirming need of roads for socio-economic wellbeing of rural population. Furthermore, the prioritisation model will replace the prevailing informal ways of rural roads prioritisation in the province; thus, contributing towards sustainable socio-economic development of the rural areas making them engines of economic growth of the province.

Key words

Rural Road, Prioritisation, Multi Criteria Analysis, Cost Benefit Analysis, Pakistan, Punjab, Travel Time Savings, GIS Tools, Indicators

Acronyms, Units and Currencies

$	United States Dollar (US$ 1.00 ≈ 156 PKR)
ADB	Asian Development Bank
ADP	Annual Development Plan
AfCAP	Africa Community Access Partnership
AHP	Analytical Hierarchy Process
AsCAP	Asia Community Access Partnership
BCR	Benefit Cost Ratio
BHU	Basic Health Unit
BUET	Bangladesh University of Engineering and Technology
C&W	Communication and Works Department
CBA	Cost Benefit Analysis
CDWP	Central Development Working Party
DDC	District Development Committees
DDSC	Departmental Development Sub-committee
DDWP	Divisional Development Working Party
DHQ	District Head Quarter
ECNEC	Executive Committee of National Economic Council
ECSP	Engineering Consultancy Services Punjab
FAMPO	Fredericksburg Area Metropolitan Planning Organisation
GPS	Global positioning system
GT	Grand Trunk
IRI	International Roughness Index
KPRRP	Khadim-e-Punjab Rural Road Program
LGED	Local Government Engineering Department
MCA	Multi Criteria Analysis
NESPAK	National Engineering Services Pakistan
NEC	National Economic Council
NPV	Net Present Value
P&D	Planning and Development
PCI	Pavement Condition Index
PCU	Passenger Car Unit
PDWP	Provincial Development Working Party
PMU	Programme Management Unit
NRSP	National Rural Support Programme
RDPI	Rural Development Policy Institute
ReCAP	Research for Community Access Partnership
RHU	Regional Health Unit
SRIP	State Road Improvement Project
THQ	Tehsil Head Quarter

TxDOT	Texas Department of Transportation
UK	United Kingdom (of Great Britain and Northern Ireland)
DFID	United Kingdom Department for International Development
VFI	Village Facility Index

Executive summary

Roads are important to Pakistan and carry approximately 91% of passenger traffic and 96% of freight traffic. Correspondingly, Punjab, Pakistan has the largest share of road assets in the county and rural road connectivity is the key constituent of provincial development. Having more than 39,000 km of farm to market roads (51% of total roads), the rural roads in the Punjab are vital for the movement of people and goods. The rural roads connect agricultural production areas with industrial hubs and consumer and retail markets and play an important role in socio-economic growth and poverty reduction. Likewise, the Punjab is the most populated province of the country with a population of 110 million (Census 2017). The rural population in the Punjab forms a significant portion of the provincial demography, amounting to approximately 63% of the total population.

Punjab's rural road network growth and sustainability is hampered by the issues of Planning and Prioritisation and resource allocation. At the start of each financial year, the Planning and Development Department, and other local government entities in the Punjab, encounter a daunting task of prioritisation of rural roads. A lack of a robust rural roads Planning and Prioritisation model leads to ad-hoc planning and poor management of scarce financial resources.

Currently, the planning process for rural road development projects in Punjab start at district, and departmental level and depending upon the scope, scale of work, and financial budgeting, may involve Federal entities. Both 'top down' and 'bottom up' approaches are used to conceive and execute a project. In most cases, the bottom up approach is used wherein a project is conceived locally based on the demand of locals and/or district administration and put forward to the relevant provincial or federal department. The department assesses the need of the project based on the department's plan and vision. If approved, the project is put forward to the appropriate approval committee based on the scope and cost of work. Regarding the top down approach, the process is the reverse. Importantly, there is no concrete methodology, tool or model that can be implemented to prioritise road projects. Therefore, the study's objective is to develop a framework and suitable methodology that can be implemented to develop a Planning and Prioritisation model for rural roads in Punjab.

This research study funded by the Research for Community Access Partnership (ReCAP) programme aims to facilitate Planning and Prioritisation of rural roads in the Punjab through adoption of a robust methodology encompassing descriptive, quantitative and qualitative modes of analysis. The ReCAP programme is funded by UK aid by the UK Government via the UK Department for International Development (DFID) as assistance to developing countries for research, capacity building and knowledge dissemination. Previously, a scoping study was conducted in Pakistan where it was found that the current state of the rural road infrastructure is not satisfactory. Consequently, the underlying study has been initiated by ReCAP in partnership with the National Transport Research Centre (NTRC), Pakistan.

This report serves as the Final Report (of the first phase) of this research project and provides a brief overview of the road sector along with the constrains that have hindered the development of an efficient and sustainable road network in Punjab. It is followed by the review of both local and global practices adopted for the Planning and Prioritisation of rural roads. A brief history of previous initiatives to improve the rural road network is also given in this report followed by the project planning process currently practiced in the Punjab. This report also highlights the techniques that are used to collect the data and feedback from stakeholders. The two stakeholder consultations and a workshops that were held with participants identified during the inception stage are also described. Lastly, the report outlines the Planning and Prioritisation model proposed for the rural roads in the Punjab.

Two modules of the Planning and Prioritisation model are proposed both of which are based on Multi-Criteria Analysis (MCA); one for the planning and prioritisation of new rural roads and the second for rehabilitation/improvement of existing rural roads. Indicators recommended for both modules are based on global best practice and stakeholder feedback. An Analytical Hierarchy Process (AHP) was employed to weigh the indicators which indicated that the Road Linkages/Connectivity indicators have the highest weight followed by socio-economic indicators.

The planning and prioritisation model will be piloted in Phase 2 of the project. The report also provides the way forward with the work plan for implementing the proposed model and piloting in one of the districts of the province. Ultimately, the aim of development of the model is to replace the prevailing (informal) method of rural roads prioritisation in the province.

1 Background

Pakistan is one of the five countries which forms the selected community of the Asian Community Access Partnership (AsCAP). AsCAP is part of the Research for Community Access Partnership (ReCAP) programme funded by UK aid via the UK Department for International Development (DFID) for research, capacity building and knowledge dissemination. The other countries which form the community under AsCAP are Afghanistan, Bangladesh, Myanmar and Nepal.

The focus of the ReCAP programme is to promote safe and sustainable rural access in Sub-Saharan Africa and Asia through research and knowledge sharing between participating countries and the wider community. ReCAP commenced on the 1st August 2014 for a period of six years. The aim of the initiative is to build on the programme of high-quality research established under previous DFID programmes and take this forward to a sustainable future adopted in practice and for informed policy making in the future. The management of ReCAP is contracted by DFID to Cardno Emerging Markets (UK) Ltd through a Programme Management Unit (PMU) alongside the AsCAP and AfCAP Regional Steering Committees.

The overall targeted outcome from ReCAP is to contribute to more cost effective and reliable low volume rural road and transport services so as to make a vital contribution to sustainable socio-economic development. In order to fully achieve project outcomes, there is a focus in ReCAP on the uptake of research into practical usage and embedment of the results of research into norms and standards.

2 Research Objective

The aim of the project is to facilitate Planning and Prioritisation of rural roads in Pakistan through adoption of a robust methodology allowing subsequent development of planning and prioritisation model.

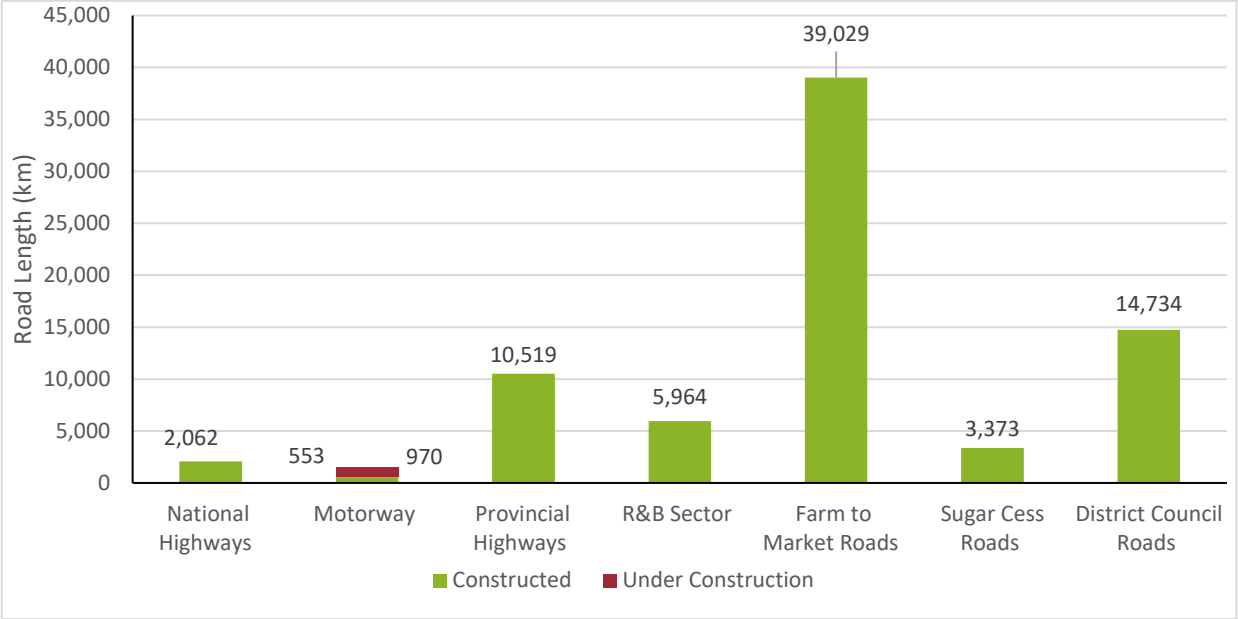
The overall objective of the project includes;

1. Investigating suitable approaches to the development of a Planning and Prioritisation Model for the Punjab Province of Pakistan.
2. Examining the viability of applying the Planning and Prioritisation model developed for LGED in Bangladesh, to be corroborated for Punjab, Pakistan.
3. Piloting the proposed methodology and developing a bespoke model within the Punjab Province.

3 Introduction to Punjab

Since Pakistan's creation in 1947, Punjab has undergone major transformations. Punjab, as the selected study area, is the most populous province of Pakistan, second largest by area, and as the largest contributor to the country's GDP. Owing to the inequitable distribution of funds, provincial development strategies have exacerbated inequalities within the province. Punjab, also has the longest road network in Pakistan, as shown in figure 3.5 (map of Punjab). The total length of the Punjab road network is around 76,200 km. Further, sub-classification of Punjab road network includes approximately 2,062 km of National Highways, 553 km of Motorways, 10,519 km of Provincial Highways and 39,029 km of Farm to Market roads and Sugar Cess roads. In addition, around 970 km of motorways are currently under construction in Punjab as shown in the Figure 3.1.

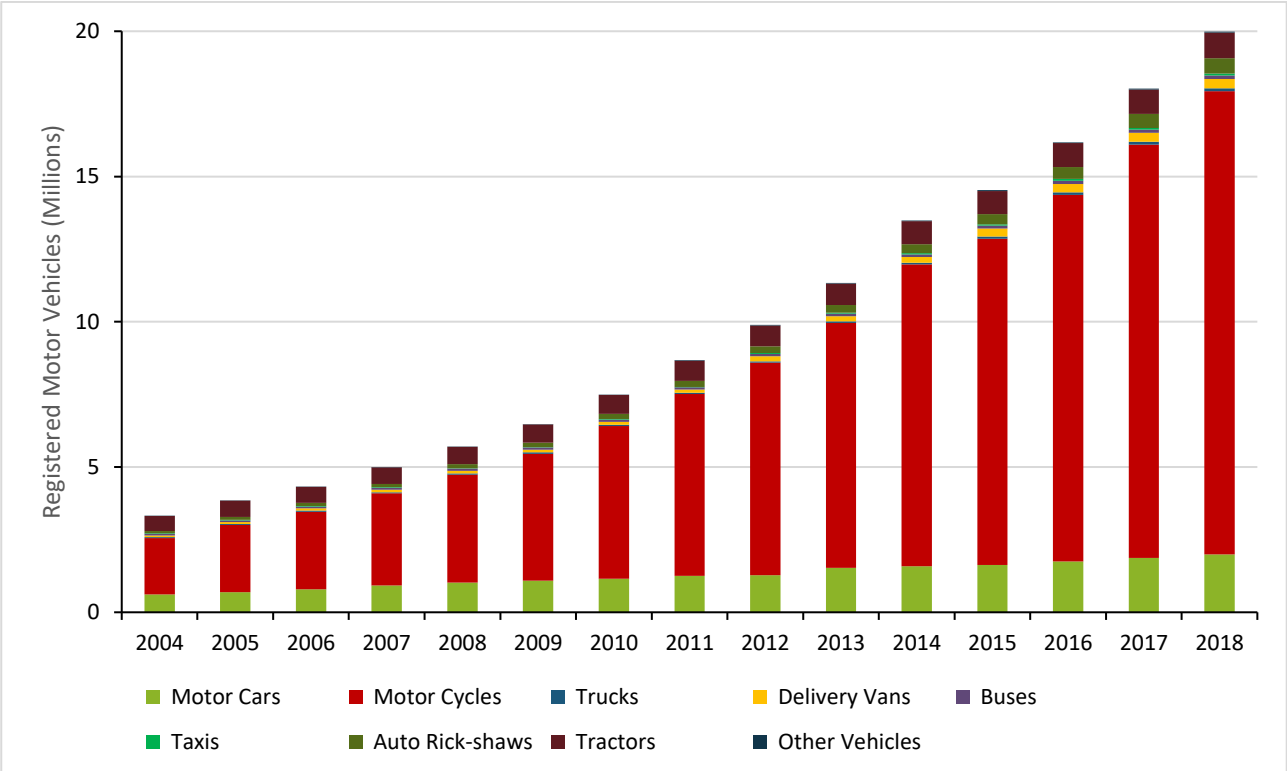
Figure 3.1 Road Network of Punjab



Source: PDS 2016

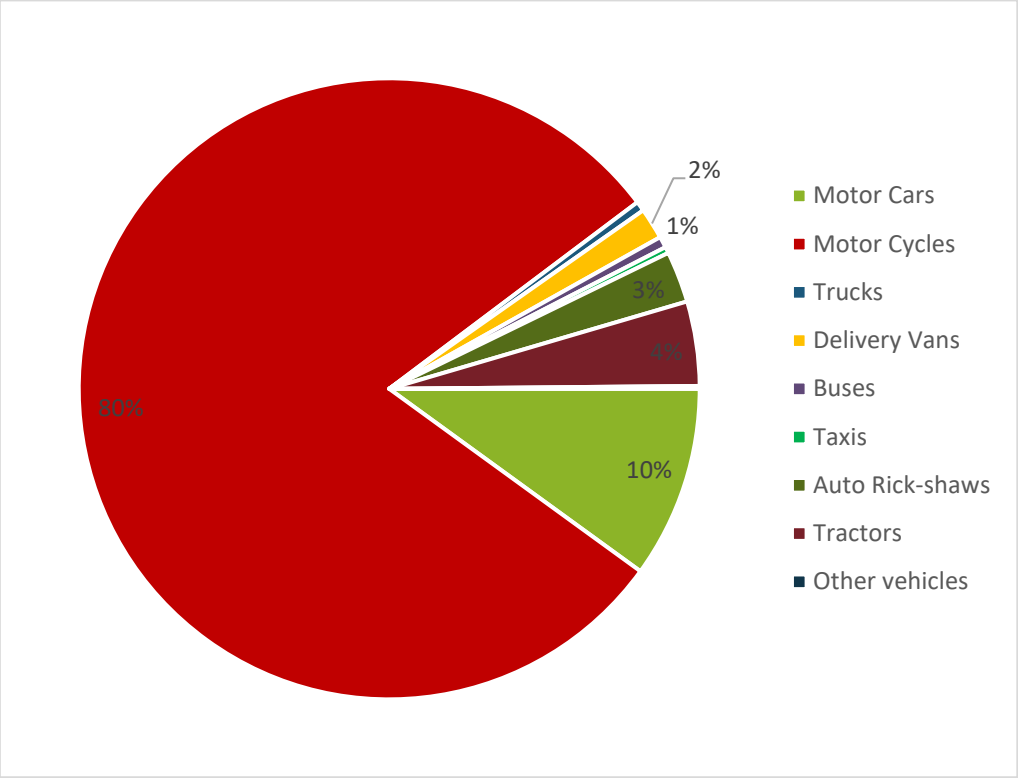
Consequent to rapid growth in population and urbanization, the number of motor vehicles registered in the province has also increased drastically over the years as shown in Figure 3.2 below. In 2015, Punjab had 14.5 million registered motor vehicles. Private vehicles, consisting mainly of motorcycles and cars, account for more than 85% of the motor vehicles in the province. Further analysis shown in Figure 3.3 reveals that motorcycles account for 80% of total vehicles, followed by motorcars which account for 10% of total vehicles. Differing to private mode, the share of public transport and commercial vehicles is less than 1% (0.7% and 0.4%, respectively).

Figure 3.2 Motorization in Punjab



Source: Excise, Taxation and Narcotics Control Department, 2018

Figure 3.3 Modal split of motor vehicles in Punjab



Source: Excise, Taxation and Narcotics Control Department, 2018

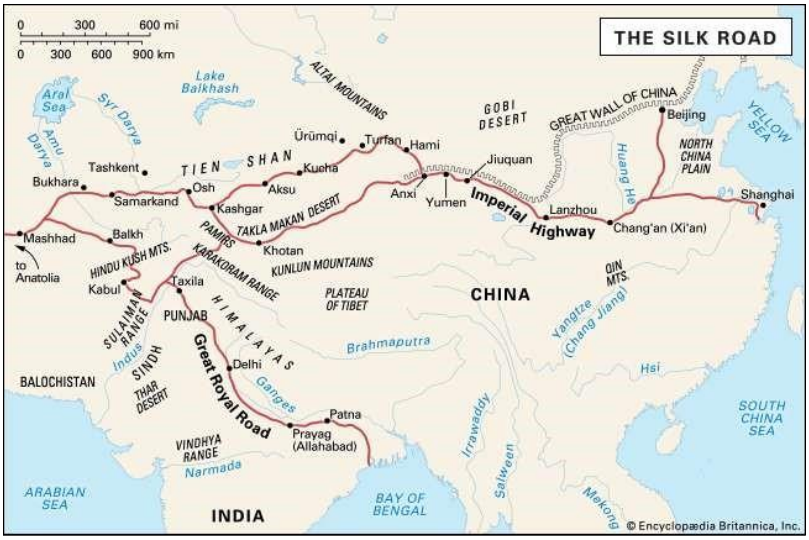
3.1 Spatial Distribution of the Road Network in Punjab

The development and spatial distribution of the Punjab Road network is influenced by two major factors. These are the (i) occurrence of natural water channels (e.g. rivers) and (ii) the geo-strategic location of Punjab within the South Asia region.

All the natural perennial rivers in the Punjab are located on the eastern side of the province and run from North to South. Historically, the invasion of armies and the trade caravans moved along the river. Consequently, identical to other human settlements / developments in the region and around the globe, all major cities of Punjab have developed primarily along the water channels. Figure 3.5 below, clearly affirms the afore-mentioned notion.

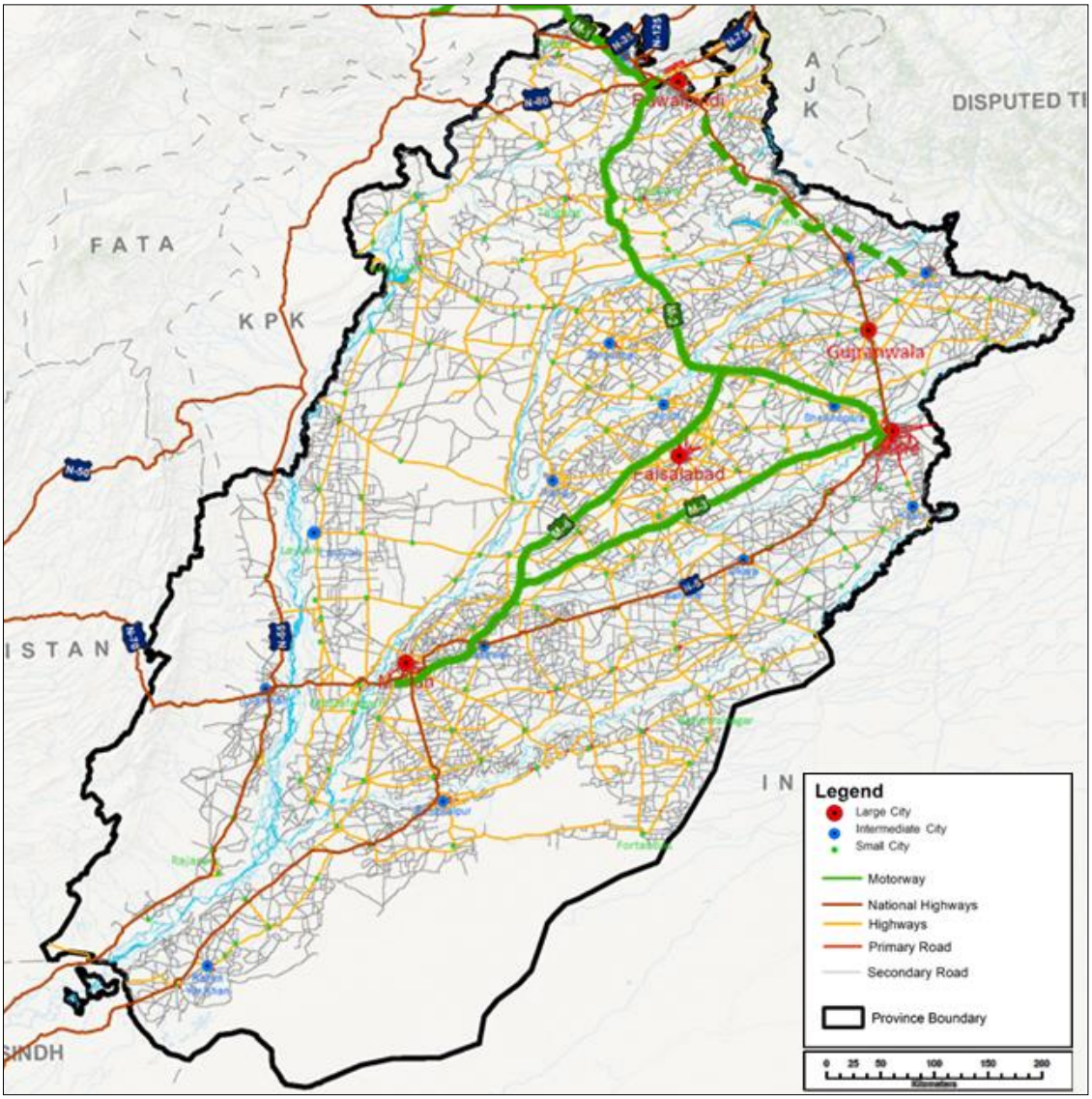
Likewise, the geo-strategic location of Punjab within Pakistan and in the South East Asia region makes it a vital connection for access to China, Iran, India and Central Asian States. The same is evident from the history, i.e., Punjab had served as both transit node and corridor within the traditional Silk Route. The Grand Trunk (GT) Road which connects Lahore with Peshawar, within Pakistan, finally terminates at Kabul, Afghanistan. The GT road is one of Asia's oldest and longest major roads used for trade purposes since ancient times. Notably, the GT road connected all then major cities and towns located along the river channels. Nonetheless, for more than two millennia, the GT Road has linked the Indian subcontinent with Central Asia through Punjab, facilitating trade along the Silk Route as shown below in Figure 3.4.

Figure 3.4 Historic silk route



Source: Encyclopaedia Britannica

Figure 3.5 Existing road network of Punjab



Source: The Urban Unit

Consistent to the development pattern of the cities, the road network over the years also followed the identical development pattern. Table 1 shows the growth of road network over time in Punjab.

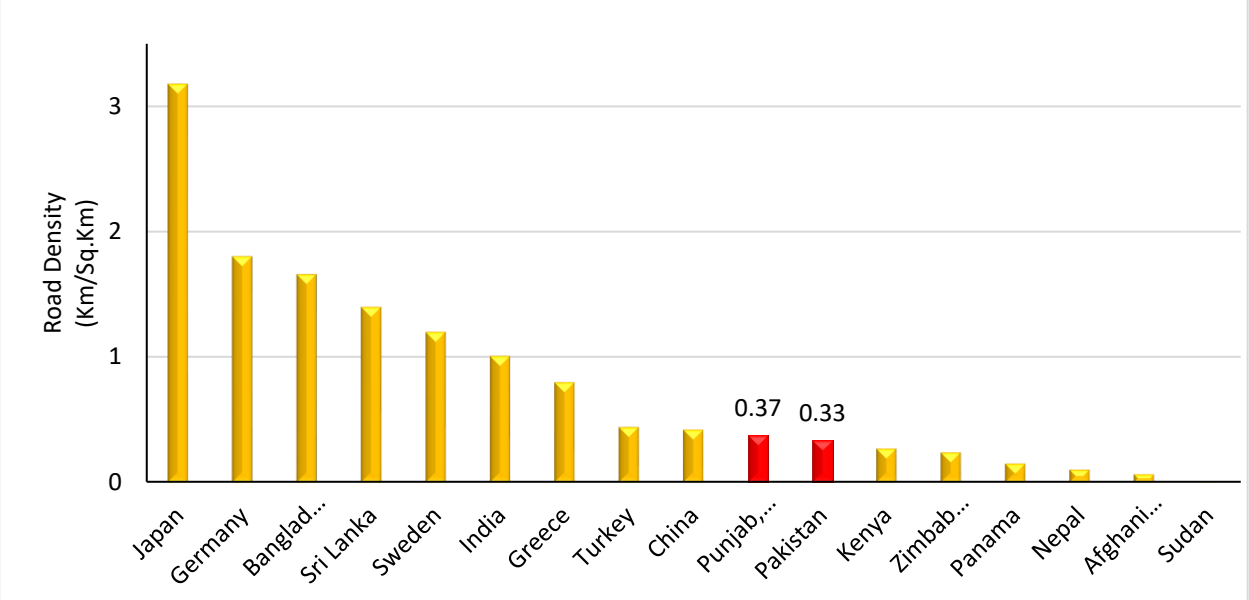
Table 1 Road length by type

Year	Total	National Highway	Motorway	Provincial Highway	R & B Sector	Farm to Market Roads	Sugar Cess Roads	District Council Roads
2008	71,916	1,610	387	8,956	5,570	37,625	3,319	14,448
2009	74,097	1,610	387	8,998	5,964	39,030	3,374	14,735
2010	74,097	1,610	387	8,998	5,964	39,030	3,374	14,735
2011	74,097	1,610	387	8,998	5,964	39,030	3,374	14,735
2012	75,526	1,610	387	10,426	5,964	39,030	3,374	14,735
2013	75,526	1,610	387	10,426	5,964	39,030	3,374	14,735
2014	75,920	1,610	387	10,821	5,964	39,030	3,374	14,735
2015	75,958	2,062	443	10,519	5,964	39,029	3,373	14,734

Source: PDS, 2016

The road density in Punjab is higher as compared to the overall road density of Pakistan and other provinces which indicates that the growth of roads in Punjab has been better as compared to other provinces (shown in Figure 3.6 below).

Figure 3.6 Road densities of countries around the world

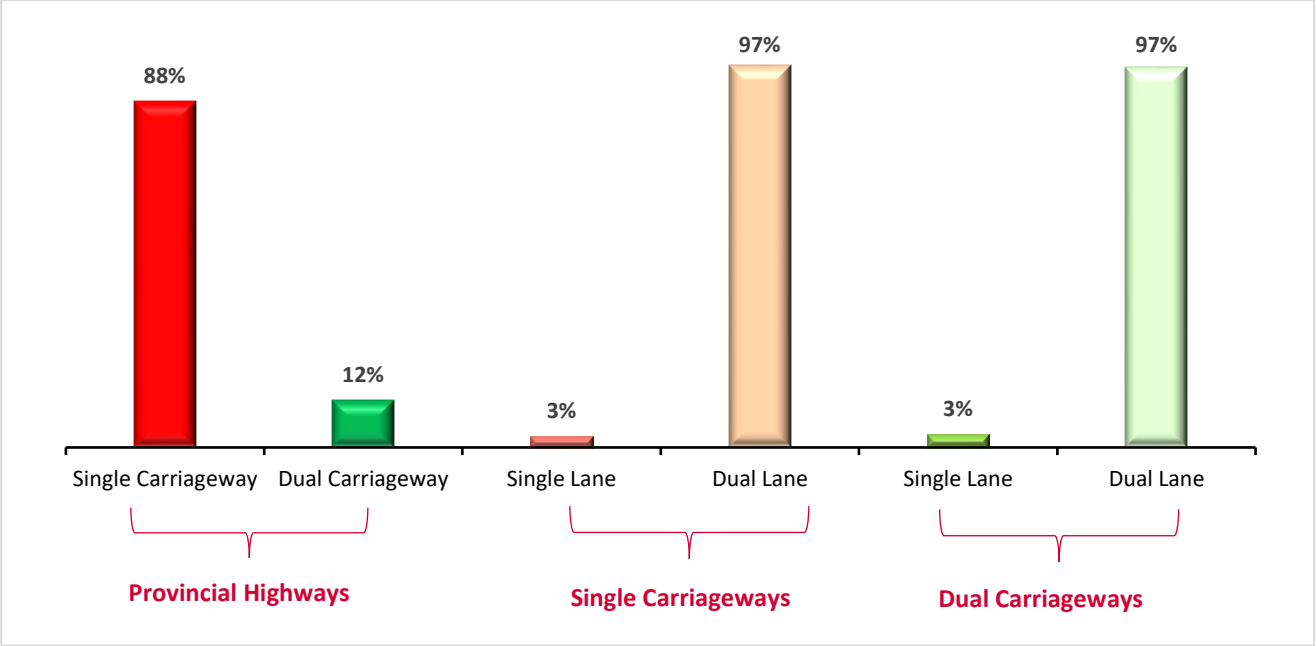


Source: worldstat.info

In addition, the major highways having multiple lanes, and dual carriageway are located on the eastern side of the province, whereas the western and central part of the province is connected through provincial

highways. These provincial highways are mostly single carriageway and single lane. The share of dual carriageways in the provincial road network is only 12 percent whereas single carriageways form 88% of the total provincial network. Remaining roads fall under Farm to Market roads, Bridges Roads, and Sugar Cess Roads, which are single lane roads and serve as secondary roads within the provincial road network. Figure 3.7 affirms the aforementioned distribution.

Figure 3.7 Lane and carriageway wise distribution of provincial highways



Source: The Urban Unit

3.2 Sector Constraints and Limitations

The size, population, geo-political significance, economic and social conditions of the Punjab call for better road connectivity for employment and industrial hubs to achieve desired economic and social goals. Gap analysis of regulatory and institutional regimes and the existing road network reveals the following.

3.2.1 Unilateral and Uneven Development

The road network of Punjab is disjointed and is unilaterally distributed across the province. The two major corridors, the National Highway Five (N5) and Motorway 2 (M2) which provides connectivity with rest of country primarily runs from North to South, traversing across the province. Importantly, N5 is located in the eastern side of the province and follows the alignment of the old GT Road thus providing connectivity and accessibility to major historic cities developed along water channels, such as, Multan, Sahiwal, Lahore, Gujranwala, Gujrat, Jhelum and Rawalpindi Likewise. M2 which is a part of greater Motorway network being constructed across Pakistan also lies in central regions of the province, and connecting Faizpur, Kot Abdul Malik, Kala Shah Kaku, Sheikhupura, Khanqah Dogran, Kot Sarwar, Pindi Bhattian, Salem, Lilla Town, Kot Momin, Kallar Kahar, Balksar, Nila Dulha, Chakri and Islamabad. There does not exist any major highway on the western side of the province. The reason attributes to the location of the river as major rivers in the past have instrumentally characterized the development of cities and town run on the eastern side of the province. The ensuing lack of major highways on the western side of Punjab has resulted in slow development of the western Punjab province.

Contrary to national roadways, the provincial road network does not provide direct connections. It is because the provincial network also follows the national grid i.e., runs from North to South direction and does not provide East to West fast connectivity.

Consequently, the existing industrial estates are not well-connected to the rest of the country. Thus, instead of supporting and facilitating growth, the existing road network creates hindrances for the efficient mobility and has a significant impact on time and cost of transportation across Punjab.

3.2.2 Implementation of Policies

A provincial road sector policy, as a core component of provincial road infrastructure development, is absent within the institutional framework. Road development strategies are developed on ad-hoc basis primarily under political motivation or in case of emergencies like floods and earthquakes. There is no robust, up to date Punjab Road Master Plan incorporating the changing socio-economic and regional interventions of the Province. The lack of Road Sector Policy in conjunction with Transport Policy has resulted in regional disparities due to the integration of employment and industrial hubs with settlements.

3.2.3 Underdeveloped Sector

The C&W Department, established to develop road infrastructure in the province, lacks adequate expertise and resources to meet growing connectivity demand. Budget gaps exist at the end of each financial year due to inadequate tendering/procurement procedures and archaic building/construction codes.

3.2.4 Lack of Professionals and Experts

Establishing efficient and functional road systems requires a strong team of experts and professionals to develop sustainable road policies and codes of practice. Outdated buildings and road research laboratories are deficient in terms of new interventions and technologies adopted globally. Poorly equipped mechanized workshops along with insufficient asset management, and obsolete monitoring/regulatory regimes result in financial throw over and further resulting in poor construction standards.

3.2.5 Lack of Updated Design Manuals and Standards, and Data Availability

There is no standard geometric design or code of practice like AASHTO for the Punjab province. Various studies conducted by C&W Department and universities have been put on the shelf. Outcomes or recommendations made in these studies were never implemented. Thus, these studies are not utilized for the purpose of upgrading old policies or standards. Standards for road designs have changed with introduction of new safety measures. However, many existing roads are not in compliance with safety standards thus leading to frequent accidents.

3.2.6 Lack of Public Participation

Road networks are the physical manifestation of social networks. Roads are always based on the type of traffic and land use and are developed with respect to connectivity, mobility and accessibility needs. Thus, it is of the utmost importance that the public must participate in road infrastructure development related decisions. However, this practice is not yet widely adopted in the Punjab.

Evidently, there is a clear policy dilemma, lack of technical expertise in the planning sector, and lack of resource mobilization resulting in losses and lost opportunities. It is important that the underlying strategy addresses the current and future needs of the province to ensure that the road network serves as a catalyst and provides an enabling environment for the socio-economic growth for all.

4 Literature Review

The literature review focuses on the review of the various prioritisation models of rural roads. It is categorised in two broad categories: i) Regional Models, which include models developed in the developing countries similar to Pakistan, and ii) Global Models, which include road prioritisation models used in the developed countries. It is followed by a summary of comparison of indicators used by the aforementioned models. The literature review also gives an overview of the road project appraisal process in Punjab and initiatives on the rural roads taken by the Punjab Government in the past. Lastly, a brief introduction is

made to the technique used for decision support system, mainly, Multi Criteria Analysis, Analytical Hierarchy Process (AHP) and the weighing criteria for the various indicators used in MCA.

4.1 Road Prioritisation Models – Regional

Countries such as Nepal, Bangladesh, India, where the rural road prioritisation has already been studied and modelled, are used as a reference. The methodology they adopted, has been briefly discussed below.

4.1.1 Nepal

A multi-criteria evaluation model was used in Nepal for ranking its rural road projects. Two stages were conducted for the development of the model. In the first stage, a set of criteria was formulated and questionnaires were developed which were later used to interview experts. In the second stage, an online interview was conducted to obtain expert opinion from different geographical locations. The results of the first stage were compared with the second stage to get an overall idea about the weightings for variables. Afterwards, three main aspects (social, economic and environmental) were taken into consideration. These three aspects were divided into sub criteria and weighted using Analytical Hierarchy Process (AHP). Economic costs were subdivided into two components i.e. financial and social. Financial costs involved construction and maintenance cost of the project and vehicle operating cost, while the social costs involved travel time cost, accident cost and pollution cost.

Similarly, social aspects were subdivided into population served per km, access to educational services and access to other services such as health, administrative services and markets; and environmental aspects were subdivided into encroachment to historical/cultural areas and previous ecology, possibility of land sliding or flooding, impacts on natural system (Bhandari, et al., 2014)

A matrix was developed to indicate certain weightings to each of the sub divided criteria's as shown in Table 2.

Table 2 Indicators and Weighting of Criteria proposed by Nepal

Criteria	Sub Criteria	Weighting (AHP) %
Economic	Construction cost	6.70
	Maintenance cost	9.41
	Vehicle operating cost	5.04
	Travel time cost	4.79
	Accident cost	8.29
	Pollution cost	3.96
Social Aspects	Population served	10.96
	Access to educational services	6.53
	Access to other services	8.87
	Road as a community priority	7.69
Environmental Aspects	Impacts on natural system	8.46
	Encroachments on historical and cultural areas	7.79
	Possibility of landslide/erosion	11.54

Source: IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) volume 11 page 53-65

4.1.2 Bangladesh

The urban and regional planning department of Bangladesh University of Engineering and Technology (BUET) conducted a research study on "Planning and Prioritisation of rural roads in Bangladesh". The goal of the project was to develop a methodology and computer software/tool for rural roads such as (Upazila, Union and village roads) managed by the Local Government Engineering Department of Bangladesh (LGED). Two prioritisation models were developed; one for the Upazila and Union roads, and second for the Village roads. The reason being the different traffic characteristics of the roads.

For the first model, a basic road network was developed consisting of all the designated Upazila and Union roads. Secondly, due to the unavailability of traffic data of the roads, a regression model was developed on which the expansion factor method was applied to forecast the traffic volume. Finally, MCA scoring and weighing framework was proposed to combine the results of CBA and social, environmental aspects. The priority of rural roads can then be decided on the basis of overall combined scores.

For the second model, a list of potential criteria for MCA including social, economic and environmental factors were identified; considering current practice techniques, expert views and literature research of LGED Bangladesh. Finally, MCA and the relative weights were determined using the Analytical Hierarchy Process (AHP) technique based on the results of opinion-based survey among policy makers, stakeholders, people residing in rural areas and experts.

Different criteria were selected for three different purposes (prioritisation of improvement of unpaved rural road as shown in Table 3, prioritisation of further improvement of roads as shown in Table 4, Prioritisation of periodic maintenance of roads as shown in Table 5.

Table 3 Prioritisation of improvement of unpaved rural road

Sr no	Criteria	Description	Weighting
1	Traffic volume	Average Annual Daily Traffic	7.95
2	Facilities served	Educational facilities, Health facilities, industries, other public centres etc.	18.65
3	Growth centres/ Rural centres served	Hats and Bazaars served by the road	29.2
4	Connectivity to higher roads and other centres	Upazila level connectivity	35.8
5	Local priority	Priority given by local representatives	8.4

Source: ReCAP Planning and prioritisation of rural roads in Bangladesh

Table 4 Prioritisation of further improvement/up gradation of roads

Sr no	Criteria	Description	Weighting
1	Traffic volume	Average Annual Daily Traffic	21.84
2	Facilities served	Educational facilities, Health facilities, industries, other public centres etc.	9.54
3	Growth centres/Rural centres served	Hats and Bazaars served by the road	17.91
4	Connectivity to higher roads and other centres	Upazila level connectivity	20.01
5	Local priority	Priority given by local representatives	14.93
6	Road type	UZR>UNR>VR	7.86
7	Road safety	If road safety is an issue	7.84

Source: ReCAP Planning and prioritisation of rural roads in Bangladesh

Table 5 Prioritisation of periodic maintenance of roads

Sr no	Criteria	Description	Weighting
1	Traffic volume	Average Annual Daily Traffic	15.05
2	Facilities served	Educational facilities, Health facilities, industries, other public centres etc.	14.85
3	Growth centres/Rural centres served	Hats and Bazaars served by the road	12.7
4	Connectivity to higher roads and other centres	Upazila level connectivity	19.65
5	Last maintenance year	Roads with long gaps of maintenance are prioritised	4.3
6	Road type	UZR>UNR>VR	14.15
7	Surface type	If road safety is an issue	7.8
8	Bus route	Presence of bus route along the route	11.5

Source: ReCAP Planning and prioritisation of rural roads in Bangladesh

4.1.3 India

More than 85% of the road network in India consists of rural roads. Therefore, to keep the road network in serviceable condition and to provide people access to public facilities, different methodologies were developed for planning the rural road network. However, the proposed methodology consisted of two phases, the first phase consisted of identification of roads for upgrade and maintenance based on the Pavement Condition Index (PCI) and identification of village facility locations using GPS.

For the identification of roads, field surveys were carried out in a vehicle travelled along the study area. The normal driving speeds were observed on the road, and based on these speed values, PCI values were assigned. For the village facility index (VFI), the facilities that were considered for analysis are shown in Table 6.

In the second stage, a facility-based model was developed for the upgrading of the existing rural road network, it involved estimating facility-based index values from the facility availability and distance from the facilities to habitation in the study area using spatial analysis tool (ArcGIS). A formula was used which involved calculating the weights of each link using:

- The population benefited by the link
- Facility index for the villages
- Pavement Condition Index (PCI) of the road

The values obtained from this formula finally gave the priority order of the village roads for upgrading. Furthermore, it was concluded that this model could also be used for planning and development of any rural road in any developing country. (Modinpuroju, Prasad and Chandra 2016)

Table 6 Parameters for estimating Village Facility Index for village roads in India

Factors	Sub factors
Education facilities	Primary
	Middle
	High school
	Intermediate college
	Degree college
Medical facilities	Sub-centres
	Maternity
	Child welfare centres
	Primary health centres
	Hospitals
Economic activity centre	Markets
	Petrol bunks
	Retail shops
	Cold storages
Transport and communication facilities	Bus stands
	Railway stands
	Post offices
	Banks
	Electrical substations

Source: Innovative Infrastructure solution 2016

4.2 Road Prioritisation Models – Global

4.2.1 Texas, USA

A large number of Texas Department of Transportation (TxDOT) districts expressed concerns over the lack of funding and personnel resources to maintain the existing rural infrastructure network under their jurisdiction, however, researchers finally proposed a criteria and parameters that could be considered in the prioritisation of rural infrastructure needs (Prozzi and Harrison 2004)

The researchers interviewed a total of 7 district members of TxDOT out of 25 districts and concluded the parameters, shown in Table 7, in setting out priority for maintenance and rehabilitation and the personnel responsible.

Table 7 Responsibility and Factors Considered in Setting Maintenance and Rehabilitation Priorities by TxDOT

District	Maintenance priorities factors	Rehabilitation priorities factors
Bryan	• Maintenance supervisor knowledge of road conditions • Public complaints • Pavement condition	• District evaluation • Cost • Average daily traffic • Political concerns
Laredo	• Pavement condition	• Cost-effectiveness • Safety • Project economic benefits • Ranking of area engineer
Lubbock	• Maintenance supervisor's knowledge of road conditions	• District funds all first priorities, then second priorities and so on until budget is exhausted.
Odessa	• Maintenance supervisor's knowledge of road conditions • Pavement condition (rutting, cracking, fatigue) • Facility type (volume, speed)	• Pavement condition (rutting, cracking, failures, etc.) • Average daily traffic • Average daily truck traffic • Past maintenance expenditures
Pharr	• Pavement condition (rutting, cracking, fatigue) • Facility type (volume, speed)	• Average daily traffic • Safety index
Tyler	• Pavement condition • Expenditures incurred	• District evaluation • Cost • Traffic volumes • Past expenditures • Visual inspection data from area engineers
Yoakum	• Lane-miles • Cost of materials • Pavement condition	• PMIS scores • Traffic volumes

Source: Prozzi and Harrison, 2004

Given the fact that the available funding currently does not cover all the identified district needs, as discussed before, each district had its own prioritisation procedure that varied from less formal assessments to some form of ranking considering different criteria.

Therefore, the researchers proposed a number of additional parameters and criteria in a "multi-attribute criteria methodology" framework that was considered by TxDOT to prioritise significant maintenance and rehabilitation projects. The proposed additional parameters are shown in Table 8 below.

Table 8 Multi-Attribute Criteria (Proposed)

Parameter/criteria	Sub criteria	Weighting
Project Cost	$	15
	$/vehicle	
	mile $/mile	
Pavement Condition	PMIS scores (distress, ride score, overall condition)	15
Demand	Average daily traffic	15
	Vehicle-miles travelled	
	Average daily truck traffic	
	Truck-miles travelled	
Past Agency Maintenance Expenses	$	5
	$/vehicle mile	
	$/mile	
Connectivity	Access to rural farms and industry	15
	Links between towns and cities	
	Link for travel across the state	
	Access to parks, wildlife and recreational opportunities	
	Alternative roads available	
Safety	Number of incidents	15
	Number of injuries	
	Number of fatalities	
Economic Benefits	Number of farms or rural shippers served	10
	Potential to attract new business and jobs	
Social Benefits	Serving poor or minority community	10
	Number of schools	
	Number of clinics	
	Number of religious centres	

Source: Centre for Transport Research University of Texas at Austin

4.2.2 Virginia, USA

For the effective planning and priority setting of the projects of the regional long-range transportation plan, the Fredericksburg Area Metropolitan Planning Organisation (FAMPO) developed a highway project prioritisation methodology. The following factors were considered by FAMPO given in Table 9.

Table 9 Factors and their respective weightings for highway project prioritisation in Virginia

Sr no	Factors	Weighting (Points)
1	Congestion relief	30
2	Safety and security	30
3	Environmental impacts	16
4	Public and community support	8
5	Funding and implementation considerations	8
6	Smart mobility	8

Source: Kimley-Horn and Associates Inc

These factors were then subdivided into sub-parameters, with each sub-parameter having their individual scores as shown in Table 10

Table 10 Sub-Parameters along with their individual weightings for highway project prioritisation in Virginia

Parameter	Sub Parameter	Weighting
Congestion Relief	Level of current and future congestion	14
	Continuity and connectivity	7
	Major users	4
	Freight use	5
Safety and security	Geometric impact on existing roadways	18
	Vehicle crash reduction	6
	Bike/Pedestrian safety	4
	Homeland security	2
Environmental Impacts	Impact on natural environment	8
	Impact on neighbourhood	8
Public and community support	Adherence to existing street and highway	4
	Community support	4
Funding and implementation considerations	Feasibility	3
	Project ready	4
	Interagency cooperation	1
Smart mobility	Growth areas	4
	Intermodal	4

Source: Kimley-Horn and Associates Inc

Using these major factors, a point system is established and certain projects are ranked. The project with the highest ranking is given the first priority.

4.3 Prioritisation Models in Punjab

4.3.1 Scorecard by PERI

Punjab Economic Research Institute (PERI) developed a score card to rank road projects, this model mainly focused on new construction projects as it assumed that road maintenance projects were given high priority.

The proposed road scorecard for Pakistan contained the following indices:

- Economic Index (EI)
- Road Condition Index (RCI)
- Road Utilization Index (RUI)
- Road Safety Index (RSI)
- Political, Social and Environmental Index (PSEI)
- Development Index (DI)

The weighting of each variable was decided by expert opinion. Each variable was further subdivided into sub-criteria's which are given in Table 11:

Table 11 Parameters and sub-criterions by PERI

Parameters	Economic	Road condition	Road utilization	Road safety	Political, Social, Environmental	Development
	Density	Resurfacing date	Traffic Count	Number of fatal accidents	Environmental impact	Road to population
	Growth Centres	Drainage condition	Level of service	Number of non-fatal accidents	Air quality	Road to area
	Economic Zone	Pavement Condition		Geometric deficiencies	Land acquisition cost	Road to motor vehicle
	B/C Ratio			Safety measures	Link to social infrastructure	Road to accident
					Strategic importance	

Source: Punjab Economic Research Institute

4.3.2 Scorecard by Urban Unit

The different cities of Punjab need a vast network of connectivity to boost its economic growth. The east and west routes have been given less attention making them vulnerable. Therefore, to boost the economy and the development of the transportation infrastructure, it is vital to connect the north and south major roads with the east and west routes. The scorecard was developed to indicate certain factors which are important for the economy and wellbeing of a country.

Zafar et al., (2009) conducted a study on 10 indicators which were given importance by the International best practices, Punjab Growth Strategy (2018) and Punjab Spatial Strategy (2047). The indicators were given ranking on a scale of 1-10 and weights were assigned to them. The indicators are shown in Table 12.

Table 12 Indicators and their weights by Urban Unit

Factor/Indicator	Rank	Weight	Weights in Real Terms
Connectivity with Major Roads	1	0.19	19
Settlements/No. of Built up area	2	0.17	17
BHUs/Hospital	3	0.15	15
Schools	4	0.13	13
Town/Market	5	0.11	11
Industry	6	0.09	9
Arable Land	7	0.07	7
POI – Any Developmental Project	8	0.05	5
Drinking Water	9	0.03	3
Railway Station	10	0.01	1
Total	-	1	100

Source: The Urban Unit

The proposed methodology consists of following steps. Impact area is selected having a buffer of 1 km from either side of proposed road. Afterwards, the score for each indicator is calculated and the summation of each indicator and weightings is carried out to get a final score. Each score is then normalized. The total score is then divided by the total length of the road to get score/km. Finally, the score is normalized to get an impact factor.

4.4 Comparison of Models

Review of the models adopted worldwide reveal that most of the models utilised Multi Criteria Analysis for ranking and prioritizing road development and maintenance projects. However, each model was developed using a unique set of variables that were deemed relevant in local context. A comparison of variables is show in Table 13 which enlists variables used in each model. In most of the cases, cost of the project and parameters of socio-economic returns of the project have been made part of the model however, weightings differ in all cases since they are subjective and based on expert opinion.

Enlisted variables provide a basis for selecting the type of indicators that can be used in the prioritisation model of road projects in general and rural roads in particular. Majorly, indicators related to socio economic development, connectivity of the region, condition of the road and utilisation of the road are important for the prioritisation model. In addition, environmental factors and political factors also need to be studied, since certain models also made this part of the model. A final list, however can only be selected after due diligence from the stakeholders.

Table 13 Comparison of parameters used in different countries for road prioritisation

Nepal	Bangladesh	India	Texas	Virginia
Construction cost	Traffic volume	Last maintenance year	Project Cost	Congestion relief
Maintenance cost	Facilities served	Bus route	Pavement Condition	Safety and security
Vehicle operating cost	Growth centres/Rural centres served	Education facilities	Demand	Environmental impacts
Travel time cost	Connectivity to higher roads and other centres	Medical facilities	Past Agency Maintenance Expenses	Public and community support
Accident cost	Local priority	Economic activity centre	Connectivity	Funding and implementation considerations
Pollution cost	Road type	Transport and communication facilities	Safety	Smart mobility
Population served	Road safety		Economic benefits	
Access to educational services	Last maintenance year		Social benefits	
Access to other services	Bus route			
Road as a community priority				
Impacts on natural system				
Encroachments on historical and cultural areas				
Possibility of landslide/erosion				

4.5 Rural Road Initiatives in Punjab

4.5.1 Khaadim e Punjab Rural Road Program

Keeping in view the vast business opportunities, and the economic return of investment, the government of Punjab launched a multi-phase and multi-year program for the rehabilitation and construction of the rural roads of the region named as Khaadim e Punjab Rural Road Program (KPRRP) with a duration of 3 years from 2015 to 2018.

The main objective of this program was to improve the connectivity of rural roads with provincial and national highways and contained the following salient features:

- Approximately 15,000 km rehabilitation and 5000 km new road construction.
- Paved roads including 0.6 m shoulders.
- Widening of 3.0 m roads to 3.6 m road.

This program was completed in 4 phases; Phase 1 was worth USD150 million, Phase 2 was worth USD 500 million, Phase 3 and 4 were USD 1,000 million.

4.5.2 Rural Accessibility Program

Keeping in view the deteriorating conditions of the rural roads of Pakistan, resulting in poor farm to market access, the government of Punjab inaugurated a programme known as Rural Accessibility Program (RAP), the objective of which was to increase the connectivity of rural areas with urban areas, for the effective transportation of agriculture/industrial products to the local market.

Punjab Highway Department was responsible for the projects under the RAP with a budget of Rs 15.38 Billion during financial year 2018-19 and 2019-20. The scope of the work included:

- Widening & strengthening of 3.0 m wide existing roads to 3.6 m wide roads including structure.
- Construction of 3.6 m wide new roads with asphaltic wearing surface.

4.5.3 Farm to Market

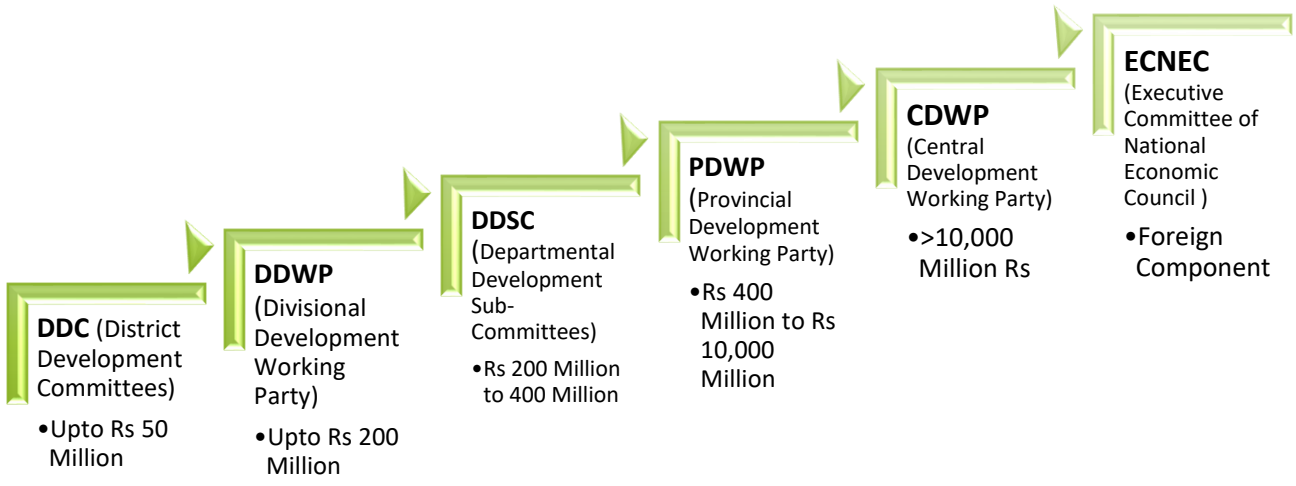
Farm to market (FMR) road project was initiated by Asian Development Bank in 1986 and was completed in 1994, It was estimated at a budget of USD 54 million, it was the first ever road project by the bank in Pakistan which was entirely dedicated to the rural roads, with the ultimate objective to improve the mobility, accessibility, support of agricultural and rural development. The project consisted of construction and maintenance of 800km rural roads of 11 districts.

Outcomes of the project significantly contributed in capacity building of the public and private sectors involved in construction of rural roads. Also, it brought various benefits to the community such as new employment and business opportunities from cottage industries, local stalls and shops. The project provided a source of income to households, improving the quality of life of rural citizens. These aspects concluded the project as successful.

4.6 Project Appraisal Process

The planning process of development projects in Punjab start at district and departmental level and depending upon the scope and scale of work, may contemplate Federal entities. Both “Top Down” and “Bottom Up” approaches are used in Punjab to conceive projects. In most cases bottom up approach is used wherein a project is conceived locally based on the demand of the locals, district administration or political representation and put forward to the relevant department. The department assesses the need of the project based on department’s plan and vision. If approved, the project is put forward to appropriate approval committee based on the scope and cost of work (Manual for Development Projects (2017). Figure 4.1 gives the overview of the planning and approval committees working at different levels in Punjab Pakistan.

Figure 4.1 Planning and approval process of development project in Punjab, Pakistan



A brief introduction each approval forum is given below.

4.6.1 Executive Committee of National Economic Council

Under the constitution of Pakistan, National Economic Council (NEC) is the supreme body that is tasked with assessing the overall economic condition of the country. It has the mandate to plan and approve projects to ensure balanced development and regional equity across the country. NEC has delegated its power to an Executive Committee of National Economic Council (ECNEC) to ensure smooth functioning of the government. One of the main tasks assigned to this committee is to approve any project that exceeds the financial limits of Central Development Working Party. In addition, any project involving foreign funding component is also approved by this department.

4.6.2 Central Development Working Party (CDWP)

Central Development Working Party (CDWP) is housed at Planning and Development Division in the federal capital Islamabad. It is tasked with clearing any provincial project whose cost exceeds Rs 10,000 Million. These projects are forwarded by Provincial Development Working Party of the respective province. The technical, financial and economic analyses of various projects are also carried out by the technical teams.

4.6.3 Provincial Development Working Party

Provincial Development Working Party (PDWP) is the highest approval forum available at provincial level. PDWP is housed at the Planning and Development department Punjab, and is chaired by the Chairman Planning and Development board. PDWP is a clearing house of development projects proposed and sponsored by various line departments of the Government of Punjab. The PDWP can sanction projects

ranging from Rs. 200 million to Rs. 10,000 million. Any project exceeding the upper limit is referred to CDWP for approval purpose.

4.6.4 Departmental Development Sub-Committees

Under the Punjab Delegation of Financial Powers Rules, 2016, any project that costs from Rs. 200 million up to Rs. 400 million are within the approving competency of Departmental Development Sub-committee (DDSC). The DDSC is chaired by the Secretary of Administrative department and representatives of Finance, Planning and Development department are included in the committee formation.

4.6.5 Divisional Development Working Party

Projects costing up to Rs. 200 million are approved by the Divisional Development Working Party (DDWP) housed at the respective division. The DDWP is chaired by the respective divisional Commissioner and includes representation of all the districts of the division in addition to divisional heads of the sponsoring department, finance department, communication and works department and Irrigation department.

4.6.6 District Development Committees

Projects costing up to Rs. 50 million are approved by the District Development Committees (DDC) housed at the respective district. The DDC is chaired by the respective District Commissioner and includes representation of all the tehsils of the district in addition to heads of the sponsoring department at district level.

4.7 Decision Support Techniques

4.7.1 Multi-Criteria Analysis

Multi-criteria analysis (MCA) can be defined as a decision-making instrument to evaluate different set of alternatives that need to be prioritised or ranked by the decision maker for setting criteria for rural and urban road assessment. It can be further divided into two steps: 1) determination of a set of criteria; and 2) a set of performance measures (indicators) for each solution, evaluated against the criteria as determined earlier (Bhandari et al., 2016). MCA comes with the option to set criteria with qualitative features, units of measurements and relative weight scales. The method accommodates the possibility that a part of criteria can be subjective, in addition to numerically measurable attributes (Bhandari et al., 2016). Moreover, the MCA tool can be useful for active stakeholder management; subject to scenarios where the strategic options are to be assessed, or a project can be implemented through different ways with implications for multiple other stakeholders at the same time (Brucker et al., 2011). The merit of the method demands that it takes into account all such considerations.

The application of the MCA method on rural road infrastructural development projects reflect that the measures used, reflect upon the likely impact of roads on socio-economic activity, agricultural productivity and environmental aspects. There are many instances where MCA technique has been used for e.g. for Rural Road development program in Nepal (2016) where weights for criteria were determined from a direct evaluation of criteria and stakeholder engagement of Nepali and foreign experts separately and together. Similarly, the same approach was adopted for the Philippine Rural Development Project (2015). It is eminent that presently, the rural assessment criteria set by MCA method is based on multiple indicators including, population served, Agricultural Productivity, classification of roads, access to health and education centres, access to markets, traffic count, poor (excluded households), access to main highways, safety compliance; where the weights are assigned to prioritise the rural roads.

On several occasions, the literature offers cases where Multi-Criteria Analysis and Cost benefit Analysis (CBA) have been simultaneously used (Gühnemann et al., 2012). On the other hand, Tsamboulas and Mikroudis (2000) used MCA and CBA together, with weights for MCA assigned by pairwise comparisons as those of the AHP and the approach was applied in Greece, in the road scheme assessment.

4.7.2 Analytical Hierarchy Process

Dalal et al. (2010) refers to the application of Analytical Hierarchy Process (AHP) in India which has been used to prioritise rural roads for the upgrading of all-weather roads. The application of the technique is in two stages i) defining the area to be served by the upgraded roads and ii) relative ranking of the road projects. Piantanakulchai and Saengkhao (2003) assigned weights to the selection of highway alignment/s in Thailand. Similarly, to choose alternative transport options for the transport system in Delhi, Yedla and Shrestha (2003) used AHP as an instrument. Bhandari et al., (2014) stressed upon the use assigning of weights through the AHP method, specifically designed for pairwise comparisons. They further stressed that AHP is a decision-making tool used to organize various criteria into a relative hierarchy, allowing for comparisons among these criteria according to the set objective of the study. A case study of Nepal (2014) reveals that the objective of the study was to evaluate the rural road projects based on different criteria of sustainability, deemed in terms of 1) Economic Criteria 2) Social Aspects 3) Environmental Aspects. Within this 'general sustainability criteria', sub-criteria or a set of indicators is determined following the determination of the relative importance and assigning weights to the general sustainability criteria. Following these two steps, with the help of local system provider a pairwise comparison was conducted to indicate the relative importance of individual projects with respect to the sub-criteria (Bhandari et al., 2014). In addition, the questionnaire for stakeholder engagement was designed in the study, to assign weights according to Analytical Hierarchy Process (AHP). It is established by these case studies that AHP, as a methodological technique can be applied for assessment of rural road infrastructure.

4.8 Selected Mean and Modes of Analysis

Review of various methodological approaches revealed that the selected methods and modes of analysis are the most appropriate for measuring disparities in terms of planning and prioritisation of the rural roads in Punjab. In addition, these methods serve as the right modes of analysis for the underlying project because socio-spatial and economic variables can produce varying results if the spatial and temporal dimensions of rural infrastructure is not considered at the time of provision; thus, requiring triangulation for verification of results derived from one method by other.

The project aims to study and propose a methodology for the planning and prioritisation of the rural roads in Punjab which can be done effectively by utilising these methods.

4.8.1 Data Collection Procedure

A significant aspect in the collection of the data is the quality of the data, i.e., reliable data from a consistent source. Therefore, it is utmost necessary to define the type and sources from where the data will be collected and methods to be used for the collection of information.

Two main approaches will be employed to collect data. The first approach is termed as primary data collection. It will aid in collecting first-hand data using qualitative techniques from potential respondents. The second approach referred as secondary data collection will be adopted to gather information from secondary sources. The data obtained from secondary sources will be re-analysed to extract information relevant to the study. Books, archives, journals, reports, government and private organisations publications, policy documents, transport strategies and plans, travel data and census data will serve as the key sources of information for the secondary data.

4.8.2 Focus Group Discussions

The proposed means and modes of analysis adopted for development of required methodology and model in the said project includes focus group discussion. Interaction among focus groups participants during the discussion provides insight knowledge of the question in consideration. Each group typically consist of 6 to 10 members. An assumption is made for each group discussion that the selected members possess those characteristics, which relates them directly or indirectly to the study topic. Each focus group is unique from other because of its purpose, number of respondents in the discussion, their composition, and procedures followed during the discussion. The researcher gathers information through perceptions of the participants

in an accommodating, non-frightening environment. Thus, it is especially vital that the groups should be interactive as their strength lives in interaction (Krueger, 1994; Patton, 2002; Litosseliti, 2003).

Furthermore, it is vital that the groups' members should take part collectively in the discussion on the concerned issues. Interaction refers to the debate among the group, which is required to keep the group dynamics alive as participants express their own views and supplement each other's response without being influenced by other members of the group. It is not necessary that the participants agree upon a single point as group discussion relates to their own personal experience and perception of the issue in question to others experience and perceptions. Focus group differs from in-depth interviews as in the interview interaction is just between respondent and interviewer, whereas, in a focus group, interaction is not only between respondents and interviewer but also among the respondents (Krueger, 1994; Patton, 2002; Litosseliti, 2003).

Notably, focus group discussions were selected as part of the methodology because in comparison to other qualitative research methods such as interviews, participants, observation, it is more advantageous and provides multiple views and different perspectives in a short time; thus, a large amount of diverse data can be collected in a small period. It offers a more natural environment than interviews where the opinion of the participant can be influenced by the interviewer. The interaction among the participants enhances the quality of data producing check and balances which the participants apply upon each other; consequently, eliminating abstract views. Focus groups provide more specific, meaningful, vigorous feedback than one that can be obtained from individually asked questions because they act as a part of the needs-assessment process of the potential respondents. This makes focus group discussion more prominent than other qualitative tools. Focus group discussion are often employed for exploring new information regarding needs, views, beliefs, attitudes of the people. Moreover, focus groups serve an examination tool for understanding participants perceptive of everyday life. Thus, focus group works more effectively as it not only considers the human tendencies, attitudes and perceptions relating to concepts, products, services, but also the programs which are developed in part by interaction with other people (Krugger and Casey, 2000; Patton, 2002; Litosseliti, 2003).

4.8.2.1 Conducting Focus Group Discussions

A comprehensive plan is drafted for conducting focus groups. The key stakeholders of focus group to be conducted are given in Table 14. Multiple group sessions are planned so that diverse views of relevant key stakeholders can be obtained.

High numbers of focus groups are selected because of varying role of the relevant stakeholders. Conducting an individual session for every group discussion will help in obtaining necessary information without the influence of other groups; thus, each session will highlight their true concerns, views, and perceptions pertaining to variables to be used and model to be developed for planning and prioritisation of rural roads.

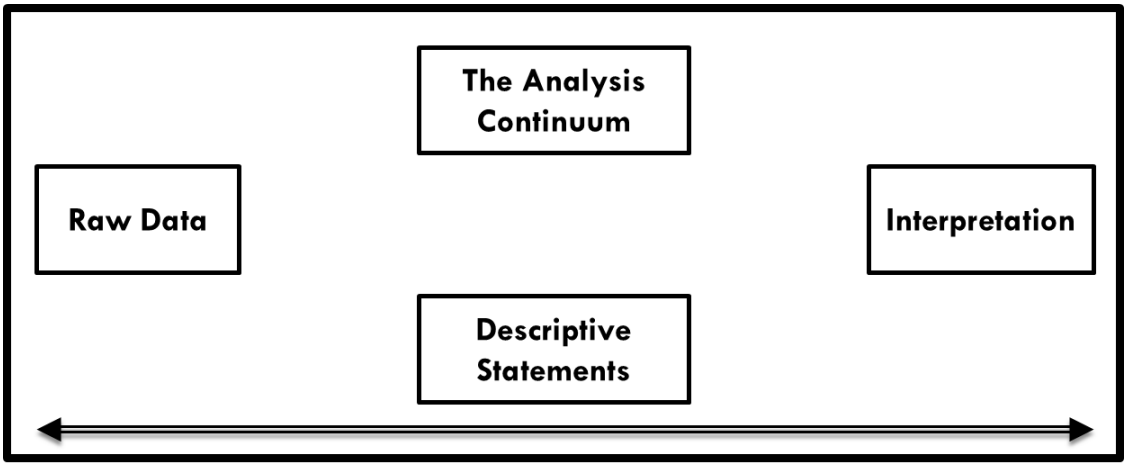
The subject information sheet and the topic guide containing questions and possible probes will be developed and passed to all participants before the start of each session. Posters in the national language stating all questions and possible probes will be drafted too and will be pasted on the walls of the session venue. Topic guides and posters will help in keeping the focus group participants focused on the research questions during the session. In addition, the subject information sheet will help to brief the participants about the aim of the study, nature of focus group, and requirements from them in the session.

4.8.3 Data Analysis and Result Interpretation

Focus group discussion produces a large amount of data, which needs to be divided and categorised into essential information needed for analysis and into comments that are less significant. Although all questions deserve the same level of analysis, but there are certain questions, which form the core of study analysis. Therefore, it is crucial to analyse the data keeping the aim of the study in focus and presenting the results in a systematic order. This could only be achieved when; the analysis being done is verifiable, focused, and practical and has the appropriate level of interpretation as stated in the analysis continuum shown in the Figure 4.2 (Krueger, 1994).

The analysis continuum comprises raw data, descriptive statements, and the interpretation whichever the analyst prefers to use. Raw data consist of exact statements made by the focus group participants that are lengthy. The descriptive analysis represents the summary of all statements made as raw data, which are analysed by the analyst. Interpretation of the data provides a clear understanding of the issue and takes into account evidence from both the field data and the research background. The interpretative side of the continuum is based upon the descriptive process as it presents the meaning of information contrary to its summary. It is vital that focus group analysis must seek to increase the level of understanding and should entertain the alternative explanations (Krueger, 1994).

Figure 4.2 The analysis continuum (Krueger, 1994)



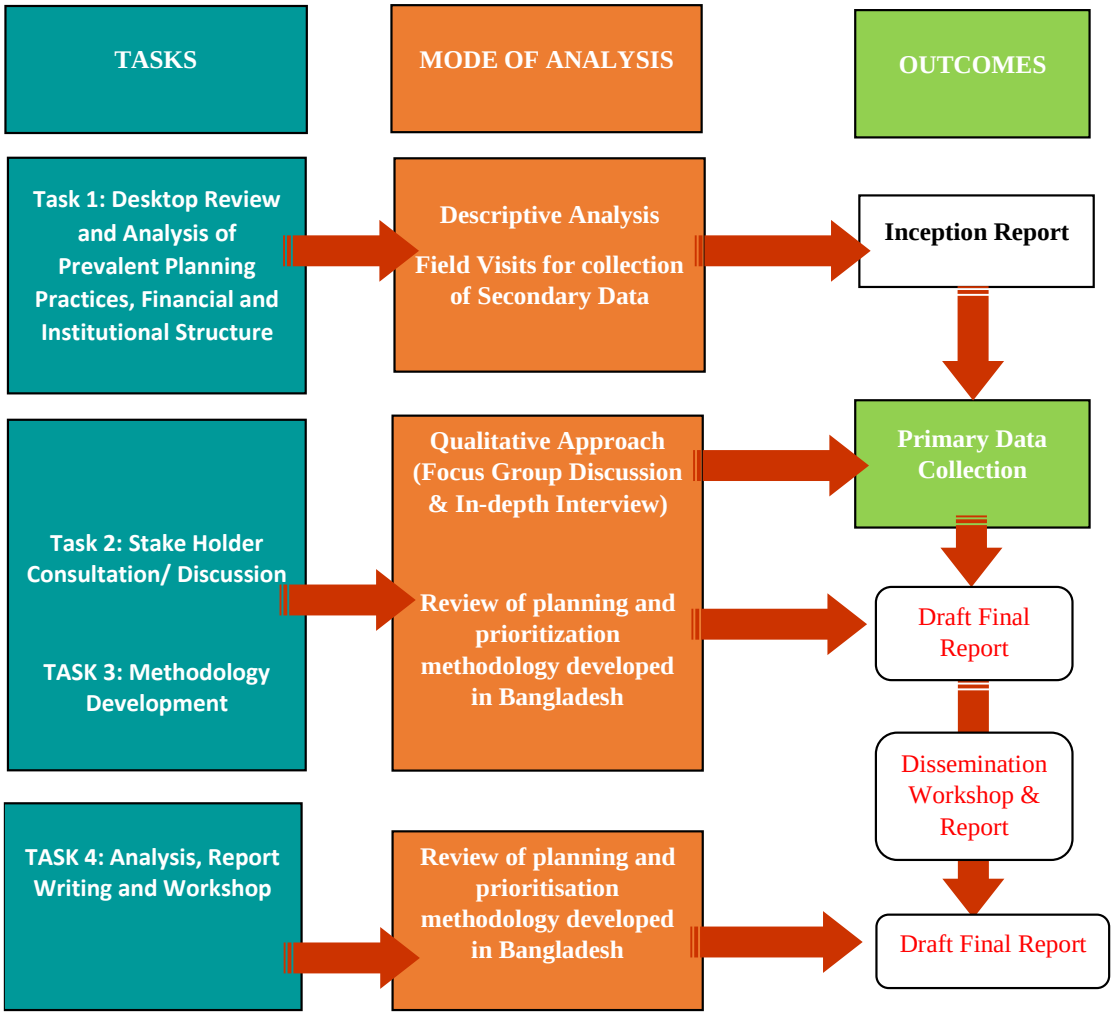
The data obtained from the focus group discussion will be analysed to transcribe the views of the participants. Both complete views and abridged transcripts will be interpreted. This will provide the necessary record of discussion, indispensable for understanding the respondent's perceptions (Litosseliti, 2003; Stewart and Shamsdasani, 2007). The descriptive analyses of the data will help in identifying opportunities, constraints and limitations of the existing planning and prioritisation system adopted for the rural roads in Punjab.

5 Methodology

The methodology adopted for this project involves composite approach encompassing descriptive, qualitative and quantitative mode of analysis. The combination of both subjective and objective techniques helped to examine the prevailing norms and procedures adopted for the planning and prioritisation of the rural roads in Punjab. Furthermore, the adopted methodology also helped to identify vital variables through triangulation achieved by use of descriptive, qualitative and quantitative modes of analysis.

The overall framework adopted for this project is shown in Figure 5.1 below. Mainly, the project is divided into four major tasks; first task is the review of literature. It included the descriptive analysis of the road sector in the Punjab province, the review of the prevailing planning paradigm responsible for development of rural roads and the review of planning and prioritisation models adopted around the world both globally and locally. For this purpose, secondary data was used which was collected through relevant departments, and published reports available on the internet. This stage concluded in formulation of Inception Report.

Figure 5.1 Overall Framework of the Study



Second and third task include stakeholder consultation and development of a methodology for a planning and prioritisation model of rural roads. Consultations were done through focus group discussions with all the relevant stakeholders identified later in the report. Opinion of experts were taken on the proposed methodology of the prioritisation model that helped to mould the model in local context. This also helped in creating sense of ownership so that the model can be made part of the planning process. Once the draft prioritisation model was prepared, a stakeholder workshop was conducted to present the prioritisation model to stakeholders and finalise the methodology of the rural road planning and prioritisation model of the Punjab.

5.1 Literature Review

A Literature Review was carried out by examining both local and global practices adopted for planning and prioritisation of rural roads.

5.1.1 Local practices

The planning approach adopted by relevant departments including Communication and Works Department (C&W), Local Government Department (Metropolitan Corporations, Municipal Corporations and Municipal Committees), Development Authorities, Planning and Development (P&D) Department for planning and prioritisation of rural roads in each year's Annual Development Plan (ADP) of Punjab was reviewed.

Notably, under the prevailing practices, the Planning and Development (P&D) Board carry out an extensive exercise of ADP Formulation and Finalization subsequent to finalization of road schemes by relevant department. Consequently, critical review of the ADP formulation and finalization process is carried out by P&D Board. Likewise, various projects of planning and prioritisation of rural roads initiated / completed under local or donor agencies funding including RAP were studied.

5.1.2 Global practices

Practices adopted globally for planning and prioritisation of roads were also studied in depth. Particularly, the methodology developed for planning and prioritisation of rural roads in Bangladesh were reviewed and its applicability in Punjab were also analysed. In addition, other regional road prioritisation models were also reviewed including model developed in Nepal by assistance from Asian Development Bank (ADB) and in India under State Road Improvement Project (SRIP)

5.2 Stakeholder Consultations

Stakeholder consultation is one of the key components that helped in finalisation of the various components of the model to be developed. It did not just provide expert opinion but it also gave the sense of ownership to the departments that are involved in the project planning and appraisal process. In this regard, identification of the relevant decision-makers and key stakeholders involved in the rural road's development, operation and maintenance was done.

5.2.1 Identification of Stakeholders

All relevant entities / organisations involved in planning and prioritisation of rural road schemes were considered as potential stakeholders. These include stakeholders from the government administration, academia, political representative and technical entities. Each category is involved at some stage in the planning and development process of rural road and are therefore important actors in the planning process. The government administration works on three levels, at the federal, provincial and local government level. However, planning and development of rural roads in Punjab is mostly up taken at local and provincial government level. The list of identified stakeholders is given in Table 14 below.

The identified stakeholders were consulted to record their perceptions, views and needs on the existing and proposed planning paradigm for rural roads in Punjab. This also essentially provided review of existing institutional structure and its implications regarding the planning and prioritisation for both development and maintenance of rural roads in Punjab including complexities, advantages and weaknesses.

Table 14 List of stakeholders involved in planning and development of rural roads in Punjab

Sr	Category	Stakeholder
1	Administrative (Federal)	National Transport Research Centre (NTRC)
2		National Highways Authority (NHA)
3	Administrative (Provincial)	Planning and Development Department
4		Community and Works Department
5		Local Government and Community Development Department
6		Transport Department
7	Administrative (Local)	Development Authorities
8		Municipal Committee/ Corporation
9		District Administration/ Union Council
10	Technical	National Engineering Services, Pakistan (NESPAK)
11		Engineering Consultancy Services Punjab (ECSP)
12	Academia	University of Engineering and Technology, Lahore
13		National University of Science and Technology, Islamabad
14	Political	Elected Representative
15		Civil Group
16	NGO	Rural Development Policy Institute (RDPI)
17		National Rural Support Programme (NRSP)

5.3 Methodology for Planning and Prioritisation Model

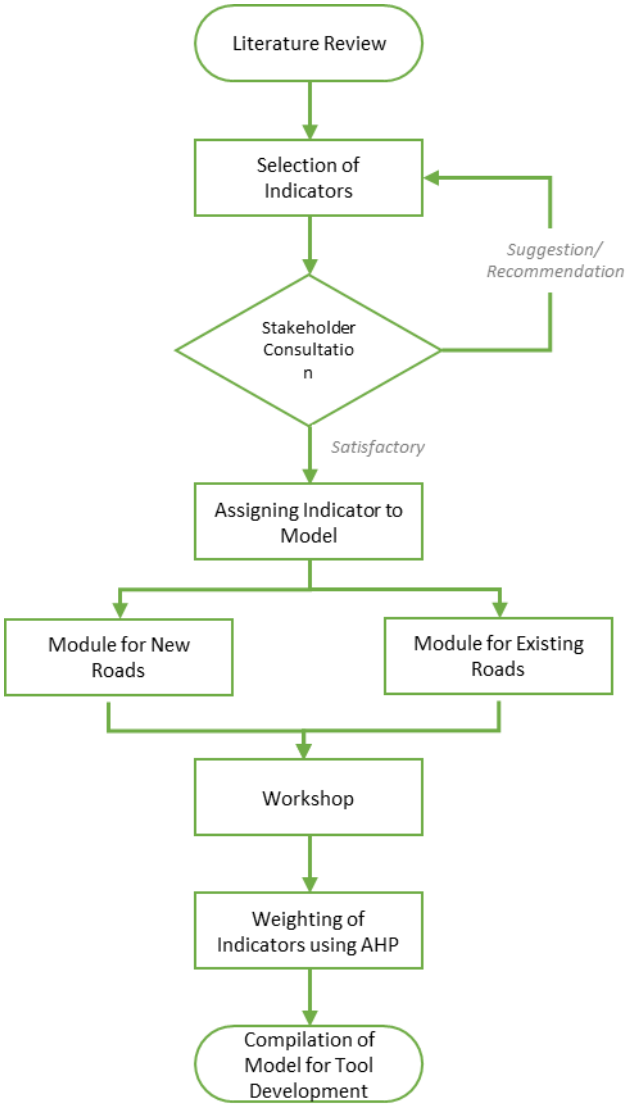
Keeping in view previous efforts of prioritisation made at the provincial level and the techniques implemented around the globe and in the developing countries, Multi-criteria analysis was key to develop the prioritisation model. This technique enables the beneficiary to customize the model by selecting the indicators and their importance based on the needs, laws, customs and procedures of the area. Majorly, MCA involves selection of indicators, their scoring and ultimately the weightings of each indicator to come up with an ordinary ranking score that can objectively rank and prioritise rural road.

Literature review also revealed that the MCA technique had been used in many similar road prioritisation models around the world. The difference remains in the indicators and weighing techniques which vary from model to model. It was, therefore, proposed to develop the prioritisation model for the rural roads of Punjab based on Multi-Criteria Analysis. Preliminary, indicators were selected based on the literature review and the parameters that were deemed important in the context of Punjab. These indicators were then presented to stakeholders and their feedback was used to include or exclude an indicator.

The projects and interventions of rural roads can be broadly categorised in major categories based on the type of the proposed intervention. First category is the construction of new rural roads which is either in virgin land, or there is an unpaved road with no underlying road structure. In both cases the department of communication and works proposes a project that is deemed as new construction. Second category is the rehabilitation or improvement of existing rural road in which case a paved road exists, but either due to poor condition or need of widening, the department proposes a project.

Considering the above two categories, it was proposed that two modules of the project be prepared and used for each category of rural road project. The indicators were then assigned to each module of the model and weighted using Analytical Hierarchy Process (AHP) technique. It enabled to customise modules according to the needs of each category of the rural road project and the resulting modules were then grouped in one broad model tool to be used by the beneficiary departments.

Figure 5.2 Methodology for development of rural road planning and prioritisation model



5.4 Workshop and Final Report

A workshop was conducted to discuss the proposed methodology developed for planning and prioritisation model of rural roads in Punjab. Model was presented to the stakeholders along with the proposed indicators. In addition, techniques used for weightings and selection of indicators were also discussed. The purpose of the workshop was to introduce the model to all the relevant stakeholders, get their feedback and entrust a sense of ownership of the model with the decision makers of the Province's planning process. Participants of the workshop included both Federal and Provincial Institutions, Professional Bodies, Development Partners, Federal Government Staff (such as the NTRC, Ministry of Communication and Planning Commission, provincial Planning and Development Department, Communication and Works Department and Transport Department, etc.) from Punjab and other provinces. After the workshop, a report based on the outcomes of the said dissemination workshop was also prepared which included details of participation by various stakeholders, record of discussions, recommendations. Subsequently, final report is produced in light of the feedback received from the various stakeholders on the methodology and proposed planning and prioritisation model.

6 Stakeholders Feedback

Stakeholder consultation was conducted through two consultative sessions; one of which was organised in Lahore and the second session was organised in Islamabad. Lahore being the provincial capital of the

Punjab province houses secretariat of all the major stakeholders involved in the planning of rural roads including Communication and Works Department, Local Government and Community Development Department, Planning and Development Department etc. Second session was conducted in Islamabad, capital of Pakistan, to cater various federal entities and facilitate their participation. In addition, a workshop was also conducted in Lahore with all the stakeholders. Details of the sessions and feedback provided is summarised below.

6.1 Activities Undertaken in Consultative Session

Each session was chaired by the team lead, Dr. Syed Murtaza Asghar Bukhari and moderated by transport specialist, Mr Zuhair Aslam. The session was kicked off by introductions from each participant to the house. A folder was distributed to each participant containing following three documents

I. Project Brief
II. Consent Form along with Privacy Notice
III. Questionnaire on Indicators along with List of indicators identified in Table 13

A presentation was made to the house outlining the project background, aims and objectives of the project and the methodology to conduct the study. Thereafter, the project appraisal process of Punjab was discussed followed by introduction of the various rural road prioritisation models adopted across the world both regionally and globally. Afterwards, the proposed methodology for developing the rural road planning and prioritisation model of the Punjab was presented and proposed indicators were discussed.

After the presentation, an interactive session was held with the participants with a brief description of the questionnaire available. The questionnaire was designed to incorporate suggestions and feedback of each participant regarding the indicator(s). It included option to “recommend” or “not recommend” a specific indicator from the list of proposed indicators. The questionnaire also included empty boxes to suggest additional indicators that they deem suitable and important in the context of rural road prioritisation model.

6.2 First Consultative Session

The session was organised in Lahore on December 27th, 2019 in Shaheen Complex Lahore. The following departments were invited to attend the session

a. Planning and Development (P&D) Department
b. Local Government and Community Development Department
c. Communication and Works (C&W) Department
d. National Engineering Services Pakistan (NESPAK)
e. Engineering Consultancy Services Punjab (ECSP)
f. University of Engineering and Technology
g. Transport Planning Unit, Transport Department

The Session was attended by representatives of four departments given in the Table 15. The session was conducted in the sequence described previously. A debate was held over the indicators and the techniques to prioritise rural roads in Punjab. Ahmad Raza Shah, General Manager of ESCP suggested that some portion of development cost should be borne by the government and some financed by locals of that area. He further suggested that there should be life cycle cost principle i.e. maintaining the life of road, to avoid rehabilitation and redevelopment until completion of its life period, to avoid extra funding requirement.

Senior Chief, Mr. Abid Razzaq stated that it is of utmost importance to identify investment priority, whether it should be given to rural road or regional road; or the rural road providing maximum accessibility. He said there is need to identify those rural roads which connect to main routes and are important from a certain perspective. He further added that work should be done in layers from national to provincial to district level. He emphasised that there should be an indicator that can outline previous civil works done on a

specific road to avoid repetition. He also said that traffic counts should be included in order to know that to which degree improvement is important for a road.

Mr. Abdul Basit, Chief Engineer from NESPAK suggested that indicators used in Texas model should be considered. Texas model consist of detailed indicators of road condition and usage such as Pavement condition, public complains, facility type, ADT Average daily truck traffic, Past expenses etc. He emphasised on the indicator pavement condition and said that an easy system should be defined for the different condition of roads so that each road along with its picture would be able to define its condition in relevance to the category defined. Mr. Fahad Ilyas from P&D department said that considering the rural development vision, rural roads should give market access. The indicator for the connectivity of the rural road from the railway line should also be considered.

Table 15 List of attendees of first consultative session held in Lahore

Sr	Name	Designation	Organisation
1	Amir Abbas	Deputy Director Highways	C&W Department, Punjab
2	Jamshaid Mahmood	Senior Engineer – Transportation	NESPAK
3	Abdul Basit	Chief Engineer	NESPAK
4	Fahad Ilyas	AC (Roads and Bridges)	P&D Department, Punjab
5	Abid Razzaq	Senior Chief (Roads and Bridges)	P&D Department, Punjab
6	Ahmad Raza Shah	Senior General Manager – Highways	ECSP

Figure 6.1 First stakeholder consultative session held in Lahore

6.3 Second Consultative Session

The session was organised in Islamabad on December 31st, 2019 in the conference room of National Transport Research Centre, Islamabad. Following departments were invited to attend the session

a. Capital Development Authority
b. Commissioner Islamabad Capital Territory
c. National Transport Research Centre
d. National University of Science and Technology
e. Rural Development Policy Institute
f. National Rural Support Programme
g. Municipal Corporation, Rawalpindi
h. Chief Engineer (North), Communication and Works Department

The Session was attended by representatives of four departments details of whom are given in Table 16. The session was conducted in the sequence described previously. Detailed discussion was held over the indicators and the techniques to prioritise rural roads in Punjab. Mr. Irteza Haider, Program Manager of National Rural Support Program referred about Poverty Scorecard which was developed by identifying poor households based on multi-dimensional criteria. He suggested that the indicator for poverty should be added in the proposed indicators for rural road prioritisation model. He highlighted that the areas with the minimum score should get the maximum priority. He also referred to the methodology used in national rural support program, which involves planning of inferior roads by cost sharing model. He further explained that the said model has been recognised as a successful practice in promoting Social Mobilization. The concept was highly appreciated by the stakeholders and suggested to incorporate it in the model.

Mr Hameed Akhtar, Chief NTRC reiterated need of developing the model based on the indicators that are not just useful in the local context but also keeping in view the availability and authenticity of available data. He said that initially, the base model should be developed on the indicators that are readily available or easily collectable, but for the future there should be room in the model to incorporate more sophisticated indicators such as road safety, black spots analysis and so on. This will also encourage relevant authorities to collect and maintain the data for its incorporation in the model.

Table 16 List of attendees of second consultative session held in Islamabad

Sr	Name	Designation	Organisation
1	Hameed Akhtar	Chief	NTRC
2	Irteza Haider	Project Manager – PITD	NRSP
3	Mr Sayyar	Deputy Chief	NTRC
4	Qasim Shehzad	Senior Sub-Engineer	Metropolitan Corporation, Rawalpindi
5	Dr Kamran Ahmed	General Manager – Transport	Zeeruk International
6	Ambreen Shahid	Deputy Chief	NTRC
7	Tauseer	Deputy Chief	NTRC
8	Khizar Javed	Deputy Chief	NTRC
9	Yousuf Zia	Assistant Chief - Technical	NTRC
10	Nafay Adrees	Assistant Chief	NTRC

Figure 6.2 Second stakeholder consultative session held in Islamabad

6.4 Workshop

A workshop was organized by Urban Unit, Lahore on January 13th, 2020 at the Punjab Civil Officer's Mess in Lahore, Punjab. The purpose of the workshop was to solicit comments and feedback on the variables of the proposed methodology of the said project from the representatives of all the relevant departments identified in the earlier stage of the study. Invitations to 15, both national and provincial departments were forwarded. The workshop was attended by various departments as given in Table 17 below.

Table 17 List of attendees of the workshop

Sr	Name	Designation	Organisation
1	Mr. Nayyar Saeed	Chief Engineer	Chief Engineer Office – Central, Communication & Works(C&W) Department
2	Mr. Ahmad Raza Shah	Senior General Manager	Engineering Consultancy Services Punjab Pvt. Ltd (ECSP)
3	Mr. Sayyar Khan	Deputy Chief	National Transport Research Centre (NTRC)
4	Mr. Zain-ul-Islam	Assistant Chief	NTRC
5	Mr. Mahmood Malik	General Manager	AAA Engineering Consultant Pvt. Ltd
6	Mr. Mahboob Elahi	Deputy Team Leader	Mott MacDonald Pakistan Pvt. Ltd
7	Dr. Kamran Ahmed	General Manager	Zeeruk International Pvt. Ltd
8	Dr. Naseer Akhtar Khan	Senior CAD Designer	Chief Engineer Office – North, C&W Department
9	Mr. Abdul Basit	Chief Engineer	National Engineering Services Pakistan (NESPAK)
10	Mr. Jamshed Mahmood	Senior Engineer	NESPAK
11	Mr. Jawad Rehmani	Regional Head	National Rural Support Programme (NRSP)
12	Mr. Aziz-ur-Rehman	Engineer	Department of Transportation Engineering and Management, University of Engineering and Technology (UET) Lahore
13	Mr. Faisal Shafique	Deputy Director	Traffic Engineering and Planning Agency (TEPA), Lahore Development Authority (LDA)
14	Mr. Kaiser. J Khatana	Chairman	Institute of Road Safety Traffic Environment Islamabad
15	Ms. Sumera Nazir	Transport Psychologist	Institute of Road Safety Traffic Environment Islamabad
16	Dr Waseem Akram	Senior Transport Planner	Transport Planning Unit (TPU), Transport Department
17	Mr Zahid Ali	Senior Chief Spatial Strategy	Planning and Development (P&D) Department
18	Mr Adil Dayal	Assistant Manager	Punjab Mass Transit Authority (PMA)
19	Mr M. Bilal	Traffic Engineer	TPU, Transport Department

First session was formally presented by the Team Leader, Dr. Syed Murtaza Asghar Bukhari. He warmly welcomed all the stakeholders and briefed on the agenda of the workshop. He then briefed the participants on the methodology of the project, reasons for holding the workshop and expected participation from the attendance. Within his presentation, he firstly presented the project appraisal process in Punjab, followed by introduction of the various rural road prioritisation models adopted both regionally and globally. These included examples of rural road prioritisation models adopted in India, Nepal, Bangladesh, Texas and Virginia. In addition, he also presented previous attempts on the prioritisation models in Punjab, Pakistan. Afterwards, the proposed methodology and indicators used for developing the rural road planning and prioritisation model of the Punjab, Pakistan was presented in detail. Finally, the floor was opened for discussion, questions and feedback.

Deputy Team Leader MMP, Mr. Mehboob Elahi inquired if there is any data regarding the number of roads that need to be constructed and the roads that have already been constructed. Dr. Murtaza commented on the NTRC Road database that provides the number of rural roads present in the Punjab. Regarding the rural roads that have already been constructed, he referred to Rural Accessibility Programme and Khadim-e-

Punjab Rural Road Project conducted earlier in Punjab where rural roads were constructed and rehabilitated. Mr Mehboob probed about the road alignment for rural roads i.e., whether existing road alignments should be prioritised or whether new alignments should be preferred. Dr. Murtaza replied to the query stating that the underlying project shall answer this question through the bespoke model being developed. He further added that prioritisation should be based on evidence-based planning.

General Manager Highways, ECSP, Mr. Ahmad Raza Shah recommended about investment priority and public private partnership that the concessionaire should provide after sale service including maintenance of the road. He also suggested that some portions of development cost should be borne by the government and some finance be arranged by local community for developing their ownership of that road asset.

Deputy Chief, NTRC Mr. Sayyar highlighted the dilemma of budget allocation and inquired whether it should be for construction of new roads or for maintenance of existing roads. Dr. Murtaza said budget allocation should not be kept the same for all the regions. He elaborated his point by giving an example of provinces. He added that Punjab, being the most populated province, already has a vast network of rural roads, so priority should be towards maintenance of roads; whereas Baluchistan, being the least populated province and having under developed rural road connectivity, should have the priority for construction of new roads.

Senior Engineer NESPAK, Mr. Jamshed Mahmood briefed about the inventory software HDM 4 which assists in identifying the life span of specific structure of the road under specific condition. He suggested about integrating the HDM 4 with the mathematical models for construction of the Rural Road. Dr Murtaza replied that the said software is not currently being used by the planning and development department so its inclusion in the model is currently not practical; however, in future the same can be integrated.

Importantly, the participants agreed that two different versions of the model be developed i.e., one should be developed for prioritisation of existing rural roads and the other version of the model should be employed for prioritisation of new roads.

The interactive session was moderated by Transport Specialist, Mr Zuhair Aslam, wherein each participant was briefed about privacy consent form and privacy notice. After that, the participants were briefed about the seven-pager AHP questionnaire developed by Economist Dr. Ghulam Moheyuddin. The questionnaire consisted of two sections. The first section was for the weightings of the indicators to be used in the prioritisation model of existing rural roads. The second section was for the weightings of the indicators to be used in the prioritisation model of new rural roads. Each section comprises of different indicators grouped into dimensions. First, the indicators of each dimension are to be compared and assigned a score. Subsequently, the dimensions are compared and given a score according to Likert Scale.

Each participant was requested to first select the indicator that was deemed more important / preferable from each pair of the indicator by writing A or B in third column of the table. Afterwards, the preferred indicator was to be given a score from the given Likert scale. The Likert scale was introduced with score of 1 to 5 where 1 represented minimum importance and 5 represented maximum importance for the preferred indicator.

Figure 6.3 Workshop held in Lahore

7 Planning and Prioritisation Model

In the methodology section, it has been briefed that two modules of the model are developed keeping in view the category of road project typically employed in the Punjab. Since each project type has its own dynamics, the set of indicators relevant for each project type varies accordingly. Similarly, the weightings among the indicators also vary for each module. For instance, an indicator variable that has more importance in the new construction may not be that important for the road considered for rehabilitation and vice versa. Therefore, it is recommended that each module will have its own set of indicators and weightings assigned to each indicator. Mainly, two modules are proposed to be developed which are as following.

I. Construction of new rural roads
II. Rehabilitation/ improvement of existing rural road

7.1 Indicators

Selection of indicator(s) is one of the key elements for developing a robust prioritisation model. The indicators will directly influence the results and are therefore selected carefully by studying prioritisation models of similar nature developed and used around the world and feedback received from the stakeholders. These indicators are subjected to data availability and relevance to the local needs in Punjab. In addition, any indicator not included in previous models, but is deemed important in the context of Punjab is also investigated and incorporated where required. The indicators are then assigned to each model based on the category of the rural road project as discussed previously. Indicators suggested to be incorporated in the model are given in the Table 18 below.

Table 18 List of indicators suggested for the prioritisation model.

Sr	Dimension	Indicator
1	Socio-Economic Indicators	Population Served
2		Arable Area
3		Education Facilities
4		Health Facilities
5		Markets
6		Industries
7	Connectivity	Road Linkages/ Connectivity
8		Railway Station
9	Road Parameters	Traffic Volume
10		Pavement Condition
11		Previous Work
12	Project Parameters	Benefit Cost Ratio
13		Public transport route
14	Local Importance	Local priority of project

7.1.1 Socio-Economic Indicators

7.1.1.1 Population Served

Facilitation of public is the main purpose of any infrastructural project especially road project since it directly benefits the population living around it. Therefore, population is the most basic indicator that directly estimate the number of people that will directly benefit from the road adjacent to them. This indicator can be calculated by estimating the populating living within certain radius / buffer of the road. Sustainable development goals developed by the World Bank uses a 2 km buffer to calculate the beneficiary population of a road. Hence, it is proposed to use a buffer of same distance to calculate the population that benefits from the road. The indicator can be calculated by dividing the population living within 2 km by road length as given in Equation 1. This will ensure consistency in comparison of roads with different length.

$$Population\ Served\ (persons/km) = \frac{P_b}{L}$$ **Equation 1**

Where,

P_b = Population within 2 km buffer on either side of road,
L = Length of road in kilometre,

7.1.1.2 Arable Area

Rural population of Punjab greatly depends on agriculture and the Punjab remains an agriculture-based economy. In rural areas, the economic activity is associated with agriculture, hence improving access of arable land to the public will in return increase the economic activity. This indicator helps producers and sellers' access to markets. The indicator can be calculated by extracting the area of arable land within 2 km buffer of the road and dividing it by the length of the road (Equation 2) to adjust for difference in length of roads to be compared.

$$Arable\ Area\ (sqkm/km) = \frac{A_b}{L}$$ **Equation 2**

Where,

A_b = Arable area within 2 km buffer on either side of road

7.1.1.3 Education Facilities

Education is a basic right and access to educational facility is an important factor to ensure the access of education to the people of the region. The indicator is proposed to be included to the connectivity of educational facilities, which will subsequently improve important education indicators such as increased enrolment rates and fewer dropout rates. Therefore, this indicator is recommended for prioritisation of rural road projects. For the said purpose, access to different level of education can be calculated and categorised in following categories:

a. Primary School
b. Secondary School
c. College
d. University

7.1.1.4 Health Facilities

Providing access to health facility is one of the basic rights that the government need to ensure. Better roads improve the access to the health facilities. It directly reduces the travel time and improve the access of health facility. Therefore, roads providing access to health facility are proposed to be prioritised. For the said purpose, access to different level of health facility can be calculated categorised in following categories:

a. Basic Health Unit (BHU)
b. Regional Health Unit (RHU)
c. Tehsil Head Quarter (THQ)
d. District Headquarter (DHQ)
e. Teaching Hospital

7.1.1.5 Markets

Markets are central component for boosting growth and increasing economic development of any region. Improved access to the markets is important to promote the economic activity. Hence, this factor is proposed so that the roads providing access to the markets can be prioritised. Major markets include Fruit and Vegetable Markets and Grain Markets

7.1.1.6 Industrial Units

The industrial sector has paramount importance in the economic growth and development of Punjab. Punjab being agriculture-based economy has major portion of agri-based industries. Industries are major source of providing employment to the public and also a major source of finished goods hence access to industries is very important parameter. This indicator can help the decision makers a lot in terms of deciding which road to prioritise, hence inculcating industry in the definitive framework of road infrastructure serves multiple purposes: it improves access to raw materials, finished goods and labour force. For the said purpose, access to different class of industrial unit will be calculated categorised in following categories:

a. Small Industries
b. Medium Industry
c. Large Industry

7.1.2 Connectivity

7.1.2.1 Road Linkages/ Connectivity

A road segment is part of the greater road network and the significance of a road segment in the network increase as it gets connected with roads of higher road class. The higher the class of the connecting road, higher is the importance of the road segment in question. A well-connected road network ensures the connectivity of region in broader context. Keeping this concept in view the said indicator is proposed to be included in the model as it will enable the model to prioritise road that provide connectivity to higher class of road. The classes of road for the said purpose are as following

a. Connection to Local Road
b. Connection to Secondary Road
c. Connection to Primary Road
d. Connection to Highway or Motorway

7.1.2.2 Railway Station

Access to railway stations not only ensures local connectivity but also help improve access between the regions. This holds for both passenger and freight traffic and is therefore an important indicator to be considered in the model.

7.1.3 Road Parameters

7.1.3.1 Traffic Volume

Traffic volume is a basic indicator that informs the user about the usage of the road. It is one of the basic and key indicators used by transport planner for planning and design of a road. Traffic count either done manually or electronically, gives the information of number of classified vehicles over a specific period of time. For the purpose of planning, Average Annual Daily Traffic (AADT) or Average Daily Traffic (ADT) is used by converting vehicles of each class into Passenger Car Units (PCU) and reported as PCU per day. Traffic Volume is also used for geometrical design and pavement design of roads wherein various components of road design such as road width, number of lanes, shoulder width etc. are decided (ASHTO).

7.1.3.2 Pavement Condition (Visual)

Pavement condition determines the existing condition of the road. Usually International Roughness Index (IRI) or Pavement Condition Index (PCI) is used for the purpose, but calculating these indices require special equipment and effort. Therefore, it is recommended to use a visual rapid assessment of the road. In rapid assessment, the physical condition of the road will be assessed based on visual reconnaissance survey in which road will be examined for potholes and surface cracks. A subjective assessment can be done to rank the surveyed road section. It is recommended that the road may be prioritised based on the its pavement condition rank. Each road can be given a rank as per the criteria given below

Sr	Description	Rank
1	Road is in good condition with no cracks, rutting or potholes	A
2	Road is in average condition with few cracks, rutting but no potholes	B
3	Road is in Bad condition with high cracks or rutting and few potholes	C
4	Road is in Poor condition with high cracks, rutting and numerous potholes	D
5	Road Surface not metaled	S

7.1.3.3 Previous Work

The indicator will provide information of last date of civil work related to maintenance, rehabilitation or construction of the segment of road under investigation. It will help to ensure that the roads neglected in the past are given priority against the one which have been up-taken by the government more recently.

7.1.4 Project Parameters

7.1.4.1 Benefit Cost Ratio

Cost benefit analysis (CBA) calculates a benefit cost ratio (BCR) that identifies the relationship between the cost and benefits of a proposed project. This indicator does tend to prioritise a road that has high traffic volume compared to a low volume road but it can be countered by other proposed indicators. The ratio is used to measure both the quantitative and the qualitative factors, since sometimes the benefits and the costs cannot be measured exclusively in financial terms. When possible, the qualitative factors are translated into quantitative terms for the results to be easily understandable and tangible. The BCR is calculated by dividing the total discounted benefits of a project by the total discounted costs of the project.

$$NPV\ of\ Benefits = \sum_{t=0}^{n} \left\{ \frac{Benefits_t}{(1+r)^t} \right\} \qquad \textbf{Equation 3}$$

$$NPV\ of\ Costs = \sum_{t=0}^{n} \left\{ \frac{Costs_t}{(1+r)^t} \right\} \qquad \textbf{Equation 4}$$

Where:

r = Discount rate,
t = Number of years,
n = Total number of years (design life).

Once the accumulated values of benefits and costs are calculated then just by dividing them BCR can be calculated as shown in the Equation 5 below.

$$BCR = \frac{NPV\ of\ Benefits}{NPV\ of\ Costs}$$ Equation 5

BCR of any road project is calculate by the sponsoring department using the above-mentioned procedure. This value directly gives the economic return of the proposed project against the cost of the project in monetary terms.

7.1.4.2 Public Transport Route

The importance of public transport cannot be overstated, since it is not only most sustainable and efficient mode of movement but it is also the only source of movement for the people who cannot afford their own vehicle. Hence, a road that is used by the public transport either formal or informal mode of transport, carry more significance than a road which is not used by such facility. However, a road may not have public transport simply because of poor condition of existing road. A short reconnaissance or interview of local can be done to identify such cases.

7.1.5 Local Importance

7.1.5.1 Local Priority of Project

This is one of the subjective indicators being recommended. It empowers local community, department, and community representatives to prioritise a road based on their opinion and requirement. This can be gathered through outreaching community and their local representation. This can help to create sense of ownership among local community and the possible beneficiaries of the project. Previously, only political voice was heard and needs of local community were often ignored. This indicator can ensure that the community needs are catered and roads can be prioritised accordingly.

7.2 Assigning Indicator to Model

Two modules are being proposed for planning and prioritisation model of rural roads in Punjab based on the category of the project and type of intervention. Each module shall have its own set of indicators and weightings. Indicators are assigned to each module based on its relevance to the type of intervention and given in Table 19 below. Broadly, four indicators i.e. traffic volume, pavement condition, previous work and public transport route are only incorporated in the module for rehabilitation/ improvement of rural roads. These indicators are relevant only in case of intervention on an already existing road and are therefore included in its model. In case of construction of new rural roads, data against afore-mentioned indicators does not exist.

Table 19 Matrix of variables proposed for each module of the model

Indicator	New Road Module	Rehabilitation/ Improvement Module
Population Served	☑	☑
Arable Area	☑	☑
Education Facilities	☑	☑
Health Facilities	☑	☑
Markets	☑	☑
Industries	☑	☑
Road Linkages/ Connectivity	☑	☑
Railway Station	☑	☑

Traffic Volume		☑
Pavement Condition		☑
Previous Work		☑
Benefit Cost Ratio	☑	☑
Public transport route		☑
Local priority of project	☑	☑

7.3 Scoring of Indicators

Value of each indicator will be calculated based on the equations given in the preceding section. Units and possible Source of data of each variable is also identified and listed in Table 20. Three Indicators i.e. traffic volume, pavement condition and public transport route requires primary data and are required only in case of rehabilitation/ improvement of existing rural roads. In such cases, data against these three variables shall be collected by field survey of the road.

Table 20 Proposed indicator units and possible source of data

Sr	Indicator	Unit	Source
1	Population Served	Persons / km	Land Scan Imagery (Urban Unit)
2	Arable Area	Sq km / km	Satellite Imagery
3	Education Facilities	Numbers	Urban Unit
4	Health Facilities	Numbers	Urban Unit
5	Markets	Numbers	Urban Unit
6	Industries	Numbers	Census for Manufacturing Industries 2017
7	Road Linkages/ Connectivity	Numbers	National Transport Research Database
8	Railway Station	Numbers	Urban Unit
9	Traffic Volume	PCU / day	Primary Data
10	Pavement Condition	Rank	Primary Data
11	Previous Work	-	Sponsoring Department
12	Benefit Cost Ratio	Ratio	Sponsoring Department
13	Public transport route	-	Primary Data
14	Local priority of project	-	Sponsoring Department

In order to ensure consistency throughout the indicators, ordinal scoring system is proposed with a maximum value of 5 and minimum value of 1 with the interval of 1. Once the value of each indicator is calculated, the indicator will be assigned a score based on the value of the indicator and criteria defined in the Table 21. The values of the indicator will be calculated using the methodology given in the afore-mentioned section.

Table 21 Recommended scoring matrix for proposed indicators

Sr	Indicator	Ordinal Score				
		1	2	3	4	5
1	Population Served	<1000	1,001 – 20,000	20,001 – 50,000	50,001 – 100,000	>100,001
2	Arable Area	<0.5	0.51 – 1.5	1.51 – 2.5	2.51 – 3.5	>3.51
3	Education Facilities	No Facility	1 Primary School	1 Secondary School or >1 Primary Schools	1 College or >1 Secondary School	1 University or >1 College
4	Health Facilities	No Facility	1 BHU	1 RHU or >1 BHU	1 THQ or >1 BHU	1 DHQ or Teaching Hospital
5	Markets	0	1	2	3	>3
6	Industries	0	1 Small Industry	2-5 Small Industries	1 Medium Industry or >5 Small Industries	Large Industry or >1 Medium Industries
7	Road Linkages/ Connectivity	No linkage	Connectivity to Local Road	>1 Connection to Local Roads	Connectivity to Secondary Road	Connectivity to Highway
8	Railway Station	0	-	1	-	>1
9	Traffic Volume	<10	10 – 100	101 – 500	501 – 1,000	>1,000
10	Pavement Condition	A	B	C	D	S
11	Previous Work	<1 year	1 – 2 years	3 – 5 years	5 – 8 years	>8 years
12	Benefit Cost Ratio	<1	1.0 – 1.5	1.51 – 2.0	2.01 – 3.0	>3.01
13	Public transport route	No Route	At least 1 informal public transport route	>1 informal public transport route	At least 1 formal public transport route	>1 formal public transport route
14	Local priority of project	No Priority	Low priority	Medium priority	High priority	Very high priority

7.4 Weighting of Indicators

Weighting of indicators for both modules was done using AHP technique explained earlier in the report. AHP is an unbiased process, which evaluates the reliability of decision-makers about their judgments, both direct and online survey conducted for this purpose. To check the consistency and reliability of the survey following formula, as given by Saaty (2008) was used

$$CR = \frac{CI}{RI} \qquad \text{Equation 6}$$

Where:

CR = Consistency Ratio,
CI = Consistency Index,
RI = Random Index,

The random index value depends upon the number of parameters that are compared, the formula for Consistency Index (CI) is as under:

$$CI = \frac{\lambda - \mathrm{n}}{n - 1} \qquad \textbf{Equation 7}$$

Where:

λ = Matrix Eigenvalue,
n = Matrix Size,

While $\lambda \geq n$, and the difference is used to measure the judgment consistency. So, when λ is closer to n, the judgment is more consistent. The value consistency ratio (CR) must be CR ≤ 0.1 (less than 10%), which shows judgment or evaluation consistency.

7.4.1 Questionnaire

Questionnaire (Annex 1) was filled by the experts involved in the planning of rural roads in the Punjab. Two separate sections were designed within the questionnaire, one for the module of new rural roads and the second one for module of rehabilitation/ improvement of the existing roads. The first section for the "Rehabilitation/ Improvement of Existing Rural Roads" included 5 dimensions and 14 indicators given in Table 22

Table 22 Indicators in Section I of the Questionnaire for AHP

Dimension	Indicators
Socio-Economic	Population Served
	Arable Area
	Education Facilities
	Health Facilities
	Markets
	Industries
Connectivity	Road Linkages/ Connectivity
	Railway Station
Road Parameters	Traffic Volume
	Pavement Condition
	Previous Work
Project Parameters	Benefit-Cost Ratio
	Public transport route
Local Importance	Local priority of the project

Second section for the "Construction of New Rural Roads" included 4 dimensions and 10 indicators given in Table 23 below. Both the sections were merged into one questionnaire form with a brief description of indicators and background of the study.

Table 23 Indicators in Section II of the Questionnaire for AHP

Dimension	Indicators
Socio-Economic	Population Served
	Arable Area
	Education Facilities
	Health Facilities
	Markets
	Industries
Connectivity	Road Linkages/ Connectivity
	Railway Station
Project Parameters	Benefit-Cost Ratio
Local Importance	Local priority of the project

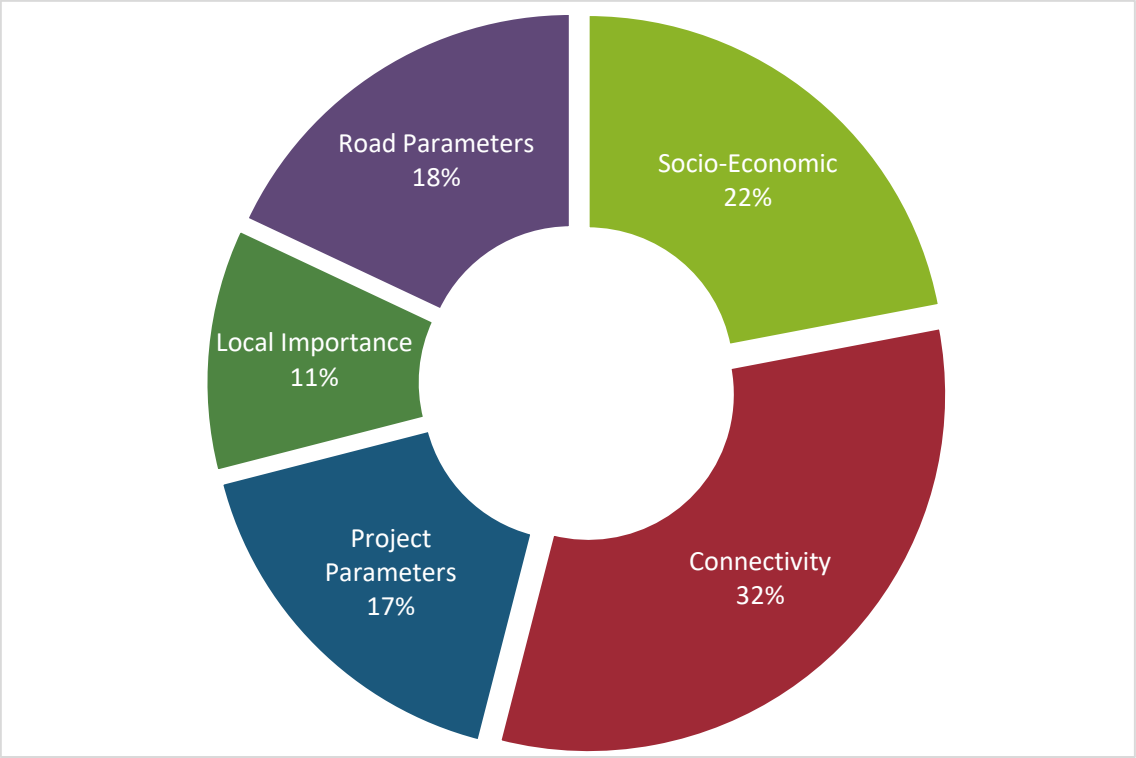
7.4.2 AHP Results and Assigned weights

The calculated value of Consistency Ratio (CR) of the aggregate index for the section of "Rehabilitation/ Improvement of Existing Rural Roads" is 0.046 (4.6%) which shows consistency in judgment/evaluation, as it is below the cut-off value of 0.1 (10%). The weights of dimensions for the "Rehabilitation/ Improvement of Existing Rural Roads" module is given in Figure 7.1. It shows that the highest weight is given to the connectivity dimension followed by socio-economic dimension. Both these dimensions affirm the idea of need of rural roads for socio-economic wellbeing of rural population. Contrary, least importance is given to the local importance of the road which was a subjective criterion and therefore deemed less important by the stakeholders. Complete list of indicators along with their weightings or the model Rehabilitation/ Improvement of Existing Rural Roads is given in Table 24 below.

Table 24 Weightings of Indicators of the model "rehabilitation/ improvement of existing rural roads"

Dimension	Indicators	Assigned Weights
Socio-Economic	Population Served	4%
	Arable Area	2%
	Education Facilities	4%
	Health Facilities	4%
	Markets	4%
	Industries	4%
Connectivity	Road Linkages/ Connectivity	17%
	Railway Station	15%
Road Parameters	Traffic Volume	8%
	Pavement Condition	5%
	Previous Work	5%
Project Parameters	Benefit Cost Ratio	9%
	Public transport route	8%
Local Importance	Local priority of the project	11%
Aggregate / Composite Score		**100%**

Figure 7.1 Weighting of Dimensions for the model of rehabilitation/ improvement of rural roads

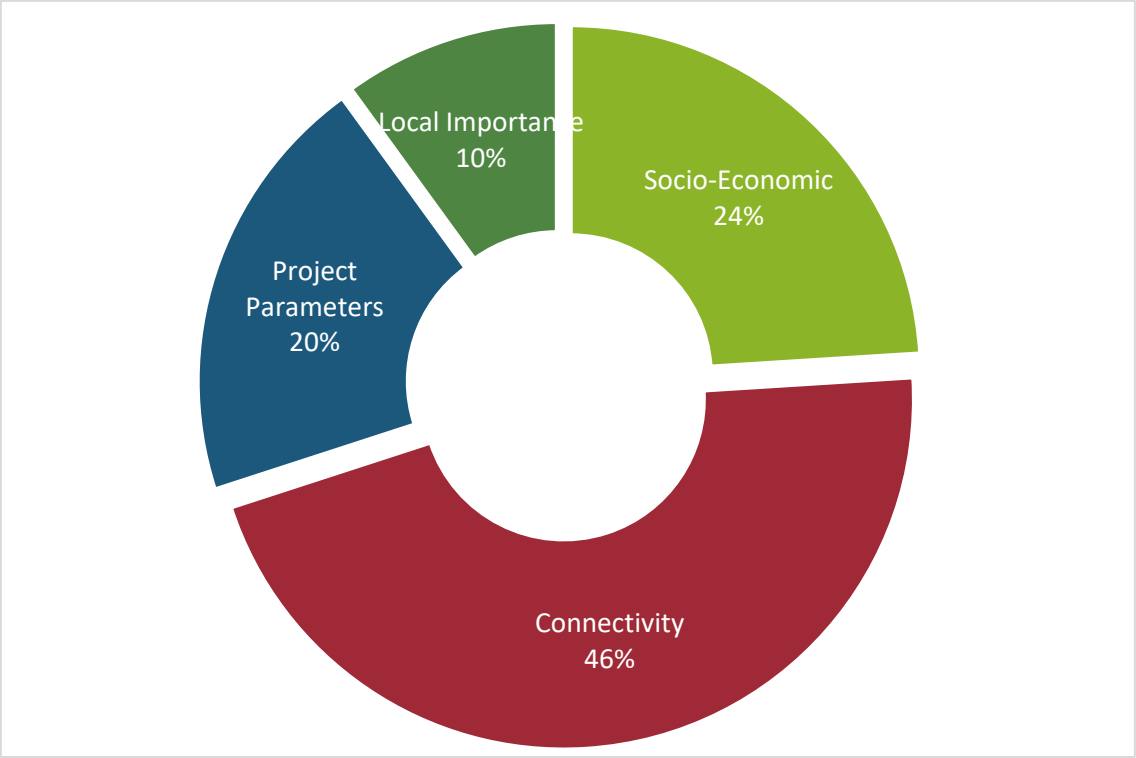


Similarly, the calculated value of Consistency Ratio (CR) of the aggregate index for the section of "Construction of New Rural Roads" is 0.027 (2.7%) which shows consistency in judgment/evaluation, as it is below the cut-off value of 0.1 (10%). The weights of dimensions for the "Construction of new rural road" Model are given in Figure 7.2. It shows that the highest weight is given to the connectivity dimension followed by socio-economic dimension. Both these dimensions affirm the idea of need of rural roads for socio-economic wellbeing of rural population. Contrary, least importance is given to the political importance of the road which was a subjective criterion and therefore deemed less important by the stakeholders. Complete list of indicators along with their weightings for the model construction of new rural road is given in Table 25 below.

Table 25 Weightings of Indicators of model: Construction of new rural roads

Dimension	Indicators	Assigned Weights
Socio-Economic	Population Served	5%
	Arable Area	2%
	Education Facilities	4%
	Health Facilities	4%
	Markets	5%
	Industries	4%
Connectivity	Road Linkages/ Connectivity	22%
	Railway Station	24%
Project Parameters	Benefit Cost Ratio	20%
Political Importance	Local priority of the project	10%
Aggregate / Composite Score		**100%**

Figure 7.2 Weighting of Dimensions for the model of construction of new rural roads



7.5 Scoring of rural road project

Total score of a project will be calculated using the following formula given in Equation 8 below.

$$S_i = \sum_{j=1}^{n} w_j I_j$$

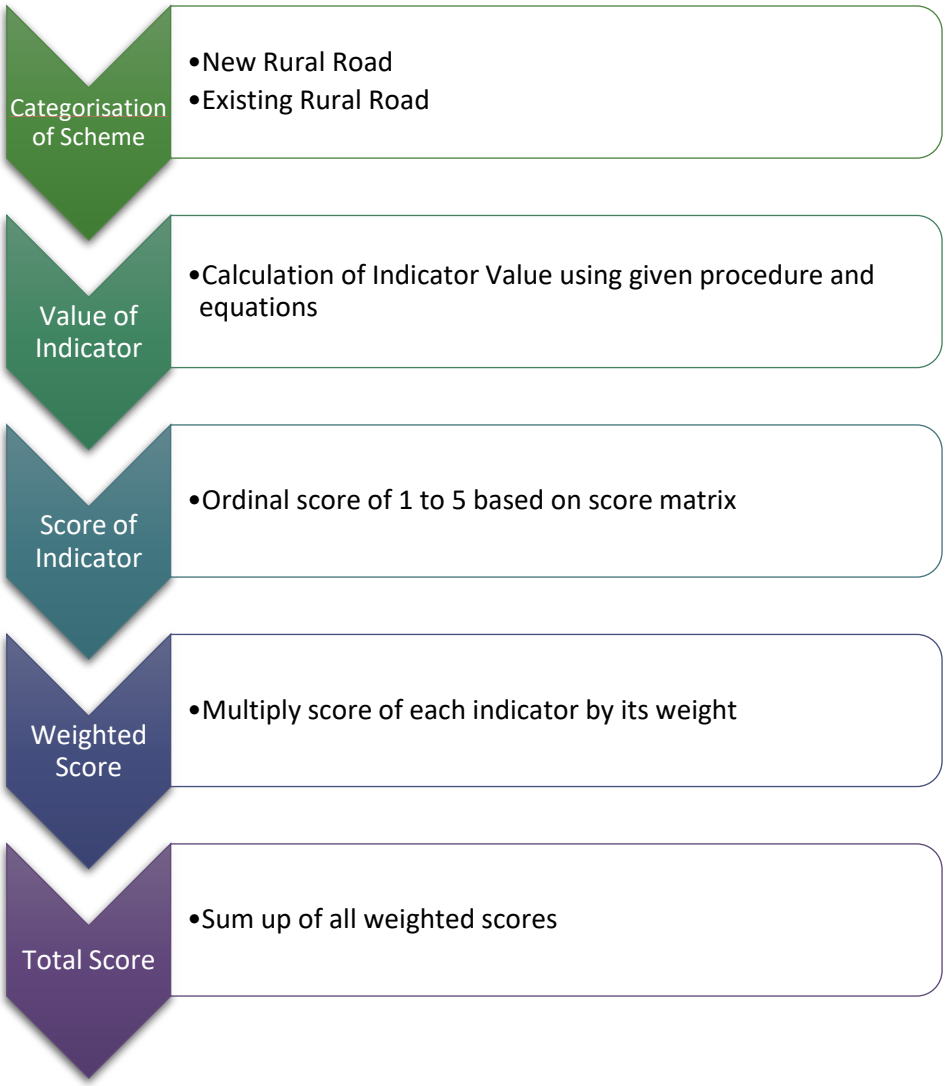
Equation 8

Where:

S_i = Score of i road scheme,
w_j = weight of variable j,
I_j = Score of individual indicators j

First, road project to be analysed will be classified in one of the two categories i.e. Construction of new rural road or rehabilitation of existing rural road. Once the category of the module of the model to be used is established, relevant indicators shall be listed down. Value of each indicator will be calculated using the method explained earlier for each indicator. Afterwards, resulting value will be assigned a score using the matrix given in Table 21. Score of each indicator will be multiplied by its weight as given in Table 24 and Table 25. The resulting weighted score will be summed up to get the total score of the scheme. Total score of the scheme can range anywhere between 1 and 5, where 1 indicates least priority of the scheme and 5 indicates highest priority of the scheme. The process of evaluating a rural road project is depicted in Figure 7.3 below.

Figure 7.3 Procedure for evaluating a rural road project



8 Phase 2 of the Project

Phase 2 is the implementation phase of the project which involves development of the rural road planning and prioritisation model as per the recommendation of the Phase 1. The model shall also be piloted in one of the districts of the Punjab based on the consultation with stakeholders. For the purpose, data shall be collected from the field and secondary sources to populate the model. Lastly, a manual and guidelines shall be prepared that will be housed with the relevant government departments. The officials will also be trained through workshop/ training sessions so that they can use the tool effectively.

8.1 Methodology

Phase 2 of the project can be divided into seven major tasks which are as follows

- Task 1: Inception Report
- Task 2: Stakeholder consultation/ discussion
- Task 3: Procurement or development of software
- Task 4: Data collection
- Task 5: Manual and guidelines development
- Task 6: Model development and piloting of methodology
- Task 7: Workshop for launch, training of the model and revised methodology

8.1.1 Task 1: Inception Report

The report will include summary of findings of the Phase 1 of the project. It will further present the detailed data collection strategy, work plan, risks and mitigations for conducting the Phase 2 of the project. The report shall outline the methodology that will be adopted to accomplish the objectives of the project. This report will also be presented to stakeholders for their feedback on implementation of the project.

8.1.2 Task 2: Stakeholder Consultation/ Discussion

It is recommended that a stakeholder workshop be held whereby all relevant stakeholders can provide feedback on the direction of the Planning and Prioritisation model and assist in making key decisions. This also includes the final list of variables and any improvement required in the methodology proposed in the Phase 1. Suggestions on the type of tool / software to be used for the development of the model can also be provided. In addition, it is recommended that the pilot area i.e. one district of the province, be selected to the satisfaction of the client.

8.1.3 Task 3: Procurement or Development of Software

A software or tool will be developed based on the methodology developed in Phase I of the project. For the GIS component of the tool as well as statistical computations, in-house capabilities of the Urban Unit will be employed. However, if required, software may be purchased both in light of the rationale developed within the methodology and upon the justification and analysis performed considering pro and cons of various available software

8.1.4 Task 4: Data Collection

Data collection for populating the Planning and Prioritisation model and beta-testing of the tool shall be based on the variables identified in Phase 1 and further refined in the stakeholder workshop. The variables have been identified in Table 20 along with its possible source and data collection requirement. Broadly, three Indicators i.e. traffic volume, pavement condition and public transport route require primary data. Data for these three variables shall be collected through field surveys whereas data for the remaining indicators can be collected through concerned departments. However, in case of any new variables identified during Phase 2, possible source of data and its collection technique will also be identified before initiating collection of data from the field.

8.1.5 Task 5: Manual and Guidelines Development

Manual(s) for the Planning and Prioritisation Model shall be developed that will provide clear guidelines on the usage of the model. It will provide step by step guidelines to use the model tool/ software. It will also standardise data collection techniques and the population of variable values in the tool. The guidelines shall be officially launched and circulated by the Planning and Development (P&D) Department of the Government of the Punjab and will be housed with the Communication and Works Department and P&W Department.

8.1.6 Task 6: Model Development and Piloting of Methodology

It includes development of a bespoke model on the proposed tool/ software. A district shall be selected for piloting (selected at the Stakeholder Workshop). Sensitivity analysis for testing of the developed model will also be done by analysing various variables. Results shall be compiled and recommendations will be made based on the outcomes of the pilot study.

8.1.7 Task 7: Workshop for launch, Training of the model and revised methodology

A Workshop shall be arranged for sharing of results and launch of the revised methodology and model for the relevant government officials.

8.2 Resources and Budget

Table 26 Experts resources required for Phase 2

Position Title	No. days
Team Leader (Transport Economist)	60
Research Assistant (Transport Specialist)	60
IT Specialist	30
Economist	20
GIS Expert	15
Survey Specialist	10

8.3 Work Plan

Table 27 Workplan for Phase 2

Sr	Task	Month								
		1	2	3	4	5	6	7	8	9
1	Inception Report	x								
2	Stakeholder Consultation/ Discussion		x							
3	Procurement or Development of Software		x	x	x					
4	Data Collection from Field and Secondary Sources				x	x				
5	Model Development and Piloting of Methodology					x	x	x		
6	Manual for the Planning and Prioritisation Model						x	x	x	
7	Workshops and Training for Planning and Prioritisation Model									x

8.4 Milestones

Table 28 Milestones for Phase 2 along with their timeline

Sr	Milestone	Milestone Expected Date (From Date of Contract)
1	Inception Report	End of 1st Month
2	Stakeholder Report	Mid of 2nd Month
3	Model Development and Pilot Implementation Report	End of 6th Month
4	Manual/ Guidelines	End of 7th Month
5	Workshop Report	Mid of 8th Month
6	Final Report	End of 8th Month

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Annex 1 AHP Questionnaire

Development of a Rural Roads Planning and Prioritisation Model for the Punjab Province of Pakistan

Date: _____

Respondent Name _____ Designation _____

Organization Name _____

Background

Two models are being prepared for each type of rural road project which are as following

1. **Rehabilitation/ Improvement of Existing Rural Roads**
2. **Construction of New Rural Roads**

The set of variables and weightages among the variables also vary for each model. Subsequently, indicators are assigned for each type of model and given in Table below.

Sr	Dimension	Indicator	New Road Model	Rehabilitation Model
1	Socio-Economic Indicators	Population Served	☑	☑
2		Arable Area	☑	☑
3		Education Facilities	☑	☑
4		Health Facilities	☑	☑
5		Markets	☑	☑
6		Industries	☑	☑
7	Connectivity	Road Linkages/ Connectivity	☑	☑
8		Railway Station	☑	☑
9	Road Parameters	Traffic Volume		☑
10		Pavement Condition		☑
11		Previous Work		☑
12	Project Parameters	Benefit Cost Ratio	☑	☑
13		Public transport route		☑
14	Political Importance	Local priority of project	☑	☑

Page **1** of **7**

In order to determine weightages of indicators, Analytical Hierarchy Process (AHP) is used. The whole questionnaire is divided in two sections; one for each model. A section comprises of series of different categories encompassing indicators paired within each dimension. Firstly, all the indicators will be compared and given a score. After that, all the major dimensions will be compared and given a score according to Likert Scale.

Instructions for filling

First, select the indicator that is deemed more important / preferable from each pair of the indicator by writing A or B in third column of the table. **Afterwards**, the preferred indicator has to be given a score from the given Likert scale. Likert scale is introduced with **score of 1 to 5** where score 1 represents minimum importance and 5 represents maximum importance for the preferred indicator.

Explanatory note for each indicator is provided below respective table for reference purpose.

Section 1: Model for Rehabilitation of Rural Road

Socio- Economic Indicators

Indicators		Preferred Indicator (A or B)	Scoring of Preferred Indicator
A	B		Less Important ⟷ More Important
Population Served	Arable Area		1 2 3 4 5
Population Served	Education Facilities		1 2 3 4 5
Population Served	Health Facilities		1 2 3 4 5
Population Served	Markets		1 2 3 4 5
Population Served	Industries		1 2 3 4 5
Arable Area	Education Facilities		1 2 3 4 5
Arable Area	Health Facilities		1 2 3 4 5
Arable Area	Markets		1 2 3 4 5
Arable Area	Industries		1 2 3 4 5
Education Facilities	Health Facilities		1 2 3 4 5
Education Facilities	Markets		1 2 3 4 5
Education Facilities	Industries		1 2 3 4 5
Health Facilities	Markets		1 2 3 4 5
Health Facilities	Industries		1 2 3 4 5
Markets	Industries		1 2 3 4 5

- **Population Served:** Number of people residing within 2 km buffer on either side of the road
- **Arable Area:** arable area includes area under cultivation or temporary crop
- **Education Facilities:** Access to different level of education facility will be calculated categorised in following categories: Primary School, Secondary School, College, University.
- **Health Facilities:** Access to different level of health facility will be calculated categorised in following categories: Basic Health Unit (BHU), Regional Health Unit (RHU), Tehsil Head Quarter (THQ), District Headquarter (DHQ), Teaching Hospital.
- **Market:** Improved access to the markets is important to promote the economic activity.
- **Industrial Unit:** Access to different class of industrial unit will be calculated categorised in following categories: Small Industries, Medium Industry, Large Industry.

Connectivity

Indicators		Preferred Indicator (A or B)	Scoring of Preferred Indicator
A	B		Less Important ⟷ More Important
Road Linkages/ Connectivity	Railway Station		1 2 3 4 5

- **Road Linkages/ Connectivity:** The classes of road for the said purpose are Local Road, Secondary Road, Primary Road and Highway or Motorway.
- **Railway Station:** Helps to improve access between the regions and hold both passenger and freight traffic.

Road Parameters

Indicators		Preferred Indicator (A or B)	Scoring of Preferred Indicator
A	B		Less Important ⟷ More Important
Traffic Volume	Pavement Condition		1 2 3 4 5
Traffic Volume	Previous Work		1 2 3 4 5
Pavement Condition	Previous Work		1 2 3 4 5

- **Traffic Volume:** Number of classified vehicles over a specific period of time.
- **Pavement Condition**: Pavement condition determines the existing condition of the road.

Project Parameters

Indicators		Preferred Indicator (A or B)	Scoring of Preferred Indicator
A	B		Less Important ⟷ More Important
Benefit Cost Ratio	Public transport route		1 2 3 4 5

- **Benefit Cost Ratio**: Cost benefit Ratio identifies the relationship between the cost and benefits of a proposed project and is used to measure quantitative and the qualitative factors.
- **Public transport route:** This route carry more significance than the other roads. Inclusion of this indicator prioritize roads that provide access to the public transport movers.

Dimension Preference in Aggregate Index

Categories		Preferred Dimension (A or B)	Scoring of Preferred Dimension
A	B		Less Important ⟷ More Important
Socio-Economic	Connectivity		1 2 3 4 5
Socio-Economic	Road Parameters		1 2 3 4 5
Socio-Economic	Project Parameters		1 2 3 4 5
Socio-Economic	Political Importance		1 2 3 4 5
Connectivity	Road Parameters		1 2 3 4 5
Connectivity	Project Parameters		1 2 3 4 5
Connectivity	Political Importance		1 2 3 4 5
Road Parameters	Project Parameters		1 2 3 4 5
Road Parameters	Political Importance		1 2 3 4 5
Project Parameters	Political Importance		1 2 3 4 5

1.Socio-Economic

-Population Served
-Arable Area
-Education Facilities
-Health Facilities
-Markets
-Industries

2.Connectivity

-Road Linkages/ Connectivity
-Railway Station

3.Road Parameters

-Traffic Volume
-Pavement Condition
-Previous Work

4.Project Parameters

-Benefit Cost Ratio
-Public Transport Route

5.Political Importance

-Local Priority of Project

Section 2: Model for Construction of New Rural Road

Socio- Economic Indicators

Indicators		Preferred Indicator (A or B)	Scoring of Preferred Indicator
A	B		Less Important ⟷ More Important
Population Served	Arable Area		1 2 3 4 5
Population Served	Education Facilities		1 2 3 4 5
Population Served	Health Facilities		1 2 3 4 5
Population Served	Markets		1 2 3 4 5
Population Served	Industries		1 2 3 4 5
Arable Area	Education Facilities		1 2 3 4 5
Arable Area	Health Facilities		1 2 3 4 5
Arable Area	Markets		1 2 3 4 5
Arable Area	Industries		1 2 3 4 5
Education Facilities	Health Facilities		1 2 3 4 5
Education Facilities	Markets		1 2 3 4 5
Education Facilities	Industries		1 2 3 4 5
Health Facilities	Markets		1 2 3 4 5
Health Facilities	Industries		1 2 3 4 5
Markets	Industries		1 2 3 4 5

- **Population Served:** Number of people residing within 2 km buffer on either side of the road
- **Arable Area:** arable area includes area under cultivation or temporary crop
- **Education Facilities:** Access to different level of education facility will be calculated categorised in following categories: Primary School, Secondary School, College, University.
- **Health Facilities:** Access to different level of health facility will be calculated categorised in following categories: Basic Health Unit (BHU), Regional Health Unit (RHU), Tehsil Head Quarter (THQ), District Headquarter (DHQ), Teaching Hospital.
- **Market:** Improved access to the markets is important to promote the economic activity.
- **Industrial Unit:** Access to different class of industrial unit will be calculated categorised in following categories: Small Industries, Medium Industry, Large Industry.

Connectivity

Indicators		Preferred Indicator (A or B)	Scoring of Preferred Indicator
A	B		Less Important ⟷ More Important
Road Linkages/ Connectivity	Railway Station		1 2 3 4 5

- **Road Linkages/ Connectivity:** The classes of road for the said purpose are Local Road, Secondary Road, Primary Road and Highway or Motorway.
- **Railway Station:** Helps to improve access between the regions and hold both passenger and freight traffic.

Dimension Preference in Aggregate Index

Categories		Preferred Dimension (A or B)	Scoring of Preferred Dimension
A	B		Less Important ⟷ More Important
Socio-Economic	Connectivity		1 2 3 4 5
Socio-Economic	Project Parameters		1 2 3 4 5
Socio-Economic	Political Importance		1 2 3 4 5
Connectivity	Project Parameters		1 2 3 4 5
Connectivity	Political Importance		1 2 3 4 5
Project Parameters	Political Importance		1 2 3 4 5

1. Socio-Economic Indicators

-Population Served
-Arable Area
-Education Facilities
-Health Facilities
-Markets
-Industries

2. Connectivity

-Road Linkages/ Connectivity
-Railway Station

3. Project Parameters

-Benefit Cost Ratio

4. Political Importance

-Local Priority of Project