DEVELOPING AND TESTING A PARTICIPATORY METHODOLOGY FOR DISTRICT ROAD NETWORK PLANNING IN NEPAL

by

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Abstract

The transport sector has received high priority since the 1950s in the economic history of Nepal. However, modalities of road construction have been shifting during the last few decades to cope with the changing requirements. From the early 1990s, the country has embarked on the policy of developing the district level roads using the labor-based technology. Due to lack of an appropriate methodology for planning the networks, the district level roads are constructed in a haphazard manner, which are less productive from economic and social viewpoints. Therefore, the broad objective of this study was to develop a methodology for planning and prioritizing the district road networks. Other specific objectives include to assess the strengths and weaknesses of the existing district level transport planning process, to propose an appropriate methodology based on the "state of the art" in the field of rural and regional transportation and adapted district reality in Nepal. To test the methodology and to recommend a computer-aided model for planning and prioritizing the district road networks were other objectives of this study.

The relevant literature on road networking, estimation of the transport demand, different technological options and techniques for assessing the benefits were reviewed. Besides that, the models for planning and prioritizing the rural and regional road network were analyzed.

For analyzing the district level planning and implementation situation, the policy makers and engineers of the sample districts were interviewed. An open-ended interview was taken with experts and practitioners in the field of transportation. Based on the strengths and weaknesses of the districts and the "state of the art" in the field of rural transportation, a methodology for developing the district road network planning was developed. The methodology has two versions, the first was designed for the developed area and the second was designed for the underdeveloped area. The methodology was translated into a computer-aided model for the developed and underdeveloped areas. The model was tested in the Nawalparasi District of Nepal.

The proposed methodology experimented with the gravity model by combining a centrality index with population and distance data. The network for the developed area was designed based on the shortest path analysis among the nodal points. The methodology established the argument that volume of transport demand is a function of the intensity of interaction. The methodology has provision for estimating the construction cost and assessing the benefits from the improved access. The economic indicators based on direct benefits were used for prioritizing the roads in the developed areas. The socio-economic criteria were used for prioritizing the roads in the underdeveloped areas. In order to adjust the geometric and pavement design of a road, the economic appraisal was introduced as a supplementary appraisal technique for the underdeveloped areas.

The District Road Planning and Prioritization Model (DRPM) was developed based on the proposed methodology. The model for the developed area is comprised of a networking module, a demand estimation module, a cost estimation module, a benefit estimation module and a prioritization module. The DRPM for the underdeveloped area has a networking module, a cost estimation module and a prioritization module. The DRPM was tested in the Nawalparasi district. The test results in the Nawalparasi district showed that the model is efficient and cost-effective. Therefore, it is expected that the model will be useful for district transportation planners of Nepal and other developing countries.

Table of Contents

Chapter	Title	Page
	Title Page	i
	Acknowledgements	ii
	Abstract	iv
	Table of Contents	v
	List of Appendices	vii
	List of Figures	viii
	List of Tables	ix
	Abbreviations	xi
1	**Introduction**	1
	1.1 The Issues	1
	1.2 Brief History of the Transport Sector in Nepal	2
	1.3 What is a District Road Network	4
	1.4 Problem Statement	5
	1.5 Research Rationale	9
	1.6 Research Questions	9
	1.7 Research Objectives	9
	1.8 Scope and Limitations	10
	1.9 Organization of the Study	11
2	**Literature Review**	12
	2.1 General Overview of Transportation Sector	12
	2.2 Road Networking	14
	2.3 Link Based Transport Demand Assessment	17
	2.4 Cost Implications of Technological Options for Road Construction	19
	2.5 Assessment of Benefits by Improved Access	23
	2.6 Computerized Models for Planning and Appraisal of Road Projects	24
	2.7 "*State of the Art*" in Regional and Rural Transport Planning Methodologies	25
3	**Research Design**	30
	3.1 Methods of Data Collection for the First Stage of Feasibility Test	31
	3.2 Data and Information Collection Techniques for Testing the Methodology	34
	3.3 Testing the Methodology	38
	3.4 Expected Result: The Proposed Methodology Confirmed	41
4	**District Level Transport Planning in Nepal**	42
	4.1 Density of Population and Roads	42
	4.2 Pattern of Revenue and Expenditure	44
	4.3 Availability and Quality of Technical Manpower	44
	4.4 Allocation of Working Time by Technicians	46
	4.5 Construction Equipment Holding by DDCs	47
	4.6 Engineering Equipment Holding by DDCs	47
	4.7 Knowledge of District Level Road Inventory	48

4.8 Statutory Planning Process 49
4.9 Actual Planning Process 50
4.10 Practice of Allocating Budget for District Level Roads 54
4.11 Summary of the District Level Transport Planning Process 55
4.12 SWOT Analysis of District Level Transport Planning Process 55
4.13 Focus on Feasible Options 57

5 Analytical Framework for District Road Network Planning and Prioritization 58

5.1 Networking of the District Roads 58
5.2 Estimation of the Transport Demand 62
5.3 Technological Issues of the District Roads 64
5.4 Benefits of the District Roads 69
5.5 District Road Network Planning in a Nutshell 73

6 Methodology for Planning and Prioritizing the District Road Network 74

6.1 Methodology for the Developed Areas 74
6.2 Methodology for the Underdeveloped Areas 85

7 Application of the District Road Network Planning and Prioritization Methodology in Nawalparasi District 89

7.1 Overview of the Nawalparasi District 89
7.2 General Background of the Transport Infrastructure Planning of the Nawalparasi District 97
7.3 Transport Infrastructure Planning for the Developed Areas 98
7.4 Transport Infrastructure Planning for the Underdeveloped Areas 109
7.5 Overall Output of the Planning Exercise 112
7.6 Financing the District Level Roads 115

8 Comparative Analysis of Transport Demand, Construction Cost and Benefits 117

8.1 Impact of Transport Growth Rates on the ENPV 117
8.2 Impact of Technology on the Construction Cost 117
8.3 Consequences of Different Benefit Scenarios on ENPV 120
8.4 Inferences from the Discussion 121

9 Testing the Methodology at the Nawalparasi District 122

9.1 Pre-Testing Phase 122
9.2 Final Testing through Questionnaire Survey 123
9.3 Laboratory Test of the Planning Exercise 130

10 Summary and Conclusions 136

10.1 Summary 136
10.2 Findings 138
10.3 Conclusions 141
10.4 Scope for Future Study 141

References 142

List of Appendices

1 Model for Developed Areas (Table 1–34) 148
2 Model for Underdeveloped Areas Based on Socio Economic Prioritization Criteria (Table 1 –12) 163
3 Model for Underdeveloped Areas Based on Economic Analysis (Table 1– 33) 170
4 Annexes Numbered According to the Respective Chapters 188
1.1 Evolutionary Process of Roads in Nepal 189
2.1 Construction and Maintenance Cost for Different Types of Roads 190
2.2 Rural and Regional Transport Planning Methodology: An Overview 191
3.1 DDC Engineers Survey 193
3.2 Policy Makers Survey 198
3.3 Checklist for Interviewing Experts and Practitioners 201
3.4 Road Observation Record Sheet 203
3.5 Cordon Survey 204
3.6 Passenger Vehicle Survey Form 205
3.7 Freight Carrier Survey Form 208
3.8 Porter Survey Form 211
3.9 Passenger Survey Form 212
3.10 Contractor Survey Form 213
3.11 Labor Productivity Measurement Form 216
3.12 Key Informant Survey Form 219
3.13 Test Questionnaire of the Methodology for District Road Network Planning and Prioritization 221
3.14 Input Data for Simulation of the Methodology 225
3.15 Guidelines for the Simulation Exercise 231
3.16 Checklist for the Open Ended Discussion with the Engineer and Planning Officer 232
3.17 Format for Recording the Questionnaire and Discussion while Conducting the Experiment 232
3.18 Checklist for the Final Output of the Simulation Exercise 232
4.1 Densities of Population by District 233
4.2 Densities of Road by District 235
4.3 Own Source Revenue of the Districts 237
4.4 District Level Survey Results 239
5.1 Required Equipment with Different Hierarchy of Contractors 240
5.2 Technically Feasible Construction Methods 241
6.1 Correlation Between Density of Road and Other Parameters 242
7.1 Present Practice of Budget Allocation 244
7.2 Allocation of all Available Resources on Priority Roads 245
8.1 Norms of the Road Construction 246
9.1 District Level Transport Plan according to the Prevailing Practice 247

List of Figures

Figure	Title	
1.1	District Level Road Network Planning Process based on the DTMP	5
3.1	Flow Diagram of the Steps Required for Developing the Methodology	30
3.2	Sampling Scheme	32
4.1	Ecological Regions in Nepal	43
4.2	Planning and Implementing Process of the District Level Roads	50
6.1	Flow Chart of the Methodology for the Developed Area	75
6.2	Methodology for the Underdeveloped Areas	86
6.3	Procedure for Network Development in the Underdeveloped Areas	87
7.1	Location Map of the Nawalparasi District	91
7.2	Topography and Drainage System	92
7.3	Land Use	93
7.4	Distribution and Hierarchy of Market Centers	94
7.5	Delineation of Inaccessible Areas from Accessible Areas	95
7.6	Developed and Underdeveloped Areas Based on Density of Roads	96
7.7	District Road Network Planning and Prioritization Model for the Developed Areas	99
7.8	Existing District Level Inventory of Roads and Trails	103
7.9	Relationship between Intensity of Interaction and Volume of Passengers	104
7.10	Relationship between Intensity of Interaction and Volume of Freight	104
7.11	District Road Network Planning and Prioritization Model for the Underdeveloped Areas	111
7.12	District Level Present and Proposed Road Networks	113
7.13	Zone of Influence of Present and Proposed Roads	114
8.1	Effect of Various Growth Rates on ENPV of a Road in Developed Areas	117
8.2	Construction Cost in Developed Areas	119
8.3	Per Km Cost of Different Agencies in the Underdeveloped Areas	120
8.4	Consequence of Different Time Savings on the ENPV	121
9.1	Revised Flow Chart of the Methodology for the Developed Areas	133
9.2	Revised Flow Chart of the Methodology for the Underdeveloped Areas	134

List of Tables

Table	Title	
2.1	Relationship between Per Capita Income and Road Density	13
2.2	Cost Per Unit of Output in Individual Work Stages of Projects Studied	20
3.1	Sample Size of District Selection	33
3.2	Respondents of the Expert Survey	34
3.3	Required Data and their Sources for the Methodological Test	35
3.4	Sample Size of Roadside Survey	38
3.5	Criteria for Comparison	41
4.1	Average Components of Revenue Sources According to the Ecological Belt	44
4.2	Average Number of Technicians by Ecological Belt	45
4.3	Number of Engineers with Computer Literacy by Ecological Belt	46
4.4	Construction Equipment Holding of DDCs by Ecological Belt	47
4.5	Engineering Equipment Holding of DDCs by Ecological Belt	48
4.6	Knowledge of District Officials about the Road Inventory	48
4.7	Opinion of Engineers on Road Project Appraisal by Ecological Belt	54
4.8	Average Number of Projects and Allocated Budget	54
4.9	SWOT Analysis and Required Strategies	56
4.10	Major Methodological Options for Planning the District Roads	57
5.1	Networking Approaches of District Roads	58
5.2	Usefulness of GIS for Developing the District Road Networks	61
5.3	Capability of DDCs to Handle the GIS	61
5.4	Approaches for Estimating the Transport Demand	63
5.5	Opinion of Engineers on Future Transport Demand	64
5.6	Main Problem Areas of the Prevailing Construction Technology	65
5.7	Possibility to Apply Labor Based Appropriate Technology by Ecological Belt	66
5.8	Possibility to Simplify the Norms and Specification by Ecological Belt	67
5.9	Benefits of the Improved Access	70
5.10	Benefits of District Roads as Perceived by the Engineers of Different Ecological Belt	70
5.11	Benefits of the District Roads as Perceived by Policy Makers of Different Ecological Belt	71
5.12	Comprehensive Overview of the Benefits of the Improved Access	71
5.13	Regional Exports of Commodities by their Characteristics	72
5.14	Regional Imports of Commodities by their Characteristics	72
6.1	Allocation of Time for Different Activities by District Level Technicians	77
6.2	Table for Identifying Shortest Routes	80
6.3	Table for Origin-Destination Road Distance Matrix	80
6.4	Example of Cost Composition of Earthwork Excavation	84
7.1	Planning Criteria Outlined by the DDC, Nawalparasi	97
7.2	Centrality Index of Present Market Centers	100
7.3	Future Centrality Index of Market Centers	100
7.4	District Road Inventory	101
7.5	Identification of the Shortest Routes	101
7.6	Origin-Destination Road Distance Matrix among Market Centers	102
7.7	Identification of the Shortest Routes after Constructing the Proposed Roads	105
7.8	Assignment of Present Intensity of Interaction to Each Link Based on Existing Road Networks	106
7.9	Assignment of Future Intensity of Interaction on Present and Proposed Links	106

7.10	Projected Volume of Passengers and Freight	107
7.11	Construction Cost of Proposed Road Project	108
7.12	Per Km Cost of the District Roads in Plain Area	108
7.13	Present Centrality Index and Rank of Market Centers in the Underdeveloped Areas	110
7.14	Future Centrality Index of the Market Centers in the Underdeveloped Areas	110
7.15	Prioritization of the Proposed Roads by Socio-Economic Criteria	112
7.16	Allocation of Resources based on Phased Construction	116
8.1	Construction Norms Expressed in Amount	118
9.1	Appropriate Agency for Planning the District Level Road Network	124
9.2	Appropriate Agency for Implementing the Transport Plan	124
9.3	Manpower Development for Planning and Implementing the Transport Network	125
9.4	Data Collection Techniques for the Developed Areas	126
9.5	Data Collection Techniques for the Underdeveloped Areas	126
9.6	Affordability of the Districts in terms of Funds and Time	126
9.7	Usefulness of the Analytical Tools	127
9.8	Capacity of Implementation of Analytical Tools	127
9.9	Appropriateness of Criteria for Assessing Benefits	128

Abbreviations

AADT	= Annual Average Daily Traffic
AASTHO	= American Association of State Highway and Transportation Officials
ADB	= Asian Development Bank
APROSC	= Agriculture Projects Services Center
AR	= Agricultural Roads
CBS	= Central Bureau of Statistics
DADO	= District Agricultural Development Office
DC	= District Council
DDC	= District Development Committee
DDP	= Dhadhing Development Project
DOA	= Department of Agriculture
DOInd	= Department of Industries
DOIrr	= Department of Irrigation
DOLIDAR	= Department of Local Infrastructure Development and Agricultural Roads
DOP	= Density of Population
DOR	= Department of Roads
DOS	= Department of Survey
DR	= District Road
DRPM	= District Road Network Planning and Prioritization Model
DRPMD	= District Road Network Planning and Prioritization Model for Developed Areas
DRPMU	= District Road Network Planning and Prioritization Model for Underdeveloped Areas
DRSP	= District Road Support Project
DRTU	= District Road Technical Unit
DTMP	= District Transport Master Plan
EBCR	= Economic Benefit Cost Ratio
EIRR	= Economic Internal Rate of Return
ENPV	= Economic Net Present Value
GDP	= Gorkha Development Project
GIS	= Geographic Information System
GTZ	= Gesellschaft fuer Technische Zusammenarbeit
HMGN	= His Majesty's Government of Nepal
IBRD	= International Bank for Reconstruction and Development
ICIMOD	= International Center for Integrated Mountain Development
ILO	= International Labour Organization
IOI	= Intensity of Interaction
IRAP	= Integrated Rural Accessibility Planning
JMA	= John Mellor Associates, Inc.
LBT	= Labor-Based Technology
LDP	= Lamjung Development Project
LGP	= Local Governance Programme
LJRP	= Lamosangu - Jiri Road Project
LRIP	= Local Road Improvement Programme
LRP	= Local Road Program
MDRP	= Malekhu – Dhadhing Road Project
MOLD	= Ministry of Local Development
MOWT	= Ministry of Works and Transport

NGO	= Non Governmental Organization
NPC	= National Planning Commission
NRs	= Nepali Rupees
ONP	= Optimal Network Problem
PDDP	= Participatory District Development Program
PLRP	= Pilot Labor Based District Road Rehabilitation and Maintenance Project
RCIWP	= Rural Community Infrastructure Work Programme
RIDP	= Rural Infrastructure Development Programme
RTI	= Rural Transport Infrastructure
RTO	= Regional Transportation Organization
SBD	= Suspension Bridge Division
SDC	= Swiss Agency for Development and Cooperation
SWOT	= Strengths, Weaknesses, Opportunities and Threats
TRRL	= Transport and Road Research Laboratory
UNCHS	= United Nations Center for Human Settlements
UNDP	= United Nations Development Programme
VDC	= Village Development Committee
VOC	= Vehicle Operating Cost
VOF	= Volume of Freight
VOP	= Volume of Passengers
VPD	= Vehicle Per Day
WB	= World Bank
WFP	= World Food Programme
WMI	= Weighted Mean Index
ZOI	= Zone of Influence

Chapter I
Introduction

Nepal has a rugged topography dissected by a number of streams and rivers. Therefore, a large part of the country is inaccessible. The major highway networks connect only few national level cities and towns located mainly in the southern plain areas. A considerable portion of the population lives in the hilly and mountainous settlements where commodities are transported either by porters or by pack animals. Transporting goods even in the plain area is not efficient due to lack of all weather road connections from road heads to hinterlands. The development professionals argue that inaccessibility is one of the main reasons for underdevelopment in Nepal.

Since the state has limited financial resources, it is necessary to mobilize local resources for construction and maintenance of transport infrastructure. Therefore His Majesty's Government of Nepal (HMGN) has handed over the responsibility for district level transport infrastructure to the District Development Committees (DDCs) with the assumption that the DDCs can effectively mobilize the local resources and acquire people's participation. As a new responsibility, the DDCs have limited skills to plan and prioritize the transport networks. Therefore, it is necessary to develop a methodology and other supporting tools and techniques that facilitate the development of sustainable road networks. The proposed methodology and other tools and techniques should be based on strengths and weaknesses of the DDCs.

Due to difficult topographic conditions, the transport infrastructure needs a high investment. In view of high investments and the meager financial resources with the DDCs, it is necessary to devise a methodology and construction technology that provide a minimum level of accessibility with available resources. In other words, it is essential to establish a balanced relationship with the investment and the benefits for a rational allocation of the scarce resources. The ninth five-year plan has mentioned that the remote and sparsely populated settlements and erosion-prone steep mountains have posed problems of developing the transport infrastructures and resource mobilization. Consequently, it has an adverse impact on the upliftment of the living standards of rural people.

1.1 The Issues

The transport sector has received high priority since the inception of the planned history of development in Nepal. The fourth plan (1970/71 – 1974/75) accorded the top priority to the transport sector. The fifth plan (1975/76 – 1979/80) gave the second priority to the transport sector. The seventh plan (1985/86 – 1989/90) recognized rural transportation as one of the basic needs for the people. After evaluating the policies of HMGN, the World Bank (1992) mentioned that the national transport sector policy is focussed on network expansion giving lower priority to the maintenance. Therefore, the eighth plan (1993-1997) emphasized the road maintenance rather than the new construction. During the eighth plan period, the responsibility for district roads was shifted from the Department of Roads (DOR) to the DDCs. However, the DDCs are in a learning stage for both construction and maintenance of the district roads. As mentioned by Scott Wilson (SW, 1997) the self-help initiatives for the construction of roads survived no more than one or two monsoons, because of the lack of a maintenance strategy, inadequate technical inputs for alignment selection, planning, design and construction etc. Paudyal (1998) maintains that unless rural roads are profitable to the local people, these can not be sustained economically. This calls for a mechanism to connect the construction and maintenance of the rural roads with the production process for input supply and marketing of produce.

The National Planning Commission (NPC, 1998) in its Ninth Plan (1997 – 2002) has emphasized the development of roads, which are durable, economical and suitable for the geological conditions of Nepal. It also highlights that such infrastructure should be constructed and maintained mobilizing the local resources. Therefore, the main issue is how to develop sustainable district transport networks by mobilizing the local resources under the direct supervision and control of the DDCs.

1.2 Brief History of the Transport Sector in Nepal

The present 10,724 km of road networks in Nepal was constructed during the last five decades (DOR, 1995). Until 1950, the country had no motorized road. In the evolving process of road construction, the approaches and strategies of road construction have been constantly changing. The major emphasis on the construction of a strategic road network during the period of 1950 – 1975 gradually changed and the country started to focus on constructing environmentally friendly roads of regional importance. The main national focus since 1990 was the development of district level roads through mobilizing the local governments and maintenance of the strategic road networks. This section attempts to trace the evolutionary process of the transport sector in Nepal.

1.2.1 Situation of Transport Infrastructure until 1950

The transport situation until the first half of the 20th century is described by Bishop (1952) that "for millions of persons scattered over far-flung and isolated villages, the only available means of transportation are steep narrow foot trails and narrow planks or loose tree trunks - bridges over turbulent rivers, which are really difficult and unsuitable even for pack animals." The historical evidence shows that the Gorkhali rulers had devised a number of arrangements for maintaining lines of transport and communications from Kathmandu to different districts. As mentioned by Regmi (1987) these arrangements could be described under two main headings: An east-west track through the hill region and postal service for the transportation of official mail and supplies. However, Rana rulers (until 1950), according to Regmi (1987), refrained from constructing large-scale transportation infrastructure because they were afraid that economic development should provide a motive for the British to annex the Kingdom. Regmi (1987) concludes that a deliberate policy of keeping the country economically undeveloped may have been justified in the contemporary situation by consideration of national security but its detrimental impact on the economy hardly needs any elaboration.

1.2.2 Strategic Network Development Phase (1950 – 1975)

The agreement among the Governments of India, United States of America and Nepal in 1958 to establish the Regional Transportation Organization (RTO) for building roads is an organized and planned way on a long term basis, was the first effort in the history of Nepalese motorized road construction in Nepal (Zimmermann and Rajbhandari, 1995). The RTO formulated a 20-year program to build north-south roads connecting Indian cities and railheads along the border. After the collapse of RTO in 1962, Nepal continued its effort to invite donors and build roads. The earlier policy of emphasizing north-south roads was replaced by the east-west roads like the East-West Highway (Mahendra Raj Marg - about 1026 km) and Prithivi Raj Marg (Kathmandu - Pokhara, 176 km). With the internal resources of Nepal and contributions received from the major donor countries and agencies like India, China, USSR, UK, USA, Switzerland, Japan, World Bank (WB) and Asian Development Bank (ADB), Nepal could develop the present strategic road networks.

During this period the length of road network reached to 3,173 km, a growth of nearly 127 km per year (DOR, 1995). Although the speed of road construction was quite high during this period, the technical aspects of road construction were not properly assessed (Schaffner, 1987). The alignments were not fixed for mass balancing. The surplus materials were dumped to the valley side causing mass scale avalanches. In addition to that, almost all roads (i.e. Prithivi Rajmarg, Arniko Rajmarg, and Siddartha Rajmarg) were constructed following the river valley alignments that accelerated the soil erosion because the road structures were exposed to the turbulent current of glacial rivers.

1.2.3 Introduction of Environment Friendly Road Construction in the Regional Context (1975 - 1990)

After realizing the adverse environmental and economic consequences of traditional road construction technology, the Swiss Agency for Development and Cooperation (SDC) pioneered to introduce the first environment friendly road construction technology by using labor based techniques in the Lamosangu – Jiri Road Project during the period of the late 70s and early 80s. The Project was implemented directly by HMGN and Directorate of Development Cooperation of Switzerland (Schaffner, 1987). The endeavor was followed by the Palpa Development Project, which was supported by the Gesecllschaft fuer Technische Zusammenarbeit (GTZ) and SDC and was implemented in collaboration with the DDC. Helvetas-Nepal was the implementing agency. The basic focus of the project was to implement environment friendly labor-intensive technology (Meyer et al. 1999) rather than strengthening the local governments. Based on the experiences of Palpa Development Project, GTZ initiated Dhadhing Development Project from 1989. The project somehow included DDCs but the payment to laborers was done either by the project appointed Non Governmental Organization (NGO) or by the project itself (SW, 1997). Therefore, the effort of the project was limited to demonstrating labor-based and environment friendly technology rather than strengthening the local governments.

1.2.4 Focus on District Roads with Decentralized Environment (Since 1990)

The strategic road networks, obviously, are significant in terms of the national unity, integrity, security and economic development. However, as highlighted by the assessment of Agricultural Projects Services Center and John Mellor Associates (APROSC and JMA, 1995), the return from the existing trunk roads is very low because Nepal does not have an agricultural road grid. Similarly, it was also realized that the sustainability of the rural roads could not be guaranteed without involving the local governments. Handing over responsibility of the District Roads (DRs) from the DOR to DDCs is an indicator of such realization at the policy level. Similarly, responsibility of urban roads is transferred to the Municipalities.

The major issue now prevailing in the country is how the local governments can plan and maintain the local roads. This is particularly true because they have limited knowledge of planning, implementation and maintenance of the road networks besides having meager own-source financial resources. Therefore, the HMGN in collaboration with the donor agencies has been trying to strengthen the DDCs. A few major foreign aid projects are presented here to show the direction of the national efforts supported by the bilateral and international donor agencies.

1. The Pilot Labor Based District Road Rehabilitation and Maintenance Project (PLRP) (1994-1998) was an important effort towards strengthening the local governments and private sector (contractors, local consultants and local equipment manufacturers). The project was formulated immediately after handing over the District Roads to the DDCs

from the DOR in 1992 (UNDP, 1992). Nonetheless, it could not expedite decentralization according to its mandate, because of the presence and active role of the project management team appointed by the Ministry of Local Development (MOLD). Therefore, the local authorities themselves played a less active role in implementing the project than planned at the beginning.

2. The ADB has been implementing a new project called Rural Infrastructure Development Project (RIDP). The project began from 1996 and Baglung, Tanahun and Kavrepalanchowk districts were taken as the project area. The project has adopted the labor intensive and environment friendly technology, which it intends to achieve through staged construction, mass balancing and bioengineering. Besides that, as an effort to improve the limitation of GTZ supported Dhading Development Project, Gorkha Development Project and Lamjung Development Project, it has actively involved the local authorities, user's committees and DDCs (SW, 1997).

3. A SDC supported district road project is going to be operationalized very soon (SW, 1997). A relatively large-scale project to be funded by the World Bank and to be executed by the DDCs with the support of MOLD is under preparation in the Fiscal Year 1999/2000. The project objectives are to strengthen the capacity of local government agencies and MOLD in planning and managing rural roads, to maintain and rehabilitate rural roads in selected districts using labor based, cost effective technology and to involve beneficiaries in project preparation and implementation (Chen, 1998). The project design is progressive in terms of decentralization.

In addition to these efforts, there are also other projects supporting the rural roads in Nepal. The Rural Community Infrastructure Work Programme (RCIWP) is supported by the World Food Programme (WFP) for food resources and GTZ for technical assistance. The project is under implementation. GTZ is also planning a road building program in Bhojpur and Sankhuwasabha districts as part of the Arun Valley Development Project (SW, 1995).

Realizing its significance, the HMGN has established the Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR) under the MOLD in 1998 (DOLIDAR, 1998a). The decentralized transport infrastructure sector, thus, is in a transitional phase in Nepal. Therefore, it will still take considerable time for developing methods and techniques of planning, technology and appraisal for the district level roads. Annex 1.1 summarizes the evolutionary process of the road sector in Nepal.

1.3 What is a District Road Network

The term network indicates "a set of geographic locations interconnected in a system by a number of routes" (Kansky, 1963). It means network can be the natural like the river system or manmade like road, electricity and canal. Each network system has its subsystems. This study has dealt with the district level road network, which is a sub-system of the national road networks. The UNCHS (1985) has mentioned that all road sections are part of a network or system serving a continuous flow of passengers and goods between centers of production and consumption, and no individual road link should be treated in isolation. It further mentions that irrespective of the geopolitical level of rural-road planning (sub-national or local), the road network at each level should be coordinated with the network of the higher and/or lower levels, thus maintaining an integrated road system. Therefore, for this study, the district level road network is defined as a set of district and regional level market centers which are connected by the district and higher level transport infrastructure. For this study, if a national road already exists between two nodes, it is part of the district level road network.

Nonetheless, the District Development Committee (DDC) does not plan for the national level road network. In fact, existence of a national road is prerequisite for developing the district level road networks. Although it provides a framework for the village and urban road network, this study does not directly deal with such local level roads. The DDC assumes the responsibility to plan, construct and maintain of the district level roads. Therefore the definition depends upon the function as well as ownership.

1.4 Problem Statement

With the objective of strengthening local governments, the PLRP (Shrestha, 1997a), initiated the concept of the "District Transport Master Plan (DTMP)". After a successful implementation of the master plan in four pilot districts[1], HMGN promulgated the national policy to prepare a master plan for each district of the country. The master plans, which have been prepared during the last few years, are the point of departure for this study.

The focus of the DTMP is to develop a district-level road network. The network is developed based on the hierarchy of settlements, existing road and trail networks and accessibility standards of a district. The next step is to prioritize improvement projects related to the roads included in the network. The prioritization criteria included both costs and benefits of a project. At the end, the priority projects are matched with the available budget in the district and roads are scheduled to be implemented in a planned manner.

The flow chart for planning the district level road network is shown in Fig. 1.1.

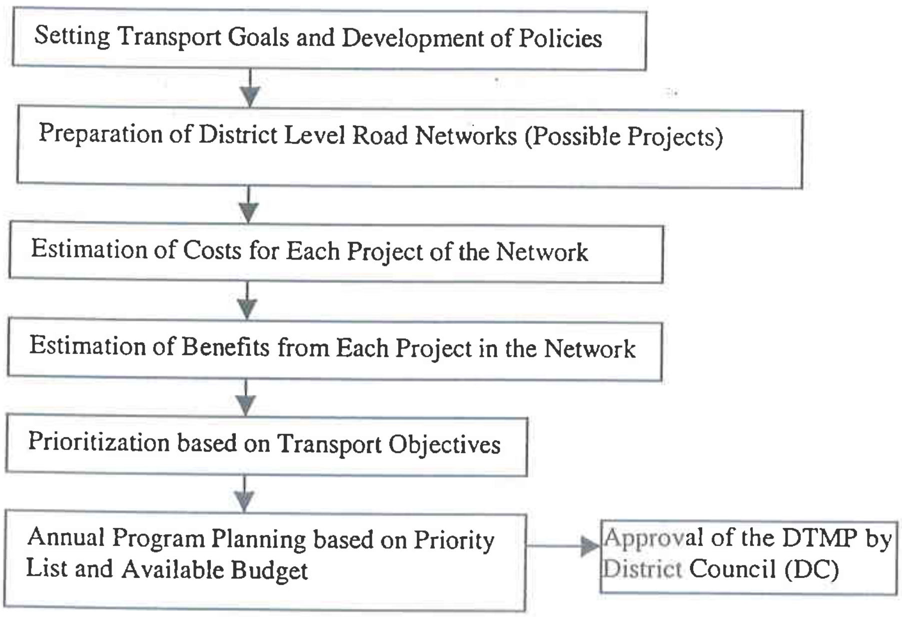


Figure 1.1 Existing District Level Road Network Planning Process based on the DTMP

In this sequence of planning activities, the main research problems are identified in the preparation of district road networks and estimation of costs and benefits. This study, therefore, has taken the areas of planning and prioritization for investigation.

1.4.1 Lack of an Appropriate Model for Developing the District Road Networks

Several road network optimization models (Garrison and Marble, 1962; Billheimer and Gary, 1973; Scott, 1969) were developed during the decades of the 60s and 70s. Most of the authors

[1] PLRP Pilot districts: Nawalparasi, Rupandehi, Kapilbastu and Syangja.

believed that an optimal network could be designed mathematically for a given space. However, as commented by Steenbrink (1974), the mathematical programming needs enormous numbers of variables and constraints. Therefore, it is not possible to solve the transport network optimization problem by straightforward application of those techniques.

Other scholars also attempted to find the optimum solution. For instance Ridely (1968) and Ochoa-Rosso (1968) have given a good description of the Branch and Bound technique. Steenbrink (1974) developed a relatively simpler model of road network optimization. Besides him, Dionne and Florian (1979), and Solanki et al. (1998) have attempted to develop optimal road network models. Nonetheless, as argued by Singh et al. (1997), the advanced planning methodologies developed in several countries for higher types of road facilities are not appropriate for the planning of low volume rural roads. They continue the present planning practices for rural roads are mainly based on ad-hoc criteria but lacking a scientific rationale. Therefore, after evaluating all available networking techniques, Singh et al. (1997) have concluded that there is a need to develop a model, which satisfies the constraints and yields the maximum or the minimum value for the objective function. They have further emphasized that the model should be fully computer based and user friendly, so that it could be used by the "grassroots" level planners, i.e. district level staff and their consultants.

Having no handy road networking techniques, Shrestha (1997b) has developed a methodology for road networking. He has used existing Centrality Index[2] to determine the nodal points. In addition to the nodal points, he also considered district accessibility standards[3], existing roads and trails and geographic characteristics for developing the road networks. However, this methodology can not cope with the "what if" scenarios. What is the consequence on the transport networks, if some public or private agency decided to install some facilities in a location? What are the consequences of the construction of a road to the rest of the networks? What if some market centers started to be economically attractive? The second and perhaps, most limiting factor is that the new links are not supported by the traffic demand. Will that road be feasible? How many vehicles are most likely to be operating in a given road is not answered by the road network model developed by Shrestha (1997b). Other master plans (SiDEF, 1998, a and b) also followed the same methodology. With no estimation of the potential vehicles, the road could not be supported by the demand.

1.4.2 Ambiguity in Cost Implications of Labor-Based and Capital-Intensive Technology

Increasing debt burden and unemployment are two major reasons for developing countries to consider employing labor-based technology (Veen and Thagesen, 1996). Therefore, the World Bank and International Labor Organization (ILO), according to Stock and Veen (1996) have been investigating the use of appropriate technologies for civil construction since 1971. One World Bank study conducted in 1971 found that labor based technology was technically feasible and generally produced the same quality of roads compared to equipment based technology. However, another study in 1971-1973 concluded that traditional labor based

[2] Centrality Index: This index measures functional complexity in terms not only of the number of functions in a place, but also their frequency of occurrence. Functions are assigned a weight in inverse proportion to the frequency with which they occur. Thus a technical school or general hospital which are found only a few places. are weighted more heavily than an elementary school or health clinic, which are more wide spread. The centrality index for a place is therefore the sum of the weights of the functions found there; the higher the index the greater the functional complexity (Evans, 1982)

[3] Accessibility Standards: The accessibility standards are defined as the agreed threshold time boundary within which a facility is considered accessible and beyond it is considered inaccessible. In the PLRP, a corridor of three kilometers is defined as the accessible area. However, in case of a natural barrier, the accessible area is limited up to that natural barrier (PLRP, 1997a).

methods of construction were not economically competitive with modern equipment based methods even at low wage rates. Stock and Veen (1996) further mentioned that a study conducted over the period 1973-1976 found that in low wage countries, labor based methods could be fully competitive with equipment based methods, as long as workers were provided with adequate tools, good incentives and effective management. Rieger and Bhadra (1979) compared the construction cost of different road projects. They found that the labor-based technology is cost effective in comparison to the capital-based and labor-intensive technology. They also found that the labor-intensive technology is cheapest in terms of shadow price. However, the study could not access the first hand information on the capital-intensive projects. Similarly the projects were implemented in different topographic, geological and administrative setup. Its recommendations are also controversial. On the one hand, it attempted to promote the labor-based technology on the other hand it recommended exempting the import duty on the spare parts of the equipment. Consequently, HMGN has been expressing its determination to promote LBT for alleviating poverty (NPC, 1998). However, it is levying nominal tariff rates on capital-intensive equipment imports. The situation has distorted the construction cost and has hindered the adoption of appropriate policies.

It is generally believed that the Labor-Based Technology (LBT) is cost effective and can produce similar results to capital intensive technology for constructing some of the infrastructure works. However, no authentic study has so far been conducted in Nepal to prove the worthiness of LBT in the specific physical and economic conditions.

1.4.3 The Confusion in Technique for Assessing the Benefits of a District Road

The central problem in the appraisal of a road project is to forecast economic activity and the associated demand for transport (Carnemark et al. 1984). Therefore, road user savings (mainly from existing traffic and some from diverted and generated traffic) are the basis for assessing benefits. However, Carnemark et al. (1984) argue that the neglect of development aspects of road investment is a major weakness in the analysis of nearly all road projects, particularly those which envision large increases in generated traffic. To include the development impact was the main motive for introducing the producer's surplus Model. Unfortunately, as the Transport and Road Research Laboratory (TRRL, 1996) mentions, the practical application of the agricultural production approach in the field has been poor. The empirical justification for estimating changes in agricultural production has been weak and a failure to consider all relevant costs of production has led to benefits being overvalued. Therefore some recent studies (for example: Tracey-White and Vaidya, 1998) have again adopted the consumer's surplus approach for evaluating rural road projects. They have adapted the consumer's surplus approach because, according to them, it avoids the problem of measuring the effect of road improvement on other economic activities (e.g. increased agriculture production and income growth) which depend on other complementary efforts and investments beyond the boundaries of the project. By returning to the use of the consumer surplus approach, the associated development effects of a road project remain unanswered. Therefore, the incomplete nature of theoretical models may be contributing to inappropriate project selection leading to underdevelopment of many rural areas in developing countries.

In Nepal, Shrestha (1997b) has proposed to calculate the benefits not independently but to consider the economic benefit as one of the criteria for prioritizing a road link. He has taken beneficiaries and cultivated land within a linear Zone of Influence (3 km on either side of a road) as indicators of economic benefits. The reduction in transportation cost might be reflected indirectly by the improvement in the accessibility score. The basic problem with this approach is the quantification of economic benefits. An analyst is not clear whether an investment is generating sufficient social benefits or not. Therefore, there is no bottom line for rejecting the road proposal or offering a lower level of transport infrastructure if the minimum required trips for a higher level road do not exist. The other World Bank supported projects in Nepal have followed the producer's surplus approach. Therefore, the wide spread confusion and ambivalence to adapt a proper method has handicapped the transport planners from selecting appropriate projects and allocating the scarce resources.

1.4.4 District Level Funding and Financial Management Issues

The DDCs in Nepal receive funding for district level roads from nine different sources. However, all sources are not coordinated (PLRP, 1997a). HMGN allocates certain funding through the DOR. A few road projects are implemented by irrigation projects. Others are maintained by manufacturing and service industries like sugar mills, hotels and resorts. Therefore, overlaps and gaps in District Roads implementation are common. The food resource received from the WFP is not recorded officially by the recipient district. Therefore it is not transparent (PLRP, 1997a). Similarly, funds from the constituency development program are seldom spent on the district roads but depend on the personal discretion of a Member of the Parliament. The funds from NGOs are also not the reliable source of funding. The NGOs are typically interested in socio-economic related projects like poverty alleviation and literacy programs rather than capital-intensive infrastructure projects. Therefore, the most reliable and significant sources of funding for district level roads are block grants received from the MOLD and own source of revenue of the district. However, the annual MOLD block grant is being reduced (PLRP, 1997a) and in the meantime the budget allocated through DOR is increasing. The budget allocated through DOR for District Roads is invested without consulting the local people's representatives. Therefore, allocating budget through DOR is considered as a reversal of the policy of decentralization. The own source revenue of the district is the regular source of funding for maintaining the District Roads. Nonetheless most of the legal provisions of local taxation are either totally inactive or generate an insignificant amount of revenue. The discussion indicates that the available resources are not efficiently coordinated.

Secondly, the present size of available budget is far below the requirement for maintaining and constructing the District Roads. The fragmentation of available budget into smaller amounts is one of the major reasons for not being able to complete the road projects. Uncompleted sections are often washed away during the monsoon period. For example the Nawalparasi DDC allocated a budget for district roads that was received from the MOLD for thirteen projects in 1993/94, having an average budget of NRs. 269, 000 equivalent to nearly 5,500 US Dollars (PLRP, 1997a). The number of projects decreased to five in 1994/95. However, the DDC again fragmented the available fund to twelve different projects in 1995/96. Assuming one million rupees per kilometer cost, the allocated budget is sufficient only for about three hundred meters of road length. Therefore, the fragmentation of resources has an adverse impact on the road condition because the incomplete road is further deteriorated causing additional environmental degradation and consequently the social costs. This situation causes the local people get extremely frustrated by the performance of the DDC. This situation adversely affects to the credibility of the DDCs.

The question arises why there is a lack of coordination among different sources of funding? Why available resources are fragmented? Why resources are not generated adequately? Due to the political interest, the available resources are fragmented. Having intransparent policy, the district authorities find it difficult to acquire the peoples' participation. The DDCs also have a limited capability to generate and manage the financial resources.

1.5 Research Rationale

No appropriate methodology exists for developing the district road networks with the DDCs in Nepal. There is a need to develop a practice oriented, cost-effective and participatory district road transport planning process to fulfill the development needs at the local level. Therefore the methods and techniques developed by this study are expected to be useful to the DDCs and the central level policy, donor agencies supporting the District Road sector and the local consultants working for the DDCs.

The demand aspect was ignored in most of the past projects that created huge quantities of roads but no agency with a capacity to maintain them. However, this fact is increasingly realized at policy levels. The eighth plan emphasized the economic viability of a road project. It also accorded a high priority to maintenance instead of new construction. The ninth-five year plan emphasized the concept that District Roads should be constructed and maintained by mobilizing local resources (NPC, 1998). To effectively mobilize local resources, it is necessary to consider local level demand aspects for road construction and maintenance. Therefore, this study intends to provide tools necessary to fill that gap.

The local consultants and transport engineers may use the recommended tools, techniques and methods to analyze the situation and to plan the district level roads. With the knowledge of the cost implications of construction and maintenance technology, the contractors can choose the appropriate fleet size, type of equipment and number and type of laborers.

This study will offer an integrated model starting from the district network planning to the prioritization of each road link. An integrated model can better address the problem because all the problem areas of rural transportation are interdependent. The selection of a particular technology will have a direct impact on the transportation costs. The level of transport demand determines the type of transport infrastructure. Therefore, the district transport planners should be aware of the implication of a change in one variable on the entire system. By offering a simple computer model, this analytical methodology shall facilitate the simulation of different probable scenarios that could be helpful for the district level transport planners.

1.6 Research Questions

The study has postulated the following research questions:

- What are the issues that need to be considered while developing the district road networks?
- What could be the basis for forecasting the future demand?
- What are the cost implications of different types of construction technologies on the overall viability of a road project?
- How to assess the benefits of a district level road?
- Are the existing models for planning and prioritizing the district road networks appropriate for meeting the needs of the developing countries like Nepal? If not, what type of model could be appropriate to address the actual needs?

1.7 Research Objectives

The broad objective of this study is to develop a methodology for planning and prioritizing the district road networks for the developed as well as underdeveloped areas. The analysis is intended to facilitate the district level transport planning process.

The specific objectives of this study are:

- To assess the strengths and weaknesses of the existing district level transport planning process.

- To propose an appropriate methodology based on the "*state of the art*" in the field of rural and regional transportation and adapted district reality in Nepal. The sub-objectives of developing an appropriate methodology are as follows:

  - To formulate the district road networking methods for areas with different degrees of development.
  - To examine the transport demand as a function of intensity of interaction.
  - To compare between capital-intensive and labor-based technologies used for road construction.
  - To identify the prioritization criteria for the areas with different level of development.

- To test the road network planning methodology in a selected district of Nepal.

- To recommend a computer-aided model for planning and prioritizing the district road networks.

1.8 Scope and Limitations

The study shall mainly focus on developing a district road network based on present and potential interactions of settlements and land use pattern. This study will attempt to identify cost implications of different types of technologies (different combinations of labor and capital). Ultimately, based on the economic rate of return (ENPV, EIRR, EBCR), and based on other socio-economic criteria, the links in the network will be prioritized.

This study only focuses on the district level roads and trails. All other transport infrastructure will be covered by this study as the given phenomena. This study does not intend to develop the methodology for roads other than the district level road networks.

This study has taken Nawalparasi district as the study area. The rationale behind selecting Nawalparasi district is its diverse agro-ecological zones. The district contains plain area (Terai), Upper Plain (Inner Terai) and hilly area. Besides that, the district was one of the pilot districts of the PLRP. The DTMP prepared by the DDC-Nawalparasi with the support of the PLRP is a point of departure for this study. Although this study collected data from the Nawalparasi district, the road productivity data from RIDP at Kavrepalanchowk and Baglung and Malekhu – Dhadhing Road Project (MDRP) were also collected.

The interviews with the policy makers, national level workshop on developing methodology for planning and prioritizing the district road networks, as well as the testing and simulation exercise of the methodology were intended to reflect the real life situation in the proposed methodology. Nonetheless, the actual reaction of people for the real allocation of resources and the way they acted during the simulation exercise may be different. Having no need of immediate financial commitment, it could be possible that the DDC members turned out to be liberal, unbiased and rational during the simulation exercise. In the real life situation, planning of the district level road networks involves political negotiations among the DDC members for regional and sectoral allocation of resources. Therefore the actual behavior could be different from their role in the simulation exercise.

1.9 Organization of the Study

There are ten chapters in this dissertation. A review of literature is presented in Chapter II. The literature review discusses the networking techniques and estimation of the transport demand. The factors influencing the construction costs and benefits of a road project is also elaborated. Additionally, computerized models and "state of the art" in the field of regional and rural transportation planning is discussed.

Chapter III deals with the research design. The methodology was developed through four successive stages. This chapter also includes the data and information collection techniques and processes for testing the methodology.

Chapter IV assesses the financial situation, availability of the manpower and required equipment and district road planning process. The assessment is the basis for the SWOT analysis.

Chapter V synthesizes the opinion of the respondents regarding developing a district level road network, estimation of the transport demand and technological issues. Additionally, this chapter also deals with the benefits of the district roads and appraisal techniques.

Chapter VI presents the developed methodologies for plain and hilly area. The methodology is based on the "state of the art" and the research findings. The developed methodology is applied in the Nawalparasi District of Nepal, which is dealt in Chapter VII.

The comparative analysis of transport demand, construction cost and benefits are focussed in Chapter VIII. The test results of the methodology are shown in Chapter IX.

Chapter X summarizes and concludes the study.

Chapter II
Literature Review

The basic objective of this study is to develop a planning methodology for developing and prioritizing the district road networks. The planning methodology includes networking, estimation of transport demand, cost implications of the technological options for road construction and assessment of benefits. Estimation of costs and benefits is followed by the prioritization of the projects.

The literature review is intended, therefore, to survey the "*state of the art*" situation in the different aspects of the regional and rural transportation. The relevant theories, models, tools and techniques are evaluated. In accordance with the research objectives, the literature review is broadly categorized into five groups. They are: 1) General Overview of Transportation Infrastructure Sector 2) Available Models for Developing the Rural Roads Networks 3) Models for Appraising and Prioritizing the Road Projects 4) Cost Implications of Technological Options for Road Construction and 5) Project Appraisal Techniques for the District Roads. This chapter elaborates and prepares the ground for adopting or further developing the methods and techniques.

2.1 General Overview of the Transportation Sector

This section deals with the comparative scenario of roads in different countries. It would have been a better comparison if only road density of the district level roads were compared. Nonetheless the statistics are not available to that detail. Therefore only the national level statistics of different countries are compared for giving a general scenario. The countries are selected as representative of developed, developing and the least developed countries. Additionally, a description is given about the road classification in Nepal.

2.1.1 A Comparison of Road Length in Selected Countries

There is a vast difference in the availability of transportation infrastructure in developing and developed countries. As shown in Table 2.1 West Germany has 63 times more road density than Ethiopia and nearly 46 times more than Nepal. In terms of income, an average West German citizen earns 81 times more in comparison to an Ethiopian and more than 65 times more than an average Nepali. In terms of road length (km) per 1000 population, the United States of America occupies the first position followed by Brazil, Germany and United Kingdom. Bangladesh, Ethiopia and Nepal are among the least developed countries in terms of this criterion as well. Therefore as shown in Table 2.1, there is a positive relationship between income and road density. However, the correlation is not that strong because the correlation coefficient between those two variables is 0.68. Other factors like population density and distribution of the arable land also have an influence on road density.

Table 2.1 does not show the type of roads. However, statistics of the developed countries like the United States, Germany and United Kingdom may have included all types of roads. In contrast, the rural roads in developing countries are largely unrecorded and unsurveyed. The PLRP (1997c) found that the actual length of district level roads (including earth roads) was nearly 6 times greater than the officially reported data. That is also one of the major reasons why rural roads find a lower level of importance in national level policies. Howe (1997) maintains that much of the literature on development processes all but ignores the traditional transport network and focuses only on the modern part. Therefore rural roads are largely overlooked and thus are poorly maintained. The district roads are part of the rural roads.

Table 2.1 Relationship between Per Capita Income and Road Density

Country	People 000, 1985	Income $, 1985	Rank	Road Length Km.	Area km²	Density (People/km²)	Road Density Km/sq. km.	Rank	Road Length (km)/1000 pop.	Rank
India	750900	226	8	1545891	3287590	228	0.470	4	2.05	7
USA	239283	14565	1	6261876	9372570	26	0.668	3	26.17	1
Brazil	135564	1300	5	1583172	8511965	16	0.186	6	11.67	2
Bangladesh	98657	150	8	7556	143989	685	0.052	9	0.076	11
Germany (W)	61015	8950	2	490045	248577	245	1.971	1	8.03	3
UK	56618	7156	3	370970	244100	232	1.520	2	6.55	4
Thailand	51310	661	6	76315	514000	100	0.148	7	1.48	8
Ethiopia	43350	110	11	37871	1221900	35	0.031	11	0.87	9
Kenya	20333	270	9	54584	582646	35	0.094	8	2.68	6
Nepal	16625	137	10	6015	140797	118	0.043	10	0.36	10
Bulgaria	8957	3200	4	37594	110912	81	0.339	5	4.19	5

Source: EPL, 1987

2.1.2 Road Classification and Design Standard in Nepal

The DOR (1994) has classified roads into five classes: National Highways (NH), Feeder Roads (FR), District Roads (DR), Urban Roads (UR) and Village Roads (VR). According to this definition, the National Highways connecting East to West, North to South and those joining the main, north-south valleys of the nation, and the roads connecting National Highways to Regional Headquarters are also classified as National Highways. The Feeder Roads are important roads of a more localized nature than National Highways. According to the DOR classification the District Roads are defined as those roads within the district which serve primarily by providing the access to abutting land carrying little or no through movement. The Urban Roads are constructed within the municipality boundary and Village Roads connect individual villages to the District Roads.

The design standards of National Highways depend upon the Annual Average Daily Traffic (AADT) on the given road so is difficult to standardize. The DOR has developed the design standards for the FR. All roads having AADT more than 50 is classified as truck standard and other roads having AADT less than 50 is classified as tractor/trailer standard.

In order to ascertain and adjust the volume of traffic, the DOR has initiated the concept of stage construction. Five development steps are laid down which should, in general, be implemented in succession. In the first stage, the project is formulated and a detailed design is carried out. A fair weather earth track is opened up in the second stage that is followed up with the fair weather gravel road in the third stage. An all weather gravel road is constructed in the fourth stage. In the final stage, the all weather bitumen road is constructed. A summary of per kilometer construction and maintenance cost of rural roads in Nepal is given in Annex 2.1.

The PLRP (1997b) modified the DOR definition of the District Roads. According to the PLRP definition, the arterial roads linking two district headquarters, main trading centers to higher classes of roads with through movement but other than defined as Feeder Roads by the DOR are defined as the District Roads. This definition recognized that there is a possibility to have the roads of arterial characteristics that are still not defined as the Feeder Road by the DOR. This study largely follows the PLRP definition of the District Road. The exact characteristics of the road that this study has undertaken are described in section 1.3.

2.2 Road Networking

This section describes the traditional models of transport network and settlements interaction network models. In addition to that, the possibility of computer application for developing the networks is also discussed.

2.2.1 Limitations of Traditional Transport Network Models

Rural transport networks in a primitive form exist wherever human settlements emerge. However, development intervention like road construction changes the interacting pattern among settlements and establishes new flow patterns. Therefore, the transportation planners are supposed to understand the dynamism of interaction pattern among settlements and guide the development process to minimize the overall transportation cost.

Transportation Planners have borrowed a substantial body of knowledge from graph theory (Price, 1971; Boffey, 1982). Minimum Spanning Tree, Steiner Minimal Tree and Shortest Path Tree Problem are some of the graph theoretic problems. These models are useful for road selection because they can incorporate functional interdependence of roads. However, budgeting interdependence is difficult to handle by these models (Khan, 1984). The network optimization problems, which can be used to model decision problems, require the incorporation of both functional and budgeting interdependencies of roads.

Mathematical programming is one of the Optimal Network Problems (ONP). However, the difficulty with the mathematical programming is the enormous number of variables and constraints. Therefore it does not seem to be possible to solve the transport network optimization problem by a straightforward application of those techniques (Steenbrink, 1974).

Branch and bound technique is another ONP that tests all possible solutions of a combinatorial optimization problem in a very intelligent way. Instead of competing the objective function for every possible combination of the decision variables only a small set of possible combinations have to be fully tested and the remaining possibilities can be rejected using boundary rules (Steenbrink, 1974).

Many authors including Ridley (1968) and Ochoa-Rosso (1968) have given a good description of Branch and Bound technique. In principle, it is possible to solve the network optimization problems with the help of Branch and Bound Technique. However, it takes a lot of computing time even for moderately sized networks, especially when a capacity restraint technique is used. Therefore branch and bound has until now only been used in practice directly for networks of up to twenty or thirty nodes (Steenbrink, 1974).

Optimal solutions from mathematical programming and Branch and Bound technique are extremely difficult to find if not impossible. By the same reason, it consumes a long time, which in most instances is not available to Planners. The objective may then change from finding an optimal solution to finding a feasible solution, that is "fairly" good or "near optimal". Heuristic methods offer such a solution for networking. However, quite often one does not know how far the solution found is from the optimal area. Even if we have a good estimate for the distance between the solution found and optimal solution for the objective function, we do not have the one for decision variables. The distance can be large, even if the value of the objective function is not too far from the optimal value (Steenbrink, 1974).

There are some recent efforts to overcome the problems with conventional heuristic techniques. Solanki et al. (1998) have presented a Modified Quasi-Optimization (MQO) heuristic developed by Dionne and Florian (1979). The computations were preformed on a Sun Sparc–10 workstation. The base network consisted of 6563 nodes and 9800 two-way links in the south central region of U.S.A. The first problem consisted of developing a network (i.e. selecting a sub-network from the complete set of highways in the National Highway network from the complete set of highways in the National Highway Planning Network, U.S.) to link together 10 counties with a projected 2020 population of at least 480,000 persons. Problem 2 addressed the same network problem, but used 20 counties with a projected 2020 population of at least 250,000 persons. Problems consisted of 30 counties with 2020 population above 178,000 persons. Solanki et al. (1998) conclude that the optimal network design heuristic was able to generate good solution networks for three realistic network design problems in a computationally feasible manner. The algorithm appears capable of producing near-optimal results on large network design problems within a few minutes of run times on a Sun Sparc-10 workstation.

Khan (1984) has evaluated the methods and concluded that the network design problems like ONP are useful models for selecting road projects because among other things, they can incorporate both functional and budgetary interdependence of projects. These models are, however, not so useful for planning rural roads in developing countries. Solutions to network design problems depend on travel costs, which are not very important for rural roads. That is, the reduction of travel cost by shortening the distance to be traveled is of secondary importance because there are many places, which are not at all accessible. Therefore, network design problems are more suitable for urban network planning.

The difficulty of solving network design problems is also their disadvantage as decision models. Similarly requirement of large volume of data and considerable time are other restricting factors especially from the perspective of the DDCs which have limited resources and capable manpower. Therefore Garber and Hoel (1996) succinctly argue that the formation of the nation's transportation system has been evolutionary, not the result of a grand plan. The system now in place is the product of many individual decisions to build or improve its various parts, such as bridges, highways, tunnels, harbors, railway stations and airport runways. There is no precedence of the uses of ONP to design a district road network. Therefore, optimality could be a suitable concept for designing a road network in a newly developed area but not for the rural districts of developing countries where people have been living for centuries.

2.2.2 Settlements Interaction Based Network Models

Few scholars have attempted to develop the regional and rural transport network based on the hierarchy of settlements and interaction among them. The theoretical background of the hierarchy of settlements is the central place theory propounded by Christaller (1933). The central place theory suggests that there exist a different hierarchy of settlements where higher level settlements offer a higher level of goods and services and vice-versa. Lower level settlements thus obtain a higher level of goods and services from higher level settlements. Mahendru et al. (1983) have proposed to adopt a five-tier hierarchy system at the state level in India. They are Central Village, Service Center, Growth Center, Regional/ Sub-regional center or District/ Sub-district center and State/ Sub-state center. A theoretical model of spatial distribution of central places consisting of central village, service center, growth center and district/ sub-district level center, arranged in a hexagonal pattern. The entire region can be served by a few such central places.

Mahendru et al. (1989) further refined their network model based on settlement interaction patterns in their previous approach. The desire for interaction among the settlements can be identified and quantified in the form of force of interaction which can be mathematically expressed by equation:

$$F_{ij} = (P_i P_j(|CS_i - CS_j|))/ d^n_{ij}$$

Where, F_{ij} = Force in interaction between two settlements i and j.
P_i and P_j = Population of settlements i and j respectively.
CS_i & CS_j = Centrality score of settlements i and j respectively
d_{ij} = Spatial distance/ intervening distance between nodes i and j.
n = Deterrence factor which can be suitably assumed or can be found by conducting surveys for rural travel pattern.

The force in interaction indicates the demand for a road between two given settlements. Singh et al. (1997) have pointed out the limitation of this approach. If, they mention, one village has some particular facility (say, education) and another village has some other facility (say hospital) then there should be a good interaction between the two but in this approach, if the difference in score is used which nullifies the score, the approach will give little or no interaction. Secondly, it is population biased and no attention is given to the construction cost.

A similar approach is proposed by Khan and Mohit (1989). The theoretical framework of their study is based on the concept of the hierarchy of settlements, which provides the nodal structure, and graph theory that helps to determine the network structure.

Shrestha (1997, b) has recommended to define the hierarchy of settlements at the first stage of networking. In addition to the settlement hierarchy, he has suggested including ancient ruins, historical and religious monuments and sites as the obligatory nodal points for network planning. At the second stage, he has proposed to prepare the existing road and trail network, which helps to delineate the inaccessible areas. He concludes that the road network should be developed based on district accessibility standards, obligatory points, existing roads and trails, demand from local people and geographical characteristics.

Therefore there is precedence that settlement interaction based network models are implemented in India, Nepal and Bangladesh. After improving its limitation, the settlement interaction based network model can be implemented in the rural areas of other developing countries. Unlike to the ONPs, this model requires less information, can be easily handled by the technicians of the DDCs. Moreover, it is transparent therefore convincing to district level policy makers and other stakeholders.

2.2.3 Possibility of Computer Application for Developing District Road Networks

Geographical Information System (GIS) packages are increasingly being used for solving spatial problems. The planning of transport networks, as purely a spatial phenomenon, can be understandably benefited by the GIS packages. The buffering operation[1] offers a facility to delineate the accessibility of an area with that of inaccessible areas. Besides that, it is convenient to study the land use pattern within the buffer zone for the purpose of economic evaluation. The overlay functions, neighborhood operations and connectivity functions are the major GIS functions (Aronoff, 1989). Computer software packages are responding to the demand of transport network designers and have included "network analyst" and "spatial analyst" in their packages (ESRI, 1996). The GIS is being used to solve several complex urban transportation problems like minimizing congestion management (Taylor et al. 2000),

[1] Buffering operation is commonly used in GIS literature to delineate Zone of Influence based on distance criteria measured from the road network.

intermodal and international freight network modeling (Southworth and Peterson, 2000), and travel time forecasting (You and Kim, 2000). However, the district transportation problems are rather simpler therefore, simple GIS functions are enough for analysis.

TransCad is one of the pertinent GIS packages designed specifically for use by transportation professionals to store, display, manage, and analyze transportation data (Caliper, 2000). TransCad includes sophisticated GIS features like polygon overlay, buffering and geo coding. Besides that the TransCad provides a comprehensive solution for many types of transportation problems like network analysis, transportation planning and travel demand modeling, vehicle routing and logistics, districting and location modeling. Nonetheless, the purchasing cost of a license could be the limiting factor for using this software especially for the local governments.

Other computer packages developed for spatial planning could also be useful for analyzing transportation problems. Among them LADSS, FLOWMAP and LocNet are particularly worth mentioning. LADSS is intended to optimize the location of facilities such as schools and hospitals (Ghosh and Rushton, 1987). Although it might not be directly relevant for transport network planning, it could be an appropriate reference tool for analyzing the impact of the facility allocation on the road network. Similarly Flowmap can be used for spatial interaction analysis and simulation procedures such as desire lines, gravity modeling, potential surface, proximity and network based accessibility analysis (Kammeier, 1999). In the context of utilizing the centrality index for developing the regional road network, the settlement score and catchment score derived from the LocNet could be the appropriate information. LocNet can be used for analyzing the service facility system and improving the transport networks. It also offers the facility of simulation and comparative analysis of spatial planning options (Kammeier, 1996; Kammeier, 1999).

2.3 Link Based Transport Demand Assessment

A transport network consists of several links and links have different characteristics. Some of the links might have already constructed and others should be newly constructed or rehabilitated. On the other hand, different links may have different owner. Some of the hinterland links could be constructed only upon the construction of the roads connecting the present road heads. Therefore the district level road network consists of the roads which are either under the DOR or under the DDC. The DDC does not assume responsibility for construction and maintenance of the national level roads. The DDC is only responsible for the district level roads either for maintenance or for new construction. Therefore the demand estimation should be mainly focussed on the district level roads. However, a district level transport planner should have information on the volume of traffic operating on the National Highways and Feeder Roads, which are under the DOR.

For the purpose of geometric design and the evaluation of economic benefits, the volume and composition of current and future traffic needs to be known in terms of cars, light good vehicles, trucks, buses and non-motorized vehicles (TRRL, 1988). In the case of Nepal, portage and animal (mainly mules, horses) transport should also be considered. The objective of carrying out travel demand analysis is to understand the interrelationships between existing travel patterns (both passengers and commodities) and rural life and economy (UNCHS, 1985). Once the factors influencing and constraining observed travel behavior or demand are identified and their interrelationships understood, the impact on rural development of policy decisions, such as, pricing, road building, provision of public transport access or extension of credit for the purchase of vehicles, can be roughly foreseen. More importantly, the travel demand determines the type of transport infrastructure. Therefore, it is directly related to the sustainability of a project. Besides the existing traffic, the road receives diverted and generated traffic. How much traffic it diverts depends upon the price or time elasticity of demand. The traffic generation depends upon several factors. One of the impact studies (Blakie et al. 1980) has suggested that the road construction in west central Nepal has contributed to a massive increase in the volume of goods imported form India and transported throughout the region. Secondly, the road promoted social visits (the use of transport facilities as consumption goods). Blakie et al. further argue that the reduced transport cost could not promote production in the road service area. It means, that although the volume of traffic generated was substantial, local production did not increase. Therefore in such circumstances, obviously, the producer's surplus model does not function. Another recent study of the GTZ (Rapp, 1997) has concluded that one of the roads constructed by the Dhadhing Development Project in Nepal could not result in significant economic changes in the field of agriculture or rural industry or in the development of increased long term off-farm employment possibilities. Sakko (1997) found that rehabilitated roads carry 10 percent more motorized vehicles than non-rehabilitated roads in Cambodia. The frequency of travel increased to 3 times a day from 2.7 times a day. The study, however, did not indicate whether productivity changed in the study area.

Francisco and Routray (1992) studied a case of infrastructure improvement in the Philippines. They examined the economic impacts of road transport in terms of increased productivity. They found that paddy production reached to 2.91 MT/ha from 1.96 MT/ha. Similarly, there was an impressive increase in the productivity of string bean, root crops and mango. Market surplus of paddy rose to 1.82 MT/ha from 0.6 MT/ha. String bean and root crops have market surplus of 2.93 MT/ha and 2.33 MT/ha against the less developed area of 1.12 MT/ha of string bean and 1.46 MT/ha of root crops. The market surplus of mango reached to 1.66 MT/ha from 0.65 MT/ha. They concluded that, the impact was positive in terms of productivity. Nonetheless, the increase in productivity seems to be incredibly on the higher side. Particularly it is questionable because productivity is not a function of improved access alone. They have warned that the road may also have negative environmental and economic impacts.

By increased level of productivity and interactions, a new transport infrastructure generates, generally, additional traffic but how much does it generate depends on several factors like entrepreneurship of local people, characteristics of the land, other subsidiary facilities like irrigation and availability of investment capital.

The five (four)-step transport demand models is the most prominent model for estimating urban transportation. Some people include the analysis of land use in addition to the trip generation, trip distribution, modal split and traffic assignment and call it five-step model. Some people consider the land use analysis part of the trip generation therefore they call it a four step model. Besides the five step model, there are also other models like Sketch Planning Method (OECD, 1974 and Sosslaù et al. 1978), Pivot Point Modeling (Kumar, 1980), Incremental Elasticity Analysis, Model estimation from traffic counts, Marginal and Corridor Models and Gaming Simulation.

Almost all of those models are developed in industrialized countries in connection with the preparation of urban transport plans. But such models are of limited use in developing countries, where incomes and land uses change frequently and rapidly, particularly in the cities and where data are often inadequate. In addition, the models can not easily handle major changes in transport policies, such as changes in transport prices, and they tend to be weak in incorporating feedback on the number of trips made when the supply of transport is changed. Most importantly they are expensive and data hungry.

Trend analysis approach to demand estimation is based on simply extrapolating past trends. Although simple in application, trend line analysis has the disadvantage that future demand estimates are based on extrapolations of the past and thus no allowance is made for changes that may be time-dependent (Garber and Hoel, 1996).

Howe (1977) concluded that the flexible use of vehicles and the absence of a conventional sampling frame are the main obstacles to the application of landuse/traffic interaction principles for forecasting travel demands. He suggests to use the vehicle owners as a sample frame from which to record trip making. More importantly, he has recommended that the intensity of government services and their relations to level of economic development and trip generation is worthy for further study. Therefore this study has attempted to establish relationship between the volume of trips with the centrality index, population and distance between two settlements.

2.4 Cost Implications of Technological Options for Road Construction

Shone and Brudfors (1997) have drawn an historical sketch of the use of labor in construction works. They further continue that the viability of using labor force in most of the developing countries persists because of the low wage rate. Because in Europe the daily wage for unskilled labor is around US $ 100/day, the use of equipment based methods is clearly more appropriate.

The World Bank (1994) has defined labor-based technology as the use of an optimum mix of labor and equipment in order to achieve the lowest cost. Stock and Veen (1996) have defined labor-based methods as the use of labor and light equipment as the pre-dominant mode of production. Although there is consensus regarding the definition, the optimal mix of labor and capital is a relative phenomenon in general and thus depends on several factors.

During the decades of the 1970's and early 80s, the International Labour Organization (ILO) and the WB conducted several studies to find the optimal mix of labor and capital. A study was conducted by Harral (1970) in India and Indonesia. The study concluded that labor-intensive construction techniques traditionally practiced in many developing countries are not economically competitive with the equipment intensive technology. Therefore the study recommended that in future work major emphasis be placed on development and demonstration of more efficient labor-intensive and intermediate civil construction technologies appropriate to labor abundant, capital scarce economies. Another study prepared by the ILO for the government of Pakistan recommends labor-intensive methods for earthwork operations. For the rest of activities, the study recommended to integrate the use of labor-intensive methods with more equipment intensive techniques.

The International Bank for Reconstruction and Development (IBRD) assigned Scott Wilson Kirkpatrick and Partners (1974) to follow-up on the findings of Harral (1974). The study, carried out in India with the objectives of employment of improved tools and machinery with a view to obtaining higher productivity of labor and increased efficiency of equipment, found that a significant increase in productivity can often be achieved with the introduction of small items of equipment and different construction techniques. The increase ranged from very little in the case of embankment construction to a 4 to 5 fold increase when a light railway was used to haul boulders over a lead of 150 – 200 m.

Irvin (1975) seems to be in consonance with Harral (1974). He explains that the labor-based technology is uneconomical from the point of view of a private entrepreneur. However, it is socially feasible. Therefore, Irvin recommends that the government should intervene by use of appropriate policy tools like subsidies to the private sector, amendment of specifications and contract documents.

McCleary et al. (1976) studied the cost implication of labor-based vis a vis capital-intensive technologies in Thailand. His findings are also very closer to Harral (1974) and Irvin (1975). Another Filipino study (Lal, 1978) found that capital-intensive technology is more expensive than modified labor-intensive method but is cheaper than traditional labor-intensive method in the case of concrete paving roads. He has devised different cheapest options for excavating and hauling. Bulldozer is cheapest up to the distance of 25 m, buffalo-drawn cart is most suitable for the distance between 25-250 m, farm-tractor is appropriate for 250-5000 m and Dump-truck is financially attractive for distances above 5000 m. However, the scenario changes if costing is done in shadow price[2]. Then the bulldozer is no longer an attractive option.

All studies have reached the following consensus:

- Traditionally practiced labor-based technology is not competitive financially with the capital-intensive methods.

- Intermediate technology, which uses small tools and equipment, could be closely competitive technically with equipment intensive technology and it could be financially attractive in some road construction activities.

- Labor-intensive technology may not be attractive in the market price, it is definitely attractive in shadow price therefore it is socially desirable if not commercially viable. Therefore, the governments of developing countries should develop appropriate policy measures to ameliorate the situation of employment.

Rieger and Bhadra (1979) conducted a comparative study on road construction technology in Nepal. Their main findings are presented in Table 2.2.

Table 2.2 Cost per Unit of Output in Individual Work Stages of Projects Studied, Valued at Standard Prices

Amount in NRs.

Project[1]	Capital/Labor ratio	Earthwork (Rs/10000 m^3)	Sub-base/base (Rs/10000 m^2)	Surfacing (Rs/ 10000 m^2)	Total Cost for 3 work stages (Rs/Km)
British	3.48	137,748	67,853	13,817	341,298
Chinese	0.41	121,144	66,102	14,128	307,278
Indian	1.07	75,159	79,376	50,971	243,776
Russian	121.83	219,352	41,402	57,074	489,114
Standard	12.97	94,421	49,307	14,563	238,525

[1] Projects named after the funding agencies.

As shown in Table 2.2, the difference in capital-labor ratio of different projects is significant. The Russian project seems to be the exceptional. The total cost of the Russian project is just two times higher than the Indian project. If all other variations are kept constant, it can be concluded that the capital-intensive technology is most expensive. The Russian project has highest capital labor ratio of 121.83 and also highest total cost of NRs. 489 thousand. The Chinese project, which uses labor-intensive technology, is 1.26 times more expensive than the

[2] Shadow Price: The shadow price is used in the project appraisal for correcting the distortions of the market place. For instance taxes, tariffs, interest charges might affect the profitability of an individual company. However, such costs do not effect the economy as a whole. Therefore, economic costs and benefits are normally calculated in the shadow price.

labor-based technology of the Indian project. Therefore the labor-based technology is found to be most cost-effective technology. However, if costs are calculated on the basis of shadow prices, the scenario changes. The labor-intensive technology of Chinese project becomes cheapest followed by the labor-based technology and capital-intensive technology.

At the first glance, the findings seem to be robust. However, the basis of this analysis is weak. The study has mentioned that the team had no first hand access to the cost information of the Russian project. The study projects were implemented in different topographic and geological conditions. Moreover, the analysis is controversial. For instance, after getting findings of cost effectiveness of labor-based technology, why it recommended to exempt the import duty of all spare parts required for the equipment available in the country and to adopt all methods capable of facilitating the speedy import of such spare parts. Such policy promoted further mechanization of the construction technology contrary to the objective of creating job opportunities for rural people.

No authentic literature could be traced for the period of 1980s and 1990s regarding the comparative assessment of the construction technology. Nonetheless, Shone (1994) claims that the economic justification for the use of labor based methods have for some time been proven on a country by country basis. Therefore, he argues it is no longer necessary to make a case as such for considering the viability of labor based methods.

Edmonds and Veen (1992) emphasized to create awareness at different levels of the socio-economic implications of not utilizing local resources and to introduce the labor-based approaches into the curricula of faculties of engineering and technical colleges. Petts (1999) has prepared a handbook of intermediate equipment for roadwork in developing countries. He implicitly states that the undervaluation of equipment in developing countries may have contributed an artificial environment of cheap equipment-intensive methodology. Therefore, he has recommended considering all direct and indirect costs so that the rents reflect the actual worth of equipment.

Veen and Thagesen (1996) have reported that the cost-effectiveness of labor-based technology has been demonstrated convincingly in terms of quality, speed and cost in Ghana. They have mentioned that in the period from 1986 to 1993, 1190 km of roads were rehabilitated at an average cost of US $ 14,000 per km at a daily causal wage rate of US $ 1.70 (1993). The average rehabilitation cost of comparable roads by equipment was US $ 16,000 per km. The savings in foreign exchange, according to them, have been up to 50%. Additional job creation and local skill development are other tangible benefits of labor based technology.

House of Consultants (HOC, 1997) conducted a study of labor wage rates, productivity norms and income/expenditure patterns in 1997 work season under Food for Work Program. The study did not compare the costs but produced productivity-related findings. The output of compaction was found 0.67 m^3/hour. The hourly clod breaking output was 1.543 m^3 and deweeding and clearing was 14 m^2/hr. It was found that the hourly output in soft soil is 0.40 m3 while that in hard and slushy soil was 0.20 m^3. According to a recent study by Jain et al. (1998) in India, the activities like earthwork, sub-base, base and surface dressing are cheaper by labor based methods in comparison to equipment based method.

Stock and Veen (1996) have identified the factors influencing the technological choice. They are: the availability of labor, the wage rate for unskilled labor, the supply of equipment and spare parts, the productivity of labor and the nature of works to be executed (including the type of works, its location, the way in which it is packaged and the way in which it is designed). Harral (1974) has categorized the factors into three groups as: i) relative productivity of the various inputs under different conditions, ii) project design including design standards and the size of the project and iii) project set up costs associated with the construction method adopted. He has further elaborated the parameters to include climate, vegetation, topography, geology and soil. Organizational parameters are described as the particular form of organization and levels of management and supervision, incentives to motivate the sufficient use of labor and equipment, living conditions at the site; workshops, stocks and equipment maintenance policies and the role of existing trade unions and their relationship with management. Similarly, social parameters also affect the productivity of laborers. Standard of nutrition and health, traditional skills, methods and tools, customary working hours and holidays and human adaptability are some of the factors that affect the labor productivity. Other social factors include work attitude of the population, particularly towards "blue color" work and physical labor and availability and performance of unskilled labor in manual work.

Labor-based technology does not mean only to employ labor instead of equipment. It requires a somewhat a different approach in design and specifications. Meyer et al. (1999) have emphasized that the LBT (Green road-Nepalese version of LBT) should consider selecting the technically appropriate alignment. Ridge alignments are preferable because it avoids major drainage structures. Similarly, alignment on the southwest face of a mountain is better than northeast face. Veen and Thagesen (1996) have maintained the need to adopt a road cross-section, which is appropriate to the techniques used. LBT can produce trapezoidal sections that are more stable than a V-shaped ditch excavated by a grader. Therefore a V-shaped design is suitable for equipment and trapezoidal shape is appropriate for LBT.

Similarly traditional equipment oriented technology demands high compaction standards and quality of materials (Veen and Thagesen, 1996). However, relaxation on those specifications that may be adequate for a rural road, allows LBT to be functional.

Meyer et al. (1999), and Shrestha and Bharati (1996) have maintained that mass balancing is the most crucial as well as the most fundamental principle in a Green Road concept. It involves locating the centerline at the middle of the excavating and embankment area. It helps to balance the cutting and filling works in mountain roads. Veen and Thagesen (1996) have mentioned that earthwork in the longitudinal direction should be minimized. They also include that if road alignment follows the terrain contours, it reduces earthwork drastically.

The green road concept adopts a natural compaction process. As elaborated by Meyer et al. (1999) construction activities are carried out during the dry season and the road is allowed to settle down over the monsoon period after each construction phase. They have recommended manual compaction if critical road sections are encountered, speedy construction is needed or enough funds are available. Nonetheless, Veen and Thagesen are in favor of light compaction equipment. They argue that large mechanical compaction equipment is difficult to move between the many sites being worked by labor crews on large construction projects and are usually under-utilized on smaller projects. The pavement structures require equipment for achieving required level of compaction.

2.5 Assessment of Benefits by Improved Access

There are two main models for quantifying the benefits of road projects. The consumer's surplus is defined as the difference between the maximum willingness to pay and actual payment. Therefore, the consumer's surplus approach to the economic evaluation of road projects stresses the quantification of road user savings (Van der Tak and Ray, 1971). This method, which is sometimes referred to as the vehicle operation cost (VOC) savings method, is best suited for cases where the existing or normal traffic or its projected growth is substantial and the estimated transport cost savings are a reliable measure of benefits of a project (Beenhakker and Lago, 1983). The consumer surplus consists of the savings in vehicle operating cost, savings in traveling time and reduction in the accident rate. Having low volume of traffic and lower speed, the rate of accident is lower in the rural areas. Therefore this study considers saving in transportation cost and saving in traveling time as the direct benefits. There was an ambivalence to use the saved time as the direct benefit in the developing countries. However, Howe (1971) established that the value of time saving is an important consideration in the developing countries. Therefore such amount should be included in the direct benefits of a road project. Beenhakker and Lago mention that the producer's surplus approach, which stresses the assessment of economic activity (particularly agricultural production), is applied in situations where there is little traffic along the road and low levels of economic activity in the area of influence. Unfortunately, the practical application of the agricultural production approach in the field has been poor. The empirical justifications for estimating changes in agricultural production has been weak and the failure to consider all the relevant costs of production has often led to the benefits being grossly overvalued. It is not recommended to use the approach unless there is a great deal of knowledge about agriculture and its likely supply response to changes in input and output prices (TRRL, 1988).

After applying the producer's surplus model for quite a long period (60s, 70s, 80s, and up to early 90s), there is a new trend to use the consumer's surplus model for evaluating rural roads. Tracey-White and Vaidya (1998) have mentioned that the producer's surplus requires detailed surveys and may be more appropriate for a full economic evaluation. The consumer's surplus is simpler and assesses the direct benefits to the users of the road. According to them, benefits are also attributed to the additional traffic, which may be generated by the lower cost of the road. The consumer's surplus also takes account of travel for non-economic purposes (including visits to health clinics, for example) which would have to be considered separately if the producer's surplus approach is adopted. Tracey-White and Vaidya emphasize that the consumer surplus approach directly measures the effects of road improvements and is more easily observable through traffic counts and other indicators of transport use. It avoids the problem of measuring the effect of road improvement on other economic activities (e.g. increased agricultural production and income growth) which depend on other complementary efforts and investments beyond the boundaries of the project.

The ultimate outcome of assessment models are the Economic Net Present Value (ENPV), Economic Internal Rate of Return (EIRR) and Benefit Cost Ratio (B/C Ratio). Nonetheless, there is a skepticism regarding the usefulness of the economic evaluation of rural roads. According to the critiques of the economic evaluation, there are several other benefits of rural roads, which can not be captured by the economic analysis. Nijkamp et al. (1991) have traced the evolutionary process of the evaluation techniques. They mention that the history of plan and project evaluation before World War II showed a strong orientation toward financial trade-off analysis. Nonetheless, these tools were not popular among the planners. Obviously, they continue, one of the reasons for this restricted use was the severe limitation of a monetary based evaluation method, in which, for example, the intangible problems and the multi actor conflict problem could not be removed in practice. Therefore, the new class of multi-criteria methods has achieved a major position in current evaluation methodology. Nijkamp et al. maintain that the popularity of these methods is caused by several considerations, including its use in institutional or procedural decision making, in which "bargaining" and other political/tactical aspects play an important role. In addition, there is a general desire in modern public plan and project evaluation not to be confronted with a single, forced solution but to obtain a spectrum of feasible solutions. Besides the multi-criteria method, the cost-effectiveness analysis is also used for evaluating rural road projects.

In Nepal, various agencies have used various types of evaluation techniques. The World Bank (1994) used the producer's surplus approach for justifying the roads included in the PLRP. Wilber Smith Associates Inc. (WSA) and Snowy Mountain Engineering Corporation International Ltd. (SMEC) (1996) have conducted a comprehensive study on the transportation costs and benefits of rural roads. After a comprehensive analysis, they concluded that the freight traffic benefits, passenger traffic benefits and producer surplus benefits from the agricultural sector should be aggregated for obtaining the total benefit of a rural road. This approach is again followed by Meyer et al. (1999) and ADB for appraising the projects in Cambodia and Philippines. The approach is promising because it incorporates the direct benefits and development impact of a road project. There is no problem with the direct benefits. Nonetheless the increased agricultural production is not the function of the improved access alone. It depends upon the land capability, farmer's initiatives and marketability of the products. Therefore the improved accessibility not necessarily results into the increased volume of production. Therefore it is not possible to predict that with the improved access the land productivity and agricultural price will also increase. Therefore, even after the judicious efforts in Nepal, Cambodia and Philippines, the aggregation of increased volume and price of the agricultural products to the direct benefits has remained questionable.

2.6 Computerized Models for Planning and Appraisal of Road Projects

The "Feeder Road Analysis Package" (FR75) (Carnemark et el. 1984) is one of the computer package for appraising the rural road projects. The model is based on the theoretical basis of the producer's surplus. Therefore, it needs total cultivated area, volume of traffic and the road construction and maintenance cost. Once these data are fed into the computer, the outcome would be the stream of the net benefit and cost. The streams of net benefit and cost are fed directly into CBPACK, a cost-benefit package used by the World Bank. The outcome of the CBPACK are: the Economic Rate of Return (ERR), Net Present Value (NPV), First Year Benefit (FYB), Benefit Cost Ratio (BCR), Cost Parametric Analysis (CPA) of a rate of return computation and Risk Analysis. The package as such is not available now. Although the program can be written easily in a spreadsheet, this package has limited usefulness because of the poor results of the agricultural production approach (TRRL, 1988). Although not for the rural roads, the Transport Research Laboratory (TRL) in UK also developed the Road Transport Investment Model for Developing Countries (RTIM) (Petersen et al. 1996). The latest edition of the resulting road investment model, RTIM3, was released for commercial use in 1993. The World Bank developed the Highway Design and Maintenance Model (HDM) in 1966. The HDM-III has provision of analysis for road maintenance in addition to road construction. The costs are determined by predicting physical quantities of resource consumption and multiplying these by unit costs or prices. Petersen et el. (1996) mention that there were quite a few limitations of the HDM–III model for evaluating even the urban and national transport network. Therefore, the International Study of Highway Development and Management (ISOHDM) has extended the scope of HDM–III model to provide a harmonized system approach to road management, with adaptable and user-friendly software tools

(ISOHDM, 2001). The HDM–4 can be used for many different road investment planning questions including broad questions of road system management policy, strategies for upkeep or improvement of road networks, the programming of road maintenance or improvement works across and budget periods when the needs for investment exceed the available budget. Besides that, HDM–4 can be used for a detailed economic assessment of investment options at the project level and research into road network management options. The World Bank's HDM-III and HDM–4 present a very good framework for the economic analysis of road investments but are not particularly customized for low-volume unpaved roads (traffic less than 200 vehicles per day), do not capture all benefits associated with low volume roads investments, and require inputs which are impractical to collect for vast networks with low traffic levels, such as material properties of surface layers and refined traffic data (Archondo-Callao, 1999).

In order to address the needs of low volume roads, the World Bank developed the Roads Economic Decision Model (RED). The RED performs the economic evaluation of improvements and maintenance projects adopting the consumer's surplus approach instead of producer's surplus approach, which is a major policy shift of the Bank for evaluating rural roads. In this respect, it is similar to the HDM. Although, it is simpler and useful for evaluating rural roads, it still uses the vehicle operating cost as a main or even only criterion for the evaluation. That makes the model unusable for the areas, which are only connected by the trails and mule-tracks like much of Nepal.

Tracey-White and Vaidya (1998) have also developed an Economic Model for Screening and Selection of the rural roads. Conceptually, it has followed the RED approach by taking VOC savings. Therefore, it also suffered from the same weaknesses. However, one has to consider the fact that the RED Model was developed for Africa and Tracey-White and Vaidya developed their model for Cambodia. In both of these cases, it must be implicitly assumed that the area that is to be planned is plain where the motorized and non-motorized vehicles operate with a nominal road construction effort. However, the situation is totally different in the hilly areas.

Crossley (1999) has developed an Expert System for the Prediction of Total Vehicle and Road Operating Costs (RANE) in Developing Countries. However, the main concern of the RANE is to assess the maintenance cost of the infrastructure and the vehicle. Therefore, it helps to develop the alternative maintenance strategies. Since its focus is not to plan and appraise the regional roads, its applicability in this context is limited.

2.7 *"State of the Art"* in Regional and Rural Transport Planning Methodologies

Different agencies and individuals have attempted to develop different methodologies for addressing different problems. The World Bank pioneered in the development of methodologies for developing countries. The Bank (Adler, 1967) has outlined five distinct, though interrelated steps. Identification of the basic goal, preparation of the inventory of the existing transport facilities, their condition and utilization, traffic forecasting by mode of transport, examination of the transport policies and operations and investment programming are the major steps. The methodology was not developed specifically for rural transportation. However, developing countries were the focus of the study and transportation planning in developing countries normally indicates rural transportation planning. The methodology is sound in terms of demand estimation and evaluation. However, it does not have the network approach in transport planning. It does not match the transport demand with the construction technology.

Roy and Patil (1977) have prepared a "Manual for Block Level Planning" for India that includes transportation planning among other sectors. The transport planning is therefore synchronized with the integrated plan. The transportation plan aims at rationalizing the routes and modes of transportation by surface, water and even air to service centers of all levels for mobility of both goods and people, for efficient distribution and marketing of goods, and for effective utilization of institutional services by people. It assumes that there is a uniform demand among the same level of centers. It proposes at least a *Kutcha* (earth) road between all villages and the lowest level of primary services center and higher level centers and relate this network to the overall transportation in the district and the state. The procedure is simple and straightforward. The consideration of the hierarchy of settlements and inter-linkages among them is a realistic approach for developing the transport network. Similarly, consideration of the present and potential agricultural flow is meaningful for developing the networks. It also considers natural barriers and the construction cost for developing the implementation program. Nonetheless, it is a supply-oriented approach. The nature of pavement is not tied up with the traffic intensity but it depends on the artificially created service centers. The evolution of market centers takes place by a natural process (whereas the service centers could be created) therefore these can be treated as the real nodal points. Secondly, all the proposed projects are prioritized and planned to he implemented gradually. There are no acceptance and rejection criteria. Such limitations create difficulties for replicating this methodology.

UNCHS (1985) has developed the "Guidelines for the Planning of Rural Settlements and Infrastructure: Road Networks". The document provides information on all the tools and techniques for planning the transport networks. The guidelines mention that there are two main classes of network models, which can be utilized for network building. They are "floating point system" and the "fixed point system". The guideline however, does not mention how such network models can be applied in the real life situations. The guideline has included the demand for and characteristics of rural travel. The household survey, community survey, roadside survey and traffic count survey are the main data collecting tools for estimating the demand. The guidelines emphasize the analysis of travel pattern, magnitude, frequency and timing of the transport demand. It has also mentioned the construction and maintenance cost. However, it accepts the prevailing costs. It does not suggest making any further attempt to investigate the appropriateness of construction norms and specifications, which is the major limitation of the guideline. Similarly, the guideline is weaker in terms of assessing the benefits. It does not recommend the particular model (consumer's surplus vs. producer's surplus model) for assessing benefits.

Beenhakker (1987) has prepared a guide for planning the rural transport services where the general planning chart and access evaluation chart are the integral parts of the methodology. The main unique feature of this methodology is to provide storage facility in the village as one of the alternatives of constructing roads. Like storage, other trips generating factors can also be provided at the point where it is demanded. Nonetheless, the question is whether or not the threshold population is enough. Perhaps that is the major limitation of this methodology. Beenhakker has also provided the Access Evaluation Chart that is supplementary to the main General Planning Chart. He emphasizes that the rural access infrastructure planning must be based on the development area's need. These needs, according to him, must be identified, located, and coordinated with each other so that the individual Rural Access Infrastructure links are properly located and provide suitable accessibility.

Before it was widely believed that the road construction could catalyze rural development. If there were enough good roads to ensure access to inputs and evacuate agricultural surpluses to markets, it was felt that rural development was sure to take off (Dixon-Fyle, 1998). Nonetheless, roads could not generate the desired impact. Therefore, the ILO has been emphasizing the accessibility approach where road is only one component among several sectors whose synergistic effect is necessary for the overall development. This is a bottom up approach of planning where a rural household is the focal point. The IRAP approach is simple and easy to understand. Therefore, adaptability by the local level planners and decision-makers is quite high. The planning process can also strengthen the decentralization process by involving the target groups in the planning process. It provides opportunity to minimize the traveling cost by creating facilities around the vicinity of the user (Howe, 1997). The methodology is suitable for the community level planning where a planner and decision-maker have the direct interface with the users. How such a methodology can be used in a district context is not clear. As the planning domain goes to the upper hierarchy, the complexity of each sector increases significantly. Therefore, it is extremely difficult to synchronize the activities with one another. Secondly, this methodology may be appropriate for the national or international grant projects. Nonetheless, the projects financed through the loan funding must be cost effective. The IRAP has no provision for the economic evaluation. The IRAP therefore can handle the micro-level access problems like the village level roads. Therefore, it will have difficulties for handling the district level roads with the regional characteristics.

The GTZ (1993) supported the Dhadhing Development Project during the second half of the 80s and early 90s. Rural transportation was one of the components of the assistance program. Therefore, the agency prepared a Transportation Infrastructure Master Plan for Dhadhing District of Nepal. The methodology for developing the master plan is rather simple. The members of the District Council identify the needs and such needs are substantiated by the experts. Therefore, no networking principle is applied. It is a discretionary type of networking procedure. Other information is collected from the reconnaissance survey. No other surveying tools and techniques are used. Therefore the main actor in this exercise is the experts being involved in the study. The study has accorded higher priority to the engineering consideration. It mentions that the alignments should pass along the ridges or mid-hill slopes, avoid rivers and streams as much as possible and the alignment should pass through geologically stable areas. The prioritization criteria are: 1) The road which opens up economically active remote areas 2) Inter-district type of roads 3) On-going road project 4) Peoples participation 5) Environmental impact 6) Road ownership (DDC roads are given higher priority). Although the people's representatives are involved in the project identification phase, the approach is biased towards the technical solution rather than the process. Secondly, it does not consider the present and potential volume of traffic. Therefore, it adopted a largely supply driven approach. Thirdly, it relies on the technical solution rather than the economic requirement. Emphasizing and prioritizing the ridge and mid-hill road may be economical and durable but it is not necessarily the most demanded one.

After a comprehensive discussion of the transport situation in two hill districts of Nepal, Basnet (1994) has developed a methodology for planning rural roads. He proposed three phases of a planning cycle: 1) Type of data 2) Methods of analysis, and 3) Selection of roads. He proposes to collect the data on market demand at the regional center, existing network of roads and trails, magnitude of export of crops along the main trading routes, potential agricultural resource base in relation to market demands of crops at the regional center, and embryo market centers. He is modest in terms of methods for data collection. He suggests collecting data using the Rapid Rural Appraisal (RRA) Technique, through key informants and group discussions. Besides that, he includes the village secretaries as the potential sources of information. Nevertheless, all of these sources provide vague information. Therefore, how much such information could be relied on is questionable. Such discussions and appraisal may generate the preliminary ideas but actual data can not be obtained from such sources. For getting the actual figures, one should count the traffic on the road. He proposes four areas of analysis. They are: regional market demands, savings in the transport costs, agricultural resource potential analysis and, market center potential analysis. The method of analysis is heavily lopsided towards the agricultural transport. Nonetheless in reality, non-agricultural transport takes place substantially. The methodology has accorded extremely low profile for the construction and maintenance costs.

WSA and SMEC (1996) have developed a national level master plan for the strategic road network and for the rural transport. The strategic road network is not under the purview of this study. Therefore, only the rural component is discussed here. However, the rural roads proposed by the WSA and SMEC study also include the strategic roads, which intend to provide accessibility to the rural areas of the country. Therefore, the principle of networking is not relevant for this study. However, the arguments regarding economic issues by this study are pertinent for the district level roads as well. It mentions, an effective methodology for evaluating rural road projects should enable an economic rate of return to be determined and upgrading of all types of road projects. It should also enable comparison to be made between investments in different sectors (WSA and SMEC, 1996). Criticizing the methodology which follow the prioritization for ranking the projects, the methodology mentions that the practice leaves unanswered two very different questions:

- Firstly: Are individual projects economically viable? In other words, is the value of the benefits expected from a road project greater than the costs required for constructing and maintaining that road? Will national wealth be higher as a result of implementing the project?

- The second question left unanswered is – how do the returns from investments in the rural road sector compare with those, which can be obtained from investment in the strategic road network and other sectors of the economy?

An evaluation process, which produces a conventional measure of overall project viability, such as the Net Present Value or Internal Rate of Return, provides answers to these questions. The methodology, nonetheless, accepts that the other indicators like regional balance and equality of access to services should be also included in the appraisal process. The study included the construction and maintenance cost for the appraisal. Similarly regarding the benefits, the study has included road user savings and producer's surplus benefits from the agricultural sector. Although this methodology says very little about the networking procedure, it is sound in terms of the economic appraisal. More interestingly, the methodology summed up the user's benefit (the consumer's surplus) of the transport industry and the producer's surplus of the agricultural industry. Otherwise, those two are regarded as competing concepts. Use of the road user's savings, as the benefit is obvious. Nonetheless, the question of whether the producer's surplus of the agricultural industry should be aggregated is still an unresolved question.

The ILO (1997) has prepared an approach for the rural road network in Nepal. The study was conducted for the MOLD and funded by the ADB. It has taken the growth centers as the nodal points for developing the networks. The networking is followed by the preparation of the district rural road inventory that also includes the trails. The demand is collected from the VDCs. The District Technical Unit appraises each of the potential projects and prepares the draft perspective plan. It is followed by other activities. The methodology, however, shares the limitations of other methodologies. The networking procedure is ultimately intuitive. It does not consider the hierarchy of settlements. It intends to collect the district inventory of rural roads from the Village-based Assistant Technicians. It means the information of the district level transport infrastructure is collected in a piecemeal basis. Instead of directly counting the road users, the VDCs are asked to forward the socio economic benefits of the project. The VDCs are also asked to provide information on the transport demand. The VDCs definitely can give their requirement but it could be difficult for them to give the demand list for the district level projects. Another limiting factor of the proposed methodology is the process of appraisal. The methodology screens or grades the project based on certain pre-specified criteria. The prioritization does not contain the demarcation line between the acceptance and rejection. Therefore, this methodology ultimately suffers from similar limitations seen in other methodologies. Ironically, the methodology does not refer to the internationally initiated methodology of the ILO called IRAP, which is already discussed above.

The PLRP attempted to establish a straightforward and participatory planning methodology (Shrestha, 1997b) for the preparation of the DTMP. The DTMP consists of the proposed road network and program planning. The proposed road network is based upon the district accessibility standards, obligatory points, existing roads and trails, demand from the local people and geographical characteristics. The proposed road networks are prioritized on the basis of prioritization criteria. Beneficiaries, cultivated land, estimated investment, economic return, accessibility and environmental impact are the main criteria for prioritization. The prioritized roads are matched with the available funds for implementation. Not having the acceptance and rejection criteria is the main limitation of this method. The transport demand is measured indirectly. The methodology accepts the labor-based technology but the appropriate mix of labor and capital is not completely defined. Therefore, despite its strength of networking and simplicity, it requires further improvement to be a useful methodology for developing rural road networks.

The detailed overview of the methodologies mentioned above is presented in Annex 2.2.

Chapter III
Research Design

Developing a methodology for the DDCs, which are extremely divergent in characteristics, is a formidable challenge for the District Transportation Planners. The size and population of the districts vary country to country. Even within a country the districts differ with one another drastically in terms of size, population and more importantly, in terms of revenue generating capacity. Nepal is not an exception for such a situation.

This study has adopted the participatory approach for developing the methodology for district road network planning. The term "participatory" should not be understood as it is commonly used for planning and implementing the local level development works. In this study, various types of people were consulted to develop the methodology. Such type of participatory method helped to develop the methodology based on district realities in terms of availability of resources, manpower and legal framework. It also increased the probability for implementation. Nonetheless, the participatory method has certain limitations. The opinion could be influenced from political and social factors. Sometimes the ignorance on the subject matter could be the limiting factor. Therefore an utmost attention was paid to prevent the methodology from possible distortion.

Conceptually, the development of a methodology involves four stages, which is presented in Figure 3.1.

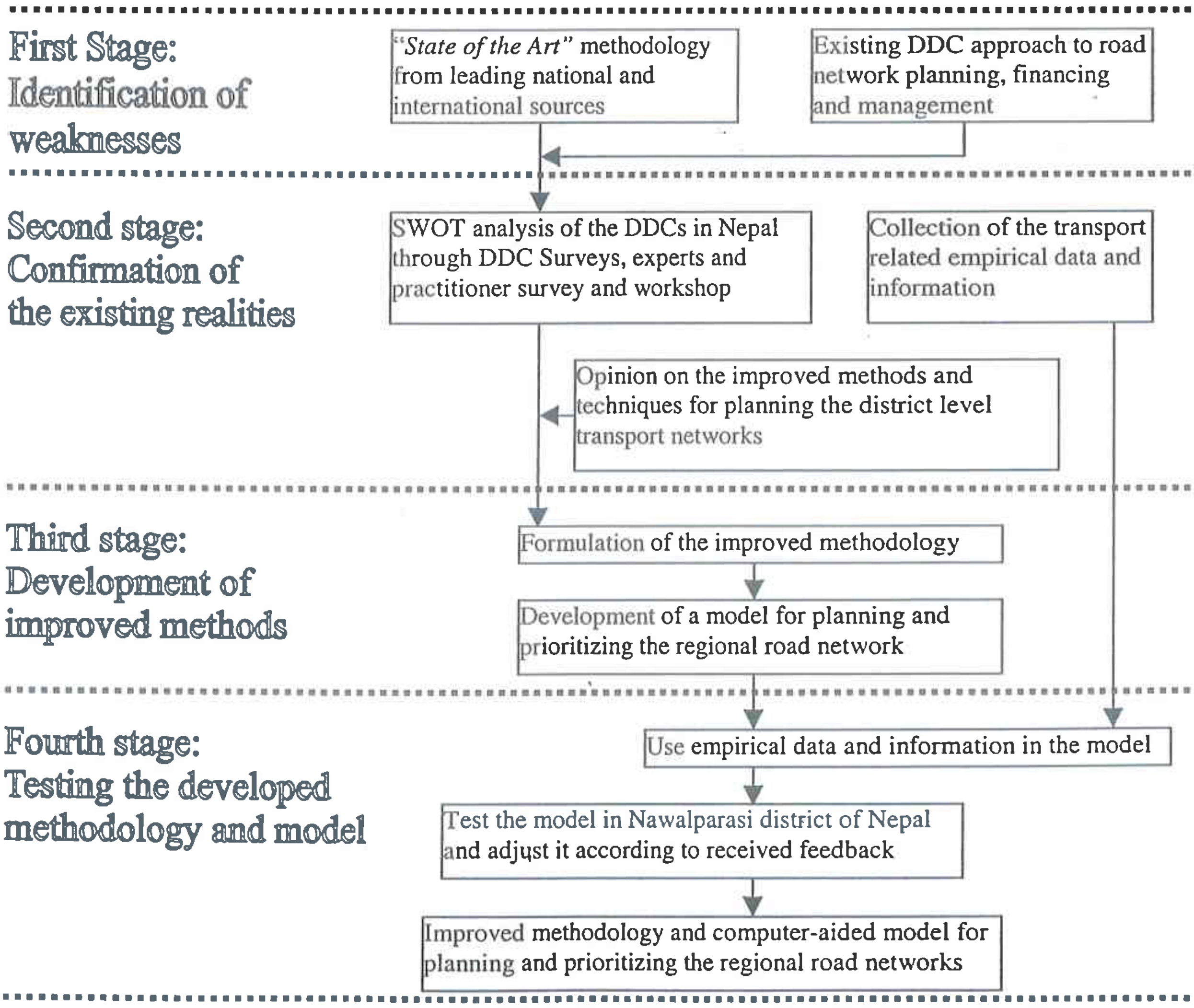


Figure 3.1 Flow Diagram of the Steps Required for Developing the Methodology

The "*state of the art*" methodologies from leading national and international sources are discussed in Chapter II. Chapter IV discusses the existing DDC approach to road network planning, financing and management. Based on the analysis, the strengths, weaknesses, opportunities and threats are outlined. Chapter V discusses the opinion on the improved methods and techniques for planning the district level transport network. Chapter VI and VII deal with the methodology and model respectively. After comparing different scenarios in the Chapter VIII, the methodology is tested in Chapter IX. This chapter (Chapter III) discusses the required data and information and their collection techniques for developing the methodology.

3.1 Methods of Data Collection for the First Stage of Feasibility Test

This section deals with the selection of the districts for conducting the feasibility tests, types of surveys and analytical approaches for developing the methodology. The findings of the analysis were presented in a workshop for validation, which is also covered by this section.

3.1.1 Selection of Districts

There is a great variation among the DDCs in Nepal in terms of geographical characteristics, population distribution and revenue generating capacity. In order to incorporate all types of districts, a stratified purposive random sampling procedure is adopted for data collection. However, having the extremely difficult topographic conditions, the planning of district level transportation is a remote possibility in the Mountain districts. The DOR constructs the strategic roads in the Mountain districts. Therefore, only two of 13 Mountain districts were included in the sample. The Hill and Terai districts were the primary focus for sampling.

The sampling scheme is presented in Fig. 3.2. As shown in Fig. 3.2, the samples are divided into three strata. In the first strata, the districts are classified by the geographic characteristics. The second categorization is based on the density of population and the third grouping is based on the level of district revenue. As mentioned earlier, only two Mountain districts were purposively selected for the reference.

The samples are selected based on following technique (*Miah, 1993)*:

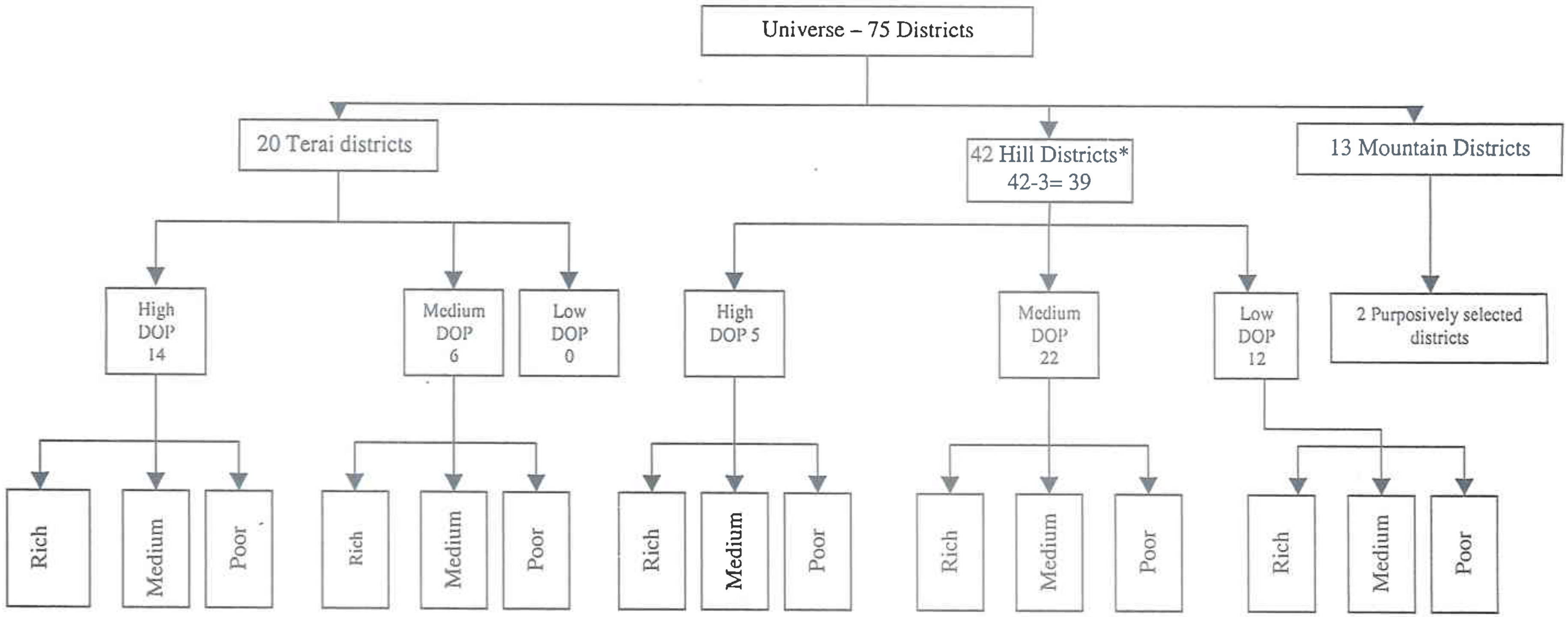
$$n = \frac{Nz^2pq}{Nd^2 + z^2\,pq}$$

Where,

n = Sample number
N = Population size
z = Standard normal variat value for the required confidence level (taken as 90% confidence level = 1.282)
p,q = Percent of attributes in universe expressed as a decimal (assumed to be 50% each)
d = Precision (6%)

Districts in Terai and Hill = 20 + 42 = 62
Nawalparasi district is obviously selected. Therefore N = 61
Applying the sampling formula, Total Sample size = 40

Nawalparasi district	= 1
Mountain districts	= 2
Total Sample size	43



DOP = Density of Population
* Kathmandu, Lalitpur and Bhaktapur are excluded because of their higher DOP.

Figure 3.2 Sampling Scheme

Based on the above expression, the sample size is determined and presented in Table 3.1.

Table 3.1 Sample Size of District Selection

1st Degree Category	2nd Degree Category	Total Districts	Sample Size
Terai Districts	High DOP	14	12
	Medium DOP	6	4
	Low DOP	0	0
Hill Districts	High DOP	8	5
	Medium DOP	22	17
	Low DOP	12	6
Mountain Districts	Not Applicable	13	2
Total		75	46

DOP = Density of Population

Although the actual required sample size is 43, the number increased due to the judgmental sampling among the districts with different density of population. Having a higher number of medium density of population group of hill districts, a greater sample size is taken than as calculated by the formula. The sample districts are classified as rich, medium and poor.

3.1.2 DDC Engineers Survey

The Engineer Survey is planned to fulfill two purposes, i.e. to identify the district level planning weaknesses and developing the new methodology. The questionnaire is broadly divided into three parts. The first section attempts to identify the general situation of the districts. The second section is intended to detect the weaknesses of the districts. The third section is designed to obtain feedback for developing the improved methodology.

A recommendation letter was written by the MOLD to each of the Engineers of the sample districts. The questionnaire was mailed along with the recommendation letter and a personal request letter. About 25 percent of respondents reacted immediately. Another 50 percent respondents reacted after a few telephone calls. It was extremely difficult to receive the response from the remaining 25 percent of respondents. Therefore, a telephone interview was conducted with all of the remaining engineers. The questionnaire was pre-tested in the Lalitpur district. The format of the questionnaire is presented in Annex 3.1.

3.1.3 Policy Makers Survey

The DDC Engineers are largely responsible for the technical issues. The policy issues are dealt with by the DDC Chairman and the Secretary of the DDC. Therefore, for exploring the possibility of generating additional resources and to formulate the appropriate policies, a policy maker survey was conducted. A questionnaire (Annex 3.2) was sent to the Chairman and the Secretary of each sample district with the recommendation letter from MOLD. However, facing difficulties receiving responses, the Chairman and Secretaries were interviewed over the telephone and by sending the enumerators.

3.1.4 Experts and Practitioners Survey

A checklist was designed (Annex 3.3) for interviewing with the experts in rural and regional transport planning. They include the Project Managers and the Chief Technical Advisers of the rural transportation projects, academicians, and officials involved in the international donor agencies. The main purpose of asking them questions was to validate the weaknesses of the DDCs and to find a new methodology. No major hurdle was encountered while conducting interviews with them.

The respondents are presented in Table 3.2.

Table 3.2 Respondents of the Expert Survey

No.	Respondents	Nos.
1	Project Managers of the former and present regional and rural transport projects	4
2	Chief Technical Advisers of the former and present rural transport projects	9
3	Consultants	8
4	Professors of Regional Planning and Transportation Planning	4
5	Central Line Agencies MOLD Secretary DOLIDAR Director DOR Divisional Engineer	 1 1 1
Total		28

3.1.5 Workshop on Decentralized District Transport Planning Methodology

After collecting opinions from the DDC Engineers, Policy Makers and other experts, the information was analyzed and synthesized in order to derive the appropriate methodologies applicable to the districts with different development status. The findings of the survey were matched with the *"state of the art"* of the transport planning methodologies. Based on the opinion survey and the *"state of the art"* of the planning methodologies, two new planning methodologies were outlined and presented in the workshop. The workshop was organized in Kathmandu where most of the participants were available. The working paper was produced and distributed to all of the prospective participants one week before the workshop. After a comprehensive presentation and other formalities, the participants were requested to forward their comments. The workshop day was divided into the inaugural session and working session. During the working session, the participants were divided into two groups. Both groups presented their results. Finally, five speakers presented their concluding remarks.

Altogether 52 participants participated in the workshop. The participants consisted of the different officials and Senior Divisional Engineers from the MOLD. The Institute of Engineering was represented by various faculties of the Civil Engineering and Urban and Regional Planning Department. Similarly, representatives from the WB, ADB, International Center for Integrated Mountain Development (ICIMOD), United Nations Capital Development Fund (UNCDF) and GTZ also actively participated in the workshop. The Chief Technical Adviser and the Senior Development Planner visited Nepal for attending the workshop from ILO, ASIST-AP, Bangkok. The rural road projects like the District Road Support Programme (DRSP) and Rural Access Programme (RAP) also participated in the workshop. More importantly, the Chairmen, Secretaries and Engineers from three representative districts were also present in the workshop. Among other participants were the representative from the Geography Department of the Tribhuvan University and the private sector consultants.

3.2 Data and Information Collection Techniques for Testing the Methodology

This section deals with the selection of the test district, criteria for the comparison and methods of data collection and analysis.

3.2.1 Selection of the Study District

Three criteria were used for selecting the test district. The first is that the district should have partly plain and partly hilly area so that both versions of the methodology could be tested. The second criterion is that the selected district should be representative in terms of population size and land area. District revenue was also implicitly considered while selecting the districts. The third criterion, though not extremely important, is that the study area should have a district level transportation study preferably conducted recently. That minimizes the requirement of primary data collection. Secondly, it is also easier to compare the findings of the present study with that of the previous study. It indicates the efficiency of the present study. Based on these criteria, the Nawalparasi district was selected as the test district and developed methodology was experimented. Khopasi – Taldhunga Road in Kavrepalanchowk district and Baglung – Binabare Road in Baglung District were taken as the sample where labor based technology is practiced. Malekhu – Dhadhing road in Dhadhing district was taken for studying the mechanized technology.

3.2.2 Tools for Data Collection

The required data and their sources for the study are presented in Table 3.3.

Table 3.3 Required Data and their Sources for the Methodological Test

No.	Purpose/ Activity	Required Data and Information	Source of Information	
			Primary	Secondary
1	Developing a preliminary district road network	1.1. Private and public basic functions in each market center within the district and major market centers adjacent to the district		District Profile, Nawalparasi District Profile, Rupandehi DTMP, Nawalparasi DTMP, Rupandehi, DTMP, Palpa
		1.2. Future trend of market centers within the district and major market centers adjacent to the district. (Time series data of population).		CBS, DTMP and the district profiles of Nawalparasi, Rupandehi, and Chitwan district
		1.3. Present and future population of each villages		CBS, PDDP
		1.4. Existing roads and trails inventory and location		DTMP and DOS
		1.5. Condition of roads and trails	Observation	DTMP
		1.6. Inter-linkages among the settlements		DTMP, District Profile
		1.7. District accessibility standards		DTMP, DDC
		1.8. Spatial plan of the district		DDC and other line agencies
		1.9. Different types of district maps		Department of Survey
		1.10. Present and future land use plans		DOA, DOInd
2	Estimation of future demand	2.1. Existing volume of transport	Transport surveys	
		2.2. Trip generation ratio	Transport surveys	
		2.3. Generated traffic	Transport surveys	DOA

3	Estimation of construction and maintenance costs	3.1. Total construction costs		Respective constructing agencies
		3.2. Annual Maintenance costs (all type)		Respective agencies
		3.3. Item-wise construction cost	Productivity Form, Observation and interview with contractors and consultants	
		3.3.1. Earthwork excavation		
		3.3.2. Embankment		
		3.3.3. Aggregate crushing		
		3.3.4. Graveling		
		3.4. Construction specifications and design standards	MDRP and RIDP	DOR, DOLIDAR
4	Assessment of benefits	4.1. Changes in land use and other benefits as envisaged by the project document of LJRP, DDP		Impact studies of LJRP, DDP, DOA
		4.2. Transportation cost in different terrain	Interview with vehicles operators, passengers	Office of Transport Management, Priority Investment Plan
		4.2.1. Transportation cost for manual transport		
		4.2.2. Transportation cost for mules		
		4.2.3. Transport cost by tractors		
		4.2.4. Transport cost by trucks		
		4.2.5. Transport cost for pedestrians		
		4.2.6. Transport cost for jeeps		
		4.2.7. Transport cost for minibus		
		4.2.8. Transport cost for buses		

3.2.2.1 Secondary Sources of Information

The DTMP and the district profile produced by the Nawalparasi DDC, are the main sources of information. Two of three neighboring districts have also produced the DTMPs that were quite useful for exploring the possibility of inter-connection of road networks. The population data was mainly collected from the Central Bureau of Statistics (CBS). The Topographic Survey Division is the principal source of maps. It has produced the topographic map of scale 1:25,000, 1:125,000 and 1:100,000. In addition to that, the Division has also produced the land suitability map (1:50,000), land capability map (1:50,000) and land system map (1:50,000). The present and future land-use data was collected from the Department of Agriculture (DOA).

The total construction and maintenance costs of the sample roads were collected from the respective constructing agency. The construction and maintenance cost was collected from the DDC, Nawalparasi and other projects like Malekhu-Dhadhing Road Project and Rural Infrastructure Development Project (RIDP).

The information on project impact was collected from the implementation of the similar projects. The impact study report of Dhadhing Development Project helped to infer conclusions on the ZOI and probable impact of a new road construction on the land use pattern. Similarly, the impact study of Lamosangu – Jiri Road Project and other impact studies conducted by Rural Access Programme are found useful.

The professional transport associations (Bus, Taxi, and Truck Associations) were a reliable source of information for the transport route, number of operating vehicles and a preliminary information of the number of passengers and freight. The transport cost by different mode of transport are taken from the Priority Investment Plan and other relevant publications in order to supplement the primary survey of transport cost of different mode of transport.

3.2.2.2 Primary Sources of Information

Primary sources of information include interviews and observations. Condition of roads was recorded by observation. Traffic survey was conducted for estimating the existing volume of trips in each route. In order to estimate the construction costs, the contractors and consultants were interviewed and the construction sites were observed. The policy makers were also interviewed for the policy issues.

a) Road Observation Record Sheet: Most of the information for the condition of road was collected from the DTMP. Only two roads were personally visited, one from Plain and the next from Hill. The sample record sheet is presented in Annex 3.4.

b) Cordon Survey: The sample form of cordon survey is presented in Annex 3.5. The traffic count data were collected in the entry/exit points of the market centers. The data was collected twice a month (one market day and one non-market day) during four consecutive months. It helped to understand the temporal fluctuation in the volume of traffic. The traffic count survey was conducted in all identified district level present and potential market centers. The cordon survey was conducted in two locations of 10 district level roads, tracks and trails.

c) Roadside Surveys: The main purpose of the roadside interview is to identify the origin and destination of the trips. Finding information on the transportation costs and traveling time are other reasons.

c1) Passenger Vehicle Survey: Based on the traffic count data, each type of vehicle was interviewed. The interview involves origin and destination of the vehicle, type of vehicle, transport demand in that route and vehicle operating costs. This questionnaire also attempts to explore the possibility of involvement of transport operators in Regional Road maintenance. Approximately 6 types of vehicles (one sample from each type of vehicle) were interviewed. In the two roads, 12 vehicles were interviewed. The sample format of questionnaire is given in Annex 3.6.

c2) Freight Carrier Survey: The questionnaire (Annex 3.7) includes information on freight carrier vehicles. All other information is similar to the passenger vehicle survey. The freight carrier includes (except porters) truck, tractor, bullock carts and mules. A total sample size of 52 was interviewed in 2 roads.

Porters also carry freight to the hilly areas where motorized vehicle service is not available. The porters transport commodities from the highway intersections to the northern hilly settlements. Therefore, porter survey was planned to be conducted in Dumkibas. Nonetheless, a seasonal bus service is being operated on that route. Therefore, a significant porter survey could not be conducted as it was planned earlier. Sample format of questionnaire for the porter survey is presented in the Annex 3.8.

c3) Passenger Survey: Finding out the origin and destination of trips is essential for the transport network planning. Therefore passengers were interviewed regarding their origin, destination, travel time and travel costs. For pedestrians and people traveling in own vehicle (bicycle, motorcycle, private car etc.), the interview was taken at the entry and exit point of a market center. In order to minimize discomfort and delays, the interview in the public vehicle was taken with the vehicle in motion. A sample questionnaire is shown in Annex 3.9. The passenger survey was conducted in 2 locations, the origin and destinations of the selected roads. There is no public transport service in Basa-Piprahiya Road. There are only 2 vehicles plying in Dumkibas-Sardi Road. Therefore, the sample size is significantly smaller than anticipated earlier. In order to understand the traffic characteristics, a transport survey was conducted in Parasi–Narayanchowk section of the Hulaki Road. The total sample size of roadside interview is shown in Table 3.4.

Table 3.4 Sample Size of Roadside Survey

Survey Type	Approximate Sample Size	Total Sample
Passenger Vehicle Survey	2 roads @ 6 vehicles per stations	12
Freight Carrier Survey	2 roads @26 vehicles per station	52
Passenger Survey	4 stations @ 2 days (4 months) 2 stations @ 2 days (1 month)	795

d) Contractor Survey: Information on the actual cost of all type of motorized and non-motorized equipment was collected from contractors. Besides that, the composition of labor and equipment in their site was also asked of them. Annex 3.10 presents the contractors survey form.

Altogether 18 contractors were interviewed. Among them five contractors are interviewed from each A, C and D class. Three contractors are interviewed from B class. Among them 6 contractors were interviewed from Nawalparasi District. Remaining contractors were interviewed from different construction sites and headquarters of construction companies.

e) Labor Productivity Measurement Form: Labor productivity measurement form replaced the job-sheet. After a field test, it was found that the data collection is difficult from the job-sheet for the supervisors and overseers. Therefore a more elaborated format of labor productivity measurement form was designed and presented in Annex 3.11. The productivity test was conducted in Khopasi – Taldhunga Road, Malekhu – Dhadhing Road and Baglung – Binabare Road. The productivity was measured of the earthwork excavation, compaction, stone masonry and other layer works. Few representative samples were taken from each road. The site engineer used his discretion for determining the sample size.

f) Key Informant Survey: Initially it was thought that 4 months of sampled travel patterns of the people would be sufficient for understanding the transport characteristics in the concerned area. Nonetheless, the discussion with the local people revealed that there is a substantial seasonal fluctuation in terms of traveling behavior. Therefore, it was considered to develop a key informant survey form and ask the opinion of local people regarding the commuting behavior and freight transport requirement throughout the year. Altogether 14 interviews were taken on two roads. The sample format is presented in Annex 3.12.

3.3 Testing the Methodology

The methodology was tested in the Nawalparasi district. The test was carried out in two phases. A pre-testing phase was followed up by the final testing of the methodology.

3.3.1 Pre-Testing

In the first phase, the findings of the study were presented in the DDC meeting and an open discussion was initiated. The DDC meeting constituted the DDC Members, DDC Secretary, Planning Officer and Engineer. Besides that, a team of donor agency and consultant also participated in the pre-testing phase. A group discussion was initiated and all participants were encouraged to contribute their opinion regarding the methodology. Additionally, all the participants were given some time to put forward their opinion. This opportunity was used for a preliminary rectification of the methodology.

After the formal meeting, the DDC Engineer and Planning Officer were asked to handle the District Road Network Planning and Prioritization Model (DRPM) after providing a preliminary conceptual and technical orientation. It was attempted at this point to trace out the limitations of the model and identify the areas where the Engineer and Planning Officer face difficulties.

3.3.2 Final Test

The final test was conducted in two different stages. In the first stage, an open discussion was conducted in the DDC meeting and a questionnaire survey conducted after the discussion. In the second stage, a laboratory test was conducted.

3.3.2.1 Open Discussion

The methodology was adjusted according to the feedback received during the pre-testing phase. A focussed and planned test was carried out in the second stage. In order to carrying out the test, a DDC meeting was called where all the members (17), DDC Secretary (1), Planning Officer (1) and Engineer (1) participated the meeting. The presence of Engineer, Planning Officer and DDC Secretary is essential in this stage because they are the persons for developing the actual plan based on the guidelines of the DDC. The DDC members represent the whole parts of the district, i.e. developed as well as underdeveloped. After a briefing on the background and objectives of the study, the output of the planning methodology was presented. The output includes the networking of the regional roads, tracks and trails, estimation of the transport demand, required investment of each road and prioritization either based on the economic evaluation or other socio-economic criteria. An initial proposal for allocating the resources including the revenue generating strategy was outlined and presented. An open discussion was initiated after the presentation for further clarity. The participants asked further questions and they expressed their opinion in favor of or against the proposal. An environment of debate was created where the participants expressed their ideas openly. In order to avoid a more assertive member dominating the whole session, every participant was asked individually towards the end of the session.

3.3.2.2 Questionnaire Based Understanding and Assessment of Methodology

In the same DDC meeting, once all the participants were clear regarding the objectives and approaches of the methodology, a questionnaire was distributed to all of the participants for obtaining their concrete opinions. Annex 3.13 presents the format of the questionnaire. After analyzing the feedback, the methodology was revised.

The Weighted Mean Index (WMI) is used for identifying the degree of priority of the respondents on a given issue. The most preferred option is given highest weight, which decreases towards the least preferred option. The WMI is calculated using the following mathematical formula:

$$WMI = \frac{w_1 f_1 + w_2 f_2 + \dots\dots + w_n f_n}{f_1 + f_2 + \dots\dots f_n} = \sum_{i=1}^{n} \frac{w_i \cdot f_i}{F}$$

$$= \sum_{i=1}^{n} \frac{w_i \cdot f_i}{\sum f_i}$$

Where,

WMI	= Weighted Mean Index
w_i	= Assigned weight for a particular class of priority
f_i	= Class of priority
F	= Total number of respondents

For assigning weights, a scale of 1 (lowest weight for least priority) to 5 (highest weight for top priority) is used. This technique is applied in Chapter IX.

3.3.2.3 Testing the Operational and Conceptual Clarity of the Officials involved in the Planning Exercise

The second part of the methodology testing was the operational capability and conceptual understanding of the DDC Secretary, DDC Engineer and Planning Officer. For carrying out this test, the participants were given a set of input data, maps and flow diagrams of the proposed methodology (Annex 3.14), which are the prerequisites for planning. The participants were specifically asked about their opinion on the forecasted data. Specifically, the population growth rate of various locations must be different because of different urbanization trends. In addition to the size of population of different urban centers, the participants were also asked to provide their opinion about different functions that might emerge by the end of the planning period. Originally such functions were estimated based on the government plans and information provided by the key informants in the locality. By cross checking the number of functions based on the judgement of the participants, the validity of the future functional index was tested.

After that, a simulation exercise was carried out. The guidelines for the simulation exercise are presented in Annex 3.15. In the first test run, the participants were asked to plan according to the "Business as Usual" manner. Despite the limitations of the ad-hoc planning based on the intuitive judgement, which are normally observed by the rational planners, the practice might be serving the necessity of the people within the budgetary, manpower and other socio-economic constraints. Moreover, the DDC representatives are the local people who have a better overview of the situation in comparison to the planners. Therefore the planners involved in the simulation exercise should not have a prejudiced idea about the "Business as Usual" approach. They could have made the decision as it is currently being practiced in the district. However, their activities were continuously monitored, their discussion recorded and if they have problems that was noted down. By this exercise, they could prepare road proposals for the next years, next five year and for the next fifteen years. The road proposal includes the new road construction, rehabilitation and maintenance.

In the next stage, the participants were asked to follow the proposed methodology. Before that, they were provided with the flow diagram of the methodology and computer model. They were briefed about the conceptual background and operational procedure of the methodology. After that, the participants started working on it. It was closely observed how they attempt to solve the problem and what conceptual and procedural issues were difficult for them to understand. It was noted down what type of questions they asked.

For conducting this exercise, a checklist was prepared and presented in Annex 3.16. Besides that, an open format for recording the questions and the discussion of the possible solutions was developed and presented in Annex 3.17. Finally, the participants were able to come up with the road proposals for the next 15 years. It was also observed how they tackled issues like: What are the justifications for those proposals? How they intend to acquire the required budget? The proposals were compared with the "Business as Usual". What are the fundamental advantages of the proposed methodology and if not what are the limitations and how can they be solved?

The proposed plans developed under both tests run ("Existing Practice" and "Proposed Methodology") were collected along with the supporting notes and explanations for further clarification. The checklist of the final output is presented in Annex 3.18.

3.4 Expected Result: The Proposed Methodology Confirmed

The proposed method can be recommended only when it is proved better than the prevailing methodology. Therefore, Table 3.5 presents the criteria for comparison, the verifiable indicators and means of verification.

Table 3.5 Criteria for Comparison

No.	Criteria	Indicator	Means of Verification
1	Cost for preparing the District Transport Master Plan	Preparation cost for the Master Plan by existing practice and proposed practice.	DDC record and present study
2	Time for preparing the District Transport Master Plan	Required preparatory time for the Master Plan by existing and proposed practice.	Interview with the DDC Engineers and the present study record
3	Precision in analysis	• Transport demand • Construction cost • Economic benefits of the road project	Analysis of the DTMP with the findings of this study.
4	Output of the planning exercise	• Accessibility • Traveling time • Level of service	Comparison of the DTMP with the present study
5	Transparency	• Degree of understanding by policy makers, bureaucrats and technicians.	Opinion of the experts, policy makers and the concerned public (meetings and questionnaire survey)
6	Efficiency in Updating	Time and cost for updating	Analysis of updating methods

Chapter IV
District Level Transport Planning in Nepal

One of the specific objectives of this study is to identify the strengths and weaknesses of the existing district level transport planning process. Any methodology, if is not based on the district realities, can not be implemented. Therefore, in order to identify the strengths and weaknesses, this chapter deals with the density of population and density of roads, pattern of revenue and expenditure and availability and quality of technical manpower of all districts. This chapter also describes the construction equipment holding by the DDCs. Against the background of all these aspects, the main focus of this chapter is to analyze the district level transport planning processes and practices of district level roads. Based on the discussion, the strengths, weaknesses, opportunities and threats of the district transport planning process are outlined.

4.1 Density of Population and Roads

Based on their geographical characteristics, the districts of Nepal are classified as Plain (Terai), Hill and Mountain. Twenty districts are classified as Plain districts, 42 as Hill, and remaining 13 are classified as Mountain districts. Obviously, the Plain belt has the highest density of population (287.49 persons/km^2) followed by the hill districts (209.51 persons/km^2). Mountain districts have the least densities of population (29.59 Persons/km^2). The DOP is a good indicator of transport demand. The densities of population is presented in Annex 4.1. Figure 4.1 shows the ecological regions of the country.

The DOR statistics are used for calculating the road density. Therefore, most of the rural roads are ignored because such roads are not inventoried. The road density is shown in Annex 4.2. There is an interesting trend in the road density among the Terai districts. The road density is highest in Jhapa district, the eastern most Terai district and diminishes gradually towards the west. Coincidentally, the Kanchanpur district, the western most Terai district has the lowest road density (0.10 km/km^2). Obviously, Kathmandu has highest densities of road (1.34 km/km^2) followed by Bhaktapur and Lalitpur districts. Any district through which the national highway passes has higher road density then the districts without the national highway. Nuwakot, Ilam, Palpa, Syangja, Dhankuta are the districts through which the national highway passes. Ten hill districts are not connected by the road at all. Out of Thirteen Mountain districts, six are not connected by the motorized road head. If the statistics are summarized by the ecological belt, the Mountain districts have only 0.01 km/km^2. The densities of roads in Hill and Terai districts are 0.07 and 0.16 km/km^2 respectively. HMGN has a plan to connect all the district headquarters.

The correlation coefficient between the population and road density is more than 0.95. It means there is a strong correlation between these two variables. The demand for road in the area with higher density of population is also higher. Consequently, more roads are constructed with the increasing political pressure. On the other hand, the area with the higher road density attracts more people from the inaccessible areas. Both forces ultimately result into the higher density of population in the accessible areas.

The densities of road is in lower level in comparison to the neighboring countries. Even the Terai area, which is considered as the most developed region has only 0.16 km/km^2, which is far less in comparison to India (0.41 km/km^2) and Bangladesh (1.12 km/km^2) (WB, 1993).

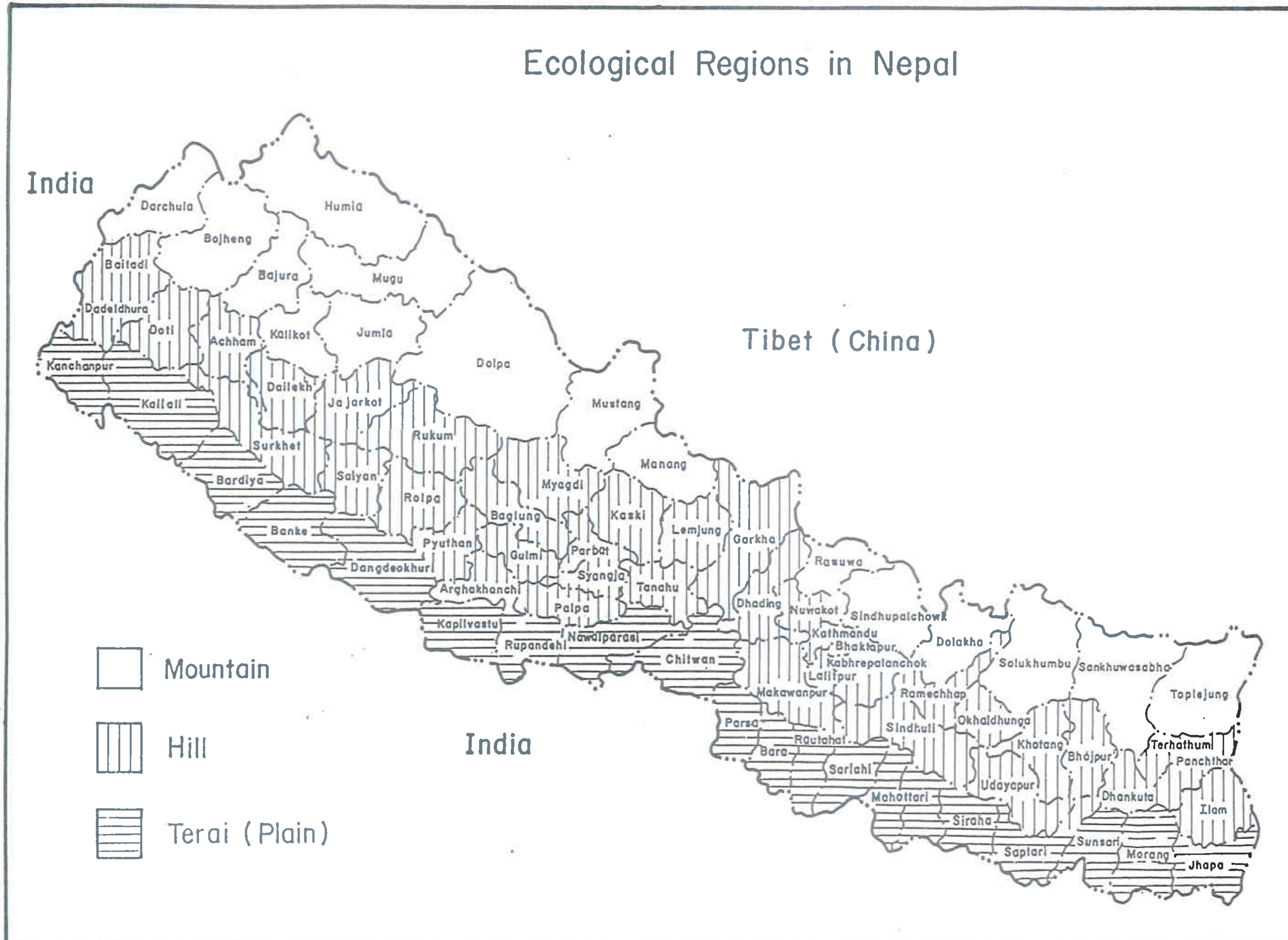


Figure 4.1 : Ecological Regions in Nepal

4.2 Pattern of Revenue and Expenditure

There are different sources of funds for a DDC. The major sources of revenue include government grants, income accruing from the sale of sand, stone chips and soil lying on the river within the district territory, local fees and taxes and amount accruable from other taxes, fees and fines and income generated from other income-generating programs. Nonetheless, the government grant is the main source of revenue. The components of the revenue sources are shown in Table 4.1.

Table 4.1 Average Components of Revenue Sources According to the Ecological Belt

Amount in NRs.

Ecological Belt	Balance of 98/99		HMGN Grant		Local Tax		Deposit		Other Revenue		Total
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	
Mountain	97,716	24.88	258,748	65.87	3,033	0.77	2,585	0.66	30,737	7.82	392.819
Hill	786,198	34.23	1,357,962	59.12	74,239	3.23	25,143	1.09	53,487	2.33	2,297.029
Terai	519,201	33.16	901,135	57.55	57,774	3.69	40,618	2.59	47,159	3.01	1,565.887
Total	1,305,399	33.79	2,259,097	58.48	132,013	3.42	65,761	1.70	100,646	2.61	3,862,916

Source: Office of Account Controller, 2000

Table 4.1 shows that the main source of district revenue is the HMGN grant, which constitutes more than 58 percent of the total revenue. The clear message of Table 4.1 is that the districts own source revenue is insignificant which is not conducive for a greater degree of decentralization. There exists a greater degree of variation for own source revenue among different districts. The own source revenue of all the districts is presented in Annex 4.3. The disparity in the revenue earning capacity among different districts is due to the locational advantage and endowment of the natural resources.

Not having budget absorption capacity also is another problem of the districts. The income and expenditure pattern showed that more than 29 percent of the total budget could not be spent on average in 1998/99. Similarly, 26 percent of total amount could not be spent during 1999/2000. Rolpa district could not spend 54 percent of its total budget in 1998/99 with that figure increasing to 62 percent in 1999/2000. There are quite a few reasons for not implementing the projects within the stipulated time. The government budget is not normally delivered on time. According to the policy makers, lack of supervision is the second largest factor for not completing the project. In most of the districts, there is only one engineer and few overseers. Therefore, it is not possible for them to supervise all the projects. Besides that, the small-scale contractors have several managerial, technical and financial problems that also contribute to the delayed implementation. The reasons for not implementing the projects are presented in the Annex 4.4(1).

4.3 Availability and Quality of Technical Manpower

This section deals with the employment status of the technical manpower, their work experience and the computer literacy rate.

4.3.1 Number, Employer and Employment Status of Technical Manpower

The MOLD deputes at least one engineer to each of the districts. Besides that, few overseers are also sent by the Ministry to the DDCs. If the districts are in need of additional overseers, they can hire them. Mostly sub-overseers are recruited by the DDCs. The average number of technicians by ecological belt is presented in Annex 4.4(2). Table 4.2 shows the average employment status by ecological belt.

Table 4.2 Average Number of Technicians by Ecological Belt (N=46)

Ecological Belt	Permanent Engineer	Temporary Engineer	Permanent Overseer	Temporary Overseer	Permanent Sub-Overseer	Temporary Sub-Overseer
Mountain	0.50	0.50	3.00	1.50	1.50	3.00
Hill	0.96	0.19	1.93	1.48	2.15	3.52
Terai	1.00	0.29	2.00	2.12	2.82	2.76

Source: Field Survey, 2000

Table 4.2 shows that there is only on average 0.5 permanent as well as temporary Engineers in Mountain districts. The average number of permanent and temporary Overseer is 3 and 1.5, respectively. The average number of permanent Sub-Overseer is just 50% of the temporary Overseers. The average number of temporary Sub-Overseer is 3.00. In the Hill districts, the average number of permanent Engineer is nearly one whereas the number of temporary Engineer is far less than the permanent Engineer. The number of permanent Overseer is greater than temporary Overseers in the Hill districts whereas the case is reverse in the case of the Sub-Overseers. Similar to the Hill districts, the ratio of permanent Engineer is greater than temporary Engineer in Terai districts. The number of permanent as well as temporary Overseer is almost equal. Similar is the situation of the Sub-Overseer.

With this information alone it is difficult to say anything about the sufficiency of manpower. However, each district should have at least 300 km[1] of district level transport infrastructure. The DDC is responsible to construct new roads, tracks and trails and maintain the existing ones. The available manpower, which is responsible for all types of construction works within the DDC, is not sufficient. For the effective planning and maintenance of the district level transport infrastructure, an independent technical unit is essential. The required number should be worked out for each district based on the requirement.

4.3.2 Experience of Technicians

The recruitment of the Engineers for the DDCs by the MOLD is a recent phenomenon. Until a few years ago, the DDCs used to have only Overseers and Sub-Overseers. The Engineer survey showed that the average experience of an Engineer is 7.09 years whereas the average period of experience of an Overseer is 6.62 years. The Sub-Overseers have approximately an equal level of experience as the Overseer. Therefore the experience of the technicians is not a constraint for planning and implementation of the district roads.

4.3.3 Computer Literacy

Engineers are conversant with computer skills to some extent. Most Overseers and Sub-Overseers have virtually no computer skills. Even the knowledge of Engineers is highly questionable because they do not have access and time to work on the computer. Table 4.3 reveals the computer literacy of the Engineers.

[1] Based on the executive judgement of experts.

Table 4.3 Number of Engineers with Computer Literacy by Ecological Belt (N = 46)

Ecological Belt	Word Processing f	Spreadsheet f	Database f	GIS f	Engineering Drawing f
Mountain	1	1	0	0	0
Hill	23	15	4	1	3
Terai	14	11	5	0	5
Total	38	27	9	1	8
% of Sample Total	82.61	58.70	19.57	2.17	17.39

Source: Field Survey, 2000
f = Frequency

Nearly 83 percent Engineers can work with word-processing and nearly 59 percent understand spreadsheet packages. Nonetheless it is highly questionable how well they can handle word-processing and spreadsheet packages, because they have obtained only one or two short term training courses. In the real life situation, they do not have to work with a computer. The computer operator works for them. It is widely observed that the quantity calculation is executed by use of a calculator. Although the percentage seems to be quite high, the actual skill might be far below than stated above. Undoubtedly the computer skill of Engineers on database packages, GIS and Engineering Drawings is largely insignificant. In such a situation, the central question to be answered is whether the GIS system can be introduced in the districts meaningfully. Can they use the packages and produce outputs of the spatial problems? Without upgrading their skills significantly, it is almost impossible. Even if the Engineers are provided adequate training and if they were motivated to work, the second pertinent question would be, will they obtain adequate time to work in GIS? The answer of this question is explored in the subsequent chapters.

4.4 Allocation of Working Time by Technicians

The Engineers of the hill districts spend their time mainly on routine work (29.67%). The construction supervision is the second highest time-consuming activity, which consumes more than 31 percent. The engineering survey and planning are other time consuming activities. The least amount of time is allocated for the socio-economic survey. The case of Terai is also more or less similar.

Overseers and Sub-Overseers mainly spend their time for supervising the construction works followed by the engineering survey. The Overseers of the Mountain districts spend 40 percent of their time on the construction supervision against 43 percent of Hill and 51 percent of Terai district Overseers. The Overseers of all ecological belts spend 22 to 25 percent of their time on the engineering survey. They spend only 3 to 7 percent of their time on planning activities. The Overseers have almost no say on budgeting, socio-economic survey and other works. There is not a significant difference between the Overseers and Sub-Overseers regarding the time allocation pattern. Most of the Sub-Overseer's time is consumed by construction supervision, engineering survey and routine works.

The discussion shows that the Engineer is the only person who works for planning. The Overseers and Sub-Overseers play only the supportive role. The relevant question could be is the allocated time for planning sufficient. More importantly, out of the total allocated time for planning how much time is allocated for planning the district road networks. For updating the plans, the time allocated by the Engineers might be sufficient. Nonetheless for the long term planning, the allocated time is not enough because as mentioned earlier it takes at least 4 months of effort to complete the transport planning exercise.

4.5 Construction Equipment Holding by DDCs

Table 4.4 presents the status of equipment holding by the sampled DDCs.

Table 4.4 Construction Equipment Holding of DDCs by Ecological Belt (N= 46)

Ecological Belt	Truck f	Tractor f	Water Tanker f	Roller (8-10 Ton) f	Roller (2 Ton)f	Bulldozer f
Mountain	0	0	0	0	0	1
Hill	0	2	0	0	0	8
Terai	2	1	0	0	0	3
Total	2	3	0	0	0	12
% of Total Sample	4.35	6.52	0.00	0.00	0.00	26.08

Source: Field Survey, 2000

Table 4.4 shows that no district has the Water Tanker, Roller (8-10 Ton) and Roller (2 Ton). Few Terai districts have Truck and Tractors. More than 26 percent of the sample districts have Bulldozers. Most of the Bulldozers were provided by the terminated projects in the locality. Very few are purchased using funds from the district treasury. Most of the Bulldozers are not functional. Out of 11 Bulldozers, eight are not functioning in the sample districts. However, most of the Trucks and Tractors are functional because maintenance facilities for such equipment are available almost everywhere. The maintenance facility for Bulldozers is not available in most of the locations. Besides that, obtaining spare parts is very difficult. Despite such a dismal fact, most of the DDCs are still tempted to purchase a Bulldozer. Interviews with the DDCs revealed that the root cause for this temptation is the commitment of politicians during their election period. That calls for an immediate implementation of the road projects, which is difficult by the labor-based technology under present organizational and legal framework of the DDC. As mentioned earlier, labor management is another serious task that is avoided if construction is implemented by use of equipment. Therefore, the DDCs should be made aware about the equipment policy. That equipment which have only limited use during a year and which can not be maintained by the DDCs due to unavailability of the maintenance facilities should not be purchased. The DDC should search a suitable intermediate technology for solving such problems.

4.6 Engineering Equipment Holding by DDCs

Most of the activities are executed by simple methods in the DDCs. Therefore, there is no need for sophisticated equipment. However, there are certain occasions when surveying and other equipment are necessary. Table 4.5 presents the equipment holding of the DDCs by ecological belt.

Table 4.5 Engineering Equipment Holding of DDCs by Ecological Belt (N = 46)

Ecological Belt	Theodolite f	Levelling Instrument f	Plane Table f	Computer f	Printer f	Plotter f	Drawing Board f	Adjust Drawing Board f	Lettering Set f
Mountain	1	1	0	2	2	0	2	0	1
Hill	20	22	0	21	21	0	23	4	15
Terai	6	15	0	15	14	0	13	2	9
Total	27	38	0	38	37	0	38	6	25
% of Total Sample	58.70	82.61	0.00	82.61	80.43	0.00	82.61	13.04	54.35

Source: Engineer Survey, 2000
f = Number of district officials

Nearly 59 percent of the sample districts have a Theodolite. Other districts are also in the process of purchasing that equipment. Although a Theodolite is not used so extensively, there are times when it is essential. Leveling instrument is used more frequently than a Theodolite. Therefore, nearly 83 percent districts have the Leveling Instrument. No district has either a Plane Table or Plotter. Almost all districts have a computer. Nonetheless, such computers are used for the general purpose of mainly typing. The Participatory District Development Programme (PDDP) has also introduced the GIS system but only printing is possible in the district. All digitization works take place in Kathmandu. It is almost imperative that each district that has a computer also has a printer. Most of the districts have an ordinary drawing board but few districts also have the adjustable drawing board. The adjustable drawing boards are mainly obtained from the donor agencies through some project and program. More than 54 percent of districts have the lettering set. Based on the discussion, it can be inferred that the DDCs have adequate amount of equipment for the present volume of works. Therefore it is not a constraint.

4.7 Knowledge of District Level Road Inventory

The major issue under investigation is whether the Engineers and Policy Makers have a proper understanding and information of the district level road inventory. Table 4.6 shows the understanding of the district officials about the road inventory.

Table 4.6 Knowledge of District Officials about the Road Inventory (N = 46)

Ecological Belt	Strategic Road (f)	Feeder Road (f)	District Road (f)	Urban Road (f)	Village Road (f)	Main Trails (f)
Mountain	0.00	0.00	0.00	0.00	0.00	0.00
Hill	11.00	14.00	12.00	2.00	11.00	8.00
Terai	9.00	8.00	8.00	5.00	4.00	1.00
Total	20.00	22.00	20.00	7.00	15.00	9.00
% of Total Sample	43.48	47.83	43.48	15.22	32.61	19.57

Source: Engineer Survey, 2000
f = Number of District Officials

No Mountain district has knowledge of the district road inventory. Similarly, less than 50% of districts have information about the strategic, district, urban, village and main trails.

Similar is the situation of Terai districts. Not having the proper knowledge of the district level road inventory is the crucial problem for planning the district level road network. According to the DOR, there is a road network of 238 km in Rupandehi district. Nonetheless, the actual survey discovered that there exists a network of more than 1000 km (PLRP, 1997c). Therefore, no district can plan the roads properly, which is the crucial problem for all the stakeholders.

4.8 Statutory Planning Process

The working areas, responsibilities and authority have mentioned that the DDC should prepare the DTMP and it should get approval from the DC. The responsibility further specifies that the DDC should construct, operate, monitor, evaluate and maintain the district level rural roads (HMGN, 1998a). The introduction of the Local Governance Act (1998) which empowers to form the sectoral agencies under the umbrella of the DDC is a revolutionary step in the history of decentralization in Nepal.

The DDC formulates the district development plan and priorities are accorded as follows (HMGN, 1998a):

- Programs immediately and directly beneficial to the people by increasing the income and employment.
- Programs to boost up the agricultural production.
- Programs which can be initiated by the use of local resources, skills and capacities.
- Programs which help to protect the environment.
- Programs which utilize skills and generates income for the women and children.

The DDC should also undertake the feasibility study of the project which studies the target of the program, expected number of beneficiaries and kind of benefits, program options, investment, local contribution, fees that can be raised from the beneficiaries for the maintenance etc. Besides these factors, protection and conservation of the environment and local contribution should be also considered. The selected projects are implemented either from the funds received from the HMGN as the block grant or specific grant, district own source revenue, loans received by the DDC, and assistance received from the NGOs. Such projects are implemented by either the DDC or a NGO.

The country is implementing the Agriculture Perspective Plan which includes the agricultural roads (DOLIDAR, 1998a). There is not much difference between the agricultural roads and rural roads. The objective of the agricultural roads is to enhance efficiency in the transportation of agricultural products from the point of production to the point of consumption, to commercialize and diversify the agricultural sector, and to make an effective food reserve system. Only those roads shall be selected where an agricultural development package program is implemented, agricultural pocket area that has potential to be integrated with the market center, the agricultural pocket area that has other infrastructure besides a road. Such roads should be approved by the DC. The probable projects received from the district shall be forwarded to the Agricultural Road Implementation Coordination Committee, which approves the agricultural road projects. Therefore, there is a difference between the ordinary district level rural road projects and the agricultural roads. The theoretical schematic diagram of the planning process is presented in Fig. 4.2.

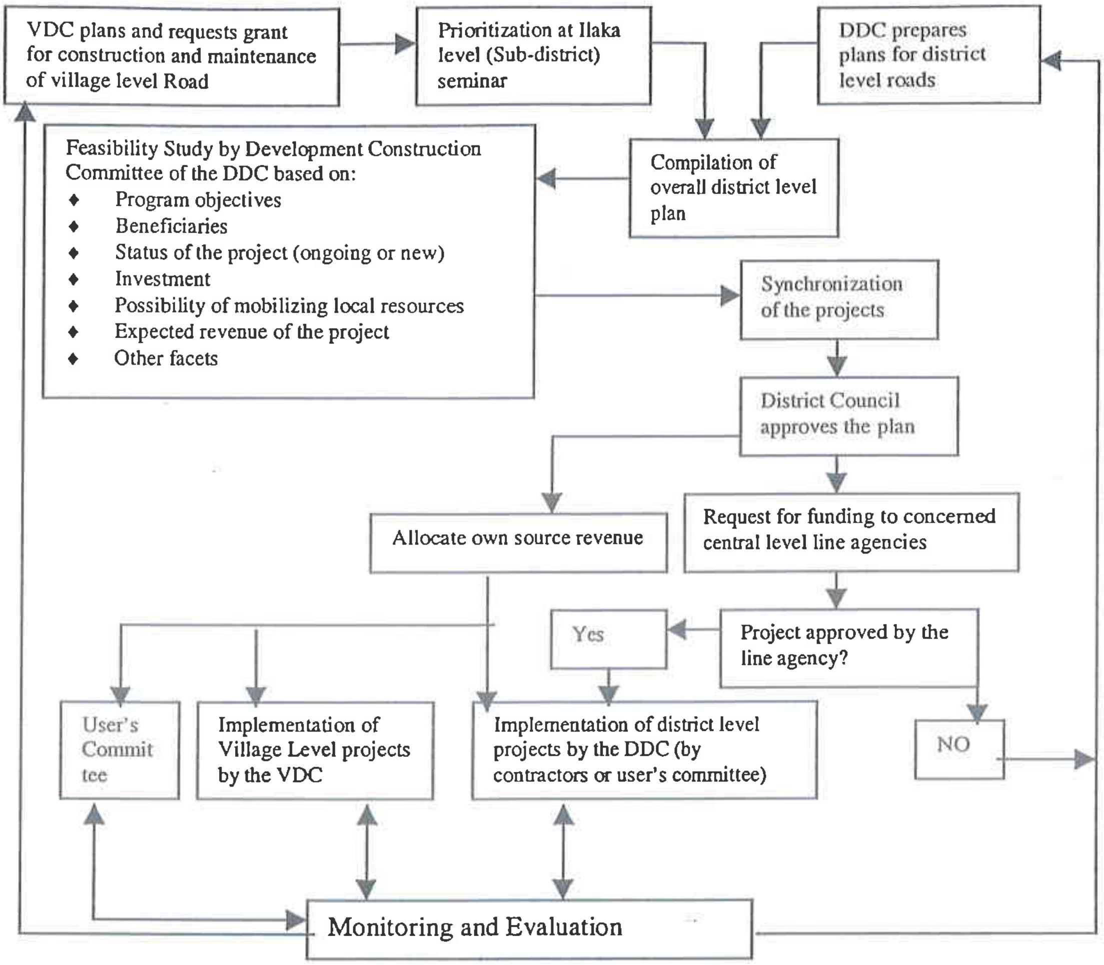


Figure 4.2 Planning and Implementation Process of the District Level Roads

Source: DDC Nawalparasi, 1993 and HMGN, 1992

4.9 Actual Planning Practices

Despite the established norms and procedures, the ad-hoc planning practice is prevalent in the country. As reported by Paudyal (1998) the VDC Chairperson of Ilam district directly sent requests for projects to the DDC Chairperson. It means the VDC Chairperson uses his intuition for selecting the project that may or may not confirm the formal procedure. Upon the request of the VDC Chairperson, the DDC Chairperson directly approves the project, which is later submitted to the DDC's regular meeting for endorsement. Alternatively, the regular DDC meeting approves the project on a case by case basis. All these projects, most of which would have reached the implementation stage by that time, are compiled and submitted to the DC for endorsement. Nonetheless the districts where PDDP and Local Governance Programme (LGP) have been launched, the plan formulation and implementation process is attempted to make systematic. In those districts, in order to get more projects identified at the beneficiary level, a "demand form" is made available from the Ward Committee on which anybody can propose a project by giving certain information. The nine Ward Committees collect the demand forms and screen them at the meeting of the Advisory Council. Feasible projects are included in the annual program by the VDC. However, in the Ilaka (sub-district) workshop very few representatives from the line agencies participate. The main reason for this was that the district-level line agencies felt that there was no point in discussing projects at the Ilaka level when implementing targets are set by their parent organizations at the center. Secondly, even when the DC finally approved the projects, they were again sent to the respective Ministries for inclusion in the annual program and budget. In many cases, projects were changed. Finally, in the case of DDC funded projects, the DDC component was too small. A large portion was expected to be borne through local contributions. Therefore, professionals were frustrated as no quality work could be expected from the allocated money (Paudyal, 1998).

4.9.1 District Transport Master Plan

Some of the districts have already prepared the DTMP through bilateral or multi-lateral support. Others are still on the way to preparation of the DTMP. Now the DOLIDAR has made the DTMP mandatory in all of the districts where the Agricultural Road Program is being implemented or is on the way to being implemented. The status of the DTMP preparation is presented in Annex 4.4(3).

Only 20 districts out of 46 have the DTMP. Among them, 60 percent of the district belong to the hilly areas. The second highest number is of Terai districts, which are 7 of 20 districts. Out of the two sampled Mountain districts, one district has DTMP. Nonetheless, the modality of DTMP varies significantly because few districts were supported by one donor and other districts were supported by another. After promulgation of the DOLIDAR approach, the DDCs are bound to follow the same approach.

The next pertinent question would be whether the districts follow the DTMP once it is prepared. It is especially pertinent question when there is a change in DDC authority. All respondent districts have indicated that the DTMP is followed while implementing the district level road projects. Nonetheless, the informal discussion and the implicit indication of the DDC Engineers have shown that the DTMP is not followed strictly, especially after the change of the DDC body.

4.9.2 Maintenance Plan

Recognizing the problem of allocating scarce resources for only new roads while ignoring the maintenance requirements of the existing roads has resulted in adverse consequences on the production and productivity of agricultural and industrial products. Therefore the DOLIDAR has promulgated the National Program for the Maintenance of the Rural Roads, 2056 (DOLIDAR, 1999). Having scarce resources and very high demand for the new road construction, the DDCs have also largely ignored the maintenance of rural roads. One question was asked with the DDC Policy makers regarding the maintenance of the rural roads. The response is presented in Annex 4.4(4).

Only 15 districts out of 46 have a maintenance plan. There is no maintenance plan in the Mountain districts surveyed. Out of the 27 Hill districts, eight districts have a maintenance plan. Similarly out of 17 Terai districts, less than 50 percent districts have a maintenance plan. However, no district has a systematic maintenance plan. There are different types of maintenance, e.g. Routine Maintenance, Periodic Maintenance, Rehabilitation and Emergency Maintenance. The districts however, have only ad-hoc allocation of budget for some stretch if the politicians realize that there is a problem. It means there is no preventative maintenance, which is essential for the sustainable rural road projects.

The respondent districts have mentioned that they have accepted the maintenance plan. Now the DOLIDAR has promulgated the National Plan for Rural Road Maintenance, 2056. According to that, each district should have a rural road maintenance plan. At the initial stage, 58 districts will be covered by the maintenance plan, which will be extended to other remaining districts in the future.

4.9.3 Rural Road Networking Concept

The response of the Engineers regarding their adoption of the networking approach is portrayed in Annex 4.4(5). Only 28.26 percent of districts adopt the networking concept in planning. This percentage is smaller than the percentage of districts that have prepared a DTMP. Normally the DTMP is ought to adopt the networking concept. Nonetheless the DOLIDAR methodology assembles the demand from the VDCs and screens the proposals. Therefore, it does not adopt the networking concept. The PLRP approach considered the preparation of the network based on the nodal points but in fact, it also followed the incremental planning approach. For some of the Engineers, it is an abstract concept. Therefore, there is a need to develop a simple networking methodology for rural road planning in Nepal.

4.9.4 Transport Demand

The response of Engineers regarding the transport demand is presented in Annex 4.4(6). More than 78 percent of Engineers expressed their opinion that there is a need of estimating the transport for the proposed new or rehabilitation project. Some Engineers have expressed their helplessness by mentioning that the politicians select the road projects for construction and rehabilitation irrespective of the transport demand. The Engineers have almost no role in project identification. Their role begins only when the project is already identified.

The Policy Makers agree that estimating transport demand is essential for planning the district level transport network. The opinion of the policy makers is presented in Annex 4.4(7). Overwhelming majority of the Policy Makers expressed their opinion in favor of the transport demand. Therefore, it can be inferred that there is a misunderstanding between the Policy Makers and the Engineers. If Engineers could convince the Policy Makers, it may not be difficult to implement the policy of estimating transport demand. More than 2 percent Mountain districts, more than 54 percent of Hill districts and nearly 33 percent of Terai districts Engineers are in favor of using transport demand.

4.9.5 Technology

The specification is the authentic expression of the technology. The Ministry of Works and Transport (MOWT) introduced the specification in 1984. Nonetheless, the construction technology has undergone drastic changes since the specification was prepared. The norms were prepared based on the specification. In the mean time labor based technology gained significant popularity. Using the secondary information, the DOLIDAR has now developed the labor based specification and norms. Most of the DDCs however, are still using the specification and norms developed by the MOWT. Engineers were interviewed about the use of norms and specifications. The response is presented in Annex 4.4(8). More than 85 percent of Hill districts use the specification developed by the MOWT. Similarly, more than 82 percent of Terai districts follow the MOWT specification. The open question is whether the specification that was prepared for the strategic road networks is applicable for the district level road or not is still unanswered. Few people argue that the specification developed at that time by the MOWT was the labor based. Therefore, it can be applicable in the present context as well. Nonetheless, other people argue that the specification and norms prepared at that time is inflated. It can be expected that the DDCs in future will adopt this newly introduced norms and specifications.

The second opinion that was asked with the Engineers was the appropriateness of the MOWT norms and specifications. The opinion on the appropriateness of the norms and specification is presented in Annex 4.3(9). Only 17 district Engineers out of 46 believe that the norms and specification developed by the MOWT is appropriate. It means more than 63 percent Engineers have rejected that the specification is appropriate.

The next question that was asked of the Engineers was of the possibility of reducing cost. As shown in Annex 4.4(10), more than 69 percent of Engineers do not believe that there is a possibility to decrease cost. That number is tentatively equal to the opinion holders who believe that the norms and specifications are not appropriate. Cost reduction is possible by introducing the intermediate technology in Terai area. For instance, Tractor towed excavator and grader are found appropriate in Terai districts. The labor-based technology is the only feasible solution for the Hill districts.

4.9.6 Estimation of Benefits

The experts and practitioners are divided in their opinion regarding the estimation of the benefits of a road project. Few consider it as the basic need, others consider it as the economic product. It may not be the economic product but it is necessary to prioritize among the different projects based on the economic return it generates. The economic benefit of a road project is not measured in the district planning process in Nepal. The legal provision also suggests considering the number of beneficiaries, investment and the fees that can be generated after the construction of the road project. Therefore, it is not necessary to conduct the economic feasibility study. One pertinent question was asked whether the DDC estimates the benefits of a rural road project. Out of 46 districts, only five districts consider benefits while planning the rural roads. These districts also could be supported by the foreign donor agencies where an economic evaluation is essential. The World Bank and the Asian Development Bank are particular on this matter. In an another question whether the benefits are actually realized after the construction, they mentioned that the benefits are actually realized after the construction of the road project. Nonetheless, there is not any systematic study in Nepal to state with authority that the benefits are realized after the construction of the road project.

4.9.7 Prioritization of the Road Project

There are economic and non-economic criteria for prioritization. In response to the question of satisfaction of the Engineers with the prioritization criteria, the Engineers have responded as shown in Annex 4.3(11). Out of the 46 sampled districts, only 8 district Engineers are satisfied with the prioritization criteria stipulated by the DDC Act. Therefore, majority of the DDCs is not satisfied with the prioritization criteria. The DDC prioritization criteria means the criteria specified in the Chapter VI, Clause 37 and Sub-Clause 2 of the DDC Act which mentions that the priorities should be given to the projects that give immediate benefits to the people by increasing the income and employment, boost up agricultural production, use more local resources, protect the environment and utilize skills and generate income for the women and children. As such, prioritization criteria seem to be moderately practical but rather abstract in characteristics. That could be the reason why the majority of the District Engineers did not like the idea. However, if such criteria are translated into the satisfactory quantitative terms then it will be more meaningful and understandable by the majority of the Engineers in the District Level. It means measuring the actual traffic movement and predicting the future traffic seems to be the appropriate method for prioritization.

The Engineers were also asked about their preference regarding the prioritization technique. Table 4.7 shows the result of their opinion. Most of the Engineers are in favor of the Economic Appraisal followed by the ranking. A combination of both ranking and economic appraisal is preferred by more than 26 percent of respondents. It means the Engineers are not unanimous regarding the appraisal technique. They have given a hint that the technique of appraisal is situational. It means in certain situation the economic appraisal is preferable and in other situations the ranking is a better solution. In some of the occasions, the combination of ranking and economic appraisal could be a better solution.

Table 4.7 Opinion of Engineers on Road Project Appraisal by Ecological Belt

Ecological Belt	Economic Appraisal (f)	Ranking (f)	Ranking and Economic Appraisal (f)	Total (f)
Mountain	1	1		2
Hill	9	14	4	27
Terai	8	1	8	17
Total	18	16	12	46
%	39.13	34.78	26.09	100.00

Source: Engineer Survey, 2000

4.10 Practice of Allocating Budget for the District Level Roads

As mentioned by Shrestha (1997b), the available funds are not always allocated in the planned manner. The fund allocation practice is presented in Table 4.8.

Table 4.8 Average Number of Projects and Allocated Budget

Description	Fiscal Year		
	95/96	96/97	97/98
Total Numbers of Projects	331	433	476
Average Amount in NRs. ,000	175	135	170
Average Numbers per District	13.24	12.37	14.00
Standard Deviation in Numbers	12.71	12.71	14.49
Standard Deviation in Project Cost	2156.15	1616.76	3200.96

Source: Office of Account Controller, 2000

Table 4.8 shows that the average amount per project was NRs. 175,000 (about 2,900 US Dollars), NRs. 135,000 (about 2,100 US Dollars) and NRs. 170,000 (about 2,500 US Dollars) in the Fiscal Year of 1995/96, 1996/97 and 1997/98 respectively. For the construction of a fair weather earth road, it costs about NRs. 1,200,000 (about 17,650 US Dollars) (Meyer et al. 1999). Therefore according to the green road approach (the cheapest technology ever known in Nepal) the available resources are sufficient only for about 100 m of road. If 100 m of road is constructed each year, it will take years to construct a nominal stretch of road. With such a nominal budget, the politicians force to construct something to the technicians. Because of a lack of funding, they design retaining walls without sufficient foundation, and they design the pavement structure without adequate thickness and quality. Such structures often collapse within a short period. Therefore, the budget allocation practice is an increasing liability to the DDC and defaming the entire construction practices.

4.11 Summary of the District Level Transport Planning Process

This chapter discussed the district level transport planning process against the background of overall district environment. It showed that Nepal is lagging behind other neighboring countries in terms of overall road network. This chapter also showed that the overall district revenue is insufficient for the construction and maintenance of the district level road networks. Out of the meager resources, the own source revenue is insignificant, which is not conducive for the decentralization process. The problem gets further serious when the DDCs are incapable to spend the available resources. Faulty budget allocation practice, insufficient manpower, inappropriate equipment policy and lack of knowledge of district road inventory among Engineers and Policy Makers are some of the reasons for poor construction and maintenance of the district roads.

In terms of the district level transport planning process, there exists a solid legal foundation for planning and maintenance of the district roads. As a new responsibility, the preparation and implementation of the transport plans for new construction and maintenance is not taking place in accordance to the spirit of the legal frameworks. Similarly, the conceptual and methodological ambiguities in the methodology for developing the rural road networks and estimation of the transport demands still persist. In terms of the construction technology, there is a general consensus that the labor-based technology should be adopted. Nonetheless an appropriate construction norms and specification should be developed. The respondents are divided in the estimation of the benefits. Similarly the respondents are found divided regarding the appraisal techniques. The actual budget allocation practice shows that the theoretical planning methodologies are not implemented in practice. The political influence is ultimately influential because the budget is fragmented in such a way that no road can be constructed and maintained meaningfully.

Based on the discussion, the strengths, weaknesses, opportunities and threats of the DDCs are identified. A preliminary sketch on the feasible options is also outlined.

4.12 SWOT Analysis of District Level Transport Planning Process

The salient strengths, weaknesses, opportunities and threats (SWOT) of the Nepalese districts are presented in Table 4.9. The SWOT analysis is based on the analysis in this chapter. In Table 4.9, the internal factors, i.e. strengths and weaknesses are arranged vertically and the external factors, i.e. opportunities and threats are arranged horizontally. Appropriate strategies are developed combining the internal factors' with that of external factors. For instance, the enactment of the local governance act combined with the experienced technical staff created a suitable environment for a greater degree of decentralization. Only environment friendly road structures can withstand in the rugged topographic condition and that is possible with the capable designers and implementers. In a similar fashion, the appropriate strategies are formulated combining the weaknesses and opportunities and weaknesses and threats. In Table 9, the strategies are shaded for emphasis.

Table 4.9 SWOT Analysis and Required Strategies

External Factors / Internal Factors	Opportunities • Enactment of the Local Governance Act. • Connecting districts with the national road network. • Mandatory preparation of the DTMP. • Realization of the importance of maintenance. • Transport demand is considered as crucial for transport planning.	Threats • Rugged topography. • Low population density in hill and mountain districts. • Scattered distribution of settlements. • Allocation of budget per DDC member induces scarcity for any single project.
Strengths • Experienced technical staff • DDCs own engineering equipment	♦ To operationalize the devolved authority for planning and implementation of the district roads with the help of experienced technical staff for improving the level of accessibility. ♦ To prepare the district level transport plan based on the national level roads using available engineering equipment and technical staff.	♦ To construct district level roads with environment friendly construction technology. ♦ To plan and construct roads based on transport demand and required level of access.
Weaknesses • Meager amount of own sources of revenue. • Poor capacity of utilizing available resources. • Low level of computer use among the district Engineers. • Top priority for routine activities. • Absence of long term planning perspective at the district level. • Procurement of the construction equipment without considering its long-term consequence. • Adhoc planning practice. • No networking concept for planning the transport infrastructure. • Lacking appropriate standards and specifications for road construction.	♦ To increase amount of local revenue with the devolved authority. ♦ To increase effectiveness of implementation by planned approach. ♦ To establish a branch for planning, construction and maintenance of road networks. ♦ To train the newly recruited staff members for computer use and applications. ♦ To introduce the rationale decision making system for purchasing the road construction equipment and adopting construction technologies.	♦ To adopt the low cost, environment friendly road construction technology. ♦ To consider other types of rural transport infrastructure including foot trails, mule tracks and suspension bridges besides the motorized road construction. ♦ To introduce the transport planning exercise and achieve consensus among all the DDC members for effective implementation in order to avoid the fragmentation of resources.

4.13 Focus on Feasible Options

Section 4.12 reviewed the main strengths, weaknesses, opportunities and threats of the DDCs in the district transportation planning. The SWOT covered broader areas of the rural transportation. Therefore this study focuses only on the issues which are directly related with planning. The "state of the art" was reviewed in Chapter 3. Aginst this backdrop, the major methodological options for planning the regional transportation infrastructure are outlined in Table 4.10.

Table 4.10 Major Methodological Options for Planning the District Road

Existing Methodology			Proposed Methodology	
No.	Main Activities	Main weaknesses of the existing planning system	Basic Approach for Under-Developed Areas	Sophisticated Approach for the Developed Areas
1	Developing a district road network • Thematic map preparation • Inventory of District Road • Identification of nodal points	• The current practice of the piecemeal approach is creating difficulties in synchronizing the market and service center in conjunction to the road network. • Transportation cost and traveling time can not be minimized.	• Prepare thematic maps manually for analysis. • Prepare road inventory by showing on the map and support by the database indicating the geometric condition and road condition. • For identifying the centrality calculate Centrality Index manually.	• GIS based thematic maps. • GIS mapping and a comprehensive database of geometric and pavement standards and road quality. • Computer based centrality analysis.
2	Estimation of transport demand	Counting beneficiaries in the adjoining settlements can not estimate the trip generation ratio correctly because the total trips also depend on the road users from other settlements and trip rate depends on the economic activities of the given area.	Existing and potential traffic estimation by trend method. • Method of data collection: Traffic Survey	• Traffic Forecasting based on existing, generated and diverted traffic. Mode of data collection: Road Side Survey, Cordon Survey, Passenger Survey, Passenger's Vehicle Survey, Freight Carrier's Survey, Key-informant Survey and other socio-economic data.
3	Estimation of cost	Adoption of the norms and specification of the MOWT, which is considered not to be realistic	Select appropriate design options and construction technology from other sister projects	Site specific design and construction technology according to the demand condition.
4	Estimation of benefits	It is difficult to justify the investment when the user's benefit is not considered.	Number of beneficiaries and area of cultivated land within the ZOI, Intensity of Interaction.	Total user's benefit and the development impact of the transport infrastructure.
5	Appraisal technique	The political selection of road projects fails to maximize the economic return and often creates social injustice.	Ranking on the basis of multiple criteria.	Economic evaluation including the development impact on production.

The present proposed methodology based on the "state of the art" and the first stage survey will be further substantiated and refined in the subsquent chapters.

Chapter V
Analytical Framework for District Road Network Planning and Prioritization

The purpose of this chapter is to prepare the ground for developing the methodology for the district road network planning and prioritization. Chapter IV described the existing situation of district level transport planning in Nepal. This chapter mainly discusses the opinions of the experts, policy makers and engineers on rural road network planning, estimation of the transport demand, technological issues of the rural roads, benefits and appraisal techniques. Based on the opinion of the respondents, existing district reality and the *"state of the art"*, a methodology is developed in the next chapter.

5.1 Networking of the District Roads

The literature review discussed the "state of the art" in the field of networking of the rural roads. Among two types of models, the traditional mathematical models are not appropriate for networking the district roads. Having a paucity of technical manpower with lower level of technical understanding, the DDCs will face difficulties to derive solutions from the mathematical programming. On the other hand the available time and resources of the DDCs also do not allow working with the mathematical models. Additionally, having a very few roads, the requirement for new construction and upgrading becomes obvious. On the other hand, the settlement interaction models are relatively easier and transparent. Therefore these models are found appropriate for planning the district level roads in Nepal. The opinions of the policy makers and engineers have further substantiated this idea. This chapter presents the findings of the surveys and interviews.

5.1.1 Practitioners' and Experts' Opinions

The practitioners' and experts' opinions of the networking approaches are presented in Table 5.1. The question was open-ended and opinions are clustered according to their similarity in Table 5.1. Each approach is explained in the subsequent paragraphs.

Table 5.1 Networking Approaches of District Roads (N = 28)

No.	Approaches	I f	II f	III f	IV f	Total f	In %
1	Existing Roads and Zone of Influence Approach	4	2	1		7	20.00
2	Central Places, Resource Potential Areas and Roads, Tracks and Trails	5	7	3	8	23	65.71
3	Opinion of Local Politicians and other people	2	2			4	11.43
4	Negative Zonation, Central Places and Existing Roads, Tracks and Trails	1				1	2.86
	Total	12	11	4	8	35	100.0

Note: I = Chief Technical Advisers; II = Consultants; III = Academicians; IV = Government Officials
Source: Field Survey, 2000

The 28 interviewees provided 35 suggestions, meaning some of the individuals provided more than one opinion. In the open-ended question, no respondent mentioned the mathematical model for planning the district road networks. Therefore the first interpretation would be that the experts and practitioners are either totally unaware of the mathematical models or are fully convinced on the non-applicability of the models for developing the district level transport networks. Therefore, mathematical modeling could be discarded. Secondly, there is a certain degree of similarity among the expressed opinions. Almost all respondents have accepted that the existing roads, trails and tracks should be considered for developing the network. However, the majority of the respondents believe that besides considering existing roads, trails and tracks, one should consider the central places.

5.1.1.1 Existing Roads and Zone of Influence Approach

Twenty percent of the respondents have favored the existing roads and the Zone of Influence (ZOI) approach for developing the district road network. This approach assumes that there exists at least a road connecting the district. Then the DDC should develop the district accessibility standards. The district accessibility standard means how much time one villager living in the remotest area should take to reach the nearest road head. It means what should be the distance between one road and another. It can be further extended and can be interpreted as how much time should one take to reach the nearest market center or the district headquarters from the remotest hamlet of the district.

The concept of the ZOI is closely related with the district accessibility standard. The ZOI of a rural road is defined as the area served, impacted or modified by a road in its immediate geographical environs. Within this area, the implementation of a road project is likely to alter the land use pattern, production cost and revenues, and marketing and distribution systems (Carnemark et al. 1984). The concept of the ZOI can be used for developing the rural road networks as well as for the economic evaluation. The PLRP used 3 km either side of the road as the ZOI. The WSA and SMEC (1996) considered the ZOI within a walking time of four hours from the alignment of the road.

According to this method, the inaccessible areas can be delineated from the accessible areas. However, this approach is almost silent on how the district road network should be developed in the inaccessible areas. The question is where to construct the road to maximize the accessibility for majority of the populations within the resource constraints. Therefore, it is useful for the preliminary analysis but should be supplemented with the additional techniques for developing the full phased transport plan.

5.1.1.2 Central Places, Resource Potential Areas and Roads, Tracks and Trails

Nearly 66 percent of the respondents are in favor of developing networks based on the central places, resource potential areas and the existing roads, tracks and trails. The use of central places for developing the rural road networks is not a new phenomenon. The literature review has elaborated the past endeavor in that direction. However, which functions should be included for evaluating the central places is not clearly spelled out in the previous studies. In the context of a country's emphasis towards developing the agricultural pocket areas, the experts and practitioners believe that the agricultural as well as industrial resource potential areas should be considered as the nodal point. It is justifiable for two reasons. The first reason could be that the resource potential area needs an access for exploiting the resources. Secondly, the resource potential area has a possibility to be developed as the nodal point in the future.

According to this methodology, present and potential market centers should be listed. Besides, the agricultural pocket areas, mines, religious and historical monuments and ruins also should be listed. It is relatively easier to enumerate the market functions and determine the hierarchy of settlements. The function that has possibility of attracting trips from outside the market center should be included in the analysis. Assigning weight to the agricultural pocket area is rather difficult and sometimes contradictory. If there is a larger built-up area, then the agricultural land could be less and vice-versa. However, the resource potential areas normally should have shown some attributes of urbanization, which can be measured in a normal way.

After fixing the nodal points, the existing roads, trails and tracks can be overlaid on the nodal points. All the links connecting the nodal points could be considered as the network in the regional level. If there is no link between two nodal points, it can be interpreted as either there exists no relationship between two points or the link is missing.

5.1.1.3 Opinion of Local Politicians and other People

This approach believes that the local people have a better knowledge of the environment. Therefore, their opinion should be the basis for developing the network. The respondents having such an opinion are only 11.43 percent. This approach uses the subjective judgement rather than the facts. The advocates of this approach proclaim that the political commitment is essential for getting any project implemented. By considering the opinion of local politicians and other people, it becomes easier to ensure the political commitment that increases the probability to get a road project implemented.

That is however, a status quo strategy. At present, the politicians select the road projects to be implemented and the technicians just implement it. As revealed by the Engineers Survey, most of the Engineers have reported that they are not involved in the decision making process. It means the technical dimension of the road project is grossly undermined. Secondly, the intuitive decision creates grounds for a politically biased judgement. Consequently, the DDC members share the available funds equally which fragments the resources in such a way that no meaningful project can be accomplished.

Therefore relying fully on the opinion of the political leaders is considered counter-productive. However, no rationale plan can be implemented without the concurrence of the political leaders. Therefore, a mechanism should be developed so that the politicians should be able to make decisions based on the rational reasoning.

5.1.1.4 Delineation of Geologically Fragile Areas, Central Places and Existing Roads, Tracks and Trails

Only few respondents (2.86%) have offered their views in favor of this approach. This approach is exactly similar to the second approach except the concept of delineating the geographically fragile areas and such areas should be prohibited for the construction activities. They suggest that after delineating such areas the planners should plan for the remaining areas. Such factors are generally considered by the road designers and they try to avoid such areas. However, on the other hand there might be economic, social and political compulsions to construct roads through such areas. Therefore theoretically, the concept should provide the initial guideline but it should not be rigid criteria for constructing a road.

5.1.2 Use of Geographic Information System in Road Networking

Geographic Information System (GIS) packages like Arc Info and Arc View or the transportation packages based on the GIS like TransCad, AIMS (GIS accident software) (UOF, 2000) are increasingly popular for developing the appropriate road networking.

Similarly, other spatial decision packages like LocNet, LADSS and FLOWMAP can be also used for solving the transport related problems.

5.1.2.1 Usefulness of GIS for Developing the District Road Networks

In response to one question regarding the usefulness of the GIS for developing the district road networks, a majority (nearly 77%) of the experts and practitioners believed that the GIS is useful for the transportation planning. Nonetheless a small majority of the Chief Technical Advisers (5 out of 9) believe that the GIS might be useful technically but considering the working environment, it is not possible to introduce in the district. Similarly one government official out of seven also believes that the districts find difficult to operate the GIS. Nonetheless all the consultants and academicians believe that the GIS should be gradually introduced in the DDCs now so that they can learn to handle it for solving the spatial problems. Table 5.2 shows the response of different experts with regard to the GIS.

Table 5.2 Usefulness of GIS for Developing the District Road Networks (N = 28)

No.	Approaches	I f'	II f'	III f'	IV f'
1	GIS is useful for district road networking	14.28	21.43	14.28	21.42
2	GIS is not useful for district road networking	17.85		7.17	3.57
3	Not Known				7.17

I = Chief Technical Advisers; II = Consultants; III = Academician; IV = Government Officials
f' = Proportion
Source: Field Survey, 2000

5.1.2.2 Capability of the DDCs for Handling the GIS

The PDDP has introduced the GIS in the districts. However, the DDCs have simply a printing facility in the district. The digitization and manipulation takes place in the PDDP supported branch of the National Planning Commission of Nepal. Even the maps produced by the PDDP are found not usable. The coordinates of different layers are not coherent. So these maps can not be overlapped and interpreted. If the UNDP supported and centrally located branch having a group of GIS experts is unable to produce the useful maps by the GIS, how can an Engineer who is occupied in several other more pressing issues and has meager knowledge of the GIS be expected to produce the results. In such a circumstance, should the districts give up the idea of GIS and concentrate on manual maps or is there still a possibility to introduce it in the appropriate ways. The experts were also asked about the capability of the DDCs to handle the GIS. The response is recorded in Table 5.3.

Table 5.3 Capability of DDCs to Handle the GIS

No.	Opinion	I f	II f	III f	IV f	Total f	In %
1	DDCs can handle the GIS			1		1	3.57
2	DDCs can handle the GIS with some external Support	3	1	2	1	7	25.0
3	Capable DDCs should be distinguished from the incapable DDCs	2			4	6	21.43
4	DDCs can not handle the GIS in the present circumstances	4	5	1	4	14	50.0
	Total	9	6	4	7	28	100.0

I = Chief Technical Advisers; II = Consultants; III = Academicians; IV = Government Officials
Source: Field Survey, 2000

Only one respondent is convinced that the DDCs can handle the GIS under the present circumstances. More than 96 percent respondents have the opinion that the DDCs can not handle the GIS under the present circumstances. However, their degree of pitch varies from one to another. About 25 percent of respondents believe that the DDCs can handle the GIS if external support is provided. More than 21 percent DDCs suspect that there could be some capable DDCs, which should be differentiated from the incapable DDCs with GIS initiated only in the capable DDCs. Nevertheless, the majority of the respondents (50%) believe that the DDCs are not capable enough to handle the GIS under the present circumstances.

A similar question was asked of the policy makers of the DDCs. Quite contrary to the result of the Expert and Practitioner Survey, the district policy makers believe that the DDCs are capable enough or should be made capable for handling the GIS. Therefore, more than 63 percent DDCs argued that the DDCs should be trusted for handling the GIS. Only about 30 percent DDCs feel that the work should be handled by the DOLIDAR. Very few respondents believe that the GIS works should be given to the private sector or to the Regional Directorate of the MOLD. It shows that the DDCs are willing to assume greater degree of responsibility that is conducive for the higher level of decentralization. However, the open ended interview with the DDC policy makers revealed that their logic relies upon the present practice of the DDCs to handle the computer for word processing, which is relatively easier than the required ability to handle the GIS. At present, most of the DDCs (nearly 83%) have a computer, especially provided by the PDDP and LGP; both supported by the UNDP. Until now, the computers are used for the purpose of word processing and spreadsheet calculations. Therefore, the DDC policy makers infer that if the computers can be functional and useful for word processing and spreadsheet why can it not be operated for the GIS purpose at the district level. They are unaware that the GIS software packages are far more expensive in comparison to the word processing packages and the operator needs higher level of conceptual and computer skill than is needed for word processing. The DDCs can not retain such GIS experts within their salary structure. Such experts have higher demand in the private and NGO sector who offer relatively higher salary in comparison to the government salary scale.

From the analysis, it can be inferred that the DDCs at the present circumstances are not capable enough to handle the GIS. However, it is useful and the DDCs should be enabled to handle it eventually. During the interim period, DOLIDAR, the officially facilitating agency to the DDCs, should initiate the idea of the GIS and should try to use it for planning the district road networks. Since the DOLIDAR is established recently, it is an over-ambitious proposal for giving the entire responsibility to it. Therefore, the manual method of developing networks based on the existing maps is the most realistic approach for all the DDCs in general. However, in this process, the capable districts logistically and technically should be distinguished and the GIS should be introduced gradually. The strategy fits with differentiating methodology for developed and under-developed areas.

5.2 Estimation of the Transport Demand

It is already explained in Chapter 4 that the Policy Makers as well as the Engineers are strongly in favor of estimating the transport demand. Statistically, more than 78 percent of Engineers and more than 89 percent of the policy makers are in favor of estimating the transport demand. Despite such an overwhelming support for the transport demand, the actual demand estimation does not take place. The projects are selected not based on the demand but according to the political interest of the political leaders. Such practice has created an unhealthy situation in the districts. The overwhelming support in favor of the transport demand is the reflection of frustration of the existing situation.

During the discussion with the experts and practitioners, it was found that there are four different opinions with regard to estimating the transport demand. Majority of the experts and practitioners (64% of the total respondents) believe that the transport demand should be estimated based on the existing, generated and diverted traffic. It means existing traffic should be carefully assessed including the seasonal fluctuation.

Table 5.4 Approaches for Estimating the Transport Demand (N = 28)

No.	Approaches	I f	II f	III f	IV f	Total f	In %
1	Existing traffic survey and estimation of generated and diverted traffic	3	9	3	5	20	64
2	Socio-political need identification	1	2	1	1	5	16
3	Existing traffic survey and Stage Construction	1		1	1	3	10
4	Not necessary from the equity perspective		2		1	3	10
	Total	5	13	5	8	31	100
	In Percent	16	42	16	26	100	

I = Chief Technical Advisers; II = Consultants; III = Academicians; IV = Government Officials
Source: Field Survey, 2000

There are different ways of estimating the existing traffic. Among them, the cordon survey is considered the most effective. Nonetheless, the volume of traffic does not remain constant throughout a road. It changes as one proceeds ahead because the traffic is distributed among different tertiary roads. Therefore, the volume of traffic should be counted in each of the junctions from where the volume of traffic either increases or decreases. It is relatively difficult to estimate the generated traffic because it depends upon several factors. However, one has to estimate based on other factors. It is easier if there is a precedence of similar places. Nonetheless, estimating generated traffic always involves uncertainties. Therefore a certain degree of precaution is required while interpreting the future volume of traffic. The issue of diverted traffic is rather easier to calculate. For instance, how many people using airplane at present will shift to the motor vehicle once the road is constructed. Considering the economic condition of the majority of the people, it can be considered that more than 70 percent people will shift to the motor vehicle.

More than 16 percent of respondents believe that the socio-political need identification is appropriate for identifying the transport demand. Such respondents had expressed before that the transport network should be based on the opinion of the local people and politicians. Because of the biases of the individuals, it may not be perfectly reliable. Nevertheless, it could help to generate the initial idea for conducting the mass scale survey.

Some respondents believe that it is almost impossible to calculate the realistic future volume of traffic, because it depends upon several factors. Therefore, about 10 percent of respondents have given their opinion that the actual present traffic should be counted as expressed before. The road should be designed to meet the present demand. Future expansion should be based on the volume of traffic that may be realized after constructing the road. Although very few people are in favor of this approach, it has a certain rationale. Because it prohibits over-design or under-design of the roads. It can be considered perfectly demand responsive. Nonetheless, due to lumpy characteristics of the road investment, it is questionable how far is it possible to match the road construction with respect to the demand.

About 10 percent of respondents have expressed their opinion that the transport demand is not necessary at all. Because the transport facility is a basic need and the state should provide such a facility to all individuals within a certain distance from the homestead of a farmer living in a distant hamlet. This argument is politically attractive and socially desirable but it is impossible to provide the transport infrastructure without prioritization and the prioritization requires certain rationale.

The Engineers were interviewed regarding their opinion for estimating the future transport demand which is shown in Table 5.5. They have indicated three aspects and each of them have tentatively equal weight. The future population, agricultural activities and future economic activities in the ZOI of a road are the determining factors of the future transport demand. As mentioned above, it is easier to estimate the future population but estimating the future agricultural activities and future economic activities are the difficult tasks.

Table 5.5 Opinion of Engineers on Future Transport Demand (N = 46)

No.	Ecological Belt	A (f)	B (f)	C (f)	Total
1	Mountain	2	2	2	6
2	Hill	18	17	17	52
3	Terai	15	14	13	42
	Total	35	33	32	100
	%	35	33	32	100

A = Future Population; B = Agricultural Activities; C = Future Economic Activities
Source: Field Survey, 2000

Before concluding the transport demand aspect, it is pertinent to ask whether the demand estimation methodology for the developed area should be the same for the developing area. To the larger extent, the demand estimation modality is similar. However, the mode of transport and interviewing technique should be different. For instance the demand estimation in one road involves counting the vehicles but if it is a foot trail, the volume of pedestrians, porters and mules should be counted. Interviewing with the pedestrians, porters and mule owners is much easier than interviewing the passengers in a vehicle. Interviewing in motion could be a solution, which is also a quite difficult task. Pre-paid post cards can be introduced but the system assumes that all the passengers are literate and they will sincerely fill the forms and return them to the researcher. The transport surveys should be conducted in each of the junctions to understand the transport demand. The cordon survey, passenger survey, freight carrier survey, passenger vehicle survey and porter survey are the major transport demand survey instruments.

5.3 Technological Issues of the District Roads

In addition to the physical working procedure, the construction technology also includes the alignment selection, design standards and environmental issues.

5.3.1 Main Technological Problem Areas in the Rural Road Sector

The main problems expressed by the respondents are expressed in Table 5.6. A majority of the experts and practitioners (33%) believe that the increasing mechanization of the construction activities has created socio-economic and environmental problems. The policy of

HMGN is promoting the mechanization of construction technology by enforcing certain types of equipment with a particular class of contractor (Annex 5.1). Besides that the DDCs acquire certain types of equipment particularly Bulldozers by using the political influence from the terminated construction projects.

Table 5.6 Main Problem Areas of the Prevailing Construction Technology (N = 28)

No.	Weaknesses	I	II	III	IV	Total	In Percent
1	Inflated norms of DOR	1	4	1	3	9	17
2	Mechanization of construction activities has created socio-economic and environmental problem	5	4	1	8	18	33
3	Problem of construction management	6			2	8	15
4	Geo-technical aspect is missing			1		1	2
5	Difficulties to understand specifications	2	3	1	1	7	13
6	LBT is time consuming and sometimes expensive			1	1	2	4
7	Controversy in specification and implementation		4		1	5	9
8	No idea	1	1	2		4	7
Total Votes		15	16	7	16	54	100
In percent		28	30	13	30	100	

I = Chief Technical Advisers; II = Consultants; III = Academicians; IV = Government Officials
Note: An option of multiple choice was given to the respondents.
Source: Field Survey, 2000

The mechanization of construction activities has severe social repercussions than technological concerns. In the context of 4.9 percent of totally unemployed and 47 percent of underemployed labor force (HMGN, 1998), it is in the national interest that employment opportunities be created in every sector of the economy. The mechanization of construction activities contributes to further unemployment. Secondly, having a negative balance of payment of NRs. 15028.5 million in 1997/98 (CBS, 1999) and an increasingly widening gap between the export and import in favor of the foreign countries, the rationale of importing expensive machinery and fuel can not be justified. Therefore the argument of 33 percent of respondents is considered valid and justifiable.

In response to the question regarding the possibility of applying further labor-based technology, more than 89 percent of respondents believed that it is possible in the earthwork excavation. Similarly a larger percentage of works can be executed through the labor-based technology in the case of embankment, layerworks and other structures. The implication of the rejection of the idea by one-fourth of respondents is that there is some necessity to use equipment in the case of embankment, layer works and other structures. The natural compaction is not enough for the district roads; it needs a compactor or roller. Similarly, the roller is essential for the layer works. In case of other structures like concrete works, the equipment like concrete mixture is required. Therefore approximately 67 percent respondents (Table 5.7) have answered that there is a possibility to further apply the labor based appropriate technology. Nonetheless the proponents of the labor based appropriate technology give their logic that if the major component of the construction works comprises the labor component, it is labor-based technology. From that logic it can be inferred that the use of some equipment does not make the whole technology a capital-intensive technology. The possibility to apply further labor based appropriate technology by ecological belt is presented in the Table 5.7.

Table 5.7 Possibility to Apply Labor Based Appropriate Technology by Ecological Belt

No.	Ecological Belt	I (f)	II(f)	III(f)	IV(f)
1	Mountain	2	1	1	1
2	Hill	27	22	20	20
3	Terai	14	12	12	11
Total		41	34	32	31
% of Total Sample		89	74	70	67

I = Earthwork Excavation; II = Embankment; III = Layerworks; IV = Other Structures
Note: An option of multiple choice was given to the respondents.
Source: Field Survey, 2000

The second problem identified by the 17 percent of the respondents is the inflated norms of the DOR. It is not the problem for the contractors but is the problem from the perspective of the country. The national expenditure increases for artificially inflated norms.

For example according to the present DOR norms, excavation of the ordinary soil including the transportation up to 10 m and 1.5 m lift requires 0.70 person day per cubic meter. Nonetheless as experimented in the Dhadhing district, it was found that the same volume of work requires 0.35 person day per cubic meter. Similarly hard soil required only 0.59 person day for one cubic meter against the provision of 0.80 person day per cubic meter in the DOR norms. The norms recommend 3 person days per cubic meter whereas the actual requirement in Dhading district is only found to be 1.39 person days per cubic meter. The DOR norms classified hard rock into two classes. The first class does not require chisel and for that it requires 5 person days per cubic meter. The second class requires chisel and it is recommended that 24.2 unskilled laborers are required for the same job. In the opinion of the experts it is very difficult to distinguish the hard rock that requires chisel and that does not. Nonetheless, the difference of mandays between them is almost 5 times. The experiment in Dhadhing district showed that one cubic meter of hard rock consumes only 4.03 person days per cubic meter in average. The difference between the norm figure and the experimental figure is significant. The experts and practitioners give further evidence that the contractors normally quote a far lower rate than the estimated value. Sometimes the quoted amount goes as much as 30 to 40 percent below the estimated amount. That also supports the idea that the norms are inflated. In-depth discussion with the contractors in Nawalparasi district revealed that the contractor's association has made an informal arrangement where contractors get the job on queue basis prohibiting the open competition. Due to such a cartel arrangement among the contractors, the competition is minimized which tends to increase the public expenses.

Third problem identified by 15 percent respondents is the problem of the construction management. Construction management is more managerial type of problem rather than technological. However, it may appear in the form of a technological problem. The problem of construction management includes the unavailability of laborers, equipment and construction materials when they are required. It also indicates the problem in coordination among different activities. Even lack of planning, organizing, directing, communicating and controlling, the essential qualities of management tend to be lacking if the problem of construction management prevails in a construction industry.

According to the regulations governing the contracting profession, there should be a certain type of technical manpower in every hierarchy of the construction company. Nonetheless, the lower class contractors artificially employ some technicians on paper to fulfill the requirement. In fact the "D" class construction companies are operated by an individual person. The person is not normally qualified enough to understand the terms, conditions and specifications which are normally written in English. Therefore they sign the document without understanding it properly. That creates the problem later on for maintaining the quality. About 13 percent of respondents have reported this phenomenon as a problem.

In response to the question on the possibility to simplify the norms and specification by ecological belt, thirty-eight percent responded positively for the earthwork excavation. Specifically the norms are over inflated and it may not be necessary to comply with the standard specifications for road and bridge works developed by the MOWT. The response clearly indicates that there exists a significant belief that the norms and specifications of layerworks and other structures could be made more simplified. The response of the Engineers regarding the possibility to simplify the norms and specification by the ecological belt is presented in Table 5.8.

Table 5.8 Possibility to Simplify the Norms and Specification by Ecological Belt

No.	Ecological Belt	I	II	III	Total
1	Mountain	1	1	0	2
2	Hill	10	10	10	30
3	Terai	7	5	3	15
Total		18	16	13	47
% of Total Sample		38	34	28	100

I = Earthwork Excavation; II = Layerworks; III = Other Structures
Source: Field Survey, 2000

The MOWT was the only specification-producing agency until recently. But now, after the establishment of the DOLIDAR, it has also prepared the new specification. However, most of the districts (84%) are still following the MOWT specification. Gradually the DOLIDAR may persuade the districts to follow the DOLIDAR specification. Out of 46 sample district Engineers, only 16 (nearly 35 percent) agree with the present specification prepared by the MOWT (Field Survey, 2000). The DOLIDAR attempted to prepare the labor-based specification but it also followed the secondary sources of information, which is not based upon the empirical evidence. How far it has adopted the lessons learned from other labor-based projects implemented in Nepal is also not known. Therefore significant differences between MOWT and DOLIDAR specification could not be found.

About 9 percent of respondents have reported that there exists a diecrepancy between the specification and implementation. The spirit of the specification is not implemented. There are several factors behind such a situation. The first could be that the specification for the district transport infrastructure is of too high a standard. Secondly, there is a lack of adequate manpower for constant supervision. Some experts and practitioners expressed a concern that effective implementation of the specification is sometimes compromised by lax oversight by the employer's technicians.

There are few respondents (about 4%) who expressed their reservations on the applicability of the labor based technology despite of its substantial merits. They have a concern that the labor-based technology is time consuming. To some extent it is a valid argument. The equipment based earthwork and other activities are much faster in comparison to the labor-based technology. But construction management is the main issue rather than the construction technology for the period of implementation. The road projects supported by the Chinese government were mainly implemented by using the labor-based technology. The Prithivi

Highway, Arniko Highway and Narayanghat – Gorkha Highway were implemented largely using the labor-based technology. Similarly the first environment friendly road in Nepal, the 110 km long Lamosangu – Jiri Road Project took only 6 years for completion which used completely labor based technology (Schaffner, 1987). There are also other instances of labor based construction like the road projects under the Palpa Development Project, Dhading Development Project, Gorkha Development Project which used the labor-based construction technology. However, the implementation of these road projects did not consume unacceptably longer time. Therefore the execution of the construction activities can be as fast as the equipment based technology due to the flexibility to start work from different locations which is not possible by the equipment based technology. Therefore the issue is one of the construction management rather than the construction technology. The construction management definitely gets complicated once the project management starts to deal with the thousands of laborers. Whereas it is sufficient to deal with few mechanical operators if mechanized construction technology is adopted.

About 2 percent of respondents have suggested that the geo-technical aspect is missing. Therefore, it should be included in the specification as well as implementation. This argument is similar to delineating the fragile area for road networking. The missing geo-technical aspect means it should be considered while designing the road network. However, unlike the delineation of the fragile areas this approach recommends to construct with required precaution.

Approximately 7 percent of respondents have no idea because they have backgrounds other than Civil Engineering.

5.3.2 Choice of Construction Technology

Choice of the construction technology depends upon several factors. The major factors include government attitude, economic level, comparative costs, establishment of appropriate administrative and financial procedures, establishment of relevant management and technical training, labor availability, labor attitude and type and location of projects (Veen and Thagesen, 1996). In the broad sense, the choice of appropriate method should be based on technical feasibility, economic viability, social desirability, and compatibility in working (IRC, 1984).

The IRC (1984) has outlined the following procedure for the selection of the appropriate technology.

- List all technically feasible methods. Exclude methods obviously unsuitable in light of local conditions.
- Estimate task level productivity for each remaining method. Exclude methods where productivity is too low.
- Estimate resources needed for each remaining method. Exclude methods for which available resources are insufficient.
- Estimate unit cost of each remaining method. Exclude methods with unit costs 25 percent higher than the cheapest.
- Check for compatibility of the remaining methods with those considered for the other related tasks of the project. Exclude incompatible methods.
- Estimate task/project cost for each remaining method. Tabulate the results and choose the most appropriate method taking all other tasks of the project into account.

The workshop organized for "Developing Methodologies for Decentralized Rural Road Network Planning, Technology and Evaluation" in April 2000 endorsed the methodology for selecting the technology. It emphasized that each job parameter and each possible technological option should be assessed based on the findings of economic, social and environmental assessment. However, the workshop emphasized that under the present circumstances, the labor-based technology should be given a priority. The workshop also suggested that the planner should be aware of the difference between the labor-based and labor-intensive technology. The LBT intends to minimize the cost through the use of proper amount labor and equipment whereas the labor-intensive technology is designed to maximize the employment opportunities. In the labor-based technology, the labor plays the vital role and equipment plays the supportive role.

As shown in the Annex 5.3, the activity like earthwork excavation can be executed in three different ways. One can use completely labor based technology by using only small tools like spade, pick and shovel or one can use a completely equipment based method like Bulldozer, Excavator or Scrapper. There still exists a third way in which earthwork can be excavated by the labor based method in hilly area and it can be excavated by the tractor towed grader in the Terai area. Similarly there are different means through which loading, unloading and transporting works can be executed. All other activities as well can be either executed by only using laborers or equipment or by using the intermediate means.

According to the procedure as listed above, the second step is to calculate the productivity of each type of available construction method. The actual calculation will be executed while implementing the methodology in Nawalparasi district. All other steps will be also carried on after the actual calculation of the productivity of each type of available construction method.

5.4 Benefits of the District Roads

This section deals with the opinion of the experts, practitioners and policy makers on the benefits and disbenefits of a road project.

5.4.1 Opinion of Experts and Practitioners

Table 5.9 shows the opinion of experts and practitioners on the benefits of the improved access. Twenty four percent of respondents mentioned that the savings in the transport costs should be included as the benefits of the improved access. The second highest response is received for the saving in time that accounted 22 percent of the total respondents. The development impact secured the third position by scoring 19 percent of the total respondents. Similarly, the producer's benefit secured 14 percent opinion. Factors like comfort or convenience, appreciation of the land value, generation of local employment, market access to the perishable goods are other benefits that were also mentioned by some of the respondents. One of the respondents strongly raised the issue of dis-benefits of the improved access, whereas some of the respondents expressed their ignorance regarding this issue. Getting access is the important phenomenon in the rural area, thus no respondent raised the issue of reduction in accidents and economies of road maintenance. Those both factors are applicable if there exists a road and only upgrading is necessary. The response indicated that the direct and indirect benefits should be aggregated in order to find out the total benefits. However, quantification of indirect benefits in the same scale of the direct benefits could be the problem. Similarly the dis-benefits should be deducted from the benefits in order to get the net benefit.

Table 5.9 Benefits of the Improved Access (N=28)

No.	Benefits	I (f)	II (f)	III (f)	IV (f)	Total (f)	%
1	Savings in transport costs	5	8	3	6	22	24
2	Savings in time	4	8	3	5	20	22
3	Social benefits	4	1	1	1	7	8
4	Producer's benefits	4	4	1	4	13	14
5	Development effect, exploitation of natural resources, sense of security, tourism	4	6	2	5	17	19
6	Comfort or convenience	2				2	2
7	Appreciation of land values		1			1	1
8	Local employment generation during the construction phase	2				2	2
9	Market access for the perishable products	3			1	4	4
10	Dis-benefits (small scale industries may die, rich buy land, import increases, environmental degradation)				1	1	1
11	Not known	1		1		2	2
	Total	29	28	11	23	91	100
	In Percent	32	31	12	25	100	

I = Chief Technical Advisers; II = Consultants; III = Academicians; IV = Government Officials
Source: Field Survey, 2000

The question was asked with the engineers and policy makers of the sample districts. The opinion of engineers by different ecological belt is presented in Table 5.10.

Table 5.10 Benefits of District Roads as Perceived by the Engineers of Different Econological Belt (N = 46)

No.	Ecological Belt	Sample Size	I f	II f	III f	IV f	Total Response f
1	Mountain	2	1	1	2	0	4
2	Hill	27	12	12	22	2	48
3	Terai	17	7	7	17	0	31
	Total	46	20	20	41	2	83
% of Total Numbers of Opinion			24	24	49	2	100

I = Transport Cost; II = Time; III = Development Impact; IV = Others
Source: Field Survey, 2000

Majority of the Engineers expressed their opinion that the development impact should be considered as the benefit of a road project. Exactly same number of respondents have mentioned that the transportation cost and traveling time also should be considered for assessing the benefit of a road project. The Engineers have assigned more emphasis to the development impact than the road user cost saving.

Similar to the opinion of engineers, policy makers are also in favor of development impact as the major component of the benefits. In terms of the ecological belt, one out of the 2 mountainous districts, are in favor of the economic development. Similarly, 24 out of 27 hill districts support economic development as the benefit of a road project. Among the 17 Terai districts, thirteen support the road contributes to the economic development. Almost fifty percent of the total respondents from all ecological belts believe that the road contributes to increase in production and poverty alleviation. Table 5.11 shows the benefits perceived by the policy makers of different ecological belt.

Table 5.11 Benefits of the District Roads as Perceived by Policy Makers of Different Ecological Belt (N = 46)

No.	Ecological Belt	Sample Size	I (f)	II (f)	III (f)	IV (f)	Total (f)	Percent
1	Mountain	2	0	0	1	0	1	1.24
2	Hill	27	16	13	24	2	55	67.90
3	Terai	17	6	5	13	1	25	30.86
Total		46	22	18	38	3	81	100.00
% of Total Numbers of Opinion			27	22	47	4	100	

I = Production; II = Poverty Alleviation; III = Economic Development; IV = Emergency
Source: Field Survey, 2000

5.4.2 Aggregation of Prioritization

It is interesting to note that three different groups have three different areas of prioritization. Therefore the Table 5.12 summarizes all three perspectives. The workshop held in Kathmandu suggested to assign certain weights to each group of respondents. Accroding to that the Policy Makers, Engineers and the Experts and Practitioners were given the weight of 2, 1.5 and 1 respectively. The Policy Makers have the authority for developing the transport policies, therefore their opinion is given highest weight. The Policy Makers take decision on the basis of Engineer's recommendation. Therefore Engineers do not have direct authority but have power to influence the decision therefore they are given second highest importance. The Experts have advisory role who are listened but they do not have direct influence. The opinion of the implementing authorities is given higher weight in comparison to the Experts and Practitioners.

5.4.2.1 Benefits of the Road Projects

Table 5.12 shows that the development impact of an improved access is valued highly, which obtained the score of 156.5. The development impact means the development induced by the road access. It could be an increase in the literacy rate, reduction in the prevalence of the diseases or better access to the health facilities, convenient access to the administrative centers and improved level of extension services to the agricultural and industrial activities. It can be also interpreted as the convenience to establish other infrastructure facilities like hydro-electricity projects, irrigation projects, and forestry projects. So the development impact has a wider and deeper ramification.

Table 5.12 Comprehensive Overview of the Benefits of the Improved Access

No.	Benefits	Experts		Engineers		Policy		Aggregate	Rank
		Score	Wt.	Score	Wt.	Score	Wt.		
1	Savings in transport costs	24	1	24	1.5			60	IV
2	Savings in time	22	1	24	1.5			58	V
3	Social Benefits	8	1					8	VII
4	Producer's Benefits	14	1			28	2	70	II
5	Development effect	19	1	49	1.5	32	2	156.5	I
6	Comfort or Convenience	2	1	3	1.5			7.5	VIII
7	Appreciation of land values	3	1					3	IX
8	Poverty Alleviation	6	1			29	2	64	III
9	Emergency	2	1			11	2	24	VI

Although the development impact, producer's benefit and poverty alleviation are categorized separately, all of three indicators have a strong relationship. In fact the development impact incorporates the issues of producer's benefit and poverty alleviation. The respondents have assigned the second priority to the savings in transport costs and savings in time. Few respondents have indicated their preference for the social benefits, convenience for traveling and relief from the emergency situation. Therefore the development impact and direct transport benefits are two major benefits in the opinion of the respondents.

5.4.2.2 Dis-benefits of the Road Projects

A road also causes adverse impacts to the local society as a whole. The first direct negative impact is the vanished employment of the porters and mules. Secondly, the regional import starts to increase considerably. The food habit of the people changes to the instant and refined food like noodles, biscuits and other beverages like liquor, cold drinks and beers. Besides that the cottage industries can not compete with the urban based and in most of the times large industries. For instance the local people of Nawalparasi district reported that many *Khandsaries* (local sugar industries) were forced to abandon the job after the establishment of the large-scale modern sugar industries. Similarly, local pottery industries can not compete with the ceramics industries. As shown in Table 5.13 that the regional exports include those products that are normally unprocessed therefore they have low value and large volume. Agro-outputs are the main regional exports.

Table 5.13 Regional Exports of Commodities by their Characteristics

No.	Particulars	Numbers of Daily Trips
1	Agricultural outputs except rice and sugarcane	88
2	Raw construction materials excluding bricks	100
3	Animals including poultry, fish and animal products	14
4	Rice	72
5	Sugarcane	19
6	Vegetables and fruits	41
7	Bricks	46
8	Wooden products including drums	32

Source: Field Survey, 2000

All regionally imported commodities are the high value, low volume manufactured goods. As shown in Table 5.14, the construction materials, agricultural inputs, grocery items, decorative items are some of the typically imported products. Therefore the regional balance of trade always goes in favor to the urban areas.

Table 5.14 Regional Imports of Commodities by their Characteristics

No.	Particulars	Numbers of Daily Trips
1	Construction materials	39
2	Agricultural inputs	13
3	Grocery items including liquor, cold drinks and kerosene	89
4	Decorative items	2
5	Utensils	1
6	Textile	2

Source: Field Survey, 2000

Some people even argue that the rich people get benefit of the improved access even at the cost of the poor. The clean rural environment gets deteriorated once the road is constructed. For instance the settlements could be bisected by a road which may cause adverse impact among the people across the road for communicating with each other.

5.5 District Road Network Planning in a Nutshell

Majority of the respondents has opinion that the central places, resource potential areas and existing transport infrastructure should be the basis for developing the road networks. The respondents believe that the GIS can be instrumental for developing the network but the DDCs at present are not in position to handle it. Existing traffic survey and estimation of generated and diverted traffic is considered to be the appropriate methods for estimating the transport demand by majority of the respondents. The technological problem was discussed for identifying an appropriate construction approach. Since the main concern was the mechanization of construction activities, it implies that the labor based construction technology should be promoted. However, the technological choice depends upon several factors. All of the influencing factors should be assessed before reaching into any conclusion. In terms of the benefit estimation, the respondents accorded highest priority to the development impact followed by the direct benefits like reduction in the transportation cost and traveling time.

Chapter VI
Methodology for Planning and Prioritizing the District Road Network

Based on the discussion in Chapter IV and V, a methodology for planning and prioritizing the district road network is developed. In previous chapters, the district was chosen as the basis for analysis, because all statistics are aggregated and available at the district level. However, the Kathmandu workshop, which was organized after conducting different type of surveys as mentioned in the methodology on "*Developing Methodology for Decentralized Rural Road Network Planning, Technology and Evaluation*", recommended that the analysis and planning should be based on the development status of the area concerned. The pattern of development within a district varies significantly among the VDCs.

The road density is taken as the indicator for defining the status of development. It would be ideal to define the status of development based on the overall road density including the rural roads and excluding the uninhabitable area. Nonetheless it is impossible to find a complete inventory including the rural roads for all districts. It is not possible to delineate the uninhabitable area. Because the districts have the scattered settlement patterns and some of the settlements are found in the middle of the jungles. Moreover the road density alone is not a good indicator to define the development status of an area. The economic and social factors are more influential than the road density for defining the status of development. However, for planning the road, the road density is considered as a good and basic indicator and its correlation with the density of population is 0.95 and with the literacy rate is 0.53 (Annex 6.1).

The density of road by district is given in Annex 4.2. As shown in Annex 4.2, the district-wise road density ranges between 0 to 0.34 excluding Kathmandu Valley districts, which have higher road density. The Kathmandu, Lalitpur and Bhaktapur districts, which constitute the Kathmandu valley, have 1.34, 0.75 and 1.05 road length per km^2 respectively. Based on the national average except the Kathmandu Valley, a spatial unit which has a road density below 0.17 km/km^2 is classified as under-developed area, and one with the density greater than 0.17 km/km^2 is categorized as developed area. Two sets of methodology are developed for developed and under-developed areas, a simple one and a more sophisticated one.

6.1 Methodology for the Developed Areas

The planning methodology needs to be consistent with the acts and directives of the country. According to the Local Governance Act, 2055 (HMGN, 1998a), the DDC should prepare the periodic as well as annual plan. The periodic plan should consider the geographic, economic and natural resources and their present utilization pattern, locational advantage, development required for poverty alleviation and empowerment of the ethnic community. After evaluating the executed projects, the short and medium term new projects are formulated based on the local development potentials. The feasibility study is conducted for each development proposal. The feasibility study contains the target of the project, number of beneficiaries and type of benefits, cost estimate and the potential revenue that can be generated after completion of the project. The act has also mentioned about the prioritization criteria. In accordance with that, those projects should be selected which generate income, promote the agricultural production, mobilize the local resources, conserve environment and alleviates poverty.

The proposed methodology for the developed area is presented in Figure 6.1 followed by the description of each step. The methodological steps are the basis for developing the computer-aided model.

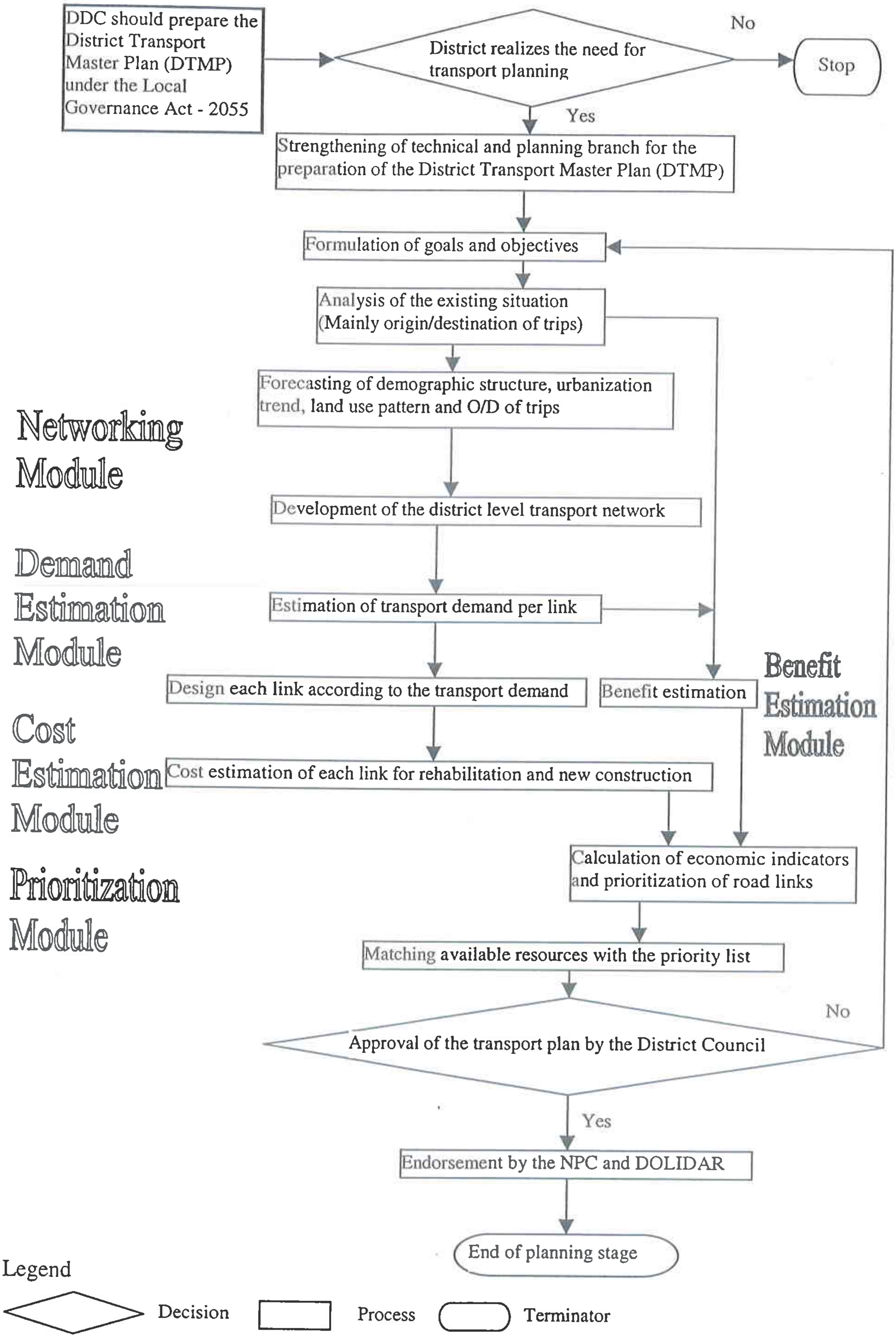


Figure 6.1 Flow Chart of the Methodology for the Developed Areas

The District Road Network Planning and Prioritization Model (DRPM) consists of networking module, demand estimation module, cost estimation module, benefit estimation module and prioritization module. Each module comprises one or more than one activity. The subjective issues need to be dealt outside the model environment. The detail elaboration of the model is dealt in Chapter VII.

6.1.1 Realization and Commitment for Transport Planning by the DDC

Preparation of the master plan is a mandatory activity in accordance with the Local Governance Act. It means that the policy makers at the central level have realized the importance of the master plan. The donor agencies have encouraged such ideas for a long time. Until now, out of 46 sample districts selected for this study, twenty have already prepared a DTMP. The DOLIDAR tied up the master plan with the funds to be allocated for the agricultural roads. The agricultural roads are funded by the Asian Development Bank. If such awareness and interest lacks with the district, it should not be imposed by other agencies. Not all the districts have prepared the plan by their willingness. The practice of dividing available resources among the DDC members equally for the development works in their respective constituency is not stopped. Unless the districts follow the rationale prioritization criteria and allocate budget accordingly, the planning exercise becomes meaningless. Therefore the DDC members need to realize the importance of the rationale planning and they should be committed for implementing the developed plan. Such realization should be expressed in terms of district resolution or request to other agencies particularly to the DOLIDAR for the preparation of the planning exercise. The participants of the Kathmandu Workshop agreed that the DDC should realize the need but they emphasized that the DOLIDAR should make the DDC members aware of the significance of such plans at the initial stage.

6.1.2 Strengthening the Technical Branch of the DDC for Planning Exercise

Most of the DDCs have one Engineer, a few Overseers and Technicians. The main responsibility of all the technical staff is to supervise the construction works. The percentage of time allocation on the construction activities increases as the hierarchy decreases. Table 6.1 shows allocation of their time in different activities. The construction supervision consumes the large part of the technical manpower. A considerable amount of their time is also spent on the routine works. The routine work is defined as the official techno-administrative type of works. Attending meetings, providing opinion on administrative issues, preparing bills for payment, agreement with the contractors and other suppliers are such routine activities. In the routine works, the involvement of lower staff decreases in contrast to the construction supervision. The main issue of this table is to show the time allocation of technical personnel on planning activities. The Technicians have almost no role in planning and the Overseers have a minimum supportive role. Mainly the Engineer is responsible for planning activities. On an average, 10 percent that means about 20 days in a year, is allocated for the planning works which is divided among different sectors for which the DDC is responsible. Therefore, the rural road planning gets insufficient time.

Having less possibility to spare time for planning by the technical manpower, especially by the Engineer, the Kathmandu workshop suggested that the DDCs should aim for establishing a permanent unit for planning the district level road network, which is difficult in the short run. Therefore the DDCs could hire consultants and should seek assistance from the DOLIDAR. However, it is not practical to retain highly specialized manpower. It is because such jobs are performed once in a few years and the remuneration of such specialists is higher. Besides that, the specialists of such caliber do not aspire for the DDC employment. Therefore, such manpower should be hired when it is required. This issue could be one of the agenda in the DDC meeting while taking decision on strengthening the technical branch for the planning exercise.

Table 6.1 Allocation of Time for Different Activities by District Level Technicians

Figures in percent

Post	Routine Work	Planning	Budgeting	Engineering Survey	Socio-Economic Survey	Construction Supervision	Other Works
Engineer	28.83	10.50	5.17	13.91	2.85	32.00	6.74
Overseer	18.89	4.07	1.98	23.59	1.54	45.87	4.06
Sub-Overseer	13.50	0.80	0.72	19.07	1.22	52.22	12.47

Source: Field Survey, 2000

6.1.3 Formulation of Goals and Policies

The DDC should formulate the goals and policies for the transport sector, which include the financial resources for the construction and maintenance of the road networks. As discussed in the previous chapter, the DDCs are heavily dependent upon government funding. The nationwide sample survey of the DDCs showed that the local tax component, which ought to be significant as a sign of the devolved authority, has remained less than 4 percent, which is obviously insignificant. Therefore, besides setting objectives for raising the financial resources, the DDC should set objectives on the district accessibility standards. In order to obtain the clarity on objectives few questions should be asked. How to raise the own sources of revenue? How much should be the Zone of Influence of a road? What is the maximum time limit that a person living in the remotest area should be able to reach to the nearest market center and district headquarters? The answers of these questions help to generate the objectives. Having clear objectives on hand, the district policy makers should fix the target for the short, medium and the long term period. Other closely related issues of setting objectives include the issues of the road ownership, implementation mechanism and land acquisition.

6.1.4 Analysis of the Existing Situation

Once the objectives are clearly formulated, the analysis of the existing situation is largely a measurement of the deficiencies compared with the stipulated objectives. The present origin and destination of trips, purpose and volume of such trips should be analyzed. Besides that, the geographic, economic, demographic situation and land use pattern should be also analyzed. The laws and ordinances are other important issues that have a direct implications on the district level transport planning should also be discussed. The information can be collected from secondary as well as the primary sources.

The secondary sources of information include the District Development Plan, District Profile and other published and unpublished information that should be collected from the Department of Agriculture, Department of Cottage Industries, Department of Forestry and Federation of Industries and Commerce. The DOR and the DDC are good sources of information for the road inventory.

Information from primary sources can be collected by the DDC workshop where the DDC members can contribute their opinion. The reconnaissance survey is another mode of data collection. Additionally, a cordon survey, passenger survey, key informant survey, passenger vehicle survey, freight carrier survey and contractor survey are instrumental for collecting required information.

The analysis of existing situation provides the basis for further analysis. The outcome of the analysis is the inventory of transport infrastructure at all levels in the district. It should include the geometric standard as well as the surface and quality of the road. The inventory should also clarify the road ownership. Besides that, the volume of traffic in each link should be calculated. By the cordon survey, one can count the vehicles by type that gives the Annual Average Daily Traffic (AADT). Similarly, the analysis of existing situation should provide information on the district level and higher nodal points. The transport cost by the mode of transport is another important outcome of the situation analysis, which can be collected from the transport surveys.

The analysis of the existing situation can be facilitated by computer applications, through GIS, Database and Spreadsheet Packages. The mapping and statistical facilities of the GIS like calculation of the area under particular type of land use, settlement distribution pattern and their proximity with the existing and proposed road, alignment selection within the natural and man made constraints, location of existing infrastructure including roads are some of the facilities that can be achieved with the help of GIS. Processing of the transport surveys, cordon survey and other socio-economic characteristics can be facilitated by the database packages. The spreadsheet packages use the outputs of the GIS and the database packages. For instance, the land area calculated from the GIS packages can be multiplied with the average productivity of land that is processed from the Database Packages. The application of the methodology in the Nawalparasi district is illustrated through this research.

6.1.5 Network Development of the District Roads

The network development of the district roads involves the identification of the nodes and that leads the structure of the links. Nodes and links constitute the network of a district. Therefore, this chapter elaborates the process for identifying the nodal points, determination of the links and development of the overall road networks.

6.1.5.1 Present and Potential Nodal Points

The Scalogram and Centrality Index are popular techniques for determining the hierarchy of settlements among the regional planners. The Scalogram is the graphical technique and the Centrality Index is the quantitative technique for determining the hierarchy of settlements. The Centrality Index facilitates the computation of the hierarchy more precisely in comparison to the Scalogram technique. Therefore, this study has adopted the Centrality Index for determining the hierarchy of the nodal points. The steps for preparing the index are mentioned below (Jenssen, 1992):

1. List the nodal points (mainly the market centers) in descending order to their population size. Start with the biggest nodal point and end with the smallest one.
2. List all the important functions and activities considered on the head of the matrix. They are arranged into sub-categories such as educational, health, economic activities and administrative functions. In order to measure quantities, identify indicators or proxy-indicators.
3. Draw a series of vertical and horizontal lines, which form the grid-work of the matrix and indicate for each grid the quantities of the respective function or activities.

4. Identify the weight of each type of function and multiply the number of functions by the weight.
5. Summarize the product of function and the respective weight row by row for calculating the Centrality Index.
6. Categorize the market centers according to the Centrality Index.

The procedure mentioned above provides the market centers of different hierarchy. In the regional context, the market centers could be classified into four classes. It could be the regional market center, district level market center, sub-district level market center and local level market center. The weekly market centers, which do not take place in the permanent market centers and the market centers, which are not visited by the customers from the other settlements are the local level market centers. Only the regional, district and sub-district level market centers should be included in the analysis.

Only those functions should be selected that attract trips from the hinterland settlements. Normally the educational institutions like colleges and vocational schools, hospitals and private clinics, wholesale shops and other industries should be included in the calculation of the Centrality Index. After identification of the nodal points and defining the functions, the Centrality Index of each nodal point should be calculated.

The procedure expressed above for calculating the Centrality Index (Sarma, Routray and Singh, 1984) can be calculated as:

$$Cj = \sum_{i=1}^{n} (Wi\ Xij)$$

Where,
C_j = Centrality Index of the j_{th} market center,
W_i = Weightage of the i_{th} function,
X_{ij} = Value of the i_{th} function (number of establishments or shops at the j_{th} market center)

The weight of each function can be calculated by adopting the Median Threshold Population Technique (Sarma, Routray and Singh, 1984). According to that technique, the weight can be calculated as:

$$Wi = \frac{\text{Median Population of the ith Function}}{\text{Lowest Median Population of the Selected Functions for Centrality Analysis}}$$

The calculation of the Median Threshold Population Technique is used to calculate the Table 1 of Appendix 1. For instance, we have to calculate the weight of a college. The median population of a college can be derived from Parasi, Kawasoti and Bardhaghat. Only these market centers have a college. The lowest median population in the series is 4239. Therefore the median population of college (9764) should be divided by the lowest median population of the selected functions for centrality analysis (4239).

The present weight is used for calculating the future Centrality Index as well. The future emergence of the new market centers and development of the existing market centers needs to be carefully examined by reviewing the sectoral plans. The agricultural, educational, irrigation, industrial, commercial banks and other financial institutions are some of the sectors which have direct implications on the development of a location. The location where private sector is interested is even more important than the government plans. The private sector investment is not predictable as it is for the government plans. The scenario needs to be further supplemented with a panel discussion of knowledgeable persons in the district. Besides discussing with different government officials, the planners should discuss with the representatives of the business community and farmers association.

6.1.5.2 District Road Inventory and Identification of the Shortest Path

The present and future nodal points prepare a framework for developing the district level road networks. In principle, the interdependent settlement system based on the natural or man-made locational advantages contribute to the overall regional development. The higher level of connectivity among all nodal points is desirable for the minimum user's cost. Nonetheless it is not practical and in many circumstances not necessary to link every node of the networks with each other. Therefore, an assessment of the existing road link should include identification number, length, surface, road class, present status and average speed of a typical vehicle.

After having nodal points and existing road inventory, the next step is to identify the shortest path for each pair of nodes. There are five major techniques of identifying the shortest path. They are methods for finding the shortest path from one node to all other nodes in the network, finding shortest path between all pairs of nodes, method for determining shortest paths when the transport network contains two types of branches, finding shortest path in a probabilistic network and method of finding minimum spanning trees (Teodorovic, 1986). However, all these methods do not consider the existing road networks. It is not practical to ignore the existing road networks. Therefore, a straightforward and simplified method of identifying shortest path in the existing system of network is devised. A typical table for identifying shortest route could be as shown in Table 6.2. An origin and destination matrix and a map showing district inventory are helpful for developing the shortest routes.

Table 6.2 Table for Identifying Shortest Routes

Origin	Destination	Route Options		Shortest Distance	Shortest Time Route (in Minute)	Possibility of Shortening	Length after Shortening	Remarks
		1	2					

After identifying the shortest distance and time, a subjective question should be asked regarding the possibility for shortening the route. In most of the circumstances, the answer could be given "Yes" or "No" because there are obvious reasons for accepting or rejecting the possibilities. To answer such question, one needs to be familiar with the district situation. If the answer is "Yes" then a new link is added and the length of the new link is determined. Such information of the shortest route is summarized in a matrix as shown in Table 6.3.

Table 6.3 Table for Origin-Destination Road Distance Matrix

Market Centers	a	b	c	d
a	X			
b		X		
c			X	
d				X

Note: Only half matrix because there are no one way connections and intra-cell distance not considered. In each cell, the physical as well as time distance should be recorded.

This networking exercise identifies the missing links and shortest path among the nodes. It helps to explore the possibility of decreasing time distance by increasing the quality of the geometric design and pavement quality. Such networks may not be optimal in the sense of the optimization models but is practical and involves less builders cost and attempts to minimize the user's cost by offering the shortest possible travel route.

6.1.6 Transport Demand Estimation

Regarding the approaches for estimating the transport demand, the majority of the Experts and Practitioners have expressed their opinion in favor of existing transport survey and estimation of generated and diverted traffic. Similarly, the Engineers have expressed their opinion that the future transport demand should be estimated based on the future population, agricultural and other economic activities.

As elaborated in the literature review, the transport demand in the urban context is estimated based on the five-step model i.e. land use and travel characteristics, trip generation, trip distribution, mode choice and assign trip to network. However, only limited concepts of the five-step model can be replicated for forecasting the regional transport demand.

For estimating the demand, cordon survey (Annex 3.5), passenger survey (Annex 3.9), passenger vehicle survey (Annex 3.6), freight carrier survey (Annex 3.7) and porter survey (Annex 3.8) are useful. Since it is not possible to conduct the transport surveys throughout the year, the 3-4 month transport surveys should be supplemented with a key informant survey (Annex 3.12). The transport surveys provide information on the existing transport demand.

The diverted traffic is easier to estimate in the normal circumstances. The diverted traffic has different forms. Firstly, people using different mode of transport at present may use the proposed road. For instance, if a place having an airport is connected by a road head, the air traffic will be decreased considerably. Secondly, the passengers and vehicles of a certain locality may be using longer route, which can be diverted to the proposed road, if it is shorter than the previous one. However, it depends upon the demand elasticity of different people and the travelling distance.

The estimation of the generated traffic is difficult. The generated traffic indicates that the additional trips which do not exist now but will be generated after the introduction of a road. The decrease in the transportation cost may instigate the greater degree of development impact in terms of agricultural or industrial productions. However, the farmers may or may not be interested in the crop diversification and intensification. Land may or may not be suitable for the new type of crops, which has demand in the market. Similarly, non-farm trips are also dependent on several other factors. Therefore, the estimation of generated traffic requires expert opinion while holding the socio-economic facts on hand.

In this whole exercise, the District Development Plan plays a pivotal role. The plan envisages the spatial development of different locations according to different natural endowment and human created infrastructure. The development proposals that are stipulated in the District Development Plan could be the basis for estimating the transport demand. Therefore, in order to incorporate the normal, diverted and generated traffic, the projected interaction based on the future centrality index of different locations can be basis for forecasting. One way of forecasting future volume of traffic is to establish relationship between the present volume of traffic and present intensity of interaction. Suppose one established the relationship as $y = a+bx$, where y indicates the volume of traffic, "x" is the intensity of interaction. In this equation, if the planner can predict the future value of "x" or "intensity of interaction" then estimation of the future volume of traffic becomes a mechanical issue. In this equation, the volume of traffic is the function of intensity of interaction.

Another way of estimating future volume of traffic is simply projecting based on the unity method. According to this method, the volume of traffic is estimated as:

$$\text{Present Volume of Traffic} = \frac{\text{Present total trips between two nodal points}}{\text{Present } I_{ij}} * \text{Future } I_{ij}$$

Between the two methods of projecting future volume of traffic, the equation method is better over the unity method. The trend equation gives the value of "y" intercept and constant based on the entire sample data. The unity method relies only on one set of data of the concerned link. Therefore, it is not reliable. This study has adopted the trend line method for projecting the future volume of traffic.

In both of the above methods, the intensity of interaction is calculated as:

$$I_{ij} = \frac{(C_i \cdot P_i) \cdot (C_j \cdot P_j)}{d_{ij}^{b}}$$

Where,

I_{ij} = Interaction between two nodal points

C_i = Centrality Index of the node i

C_j = Centrality Index of node j

P_i = Population of node i

P_j = Population of node j

d = Shortest path distance between i and j

b = deterrence function

The interaction between the nodal points, I_{ij} determines the strength of interlinkages among the pair of settlements. As seen in the equation that the I_{ij} is the product of the Centrality Index, population and distance between the origin and destination. However, the characteristic of the deterrence function ^{b} depends upon the type of the facilities for which a trip is originated. Normally, the value of ^{b} is taken as 1 in socio-economic studies. However, the volume of traffic with the value of 1 was found in higher side. Therefore, it is taken as 2 in the present study.

There are three types of variables in the calculation of the intensity of interaction. They are population, centrality index and distance. Among them population is reliably predictable and the distance is the constant. Estimation of the centrality index involves certain risks. Nonetheless the government plans are the basis for estimating the future facilities in the market centers, which are included in the periodic plan of the DDCs and sectoral plan of the concerned line agencies. Taking interviews with the local business community, industrialists, farmers and people's representatives help to estimate the number of private facilities in a given market center. It is obvious that the degree of accuracy decreases as the planning period increases. Therefore it is necessary to update such information every five years when the whole plan also should be reviewed. This is an attempt at linking district planning methodology and district development indicators with road planning methodology.

In this whole exercise of projection, the unit of calculation should be the one individual link. The volume of traffic varies among different links. One transport route may go through more than one link. In order to estimate the traffic in different links, one should identify the shortest route for a given pair of nodes and the links through which the route passes. After identifying the links in each shortest route, the intensity of interaction should be assigned accordingly. In the first phase, the present intensity of interaction should be assigned in the existing road networks. It gives the relationship between the volume of traffic and intensity of interaction. In the second phase, the intensity of interaction should be assigned to the present and proposed links. The future value of intensity of interaction is used for forecasting the future volume of traffic on each link.

Despite this meticulous effort for projecting the future volume of traffic, there is no guarantee that the actual volume of traffic follows the forecasted volume. There are several unexplained variables and assumptions behind it. Therefore demand estimation should be used for acquiring the right of way which will become difficult to acquire later on. Similarly, the cross-drainage structures are difficult to construct incrementally. The road should be constructed for the present volume of traffic and it should be widened up according to the future volume of traffic. Stage construction can be introduced for the pavement structures. Having the lumpy characteristics of the road investment, it does not however, follow the demand growth rate in a linear way. It follows a staged widening process.

6.1.7 Estimation of the Construction Cost

The roads constructed without considering the transport demand are over-designed or under-designed. Therefore, it is desirable that the road project at least serves the present demand and continues serving few years into the future. For this to happen, the road construction needs to be based on the present and forecasted transport demand. According to that standard, the cost of a road project should be estimated. The geometric and pavement standards are the influencing factors for the construction cost. The second closely related issue with costing is the construction technology. Normally, it is found that the capital-intensive technology is expensive in comparison to the labor based construction technology. However, before jumping to any conclusion, it would be meaningful to analyze the technological issue more systematically. The Indian Road Congress (1984) concludes that the choice of appropriate construction method should be based on the technical feasibility, economic viability and social desirability.

The basic inputs include (Transport and Road Research Laboratory, 1988) hourly wage rates, other labor costs and overheads, construction equipment purchase prices and/or hire rates, management, supervisory and administrative salary rates and prices of materials, prices of services and utilities, transport, shipping and freight charges, import duties, taxes, insurance and interest rates. The overview on the cost composition is illustrated in Table 6.4. In Table 6.5, the cost is calculated for 100 m^3 of earthwork excavation. According to this cost calculation, per cubic meter earthwork excavation costs NRs. 90.04. In the similar fashion, the construction costs can be estimated for other available construction technologies and other construction activities.

Table 6.4 Example of Cost Composition for Earthwork Excavation

No.	Description	Unit	Quantity	Rate (in NRs.)	Amount (in NRs.)
1	Materials				
	Sub-Total		0	0	0
2	Equipment				
2.1	Excavator	Working Hours	8	750	6,000
2.2	10 Wheel Dump Truck	Working Hours	0	440	0
	Sub-Total				6,000
3	Laborers				
3.1	Foreman	Working Hours	8	50	400
3.2	Operator	Working Hours	8	75	600
3.4	Unskilled Labor	Working Hours	40	8.75	350
	Sub-Total				1,350
4	Fuel*				
4.1	Excavator	Working Hours	8	8	1,504
	Sub-Total				1,504
5	Lubricant Oil @10% of Fuel				150
Total					9,004
	Per Unit Cost	Cubic Meter	100	90.04	9,004

*Fuel price is taken as NRs. 23.5.

6.1.8 Benefit Estimation of District Roads

Table 5.12 showed that the development impact considered as a most important benefit of a road project. It is especially true for the inaccessible areas. However, there exists a minimum accessibility in the developed areas. The main motive for constructing or rehabilitating new road is to decrease the transportation cost and traveling time. Therefore this study has taken the reduction in transportation cost and traveling time as the benefits of a road project in the developed area.

6.1.9 Prioritization of the Road Links

A network consists of several links. It is not possible to construct all roads at a time due to resource and time constraint. Therefore each link in a network should be prioritized. After developing a district level network, a road planner is expected to estimate the road cost and benefit of each link in the network. It is already mentioned in section 6.1.8 that only direct benefits should be considered for the developed areas. It is obvious that the Economic Net Present Value (ENPV), Economic Internal Rate of Return (EIRR) and Economic Cost Benefit Ratio (ECBR) should be used for appraising the district road project. Based on those indicators, the roads should be prioritized. A minimum rate of return should be fixed beforehand below which the road should not be financed. The road with the highest economic rate of return should get the first priority and so on. A minimum rate of return screens out the road projects.

6.1.10 Matching Available Resources with the Priority Roads

The DDCs are currently receiving funds for new construction, rehabilitation and maintenance of district roads from different sources. The major source is the block grant provided by the MOLD. Due to increasing commitment of the government on the decentralization, it can be at least anticipated that the block grant will not be diminished. The second considerable source is the "Local Development Construction Program", which is again the general grant provided by the MOLD to the DDC, a major part of which is allocated to the district roads. The DDC's own source revenue is another major source for financing the district roads. Besides that, the district road sector is receiving certain amount of funds from the "Constituency Development Program" and "Development Grant Program". However, the fund received from the Constituency Development Program is spent according to the wish of the Member of the Parliament. Different donor agencies are active in supporting the district road sector in different districts. The World Bank funded "Rural Infrastructure Program", the "Rural Community Infrastructure Development Program" supported by the World Food Program and the "Agricultural Road Program" financed by the Asian Development Bank are active in some of the districts. Despite having several sources with considerable amount of resources, the efforts are not coordinated. These programs could not have generated the desired results. Therefore, the transport plan should assess the existing and potential sources of revenue and find a comprehensive solution for allocating resources. Allocation of resources to the priority projects while striking the regional balance is the crux of the challenge that needs to be acceptable for all the stakeholders.

6.1.11 Other Activities

The planning exercise is over once the District Council approves and the DOLIDAR and NPC endorse the DTMP. Although the issue is outside the purview of this study, it is pertinent here to mention the controversy. Until now, the MOLD does not allocate funds according to the requirements of the DDC. The NPC has no influence on the fund allocation. Therefore, the endorsement has almost insignificant role in the planning process. The MOLD has used the document for negotiating with the donors. The investment from the donors is directly tied up with the DTMP in the case of World Bank funded "Rural Infrastructure Project" and ADB supported "Agricultural Road Development Project". After going through this process, the MOLD releases the funds to each DDC either in the form of the block or specific grant for rural roads. Upon getting concurrence from the MOLD, the DDC initiates the implementation process, which involves preparation of the project, awarding the contract and physical implementation. The monitoring and evaluation are weaker parts in the project implementation cycle.

6.2 Methodology for the Underdeveloped Areas

The planning methodology for the underdeveloped areas is shown in Figure 6.2. Most of the activities for the underdeveloped districts are similar to the developed districts. For instance, realization of the need of transport planning by the DDC, strengthening the technical branch of the DDC, formulation of the district transport policies and analysis of the existing situation are the activities which are similar to the developed areas. However, the methodology for networking is different from the developed areas. Another major difference with the developed areas is the identification and quantification of the criteria for the prioritization. The calculation procedure of the financial revenue is identical to the developed areas. The amount of revenue in the developed areas, in general, is greater than the underdeveloped areas.

An assessment of the volume of traffic is essential for designing the road network and prioritizing it. If the data is available in the AADT, it should be converted into the number of passengers and freight in quintal.

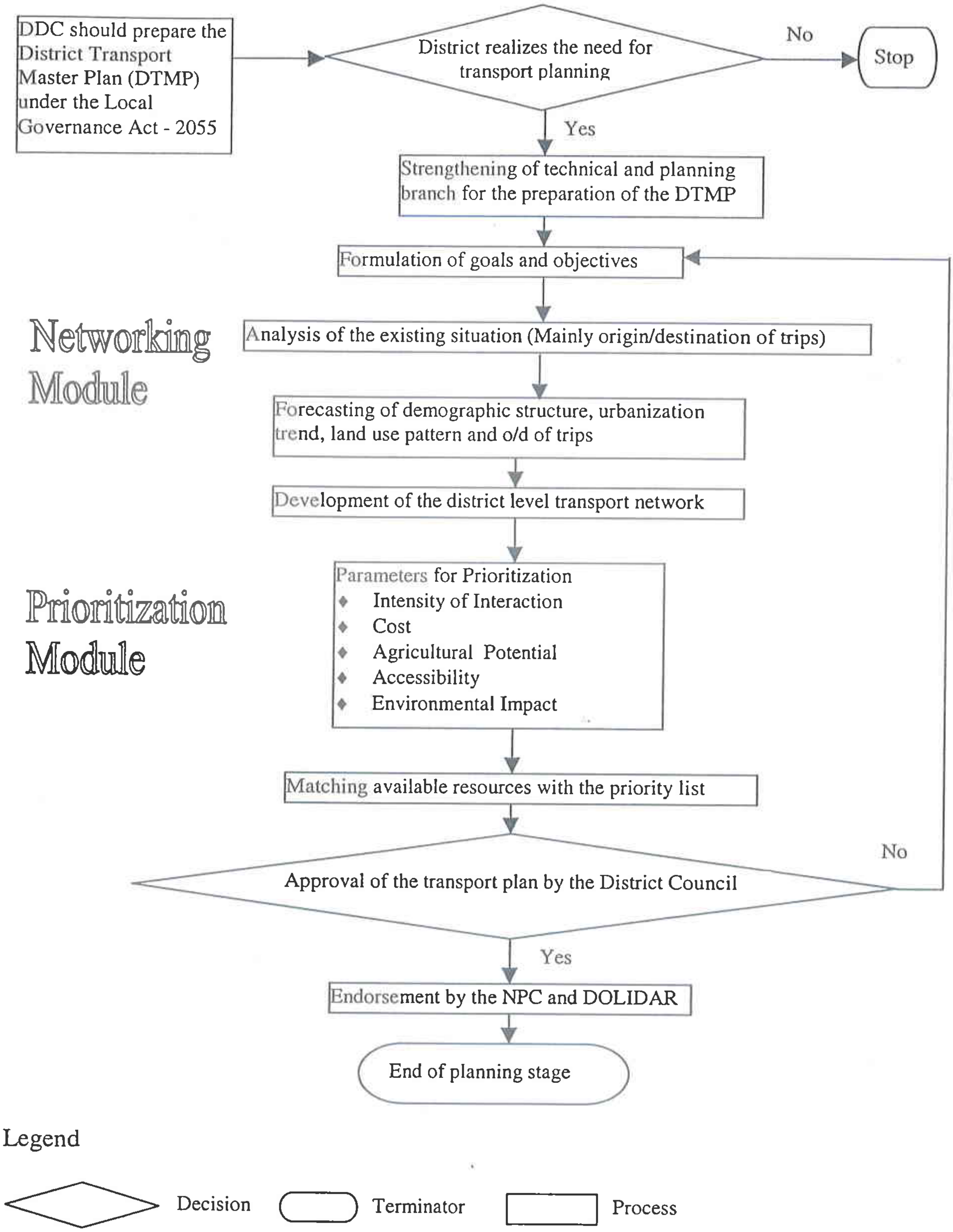


Figure 6.2 Methodology for the Underdeveloped Areas

6.2.1 Network Development in the Underdeveloped Areas

The flow chart of networking is shown in Figure 6.3. Saving in the transportation cost and traveling time is the main issue for the transport planning in the developed area whereas the transport planners intend to provide the basic accessibility in the underdeveloped area. For developing the transport networks, the status of accessibility of all settlements needs to be analyzed. For that purpose, the accessible areas should be distinguished from the inaccessible areas.

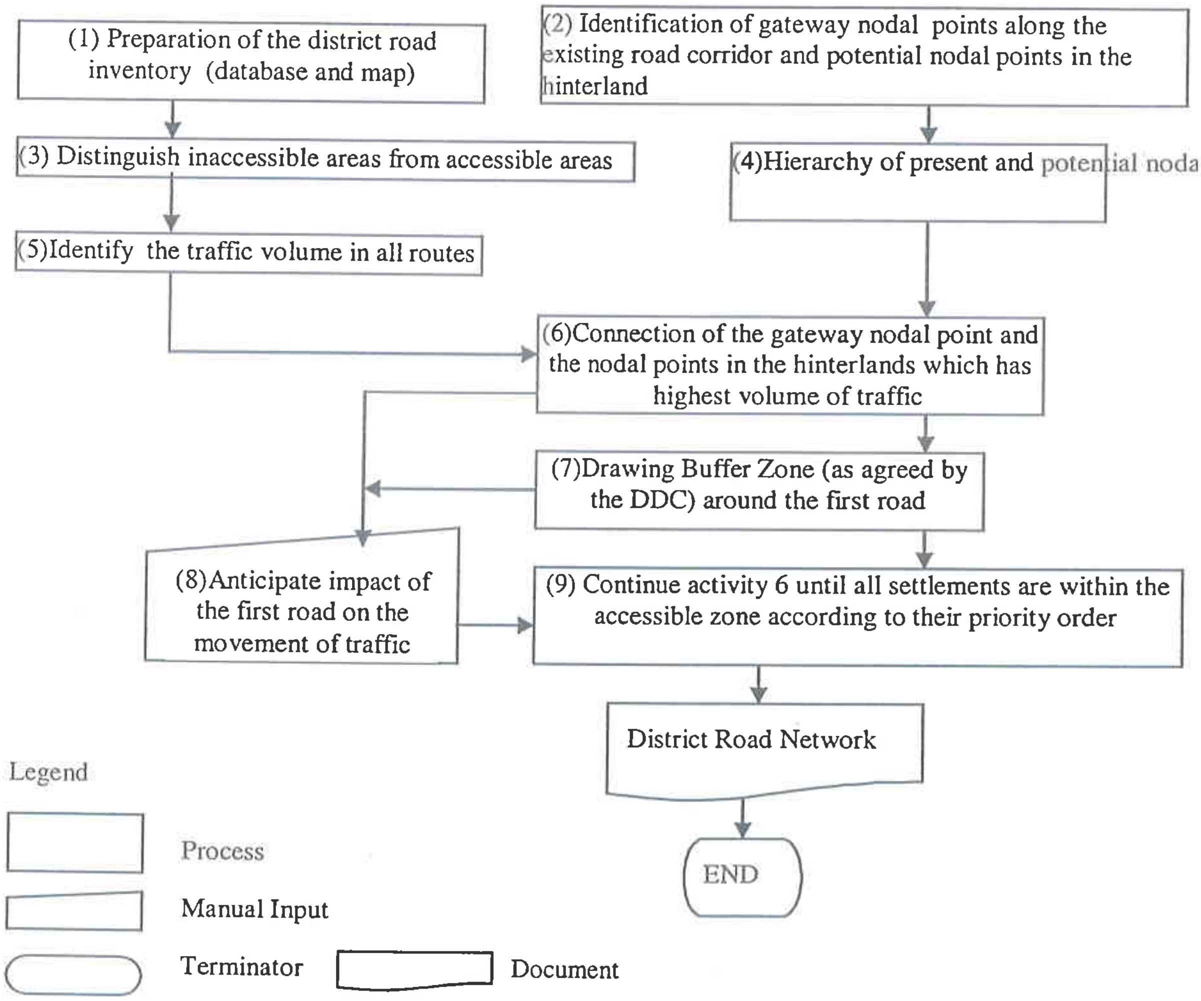


Figure 6.3 Procedure for Network Development in the Underdeveloped Areas

The potential nodal points should be explored within the inaccessible areas and such market centers should be connected with the gateway nodal points of the National Highways. In such a way transport network could be generated in the underdeveloped areas.

The methodology for developing the Centrality Index is the same as in the developed areas. One should also include the nodal points of the neighboring districts because the traffic movement goes beyond the district boundary. It needs a careful subjective judgement for identifying and determining the Centrality Index of the potential nodal points in the under-developed areas. The District Development Plan can be helpful for determining the facilities in a given location.

6.2.2 Prioritization of the Road Links

One of the major differences in the methodology between the developed and underdeveloped areas is the difference in the prioritization criteria. The roads in the developed areas are prioritized based on the economic criteria. However, the roads in the underdeveloped areas are prioritized based on economic as well as non-economic criteria. Providing access to the under-developed areas is more of welfare oriented rather than economic consideration.

In order to identify the prioritization criteria for the underdeveloped areas, all sample experts (28) were asked to mention their preference for criteria. The criteria were compiled and presented in the Kathmandu Workshop, which was organized for developing the transport planning methodology. In accordance with that, five criteria were selected. They are construction cost, agricultural potential, intensity of interaction, accessibility and environmental impact. It was attempted to avoid colinearity among the criteria. The Kathmandu workshop endorsed the criteria and the respective weights.

The roads of the underdeveloped areas of the test districts were prioritized based on the suggested criteria and their weight. The findings were presented in the DDC meeting during the pre-testing phase of the methodology. Accordingly 20% weight is assigned for construction cost, 25% for agricultural potential and 30% for the intensity of interaction. Similarly, accessibility and environmental impact are assigned 15% and 10% respectively. However, due to absence of actual road cost, per km construction cost is taken for the purpose of the present model, which is equal for all roads. Therefore, the construction cost is ignored for the prioritization purpose in the present model that should be considered in the real life situation once a planner has the construction cost for all the roads.

The weight allocation process to each link was also devised. The link with lowest per km construction and maintenance cost obtains the highest score and other links get proportionately less score according to their respective cost. Similarly, largest cultivated land area within the Zone of Influence gets highest score and score decreases proportionately. The intensity of interaction is accorded the highest significance by assigning 30% score. The highest intensity of interaction obtains full score and it decreases proportionately. The accessibility status is classified into inaccessible, partly accessible and accessible. The inaccessible area is defined as those areas, which are beyond 3 km from the existing road and motorized vehicles are not available throughout the year. In the partly accessible area, motorized vehicles are available during the dry season. In the accessible area, motorized vehicles are available throughout the year and those places are within 3 km of the road head.

After presenting the result by using above criteria in the pre-testing phase, the development bank officials and engineers argued that a prioritization based on the socio-economic criteria is not enough. It also requires an economic evaluation as applied for the developed areas. According to them, there is no cut off point below which either road should not be constructed or the geometric standard should be adjusted. Secondly, socio-economic prioritization criteria do not allow the inter-sectoral comparison. Therefore, there should be a common denominator, which allows comparison among the projects of different sectors. They suggest that the economic consideration should be a supplementary exercise to the prioritization based on the socio-economic criteria. The prioritizing includes a final step where costed links by order of priority are compared with budget available.

Chapter VII
Application of the District Road Network Planning and Prioritization Methodology in Nawalparasi District

This chapter provides a brief overview of the Nawalparasi district followed by application of the methodology in the district. The overview includes location of the Nawalparasi district, topography and drainage system, land use, distribution and hierarchy of the market centers, development status of different areas in terms of road density and status of accessibility within the district. As the district is divided into two parts in terms of the road density, two different types of methodology are developed. The computerized methodology is divided into the District Road Network Planning and Prioritization Model for the Developed Areas (DRPMD) and District Road Network Planning and Prioritization Model for the Underdeveloped Areas (DRPMU). The DRPMD is composed of five modules. They are the networking module, demand estimation module, benefit estimation module, cost estimation module and prioritization module. The DRPMU involves less calculation in comparison to the DRPMD.

The empirical data collected from the district are fed into the models and results are analyzed. As recommended by the experts and development bankers, the roads in the underdeveloped area are further evaluated by using DRPMD and finally the results are compared.

7.1 Overview of the Nawalparasi District

The Nawalparasi district is located in the south-western part of Nepal between parallels $27^0 12'$ and $27^0 47'$ N and meridians $83^0 36'$ and $84^0 25'$ E. The district is bordered by Chitwan district to the east, Tanahun and Palpa district to the north, Rupandehi district to the west and India to the South.

The total area of 2016 km^2 is divided into three distinct geographical zones. The area south of Daunne hill (*Siwalik* range) constitutes about 55 percent of the total land area which is composed of the gangetic alluvial plain, called *Terai*. It is gently sloping cultivated land interspersed by sub-tropical or dry jungle. This area is prone to flooding and mass scale erosion by the frequent changes of the river course. Therefore, the construction of the cross-drainage requires a special geological study. The elevation of this area remains below 200 m from the sea level. Therefore, it experiences a tropical climate (PLRP, 1997a).

The *Siwalik* range extends from Tribeni to the northwestern side. Its elevation abruptly increases from 200 m to 1000 m above sea level. The geological formation of these hills is normally fragile and thus greatly susceptible to soil erosion. The *Siwalik* range has formed the inner Terai, which is similar to the Terai. However, elevation of this area is slightly higher. This area receives huge quantities of colluvial materials brought by rivers from the *Mahabharat* and *Siwalik* ranges. It is a good source of construction materials but it poses a great challenge for road designers because outlets of culverts and bridges are filled in by such materials. Flash floods create a dilemma for the road designers because travelers suffer from transport interruption for a few days in a year; otherwise, these rivers remain dry throughout the year. In order to avoid traffic interruption for few days in a year, the DOR is considering constructing heavy structures in the National Highways. It is justifiable for the National Highway to construct the bridges. However, the district level planners should consider other alternatives. Among them, one can accept the interruption for few days in a year by constructing the simple causeway. Another option is the ventilated causeway. Such structures are useful from where the streams stop carrying boulders and debris. Selection of the alignment that involves less number of cross drainage structures is the best option.

The geographical cross section abruptly rises towards the north after crossing the Siwalik range and culminates at about 2000 m altitude in the *Mahabharat* range. The precipitously sloped mountain formation is a natural barrier between the Terai and the mid hill areas. The elevation descends gradually and ends at the Kali Gandaki River valleys in the northern part of the district. Several loops and bends are required to gain height for the road construction. A few irrigated and fertile river valleys like Bulintar, Dedgaon and Sardi Bagaincha experience the tropical climate. Fig. 7.1 shows the location and Fig. 7.2 shows the topography and drainage system.

The density of population is the highest in the settlements of the plain area, which is above 500 persons per square km. There are many hill settlements that have population densities of less than 100. The river valley settlements have a density of population that ranges between 100 – 300.

Most of the district area is covered by forest (57%) followed by cultivated land (35%). The remaining land areas are rocky, inundated, fallow or used for roads and homesteads. The land use map is presented in Fig. 7.3. Mainly the Terai area grows rice, wheat, vegetables and fruits. With the establishment of sugar mills, the sugarcane cultivation is also increasing. The hill settlements grow ginger and orange.

The highway corridor is attracting many large industries. Bhrikuti Paper Mills at Gaindakot and Lumbini Sugar Mills at Sunwal and Shree Distillery at Arun Khola are the principal industrial establishments. Besides that, having locational advantage of the Nawalparasi district in the national geographical setup and transport network perspective in particular, several industries are getting established in the Gaindakot, Pragatinagar and Kawasoti areas. Some of them are raw material based and others are market-oriented.

The PLRP (1997a) mentioned 20 market centers and out of them nine are service centers as well. In case of the Nawalparasi District, the market centers are developed along the highway corridor, which are points of origin for other roads leading towards the hinterlands. The size of market center is normally in proportion to the size of the hinterland population. The distribution and hierarchy of the market centers is shown in Figure 7.4.

With this brief overview, the whole district is divided into the developed and under-developed areas. The plain area located in the southwestern part of the district is considered as developed area and all hilly areas including the Inner-Terai is considered as the under-developed areas. The villages which have road densities more than 0.17 km/km^2 are defined as the developed areas and those which have less than that are defined as the under-developed areas. The status of development can be assessed from other indicators as well. Due to the poor level of accessibility and topographic situation, the people of the hill settlements are deprived of the health, educational and market facilities. The level of accessibility is shown in Figure 7.5 and the status of development is in Figure 7.6.

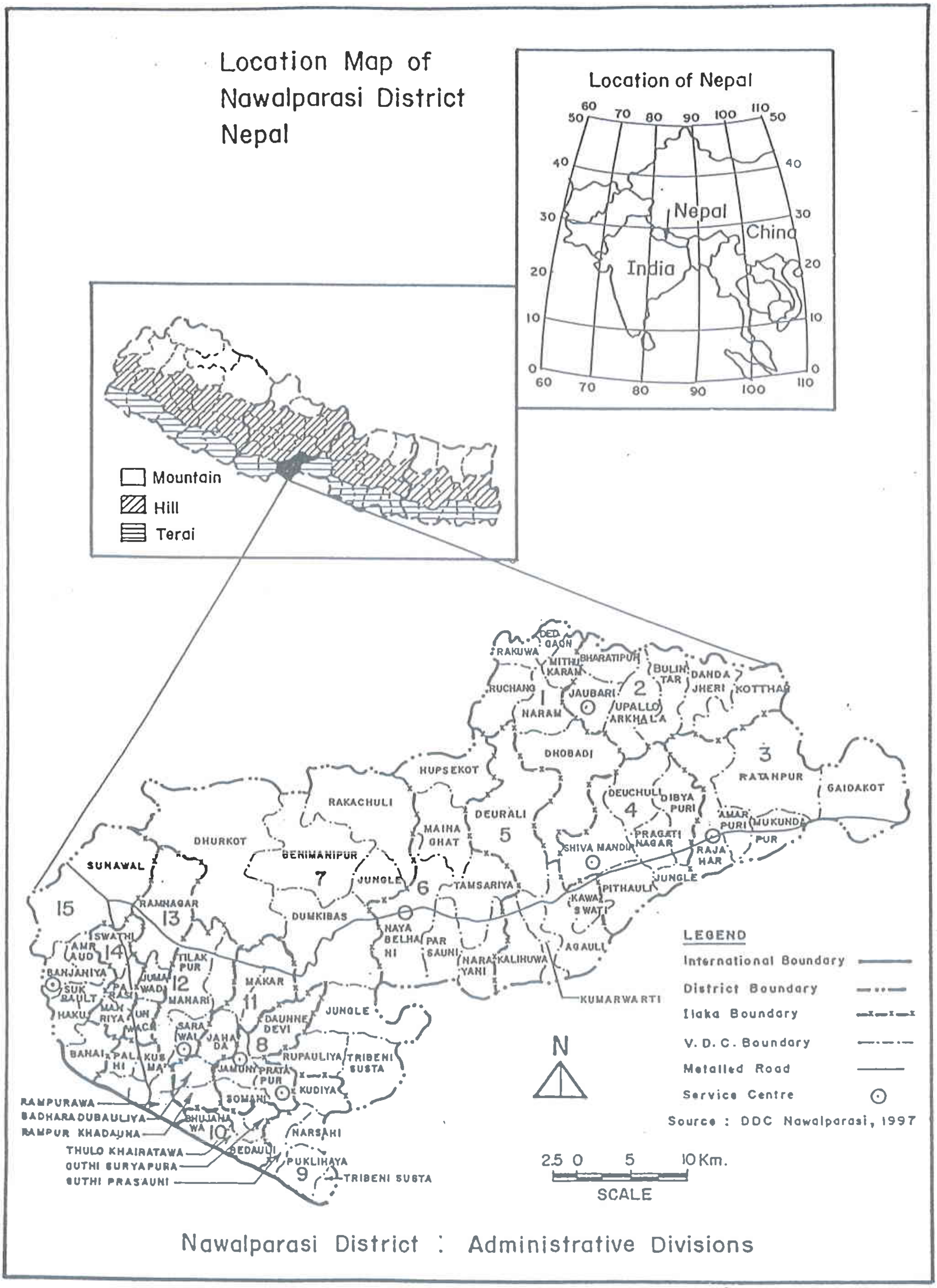


Figure 7.1 : Location Map of Nawalparasi District

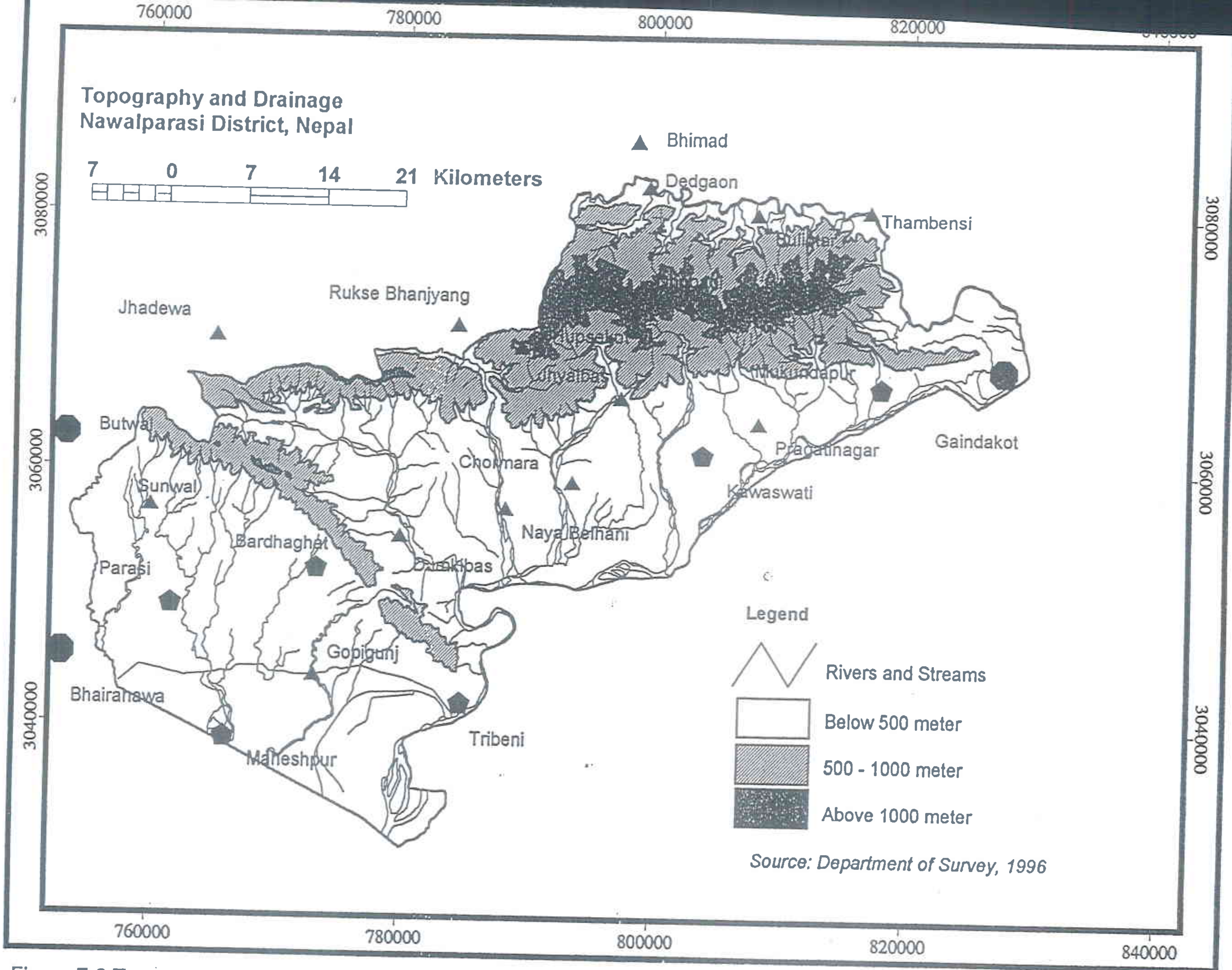


Figure 7.2 Topography and Drainage System

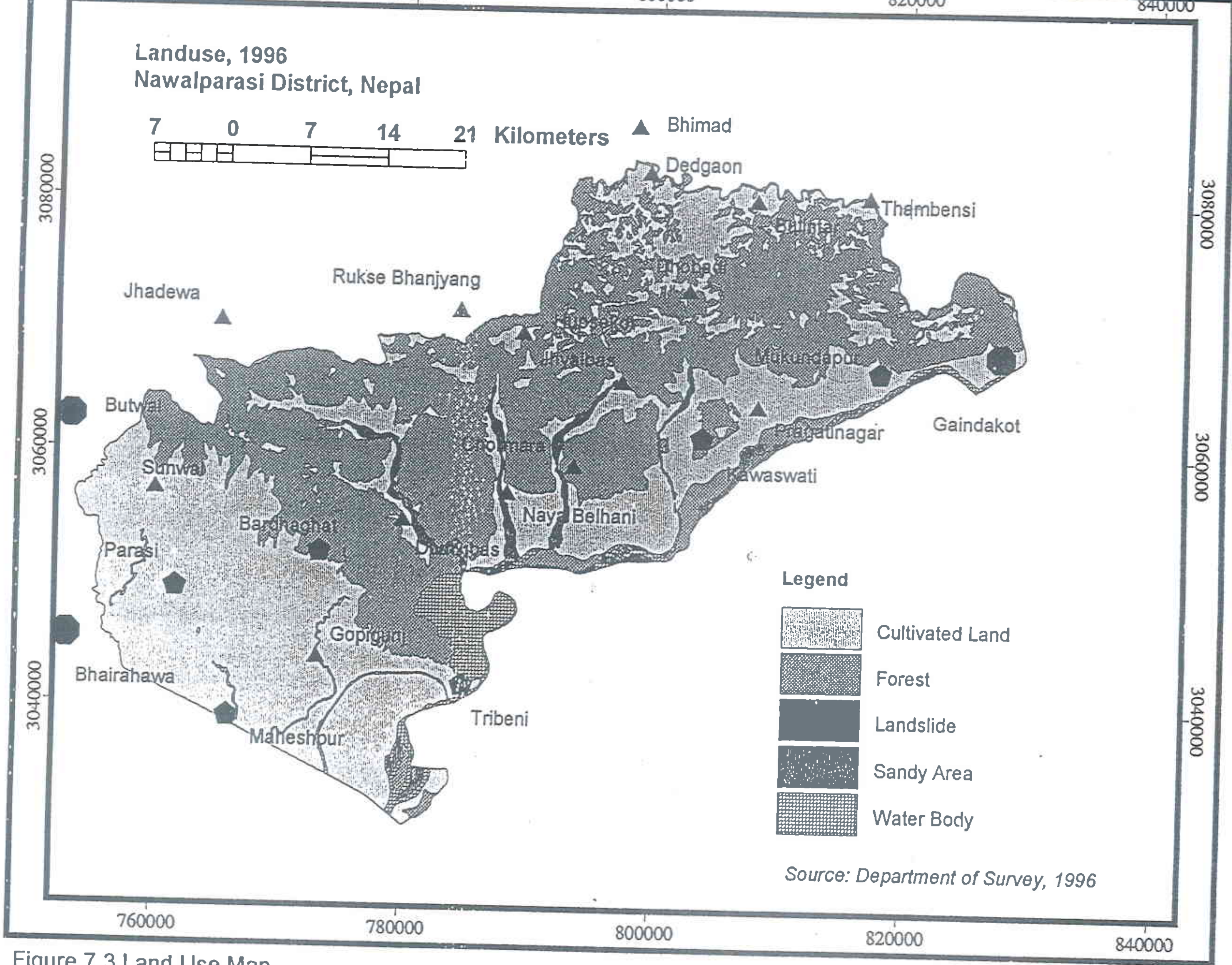


Figure 7.3 Land Use Map

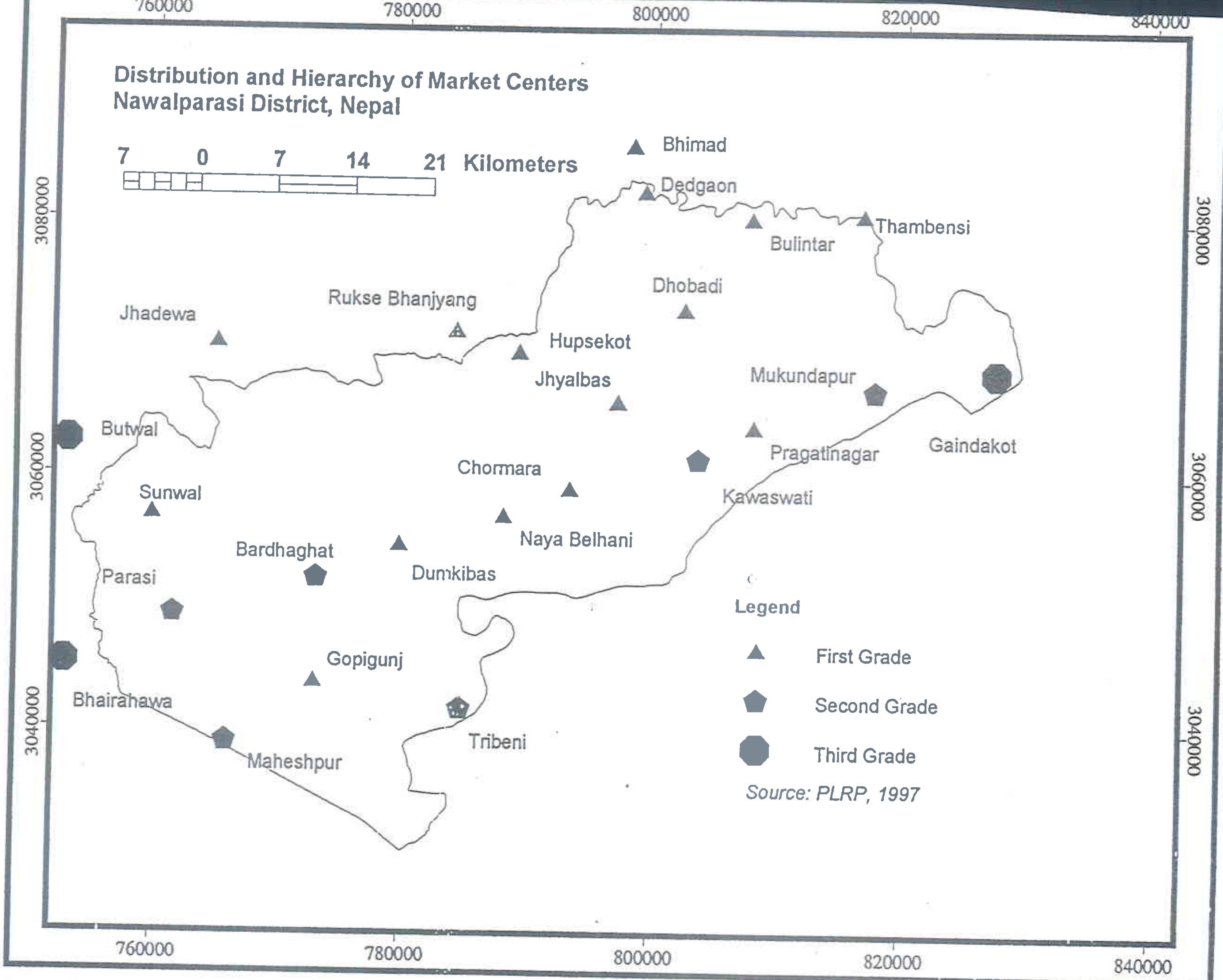


Figure 7.4 Distribution and Hierarchy of Market Centers

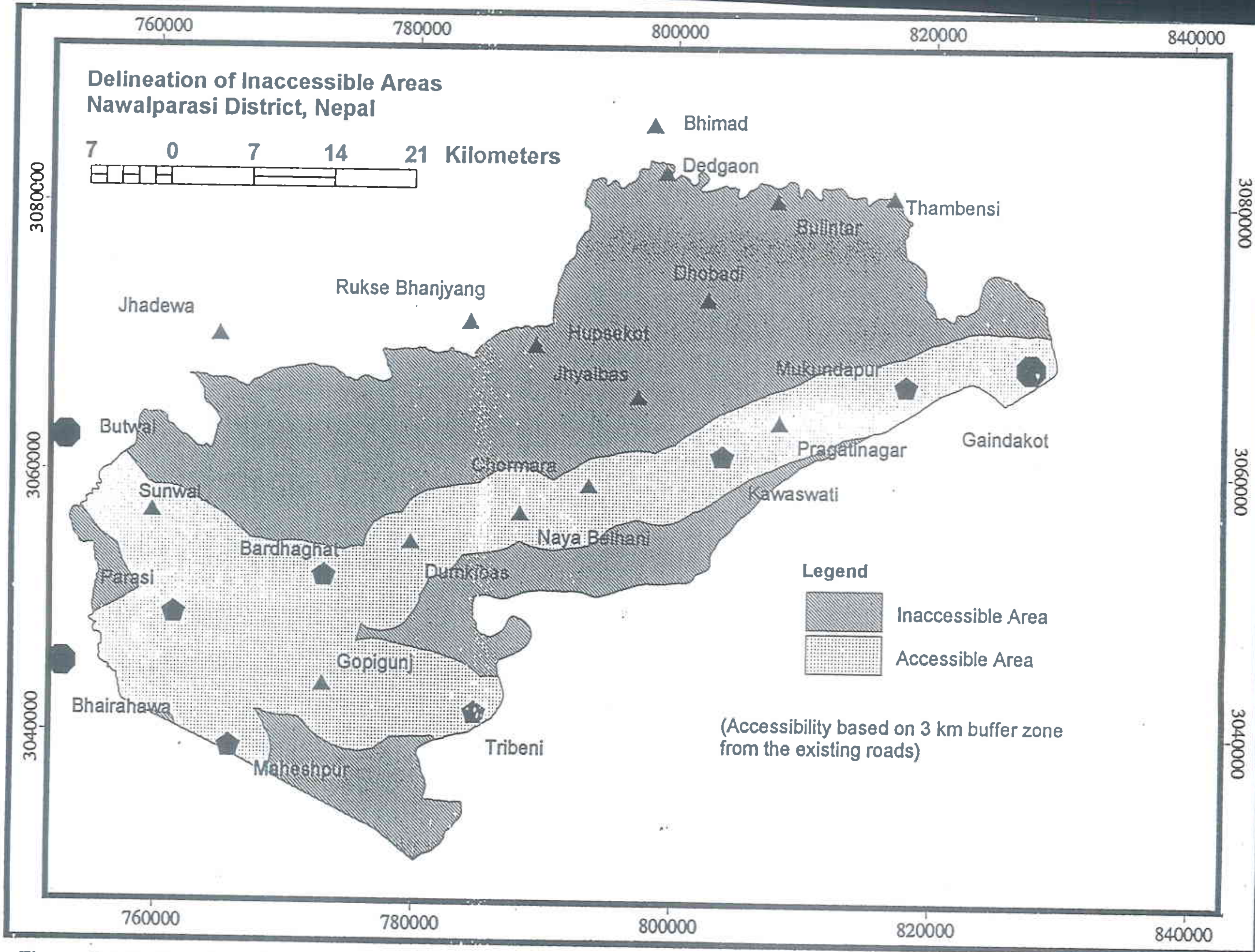


Figure 7.5 Delineation of Inaccessible Areas from Accessible Areas

Under Developed and Developed Areas Based in Road Density
Nawalparasi District, Nepal

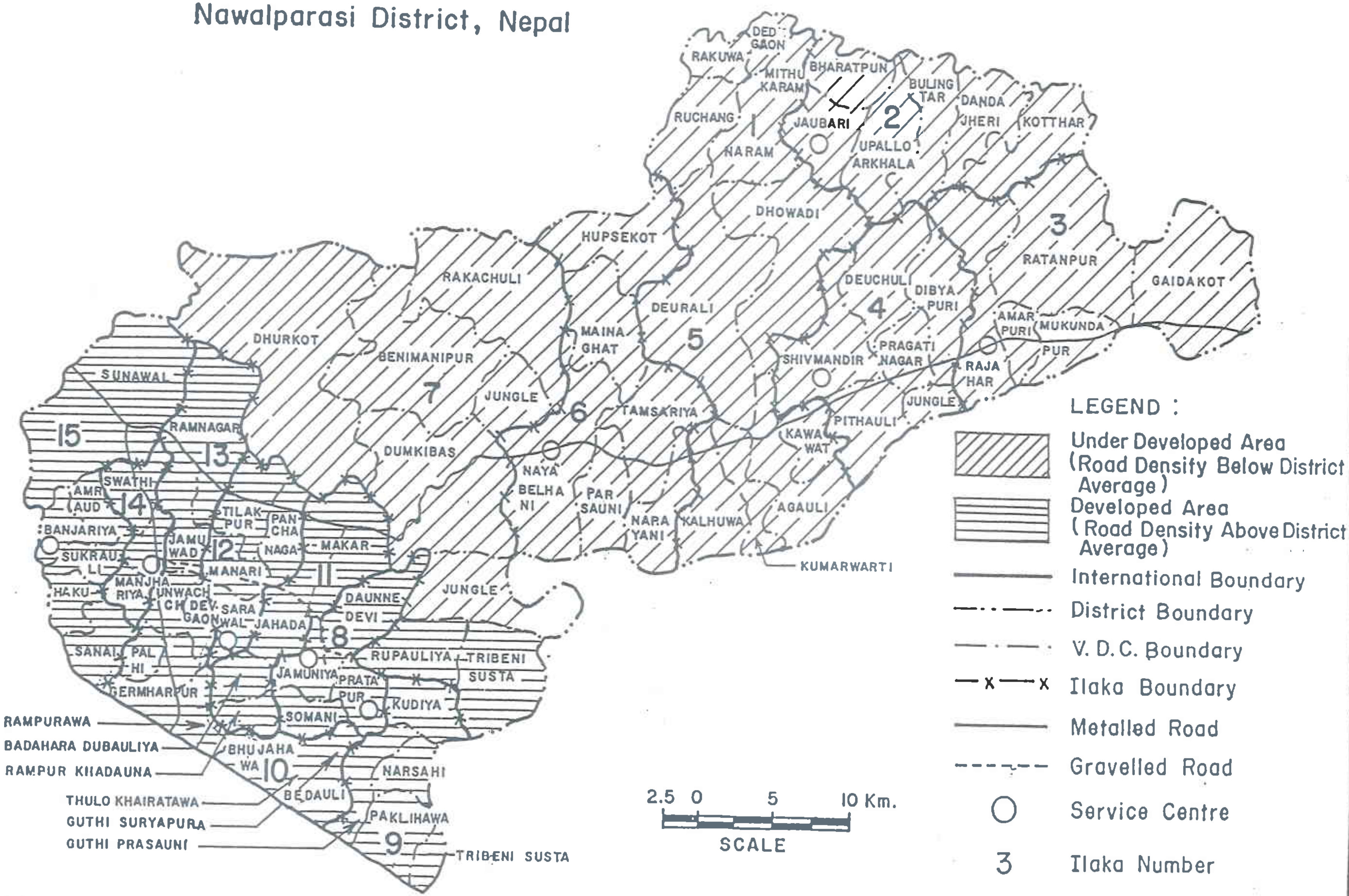


Figure 7.6 : Developed and Under Developed Areas Based on Road Density

7.2 General Background of the Transport Infrastructure Planning of the Nawalparasi District

According to the methodology that is elaborated in Chapter VI, it is necessary that the DDC should realize and be committed to transport planning. The Nawalparasi DDC requested PLRP for technical support to prepare the DTMP. Now the DTMP is already prepared and the DDC is contemplating to update it. These evidences show that the DDC has realized the importance of the transport planning exercise. The second step is to strengthen the technical and planning branch. The DDC has one Engineer, five Overseers and eight Technicians. Additionally, it has one Planning Officer. The planning exercise requires a considerable involvement of the Engineer. However, the present Engineer can not spare time due to his present volume of works. Therefore, one additional Engineer is required. Since the Planning Officer is an administrative cadre, he is not trained in the planning exercise. It is necessary to train the Planning Officer for making him to be capable enough for the planning job.

The formulation of goals and policies as the third step of the transport planning, is derived from the DTMP (PLRP, 1997a) and the interviews with the district officials of the Nawalparasi district. The DDC stipulated the goal as improvement of rural access in order to provide better opportunities to the rural population and contribute to poverty alleviation, both in short term by creating employment through the labor-based construction, and in the long term by improving the conditions for economic and social development (WB, 1994). In addition to formulating the goals, the DDC also outlined the planning criteria, which are presented in Table 7.1.

Table 7.1 Planning Criteria Outlined by the DDC, Nawalparasi

No.	Planning Criteria	Unit	Standard
1	Travelling time from the remotest village to the district headquarters		
1.1	Terai	Hours	< 2
1.2	Hill	Hours	< 4
2	Travel time to market center		
2.1	Terai	Hours	< 1
2.2	Hill	Hours	< 2
3	Zone of Influence (Hill and Terai)	Km	3

Source: PLRP, 1997a

The DDC has adopted other policies and strategies that are mentioned below:

1. Only residual amount from the maintenance will be spent for constructing and rehabilitating the roads. It means the maintenance of the existing road gets the first priority.

2. Irrespective of the prioritization, the roads, which are already started and completed more than 50 percent will be continued for implementation.

3. Only external sources will be mobilized for construction and rehabilitation of the roads in the Terai area.

4. All DDC internal resources like block grants and other development grants will be invested for new construction of the roads in hilly areas.

5. The DDC shall adopt the staged construction strategy.

6. The DDC shall create the "District Road Fund" where all sources of the revenues earmarked for roads will be deposited. Considering the commitment of the government towards decentralization, the budget at present channeled through the DOR will be provided to the DDC.

7. A 15-year perspective plan, 5-year periodic plan and an annual plan will be prepared for implementation of the district level roads. That is expected to allow flexibility for the short and clear horizon for the long run.

Against the background of the Nawalparasi district and general planning environment, an electronic spreadsheet-based model DRPM (District Road Network Planning and Prioritization Model) is developed. The DRPM has two versions, one for the developed areas and another for the underdeveloped areas.

7.3 Transport Infrastructure Planning for the Developed Areas

The District Road Network Planning and Prioritization Model for Developed Areas (DRPMD) is divided into five modules. The networking module includes identification of the nodal points and inventory of the existing transport infrastructures. Both of these information help to determine the district level transport network. The estimation of the transport demand, cost estimation of each link and the benefit estimation are the independent modules of the DRPMD. Similarly, the prioritization is also an independent module. The activity of matching available resources with the priority list is not directly integrated in the model. The matching of resources depends upon several policy decisions, availability of the resources and the DDC policies and strategies for construction, rehabilitation of the regional road projects. Therefore, the component of matching available resources with the priority list is directly linked with the model but not as a component of it. The schematic framework of the model is shown in Figure 7.7. The detail spreadsheet-based model is presented in Appendix 1.

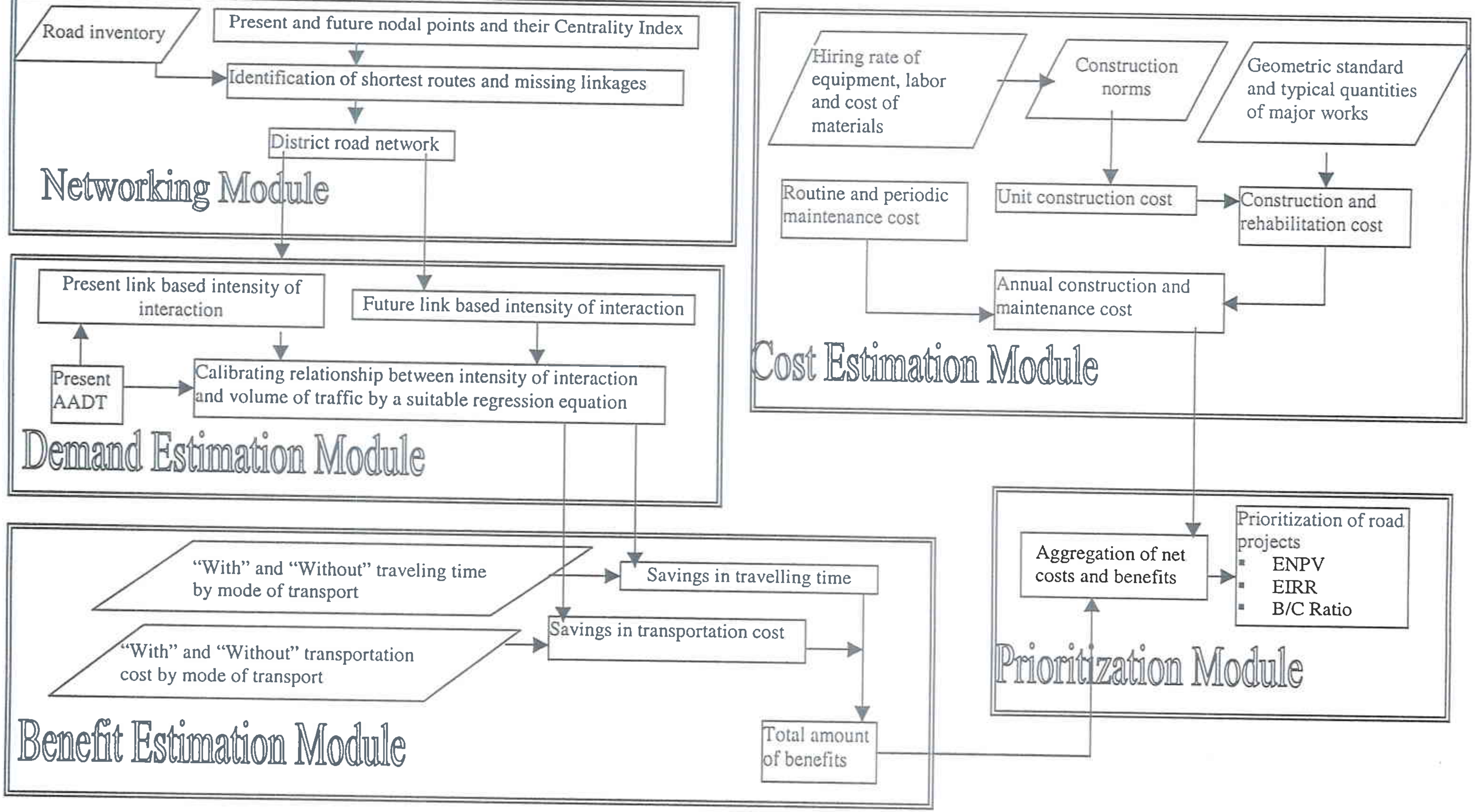


Figure 7.7 District Road Network Planning and Prioritization Model for the Developed Areas (DRPMD)

7.3.1 Networking Module

The network is defined as the set of nodes and links. In the context of networking of the district roads, the market centers are considered as the nodal points. The market centers are the settlements where the facilities for the rural population are located. Therefore these are trip attracting and generating points. The district level roads, tracks and trails are taken as the links of the network. Existing market centers and their hierarchy is shown in Table 7.2 and the future market centers are shown in Table 7.3. The methodology for computing the Centrality Index is explained in Chapter VI. After identifying the nodal points, the shortest routes in terms of distance and time are identified.

Six market centers are identified in the developed area of the district. Although Butwal and Bhairahawa are located outside the district, those two market centers serve higher level needs of the Nawalparasi district. Therefore, functionally there are eight market centers, which are considered as the nodal points for developing the networks. Although it is not included in the analysis, the Basa market center has certain potential for being upgraded as the district level market center in future. Besides that all other village level market centers which have a centrality index below 10 are not included in the list of district level market centers.

Table 7.2 Centrality Index of Present Market Centers

No.	Market Centers	Population	Centrality Index	Rank	Location
1	Parasi	7,177	71	III	Non-highway
2	Bardhaghat	11,334	34	VI	Highway
3	Sunwal	5,177	26	VII	Highway
4	Tribeni	14,278	38	V	Non-highway
5	Maheshpur	10,499	41	IV	Non-highway
6	Gopigunj	4,364	14	VIII	Non-highway
7	Butwal	54,179	200	I	Highway
8	Bhairahawa	48,306	150	II	Highway

Table 7.3 Future Centrality Index of Market Centers

No	Market Center	Future Population	Centrality Index	Rank	Location
1	Parasi	9,660	183	III	Non-highway
2	Bardhaghat	16,415	128	IV	Highway
2	Sunwal	7,497	106	V	Highway
3	Tribeni[1]	18,037	76	VI	Non-highway
4	Maheshpur[2]	13,275	71	VII	Non-highway
6	Gopigunj	5,456	65	VIII	Non-highway
7	Butwal[3]	68,745	350	I	Highway
8	Bhairahawa[4]	61,293	300	II	Highway

CI = Centrality Index

1 Indian town of Balmiki Nagar included, Centrality Index and population approximate.

2 Indian town of Thutibari included, Centrality Index and population approximate.

3 Located in Rupandehi district, Centrality Index approximate.

4 Located in Rupandehi district, Centrality Index approximate.

Table 7.2 and 7.3 show that the market centers at the highway corridor will be growing and the market centers along the Indian border and the market centers located between the Indian border and National Highway will have declined growth rate. The people of the district have stronger linkages with other cities and settlements of Nepal than the Indian cities. Maheshpur and Tribeni have fifth and sixth position now, however, it is predicted that these market centers will fall down to the sixth and seventh rank within the planning period. On the other hand, Bardhaghat and Sunwal will be upgraded from sixth and seventh position to fourth and fifth position. Butwal, Bhairahawa and Parasi have maintained their original position in the planning period as well.

At the second stage of networking, an inventory and status of the district and higher level road networks is assessed and presented in Table 7.4 and Figure 7.8.

Table 7.4 District Road Inventory

ID	Road	Length[1] (km.)	Surface	Road Class	Present Status	Average Speed of Vehicles (km/hr)
1	Mahendra Highway	94.8	Bituminous	National Highway	All weather	45
2	Sunwal-Parasi	8.9	Bituminous	Feeder Road	All weather	40
3	Parasi - Maheshpur	12.0	Bituminous	Feeder Road	All weather	40
4	Parashi-Bhairahawa (Mahoo)	7.4	Gravel	District Road	All weather	30
5	Parasi- Gopigunj	13.3	Gravel	District Road	All weather	30
6	Bardhaghat- Gopigunj	9.0	Gravel	Feeder Road	All weather	30
7	Canal Road	32.0	Gravel	Corporate Road	All weather	30
8	Gopigunj - Tribeni	17.0	Gravel	Feeder Road	All weather	30
9	Tribeni-Maheshpur	20.9	Earth	District Road	Seasonal, poor	

[1] Road length is calculated based on GIS application.

Among nine roads, National Highway, Feeder Roads and Corporate Road are not under the responsibility of the DDC. Among three district roads, the condition of two roads is satisfactory. The only road that needs new construction is Tribeni – Maheshpur. Currently it is a bullock cart track without cross drainage structures, embankment and pavement structures. The road no. 10 is not included in the inventory because it has the characteristics of a Village level road. Nonetheless it could be upgraded as a district level road if the volume of traffic justifies. Therefore it is indicated in the map but excluded from the calculations.

Given the existing market centers and road inventory, it is attempted to identify the shortest path in terms of distance and time for developing the network and estimating the volume of traffic. For identifying the shortest path in terms of time, the average traveling speed of a bus is taken. The shortest path analysis is used for developing the network and relationship between the intensity of interaction and volume of passengers is calibrated. The identification of the shortest path is depicted in Table 7.5. Table 7.5 should be studied in conjunction with the Figure 7.8, which shows the existing roads and trails in the district.

Table 7.5 Identification of the Shortest Routes' (Distance in Km)

Origin	Destination	Route Options*		Shortest Route Distance (Km)	Shortest Time Route (in Minute)	Possibility of Shortening	Length after Shortening	Remarks
		1	2					
Parasi	Bardhaghat	5, 6 (24)	2,1(26)	5,6 (24)	2,1 (36)	No	NA	
Parasi	Sunwal	2 (9)		2 (9)	2 (14)	No	NA	
Parasi	Tribeni	5, 8 (32)		5, 8 (32)	5, 8 (64)	No	NA	
Parasi	Maheshpur	3 (12)		3 (12)	3 (18)	No	NA	
Parasi	Gopigunj	5 (15)		5 (15)	5 (30)	No	NA	

Parasi	Butwal	2, 1 (30)		2, 1 (30)	2, 1 (41.5)	No	NA	
Parasi	Bhairahawa	4 (21)		4 (21)	4 (42)	No	NA	
Bardhaghat	Gopigunj	6(9)		6(9)	6(18)	No	NA	
Bardhaghat	Sunwal	1 (17)		1 (17)	1(23)	No	NA	
Bardhaghat	Triveni	6, 8 (26)		6, 8 (26)	6, 8 (52)	No	NA	
Bardhaghat	Maheshpur	6, 5, 3 (48)		6, 5, 3 (48)	6, 5, 3 (66)	Yes	23	New Construction
Bardhaghat	Butwal	1 (38)		1 (38)	1(51)	No	NA	
Bardhaghat	Bhairahawa	1 (62)	6, 5, 4 (45)	6, 5, 4 (45)	1(90)	No	NA	
Sunwal	Tribeni	1, 6 (43)	2, 5, 8 (41)	2, 5, 8 (41)	1, 6 (75)	No	NA	
Sunwal	Maheshpur	2, 3 (21)		2, 3 (21)	2, 3 (32)	No	NA	
Sunwal	Gopigunj	1, 6 (26)	2, 5 (24)	2, 5 (24)	1, 6 (41)	No	NA	
Sunwal	Butwal	1 (21)		1 (21)	1(28)	No	NA	
Sunwal	Bhairahawa	1 (45)	2, 4 (30)	2, 4 (30)	1(40)	No	NA	
Tribeni	Maheshpur	9 (21)		9 (21)	9	No	21	Needs Upgrading
Tribeni	Gopigunj	8 (17)		8 (17)	8 (34)	No	NA	
Tribeni	Butwal	8, 6, 1 (64)	8, 5, 2, 1(62)	8, 5, 2, 1(62)	8, 6, 1(103)	No	NA	
Tribeni	Bhairahawa	8,5,4 (53)		8,5,4 (53)	8,5,4 (106)	No	NA	
Maheshpur	Gopigunj	5, 3 (27)		5, 3 (27)	5, 3 (48)	Yes	13	New Construction
Maheshpur	Butwal	3, 2, 1 (42)		3, 2,1(42)	3, 2, 1(60)	No	NA	
Maheshpur	Bhairahawa	3, 4 (30)		3, 4 (30)	3, 4(60)	No	NA	
Gopigunj	Butwal	6, 1 (47)	5,2,1 (45)	5,2,1 (45)	6, 1(69)	No	NA	
Gopigunj	Bhairahawa	5, 4 (36)		5, 4 (36)	5, 4(72)	No	NA	
Butwal	Bhairahawa	1 (24)		1 (24)	1(32)	No	NA	

*Length of the route is given in parenthesis in Km.
NA = Not applicable

Table 7.5 not only indicates the shortest route in terms of distance and time but also indicate the missing link among the market centers. The shortest route in terms of time is more useful information than the physical distance. Therefore based on time distance, a shortest path matrix is prepared and presented in Table 7.6.

Table 7.6 Origin-Destination Road Distance Matrix among Market Centers[1]

Market Centers	Parasi	Bardhaghat	Sunwal	Tribeni	Maheshpur	Gopigunj	Butwal	Bhairahawa
Parasi	0	26(36)	9(14)	32(64)	12(18)	15(30)	30(42)	21(42)
Bardhaghat		0	17(23)	26(52)	25(66)	9(18)	38(51)	62(90)
Sunwal			0	43(75)	21(32)	26(41)	21(28)	45(40)
Tribeni				0	21([2])	17(34)	64(103)	53(106)
Maheshpur					0	13([2])	42(60)	30(60)
Gopigunj						0	47(69)	36(72)
Butwal							0	24(32)
Bhairahawa								0

[1] Figures outside the bracket show the distance in Km and inside the bracket shows the time distance in minute.
[2] No motorable road exists now, therefore requires new construction.

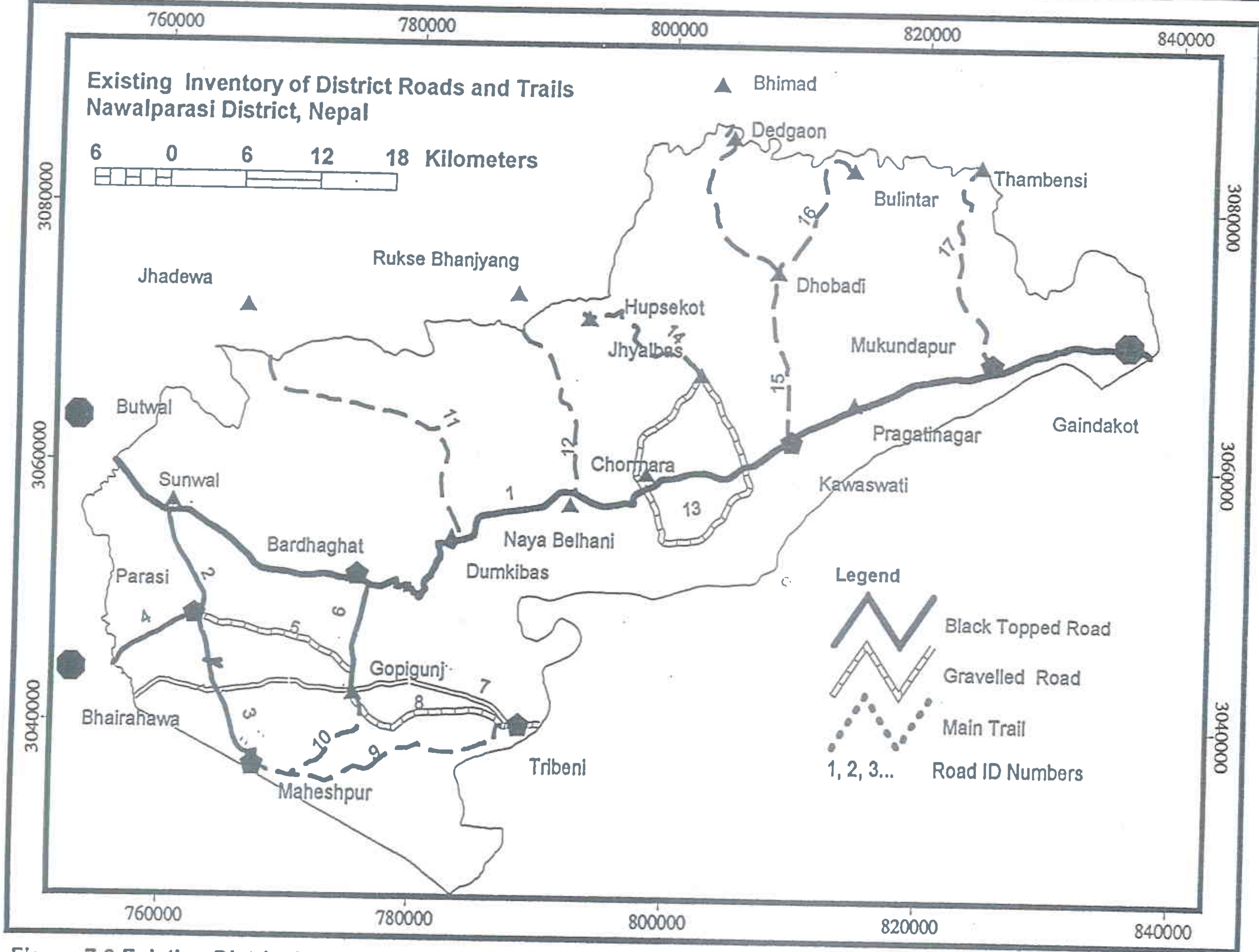


Figure 7.8 Existing District Level Inventory of Roads and Trails

Based on Table 7.4, 7.5 and 7.6, it can be inferred that the Tribeni – Maheshpur and Gopigunj – Maheshpur are missing links in the network. Bardhaghat – Maheshpur route uses the same link between the Gopigunj and Maheshpur.

7.3.2 Transport Demand Estimation Module

In this section, the relationship between intensity of interaction and the volume of traffic (passengers and freight) is established. In the second stage, the future intensity of interaction is assigned to each link according to the principle of shortest path. Based on the future intensity of interaction and the established relationship at the first stage, the future volume of passenger and freight is estimated.

The relationship between the intensity of interaction and present volume of passenger is shown in Figure 7.9. As shown in Figure 7.9, the relation is explained as: $y = 45870x^{0.3015}$ and R^2 is 0.4844. Figure 7.10 shows the relationship between the intensity of interaction and volume of freight.

Figure 7.9 Relationship between IOI and VOP

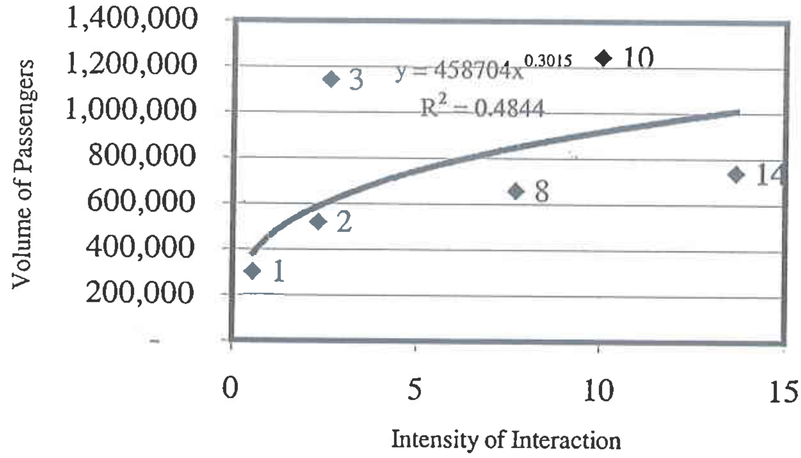
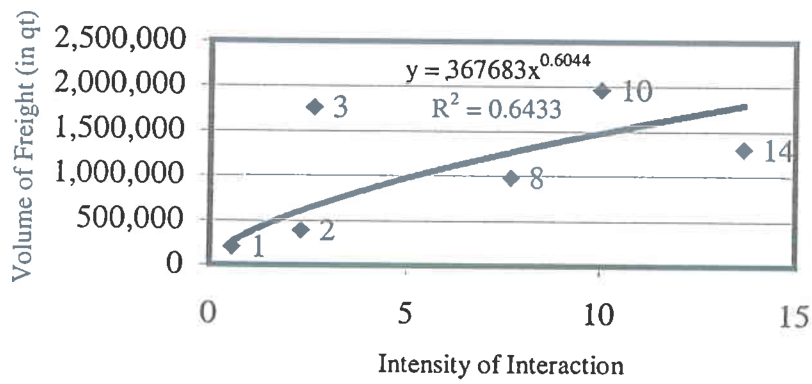


Figure 7.10 Relationship between IOI and VOF



As shown in Figure 7.9, the relationship between the volume of passenger and intensity of interaction is weak. The intensity of interaction accounts for 48 percent of the variation in the volume of passengers, meaning that random and other factors account for more. In that sense, the probability of inaccurate estimation is high. In case of freight, the relationship is relatively stronger. In both cases, there is no certainty that the future volume of traffic can be accurately estimated. However, the forecasting always involves a degree of uncertainty whatever method is used. The proposed method is comparatively more reliable than other methods because it considers all trips generating and attracting factors. Additionally, sensitivity analysis and other strategies like staged construction help to reduce the uncertainties. Moreover, the methodology has a built-in mechanism regarding the stability of relationship over time. The centrality index is one of the variables of the intensity of interaction, which gets less weight as the number of functions increase and the weight increases as the number of functions decrease. In addition to that, as a precautionary step, the staged construction technology should be adopted in order to avoid redundancy in investment. The staged construction technology is demand responsive. Table 7.7 shows the shortest routes considering the proposed roads.

Table 7.7 Identification of the Shortest Routes after Constructing the Proposed Roads (Distance in km)

Origin	Destination	Links in the Route[1]		Shortest Distance	Shortest Time Links[2]
		1	2		
Parasi	Bardhaghat	5, 6 (24)	2,1(26)	5,6 (24)	2,1(36)
Parasi	Sunwal	2 (9)		2 (9)	2(14)
Parasi	Tribeni	5, 8 (32)		5, 8 (32)	5, 8(64)
Parasi	Maheshpur	3 (12)		3 (12)	3(18)
Parasi	Gopigunj	5 (15)		5 (15)	5(30)
Parasi	Butwal	2, 1 (30)		2, 1 (30)	2, 1(41.5)
Parasi	Bhairahawa	4 (21)		4 (21)	4(42)
Bardhaghat	Sunwal	1 (17)		1 (17)	1(23)
Bardhaghat	Triveni	6, 8 (26)		6, 8 (26)	6, 8(52)
Bardhaghat	Maheshpur	6, 10 (18)		6, 10 (18)	6, 10(66)
Bardhaghat	Butwal	1 (38)		1 (38)	1(51)
Bardhaghat	Bhairahawa	1 (62)	6, 5, 4 (45)	6, 5, 4 (45)	1(90)
Sunwal	Tribeni	1, 6, 8 (43)	2, 5, 8 (41)	2, 5, 6 (41)	1, 6(75)
Sunwal	Maheshpur	2, 3 (21)		2, 3 (21)	2, 3(32)
Sunwal	Gopigunj	1, 6 (26)	2, 5 (24)	2, 5 (24)	1, 6(41)
Sunwal	Butwal	1 (21)		1 (21)	1(28)
Sunwal	Bhairahawa	1 (45)	2, 4 (30)	2, 4 (30)	1(40)
Tribeni	Maheshpur	9 (21)		9 (21)	9(42)
Tribeni	Gopigunj	8 (17)		8(17)	8(34)
Tribeni	Butwal	8, 6, 1 (64)	8, 5, 2, 1(62)	8, 5, 2, 1(62)	8, 6, 1(103)
Tribeni	Bhairahawa	8,5,4 (53)		8,5,4 (53)	8,5,4(60)
Maheshpur	Gopigunj	10 (14)		10 (14)	10(28)
Maheshpur	Butwal	3, 2, 1 (42)		3, 2,1(42)	3, 2, 1(60)
Maheshpur	Bhairahawa	3, 4 (30)		3, 4 (30)	3, 4(60)
Gopigunj	Butwal	6, 1 (47)	5,2,1 (45)	5,2,1 (45)	6, 1(69)
Gopigunj	Bhairahawa	5, 4 (36)		5, 4 (36)	5, 4(72)
Butwal	Bhairahawa	1 (24)		1 (24)	1(32)

[1] Length of the route is given in parenthesis in Km.
[2] Time in minutes.

The present intensity of interaction is calculated in Table 8 and future intensity of interaction is calculated in Table 10 of Appendix 1. Intensity of interaction is assigned to the concerned link of the shortest path for calculating the expected volume of passengers and freight. Table 7.8 shows the assignment of present intensity of interaction and Table 7.9 shows the assignment of the future intensity of interaction.

Table 7.8 Assignment of Present Intensity of Interaction to Each Link Based on Existing Road Networks

Link ID	Link	Routes using the link	Assignment of Intensity
1	Mahendra Highway	Parasi – Bardhaghat, Butwal, Bardhaghat – Sunwal, Butwal, Bhairahawa, Sunwal – Tribeni, Gopigunj, Butwal, Bhairahawa, Tribeni – Butwal, Maheshpur – Butwal, Gopigunj – Butwal	0.29+6.13+0.18+2.91+0.7 3+.04+.01+3.31+0.48+2.6 2+0.29 = 16.99
2	Sunwal - Parasi	Parasi – Bardhaghat, Sunwal, Butwal; Maheshpur–Sunwal, Butwal	0.29+0.85+6.13+0.13+ 2.62= 10.62
3	Parasi - Maheshpur	Maheshpur – Parasi, Sunwal, Butwal, Bhairahawa	1.51+0.13+2.62+3.44 = 7.70
4	Parasi - Bhairahawa	Bhairahawa – Parasi, Tribeni, Maheshpur, Gopigunj	8.37+1.39+3.44+0.48 = 13.68
5	Parasi - Gopigunj	Parasi – Triveni, Gopigunj; Triveni – Bhairahawa, Gopigunj – Bhairahawa	0.27+0.13+1.39+0.48 = 2.27
6	Bardhaghat - Gopigunj	Bardhaghat – Tribeni, Maheshpur, Sunwal – Tribeni, Gopigunj, Butwal – Tribeni, Gopigunj	0.31+0.49+.04+.13+1.43+ 0.29 = 2.69
8	Gopigunj - Tribeni	Tribeni – Parasi, Bardhaghat, Gopigunj, Butwal, Bhairahawa	0.27+0.31+0.11+1.43+1.3 9 = 3.51
9	Tribeni - Maheshpur	Tribeni – Maheshpur	0.53

Table 7.9 Assignment of Future Intensity of Interaction on Present and Proposed Links

Link ID	Link	Routes using the Link	Assignment of Intensity
1	Mahendra Highway	Parasi – Bardhaghat, Butwal, Bardhaghat – Sunwal, Butwal, Bhairahawa, Sunwal – Tribeni, Gopigunj, Butwal, Bhairahawa, Tribeni – Butwal, Maheshpur – Butwal, Gopigunj – Butwal	5.49+47.19+5.76+35.04+ 10.06+0.59+0.42+43.18+ 7.19+8.04+2.96+8.04+ 3.87 =177.83
2	Sunwal - Parasi	Parasi – Bardhaghat, Sunwal, Butwal; Maheshpur–Sunwal, Butwal	5.49+17.25+47.19+1.70+ 12.90 = 84.53
3	Parasi - Maheshpur	Maheshpur – Parasi, Sunwal, Butwal, Bhairahawa	11.59+17.25+12.90+19.32 = 61.06
4	Parasi - Bhairahawa	Bhairahawa – Parasi, Tribeni, Maheshpur, Gopigunj	73.6+8.96+19.32+7.26 =109.14
5	Parasi - Gopigunj	Parasi – Tribeni, Gopigunj; Triveni – Bhairahawa, Gopigunj – Bhairahawa	2.36+2.73+8.96+7.26 =21.31
6	Bardhaghat - Gopigunj	Bardhaghat – Tribeni, Maheshpur, Sunwal – Tribeni, Gopigunj, Butwal – Tribeni, Gopigunj	4.33+5.83+0.59+0.42+ 8.96+7.26 = 27.39
8	Gopigunj - Tribeni	Tribeni – Parasi, Bardhaghat, Sunwal, Gopigunj, Butwal, Bhairahawa	2.36+4.33+0.59+1.73+ 8.04+8.96 = 26.01
9	Tribeni - Maheshpur	Tribeni – Maheshpur	2.96

Based on Figure 7.9 and 7.10, the future transport demand is estimated. The future linkwise intensity of interaction is used in the regression equation of Fig. 7.9 and Fig. 7.10. The power trend equation for the passenger is $y = 458704x^{0.3015}$ and trend equation for freight is $y = 367683x^{0.6044}$. The projected values are presented in Table 7.10.

Table 7.10 Projected Volume of Passengers and Freight

Passengers

Route ID	Route	Base Year (Passengers)	Growth Rate in %	Future Volume of Passengers
2	Sunwal - Parasi	1,241,913	2.30	1,747,870
3	Parasi - Maheshpur	658,825	5.40	1,450,211
4	Parasi - Bhairahawa	739,125	6.45	1,887,936
5	Parasi - Gopigunj	517,713	5.49	1,153,868
6	Bardhaghat - Tribeni	1,140,443	0.24	1,181,806
8	Gopigunj - Tribeni	855,332	-1.95	636,523
9	Tribeni - Maheshpur	298,753	5.38	655,839

Freight

Route ID	Route	Base Year (Freight)	Growth Rate in %	Forecasted Freight
2	Sunwal - Parasi	1,961,875	6.95	5,371,858
3	Parasi - Maheshpur	976,375	9.28	3,694,809
4	Parasi - Bhairahawa	1,299,765	11.06	6,269,548
5	Parasi - Gopigunj	380,948	12.85	2,336,583
6	Bardhaghat - Tribeni	1,753,825	2.26	2,451,371
8	Gopigunj - Tribeni	1,315,369	4.74	2,634,732
9	Tribeni - Maheshpur	197,100	8.91	709,084

7.3.3 Cost Estimation Module

The total construction cost is the function of hourly hiring rate of equipment, hourly rate of laborers and the unit price of materials. Two types of roads are considered for analysis. The Category I[1] road is taken for the first round of analysis. The construction cost of the proposed road is presented in Table 7.11. The detail analysis is presented in Appendix 1.

Among 8 roads in the developed areas, Table 7.11 presents the cost of only Road No. 9. All other roads except Tribeni – Maheshpur road are already constructed. At present, Gopigunj-Maheshpur road is ignored because of low volume of traffic. However, it can be considered as a district road in future. The cost calculation module also includes the annual construction and maintenance cost. The maintenance cost has fixed as well as variable cost components. As the number of vehicle increases, the cost on particularly periodic maintenance increases significantly. Nonetheless, such an increase in costs depends on several other factors like drainage system, sub-grade, pavement design and workmanship besides obviously the volume of traffic. Therefore, the relationship between the cost and volume of traffic is not established by this study. Instead, it has adopted from prevailing practice of the DOR.

According to the equipment-based method, the earthwork excavation for one cubic meter costs nearly NRs. 66, for embankment more than NRs. 50 and sub-base NRs. 635. For the Category I road, having formation width of 6 m, carriageway width of 3.5 m and average height of embankment of 1 m costs more than NRs. 17 million per km of road. The

[1] The district level roads are classified as Category I and Category II. The geometric standards of both types of roads are given in Appendix 1.

construction costs of other structures are assumed to be similar to the labor based technology. The impact of labor based technology on the Net Present Value and Rate of Return is presented in the sensitivity analysis.

Table 7.11 Construction Cost of Proposed Road Project

Total Length 20.9 Km

No.	Particulars	Unit	Quantities		Unit Rate	Amount
			Per Km	Road No. 8	In NRs.	In NRs. ,000
1	E/W Embankment	Cum	7500	156,750	50	7,854
2	Pipe Culverts					0
	60 cm dia	nos.	2	42	3,975	166
	90 cm dia	nos.	1	21	7,196	150
	(Length of PC along formation)	m	9	188		0
3	Slab Culverts					0
	Span upto 2 m.	nos.				0
	Span upto 3 m.	nos.	0.5	10	445,057	4,651
	Span 4 m. or more	nos.	0.3	6	568,408	3,564
4	Causeways	rm	10	209	12,679	2,650
5	Sub-Grade Preparation	Sqm.	5500	114,950	22	2,524
6	Sub-base	Cum	5500	22,990	635	14,595
7	Base	Sqm.	3500	73,150		0
8	Surface Dressing	Sqm.	3500	73,150		0
Total Cost						36,155
Per Km. Cost						1,730

Source: Appendix 1

Table 7.12 shows the global cost of road construction under different circumstances (WSA and SMEC, 1996).

Table 7.12 Per Km Cost of the District Roads in Plain Area (at 1996 price)

Amount in NRs.

No.	Particulars	Category I	Category I
1	First stage construction: fair weather earth road	727,500	582,500
2	Second stage construction: fair weather gravel road	1,304,000	988,000
3	Third stage: all weather gravel road	1,614,500	1,298,500
4	Fourth stage: all weather sealed road	2,282,000	
	Upgrading Costs		
1	Improving of existing impassable earth track Upgrading to fair weather earthen road	467,500	383,000
2	Improvement of fair weather earthen road to fair weather gravel road	758,000	557,500
3	Improvement of fair weather earthen road to all weather gravel road	1,068,000	867,500
4	Improvement of fair weather gravel road to all weather gravel road	572,000	516,500
5	Improvement of all weather gravel road to all weather sealed road	861,000	

Source: WSA and SMEC, 1996

7.3.4 Benefit Estimation Module

Savings in the transportation cost and saving in the traveling time are considered as the benefits of the improved infrastructure. For the valuation of savings in the traveling time, only 50 percent of the saved time are considered as the productive time and such time is multiplied with the unskilled labor wages. Similarly, one quintal of freight is considered equivalent to one person and savings in the travelling time is calculated accordingly. In order to simplify the calculation, a mid-year figure of number of passengers and volume of freight is used for calculating the benefits. Ideally, one can use the benefit for the respective year according to the forecasted volume of traffic.

Based on these assumptions, it is found that the ENPV is 5.33 million, EIRR 10 percent and BCR 1.15 at 7 percent discount rate. Therefore the road project is viable.

7.4 Transport Infrastructure Planning for the Underdeveloped Areas

The theoretical discussion in section 6.2 is the basis for formulating the model for the under developed areas. In addition to the difference in approach for the networking, the fundamental difference between the developed and underdeveloped areas is that the developed areas require the economic analysis but for the underdeveloped areas, prioritization based on socio-economic criteria is sufficient. Similarly, there are several other simplifications for the underdeveloped areas in comparison to the developed areas. However, the feedback received during the pre-testing of model suggested that the economic analysis is required for the road projects in the under-developed areas as well. Therefore, both types of prioritization are included in this chapter. The framework for prioritizing the roads with economic indicators is identical to the model for the developed areas. The framework of the model for prioritizing the roads by socio-economic criteria is shown in Fig. 7.11 and the model is presented in Appendix 2.

7.4.1 Networking in the Underdeveloped Areas

As described in the conceptual framework, the accessible areas are delineated from the inaccessible areas and presented in Figure 7.5. After delineating the accessible areas and inaccessible areas, the gateway nodal points were identified. Gaindakot/Narayanghat is the regional market center where people from all under-developed areas visit for obtaining the higher order goods and services. However, there is no immediate hinterland originating from Gaindakot/Narayanghat area towards Nawalparasi district because of the Kaligandaki River. The main district level gateway nodal points are Mukundapur, Kawaswati, Chormara, Naya Belhani (Arun Khola) and Dumkibas.

The hinterland nodal point of Mukundapur is Thambensi. Thambensi is a river valley settlement with fertile land and dense population. The existing mule track originating from Kawaswati bifurcates from Dhowadi and one heads towards Dedgaon and another reaches to Bulintar. Dedgaon and Bulintar both locations have development potential. Both places are irrigated and fertile river valleys with relatively higher population density. Few groceries, textile shops, rice mills and other government facilities indicate that these settlements can grow as the nodal center in future. Moreover, the Dhowadi can be the collection center for ginger, orange and milk. The Mahabharat range is suitable for ginger, orange and animal husbandry. The destination point of the road originated from Naya Belhani is Ruksebhanjyang, which has a growth potential as the agricultural produce collection center and commercial point for the settlements in the vicinity area. The road, which originates from Dumkibas, connects Jhadewa of Palpa district, which is a small market center of that area.

The present market centers and their rank is presented in Table 7.13.

Table 7.13 Present Centrality Index of Market Centers in the Underdeveloped Areas

No.	Market Centers	Population	Centrality Index	Rank
1	Gaindakot[1]	81,990	199.87	I
2	Mukundapur	4,239	38.51	III
3	Chormara	4,125	12.93	VII
4	Naya Belhani	4,088	23.67	V
5	Dumkibas	3,099	16.23	VI
6	Jhadewa[2]	5,500	8.00	VIII
7	Rukshe Bhanjyang[3]	2,148	7.00	IX
8	Dedgaon	3,461	7.00	IX
9	Kawaswati	9,764	55.76	II
10	Pragatinagar	9,649	24.65	IV
11	Jhyalbas	3,375	6.00	X
12	Thambensi	3,362	5.00	XI
13	Hupsekot	3,690	5.00	XI
14	Bulintar	3,934	6.00	X

[1] Ganidakot includes also the population and Centrality Index of Narayanghat as well.
[2] Jhadewa is located in the Palpa district.
[3] Rukse Bhanjyang is located in the Palpa district.

The underdevelopment is illustrated by the Centrality Index of majority of the market centers. Unlike to the developed areas, the market centers with the Centrality Index less than 10 are also taken as the nodal point because it is difficult to find the established market centers in the under-developed areas. The future rank of the market centers is shown in Table 7.14.

Table 7.14 Future Centrality Index of Market Centers in the Underdeveloped Areas

No.	Market Center	Future Population	Centrality Index	Rank
1	Gaindakot	166,881	306.38	I
2	Mukundapur	6,139	81.21	III
3	Chormara	5,552	57.02	VI
4	Naya Belhani	5,921	61.58	V
5	Dumkibas	4,488	48.86	VII
6	Dhurkot	7,042	25.00	X
7	Rukshe Bhanjyang	2,725	20.00	XI
8	Dedgaon	2,084	33.78	VIII
9	Kawaswati	14,141	171.49	II
10	Pragatinagar	13,974	68.87	IV
11	Jhyalbas	3050	33.18	IX
12	Thambensi	595	15.24	XII
13	Hupsekot	4,682	12.00	XIV
14	Bulintar	4,992	15.00	XIII

It is expected that there will be a significant growth in the Centrality Index in the under developed areas. The Gaidakot/Narayanghat market center will further strengthen its position followed by the Kawaswati market center, which is declared as the sub-district headquarters for providing administrative services. All other market centers along the National Highway will also grow significantly. The hinterland market centers will grow at a slower pace than the gateway market centers.

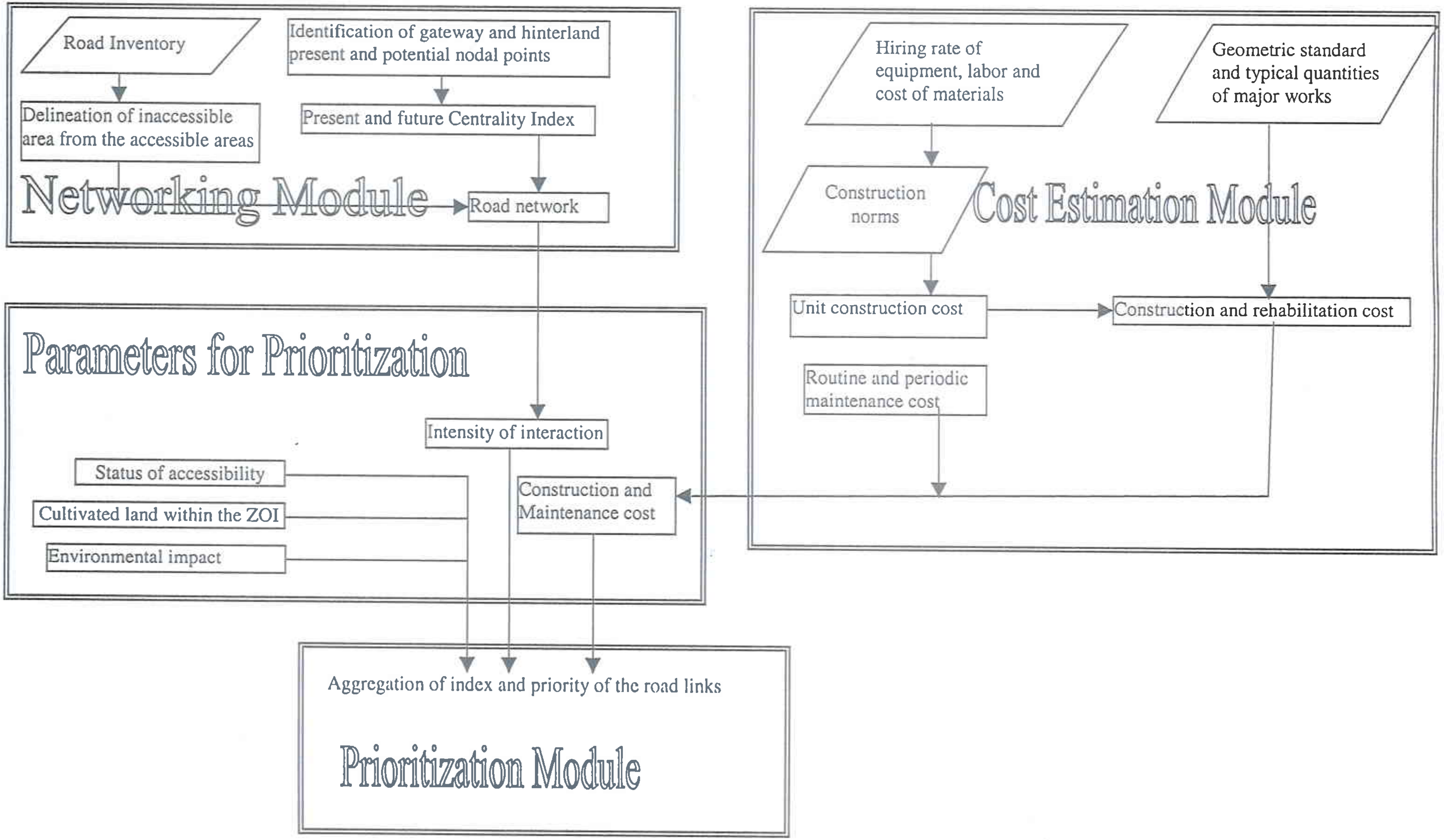


Figure 7.11 District Road Network Planing and Prioritization Model for the Underdeveloped Areas (DRPMU)

7.4.2 Prioritization Module

The cost component is excluded from the DRPMU areas because the actual data are not available for all roads. As described in section 6.2.3, agricultural potential, intensity of interaction, accessibility and environmental impact are included as the prioritization criteria. Table 7.15 shows the prioritization criteria their weight and score of all candidate roads. The detail calculation of each parameter is shown in Table 12 of Appendix 2. The prioritization criteria and their weights were derived from the expert interviews, policy makers survey and DDC meetings.

Table 7.15 Prioritization of the Proposed Roads by Socio-Economic Criteria

R. No.	Road Name	Parameters				Total Score	Rank
		Agricultural Potential	Interaction	Accessibility	Environmenta Impact		
	Weight	0.3	0.45	0.15	0.	1	
1	Dumkibas - Dhurkot (Jhadewa)	0.16	0.26	0.075	0.0	0.55	III
2	Kawaswati - Dedgaon (Bhimad)	0.3	0.45	0.15	0.C	0.96	I
3	Jhyalbas - Hupsekot	0.14	0.10	0.15	0.C	0.44	V
4	Chormara - Jhyalbas	Already Constructed					
5	Dhobadi - Bulintar	0.30	0.17	0.15	0.(	0.64	II
6	Mukundapur - Thambensi	0.19	0.03	0.15	0.(	0.43	VI
7	Naya Belhani - Ruksebhanjyang (Majhkot)	0.12	0.14	0.15	0.(	0.48	IV

The candidate roads are also evaluated economically. All the roads have generated the negative ENPV, EIRR and EB/C ratio less than 1. Even decreasing standard f om Category I to Category II road, the economic return did not changed considerably. The si uation suggests that the roads in hilly area should be constructed by using staged construct on technology. However, the estimation of the economic benefits only considered the d ect benefits. The indirect benefits like increase in the agricultural production, pro otion of the non-farm activities and greater degree of health and hygienic situation are ot covered by the economic benefits. The model for prioritizing roads of the underdevel ped areas by using economic analysis is given in Appendix 3.

7.5 Overall Output of the Planning Exercise

The overall district level road network for developed as well as underdeveloped areas is presented in Figure 7.12. All roads are planned to complete within a period of 15 years. Nonetheless the duration of completion depends upon the availability of the financial resources. Section 7.6 deals with the requirement and availab lity of the financial resources. The ZOI of present and proposed road network is presented in Figure 7.13. The ZOI shown in Figure 7.13 indicates that almost entire district settlements are served with the district level road networks with defined definition of accessibility within 3 km from the road head. The unserved areas are mainly covered by forest. Few uncovered settlements should be served by the Village Roads. The networks also meet the planning criteria of traveling time from the remotest village to the district headquarters within 2 hours in the Terai area and 4 hours in the hilly areas could be achieved. The traveling distance of 1 and 2 hours from the settlements to the market centers is also fulfilled. Therefore, the district objective of improving rural access could be achieved by the proposed road network.

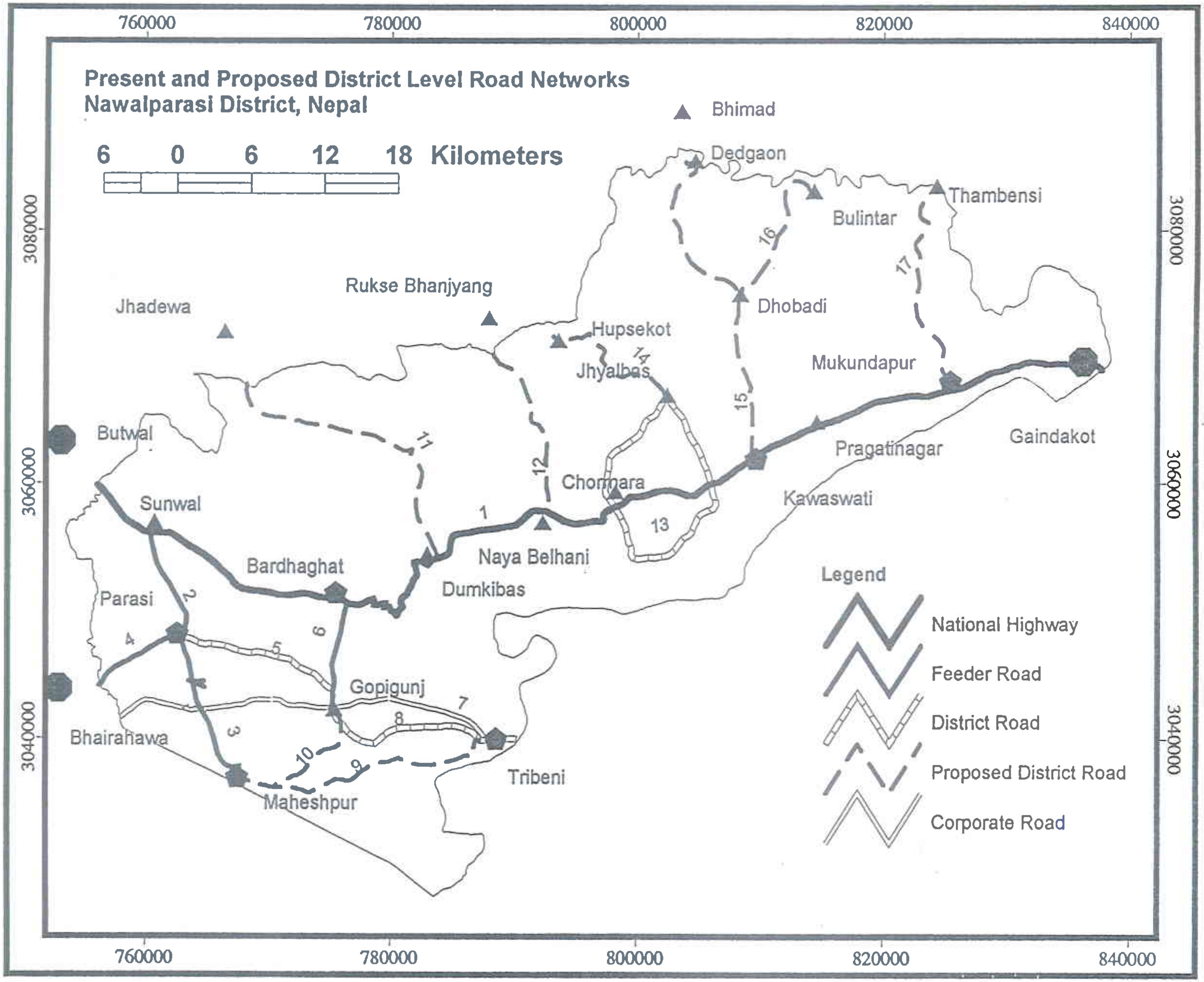


Figure 7.12 District Level Present and Proposed Road Networks

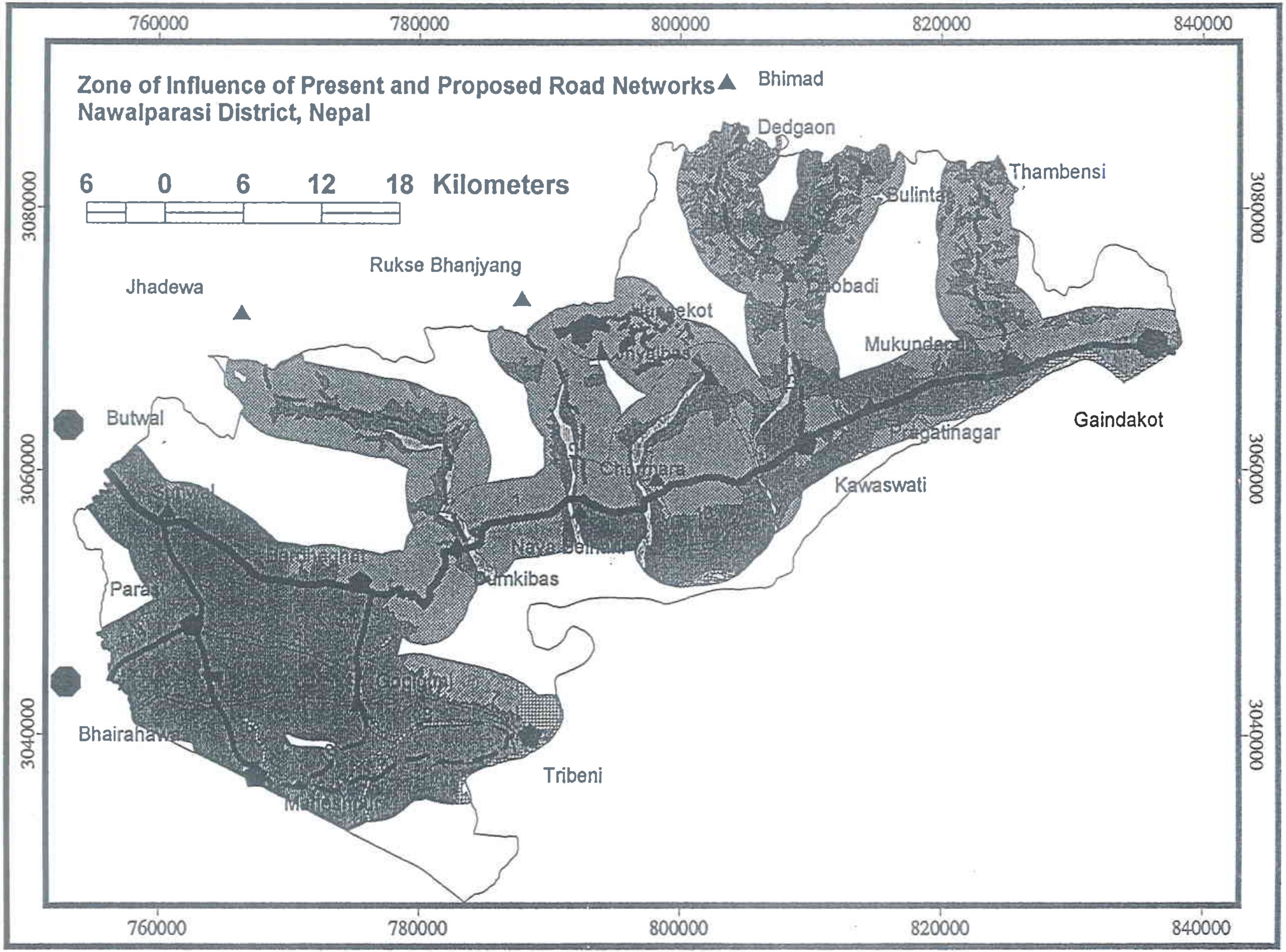


Figure 7.13 Zone of Influence of the Present and Proposed Roads

7.6 Financing the District Level Roads

As shown in Annex 7.1, most of the roads have received one to two hundred thousand rupees, (1300 – 2700 USD), which is insignificant for the new construction and rehabilitation works. The interviews and informal discussions with the DDC members showed that there is a social and political compulsion for fragmentation of resources. There is no guarantee to get funds later if they agreed to the prioritized roads based on the rational criteria for the current year. However, everybody seems to be in consensus that the practice may satisfy the short-term political problem of the people's representatives, but it is counter productive in view of providing the good access to the local people.

In order to overcome the problem, the second alternative could be to allocate the entire budget on one project until its completion, which is shown in Annex 7.2. However, due to small amount of the available resources, such practice could be able to complete only 3 roads throughout the planning period (15 years), which is not acceptable for all the DDC members. The practice does not achieve the regional equity. Such practice was adopted by the PLRP. It is an ideal but not practical.

The stagewise construction approach is a realistic political and technical solution. Table 7.16 shows the forecasted cash inflows, which is based on the assumption of the PLRP (1997a). The required budget for maintaining roads is deducted before allocating to the new roads. Table 7.16 derived the stagewise road construction data from Table 22 of Appendix 3. The available budget is allocated for the construction of the first stage, which is opening up a road with a narrow trail. The costs of subsequent stages are allocated to the respective years according to the availability of budget. For instance, the DDC has NRs. 3891 thousand disposable capital net of maintenance liabilities, which is allocated to the first priority project of Kawaswati-Dedgaon road. For the first stage, the Kawaswati-Dedgaon road requires NRs. 2949 thousand. There is still a surplus of NRs. 943, which the DDC can allocate to the second priority project of Dhobadi-Bulintar. With the surplus amount, all required works of the Dhobadi-Bulintar can not be completed. Therefore, the deficit budget of NRs. 369 should be financed from the budget of second year. In such a way, the budget is allocated to the priority road projects until it is exhausted for the given year. Once it is exhausted, the road construction is carried over to the subsequent year. The fund is sufficient up to the third stage of construction during the planning period of 15 years for all proposed roads. Therefore, the DDC should either raise funds to meet the deficit amount from other internal sources or from the external sources for the final construction.

The stagewise construction approach is a realistic political solution because certain works can be executed in almost all roads during the initial few years of the planning period. The action shows to local people that the DDC is serious and committed to construct the proposed road. The DDC members can make effort to acquire funds for the given project. On the other hand, it is technically sound because stage construction strategy allows some time for the natural compaction of embankment and it also allows the growth of vegetation for stability of the road stretch. Due to small quantity of excavated materials every time, it is easier to handle. On the other hand, it provides some important clues for the size of cross-drainage structures. The faulty longitudinal and vertical alignment can be corrected. Therefore, the proposed testing exercise has used the stage construction strategy in consonance to the DDC.

Table 7.16 Allocation of Resources Based on Phased Construction

NRs. in ,000

No.	Cash Flow	Fiscal Year														
	Forecasted Cash Inflow	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Road Sector Expenses from the Own Source Revenue (15%)	2042	2162	2718	2900	3289	3618	3980	4369	4816	5297	5827	6410	7160	7051	7756
2	25% of the Constituency Development Program	439	483	532	585	643	707	778	856	942	1036	1139	1253	1379	1516	1668
3	Toll Tax	463	486	510	536	563	591	620	651	684	717	753	741	830	872	916
4	Peoples Participation	677	745	820	1173	1290	1419	1561	1717	2182	2400	2640	2900	3195	3747	4122
5	Block Grant	3300	3531	3778	4043	4326	4628	4952	5299	5670	6067	6492	6946	7432	7952	8509
	Total Revenue	6922	7407	8358	9236	10111	10964	11891	12892	14293	15517	16851	18250	19996	21139	22971
	Forecasted Cash Outflow															
	Total Maintenance Liabilities	3030	364	400	440	4880	532	586	644	7145	779	857	943	10461	1141	1255
	Disposable Capital	3891	7044	7958	8796	5231	10431	11306	12248	7148	14737	15994	17307	9534	19997	21716
	New Construction and Rehabilitation Projects															
1	Tribeni - Maheshpur (External Source)1															
	Disposable Capital															
2	Dumkibas - Dhurkot (Priority III)		2542			12711	-12503	-2072				20337	-18093	-786		
	Disposable Capital		4132			-12503	-2072	9234				-18093	-786	8748		
3	Jhyalbas - Hupsekot (Priority V)		1291					6457	-4494						10331	
	Disposable Capital		1387					-4494	7754						6781	
4	Kawasoti - Dedgaon (Priority I)	2949		14744	-7261					23591	-17993	-3256				17693
	Disposable Capital	943		-7261	1536					-17993	-3256	12738				-4083
5	Mukundapur - Thambensi (Priority VI)		1861	-474					9304	-1550					14887	-8106
	Disposable Capital		-474	7484					-1550	5598					-8106	13610
6	Dhobadi - Bulintar (Priority II)	1312	-369		6559	-5023						10494				
	Disposable Capital	-369	6674		-5023	208						2244				
7	Naya Belhani - Ruksebhanjyang (Priority IV)		1454					7271						11633	-2885	
	Disposable Capital		2678					1964						-2885	17113	

1 = The roads in the developed area shall be financed by the external sources. Therefore external sources are not mentioned in calculations.

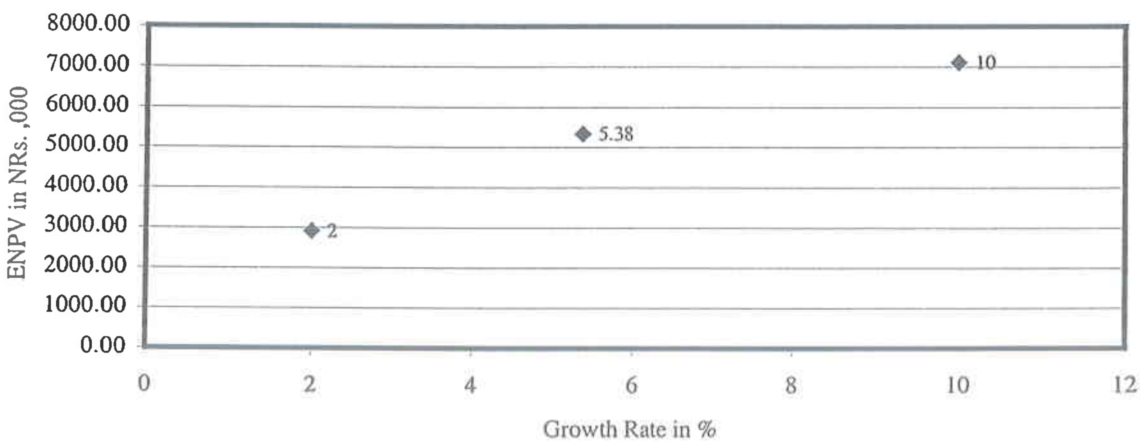
Chapter VIII
Comparative Analysis of Transport Demand, Construction Cost and Benefits

The Chapter VII dealt with the DRP model which incorporates the transport demand, construction cost and benefits of the district transport infrastructure. Since each parameter of the model involves uncertainties, it is necessary to simulate the parameters in different conditions. Therefore, this chapter projects different scenarios of demand, cost and benefits and the implication of each scenario on the economic performance of a project.

8.1 Impact of Different Transport Demand Growth Rates on the ENPV

The DRPMD and DRPMU have relied upon the premises that the transport demand depends upon the population growth rate, interdependence of the settlements, available functions in different centers and land use patterns. The transport demand changes as one or more of these factors change over the period. There is only one proposed road (Road No. 9) in the developed areas for new construction. As population growth rate of the overall district remained more than 2 percent during the period of 1981 to 1991, it can be expected that movement of passengers and freight will grow at least by two percent. In addition to the minimum growth rate, the ENPV is calculated in higher growth rates. The expected growth rate based on the traffic projections in the Appendices 1 is 5.38 percent for passenger and 8.91 percent for freight. The ENPV is calculated using these most likely growth rates. Additionally, the optimistic growth rate of 10% was also used for estimating the ENPV. From all scenarios, the project is economically viable. Figure 8.1 shows the relationship between the growth rate in transport demand and the ENPV.

Figure 8.1 Effect of Various Growth Rates on ENPV of a Road in Developed Areas



There are six road projects under investigation in the underdeveloped areas. It was attempted to analyze the impact of pessimistic, most likely and optimistic growth rates on ENPV. However, all of the rates yielded the negative ENPV. Therefore, the roads in the hilly areas, which have a nominal volume of traffic, can not be economically justified with the direct benefits alone.

8.2 Impact of Technology on the Construction Cost

There are two norms for construction activities in Nepal. The widely practiced norms (HMGN, 1984) is the one which was prepared by all technical line agencies (Department of

Electricity, Department of Irrigation and Climatology, Department of Housing and Physical Planning, MOLD, DOR, Department of Water Supply and Sewerage and Department of Civil Aviation) under the coordination of DOR. It is obvious that the construction technology and socio-economic pattern is changed after such a long period. The second set of norms was introduced by the DOLIDAR (DOLIDAR, 1998). The DOLIDAR attempted to introduce the labor-based technology. However, it is not based on the empirical evidences. Other agencies like the GTZ have also developed construction norms, which they follow for their own projects.

This study has collected empirical data from two sites of the Rural Infrastructure Development Project (RIDP), which is supported by the ADB. Besides that, empirical data were also collected from Malekhu – Dhadhing Road Project (MDRP), which is under construction (in 2000), with the loan assistance from the German Bank for Reconstruction and Development (KFW). The RIDP project has adopted the labor-based technology and the MDRP has adopted the capital-intensive technology. In addition to that, the Contractor Survey also included the construction technology adopted by the respective contractors. Annex 8.1 shows the construction norms adopted by the DOR, DOLIDAR and the GTZ and the findings from the empirical survey and contractor interviews. Only those items are taken which are applicable for the district level roads. Those are earthwork excavation (ordinary soil, soft rock and hard rock), embankment and sub-base course. Those items, which are obviously labor-intensive or equipment intensive are not included. For instance, the structural works by nature are labor-intensive. The marginal difference in the materials because of the construction technology is ignored.

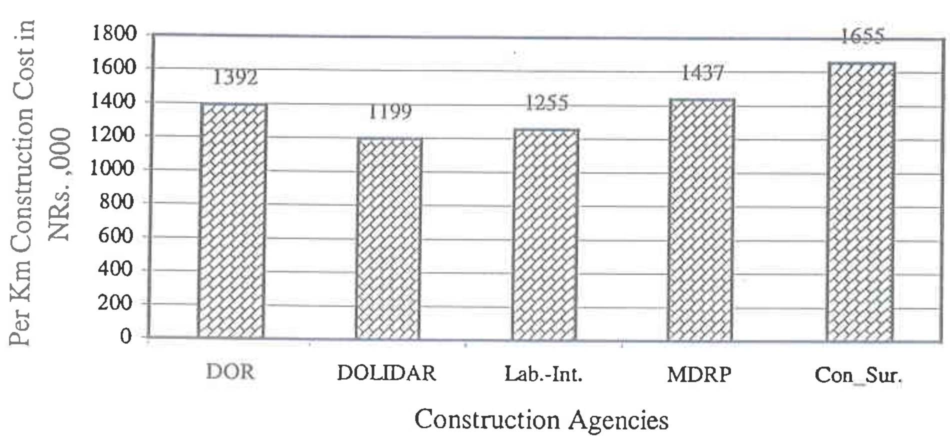
All roads mentioned in Annex 8.1 are either labor-intensive or labor-based except the MDRP. The per day labor productivity ranges between 1.09-3.13 m^3. The productivity of each of the items varies among different projects. Table 8.1 shows the cost of each item mentioned in Annex 8.1. The wage rate of NRs. 70 is used for the unskilled labor and NRs. 140 is used for the skilled labor.

Table 8.1 Construction Norms Expressed in Amount (in NRs.)

Agency	Earth Work Excavation (m^3)			Embankment (m^3)	Sub-Base Course (m^2)			
	Ordinary Soil	Soft Rock	Hard Rock					
DOR	49	210	1694	35		85	5	90
DOLIDAR	42	280	1190	18	7	66	5	78
GTZ	49	350	1400	49		46		46
GTZ-SIDEF	25	140	1470	0		0		0
RIDP-Kavre	48	106	123	0		0		0
RIDP-Baglung	22	47	117	0		0		0
MDRP	64	0	0	41		0		0
Contractor Survey (Average)	39	123	280	70		0	0	0
Mean	42	157	784	27	7	25	3	27
Standard Deviation	14	117	717	26		35	3	38.9

As shown in Table 8.1, the GTZ-SIDEF, RIDP-Kavre and RIDP-Baglung have not implemented the embankment and sub-base works. Although the GTZ has mentioned its rate for the sub-base, it uses the sub-base works in the areas where it is necessary. Therefore the GTZ, GTZ-SIDEF, RIDP-Kavre, RIDP-Baglung are combined together because of their labor-intensive characteristics. Although the DOR and DOLIDAR are very closer in terms of their construction technology, their rates are presented separately. Figure 8.2 presents the consequence of different construction technologies on per km road construction cost in the developed areas.

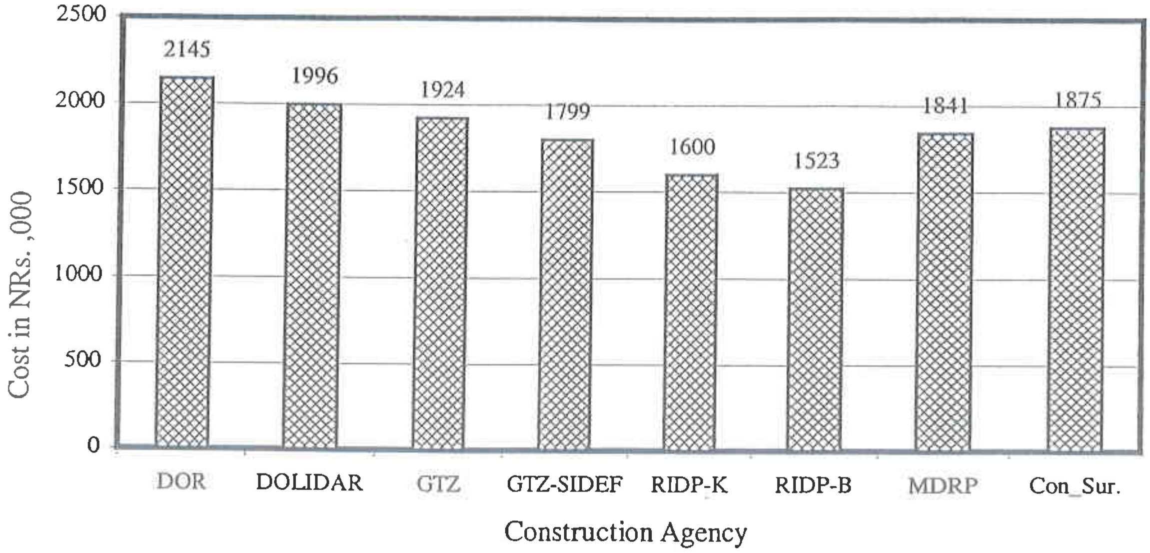
Fig. 8.2 Construction Cost in the Developed Areas



As illustrated in Figure 8.2, the difference in cost between the labor-intensive technology and labor-based technology is not substantial. In the plain area, the labor-based technology, which uses simple equipment like tractor towed leveler, low loading trailer, and water-bowser is cheaper option as compared to the labor-intensive technology and capital intensive technology. The DOLIDAR approach is nearly 5 percent cheaper than the labor-intensive technology and nearly 20 percent cheaper than Malekhu – Dhadhing Road Project (MDRP), which uses the capital-intensive technology. The construction quality by the labor-based technology is satisfactory in the plain area because of the use of the compaction equipment.

The cost implication of capital-intensive, labor-based and labor-intensive technology is also observed in under-developed areas where earthwork excavation is substantial. In the under-developed areas, the labor-intensive technology is cheapest, which is NRs. 1,523 thousand for one km of road in RIDP Baglung. The labor based technology of DOR and DOLIDAR are expensive in comparison to the capital intensive technology projects of MDRP and the figures obtained from the Contractor Survey. The main reason behind the situation is the inappropriateness of the tractor-towed implements in the hilly areas, which can be used in the plain area. Figure 8.3 shows the impact of technology on the construction cost in under-developed areas.

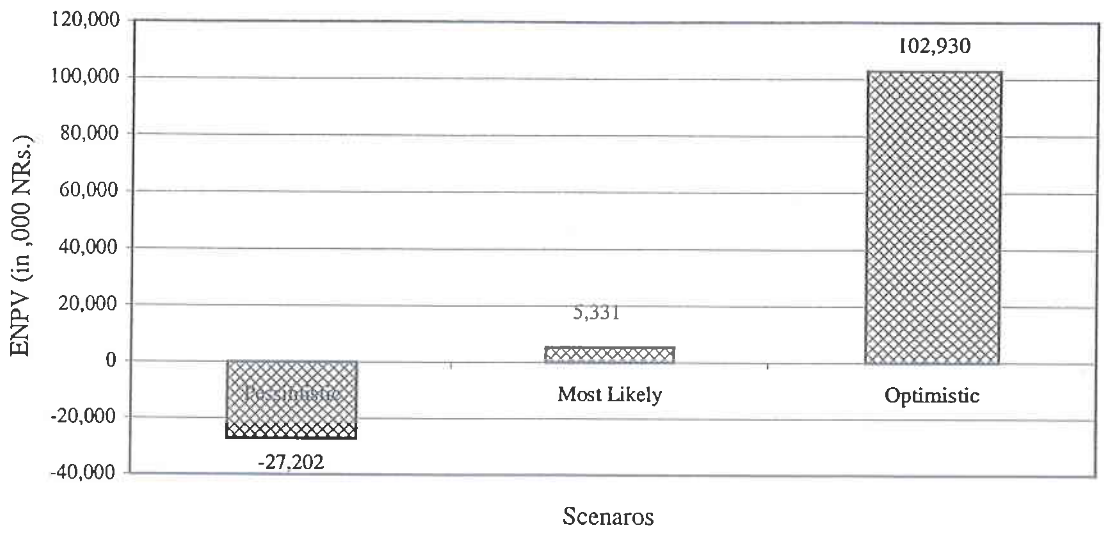
Figure 8.3 Per Km Cost of Different Agencies in the Underdeveloped Areas



8.3 Consequences of Different Benefit Scenarios on ENPV

The DRP Model used only the direct benefits of the road projects in the developed areas. Although, a road project contributes to the economic development, as an intermediate good, it has indirect relationship. It facilitates the economic development but can not influence directly. The savings in the transportation cost and savings in traveling time are the direct benefits of the transport projects. Therefore it is attempted to analyze the consequence of variation in the direct benefits to the economic performance of the projects. Among two variables of the direct benefits, the saving in transportation cost is pretty static. However, the value of saved time depends upon the available opportunity cost. In one extreme, the road user may not invest the saved time on the productive purpose at all. In that case there is not benefit. On the other hand, it can be assumed that the productive time will be fully utilized. Moreover, it can be also assumed that the level of skill of certain segment of the transport user will be upgraded. Therefore the value of saved time should be calculated considering semi-skilled, skilled and even professional group of travelers. Considering all these factors, three scenarios are projected. In the pessimistic scenario, the saved time will have no value. In the most likely scenario, only 50 percent of the saved time will be used for the economic purpose and all the passengers are unskilled labor. In the optimistic scenario, all saved time will be used for the economic purpose and some of the travelers are professionals and other are skilled, semi-skilled and unskilled laborers. Therefore in order to simplify calculation, all saved time is valued at the wage rate of the skilled labor. The result is shown in Figure 8.4. As shown in the Figure, the ENPV is negative in pessimistic scenario and it is positive in the most likely and optimistic scenario.

Figure 8.4 Consequence of Different Time Savings on the ENPV



It is almost meaningless to conduct a similar exercise for the underdeveloped areas. All the projects will have the negative ENPVs in all type of scenarios if only the direct user's benefits are considered. However, if the increased agricultural outputs and price is also considered, the scenario will be different and all of the roads will have positive ENPV under all scenarios.

8.4 Inferences from the Discussion

The comparative analysis needs to be viewed according to the available resources with the district. As discussed in Chapter VII, the district has insignificant amount of resources and it has to construct several roads in order to provide a basic level of accessibility. Therefore it is logical that the district needs to adopt low cost construction technology. Having lower volume of traffic, the geometric and pavement standards can be adjusted according to the requirements. Secondly, even the road in the developed areas, the ENPV is negative in the pessimistic scenario. It means the design standard should be lowered from Category I road to Category II road. All roads in all scenarios can not generate positive ENPV if only direct benefits are considered in the underdeveloped areas. Therefore the comparative analysis substantiates that the stage construction practice is appropriate particularly in the underdeveloped areas.

Since it would be an arduous task to calculate each scenario manually, the DRP model facilitated the analysis and enabled to see the consequence of different probable situations within a fragment of time compared to the manual analysis.

Chapter IX
Testing the Methodology at the Nawalparasi District

The planning tools and techniques have little relevance if they are not adopted by the DDCs. Therefore in order to validate the research findings and to identify the possible practical and legal bottlenecks, the developed methodology was tested in the Nawalparasi district in Nepal. The methodological test was carried out in two phases. The one-day pre-testing phase took place on 25th April 2001 at the Nawalparasi DDC office. During the pre-testing phase, the proposed methodology was presented to the DDC meeting with the Engineer, Planning Officer, DDC Secretary and the DDC Members all participating. The District Planning Adviser of the PDDP also attended the pre-testing meeting. In the second phase of the pre-testing exercise, the Engineer, Planning Officer and Overseers were briefed about the DRP Model and asked to operate it.

The methodology was refined based on the feedback received during the pre-testing phase. The final test was carried out adopting the systematic approach by developing the structured questionnaire and creating the environment for the simulation exercise. The final test was conducted during 19-21 June 2001 at the office of Nawalparasi district. This chapter elaborates the findings of the test results. The suggestions received at the DDC while testing the methodology are appropriately incorporated in this thesis.

9.1 Pre-Testing Phase

During the pre-testing phase, it was intended to receive the preliminary feedback of the DDC members and other planning professionals in order to conduct a full fledged test.

9.1.1 Preliminary Reaction of the DDC on the Methodology

During the first phase of the test, the proposed methodology was presented in the DDC meeting. A brief discussion took place after the presentation for further clarification that led to an elaborate group discussion. Besides that, each participant was asked about his or her reaction to the proposed methodology. The meeting reached the following consensus:

1. The fragmentation of the available financial resources will never be able to complete even a single road satisfactorily. Therefore, a rationale plan like the one presented is necessary for the district. However, due to public pressure, the DDC members are forced to acquire a certain amount of funds for their respective constituency. The action satisfies the people to some extent but it is not meaningful. Having realized the weaknesses of such a practice, the DDC members expressed their commitment to adopt the rationale plan after two years when most of the on-going projects will be completed.

2. The DDC supported the nodal point based approach of networking. The proposed approach could reduce the district level road length, which would be manageable from the perspective of district resources and manpower. The previous transport plan included the village roads, thus, the road length reached to 413 km. Due to the increased road length, the DDC liability increased considerably to the point of its inability to construct, repair and maintain all of the roads. Therefore, the DDC was considering identifying the arterial district roads. The proposed methodology has offered such a solution by reducing the road length to 164 km, a reduction of more than 60 percent.

3. The DDC proposed certain amendments in the weight of the prioritization criteria. They suggested increasing the weight of agricultural potential from 0.15 to 0.25 and decreasing the weight of interaction from 0.45 to 0.30. It was also suggested that the weight of accessibility be increased from 0.1 to 0.15. The suggestions were incorporated into the model. The logic behind such amendments is that the DDC members assign more weight to the development impact of the improved access. Therefore, they decreased the weight for the intensity of interaction. Similarly, considering the significance of accessibility for other than economic purpose, its weight was also increased.

4. Some of the participants emphasized that the prioritization based only on the socio-economic criteria is not sufficient even for the roads in the underdeveloped areas. Besides prioritizing based on the socio-economic criteria, the roads should be economically evaluated and prioritized. This not only helps to cross check the validity of the prioritization based on the socio-economic criteria but it also provides the opportunity to adjust the geometric and pavement standards of a given road according to the transport demand. It also facilitates the inter-sectoral financial performance of the projects.

9.1.2 Ability of the District Professionals to Handle the Methodology

In addition to discussing the issues in the DDC meeting, the Engineer and Planning Officer were asked to operate the model after providing the conceptual background and operational procedure. Before discussing the ability of the Engineer and Planning Officer to handle the model, it is worth mentioning that the DDC has a modern Computer (Pentium III) and a laser printer. The Civil Engineer quickly picked up the concepts and operational technicalities of the spreadsheet based District Road Network Planning and Prioritization Model (DRP). However, he is not trained in the GIS software packages. Therefore, if he is provided a short training course on GIS software packages and if the DDC creates an environment for him to work with the computer, he can handle the whole planning exercise independently. Of course, he should be supported by other staff for collecting data from the field. The District Secretary mentioned that there are other DDC staff who can support the Engineer with handling the GIS and other computer related works. Besides that, the Engineer feels comfortable with the model and is convinced that it can generate a better district level road network. He also feels that it helps to prioritize with a greater degree of accuracy. He believes that such a model can be handled by most of the district level engineers in other districts as well.

The case of the Planning Officer is totally different. Although he is given a position of the Planning Officer, he is not a planner by profession. He is a common government administrative cadre. He is unable to use computer. He could understand the planning concepts very vaguely. He can not operate the computer even after providing the short-term training courses. Therefore at the present context, no technical task can be expected from the Planning Officer. However, he can be a coordinator to deal with the DDC members, and manage the field level activities under the guidance of the Engineer. Since he has very little understanding of the surveying methodology, he can not lead the team. Therefore under the present circumstance, the Engineer should be the team leader for the transport planning exercise and the Planning Officer can be a facilitator.

9.2 Final Testing through Questionnaire Survey

The methodology was adjusted according to the feedback received during the pre-testing phase. In the beginning of the final test, the participants were again informed about the background, objectives and scope of the study. Besides that, the developed methodology was discussed extensively. The DDC Chairman, Vice Chairman and all the DDC Members, DDC Secretary, Planning Officer, Engineer and two Overseers participated in the meeting. After presenting the methodology and analytical findings, a discussion took place to help eliminate any confusion. After that, a questionnaire survey was conducted for their understanding and assessment of the methodology.

9.2.1 Appropriate Agency for Planning and Implementing the Transport Plan

Table 9.1 shows that the DDC commands the highest Weighted Mean Index (WMI). It means the respondents believe that the DDC is the appropriate agency for planning the district level road networks. The respondents in favor of DDC also believe that the DDC can handle the transportation planning issue independently. The second strong opinion was expressed in favor of DDC with active guidance of the central level line agencies. There is a considerable support in favor of the opinion that the road should be planned by the people's representatives. This opinion undermines role of the technical and planning professionals. There is no scope for other agencies to be involved in the district level transportation planning exercise. Therefore, the central outcome of this exercise is that the DDC should be the focal point for initiating and implementing the transport plans.

Table 9.1 Appropriate Agency for Planning the District Level Road Network

Total Size of Respondents 17

Agency	Degree of Priority					WMI
Weights	5 Highest	4	3	2	1 Lowest	
District Development Committee	10	3	2		2	4.12
DDC with Active Guidance of Central Line Agencies	3	5	7	1	1	3.47
DDC with Support from Central and Other External Agencies	1	4	3	8	1	2.76
People's Representatives	4	5	3	4	1	3.41
Other Agency				8	9	1.47

Source: DDC Survey, 2001

Similarly, Table 9.2 shows that the majority of the respondents have strong an opinion that the DDC should be the implementing agency. Considering the responses in favor of the DDC but with support from either central level line agencies or from the external agencies, it can be said that the DDC needs a certain level of external support for effective implementation of the road projects.

Table 9.2 Appropriate Agency for Implementing the Transport Plan

Total Size of Respondents 17

Agency	Degree of Priority					WMI
Weight	5 Highest	4	3	2	1 Lowest	
District Development Committee	9	7	1			4.47
DDC with Active Guidance of Central Line Agencies	6	5	6			4.00
DDC with Support from Central and Other External Agencies		2	5	6	4	2.29
User's Committee	2	2	1	9	3	2.47
Other Agency			2	8	7	1.7

The findings presented in Tables 9.1 and 9.2 suggest that the DDC should be given responsibility for planning and implementing the district transport plan. In accordance with that, the PLRP delegated responsibility for planning and implementing the district level transport plan to the pilot districts. However, it could not be implemented effectively.

Regarding this, more than 29 percent of the respondents mentioned that the change of the DDC members was the main reason for not implementing the transport plan. The second largest majority (19.5%) believes that the DDC members are compelled to acquire as much resources as possible to their respective constituency by their political party and the general voters in the area. The tendency to acquire more funds prohibits the rationale allocation of the financial resources. Some of them believe that the concept of the plan was imposed by other agencies and the methodology was not appropriate.

The discussion above was intended to justify the first step of the proposed methodology that a realization of the need for a transport plan is essential for initiating the planning exercise. The main outcome of the above discussion is that the master plan should be prepared only for the period of the elected members, which is 5 years according to the prevailing local government laws in Nepal. The exercise for preparing the master plan should take place immediately after the DDC formation. The DDC members should be given an orientation about the transport plan, which is included in the flow chart of the methodology. The idea is emphasized in the simulation exercise by the Planning Officer, Engineer and other technicians as well. Besides that, a perspective plan should be prepared for the long term (15-20 years) which needs to be updated to accommodate the new realities which were not anticipated during planning period. An annual plan is essential for operationalizing the transport plan.

9.2.2 Manpower Requirement for Preparation and Implementation of Transport Plan

The policy maker survey revealed that the available manpower at the district level is busy with routine works and it has limited expertise on transport planning. Therefore, the DDC requires additional trained manpower. Table 9.3 shows the opinion on the probable sources of trained manpower as perceived by the respondents.

Table 9.3 Manpower Development for Planning and Implementing the Transport Network

Total Number of Respondents 17

Options	Degree of Priority					WMI
Weight	5 Highest	4	3	2	1 Lowest	
Training to the Existing Manpower	9	6	0	1	1	4.23
Additional Manpower from DOLIDAR	3	8	1	1	3	3.23
Recruiting additional Manpower by the DDC	5	4	2	3	3	3.29
External Support for the Initial Phase	2	9	1	3	2	3.35
Other options	0	0	7	5	5	2.11

Based on the Mean Weighted Index (WMI), the participants in the simulation exercise prioritized the following facts in order to strengthen the staffing situation for preparing and implementing the transport plan. The facts in descending order are: training of the existing manpower, external support for the initial phase, recruiting additional manpower by the DDC, additional manpower from DOLIDAR and other miscellaneous options. It indicates that the DDC intends to train the existing manpower and it is ambivalent for adopting other policies.

9.2.3 Networking of the District Level Transport Infrastructures

Two different versions of the methodology were presented for developed and the under-developed areas. The road density was the indicator for demarcating the developed and under-developed areas. The national average of 0.17 km/km^2 is taken as the demarcating point. Out of 17 respondents, sixteen supported the idea of demarcation of areas based on the national average of road density. The another question focussed on the tools for data collection in the developed and underdeveloped areas. Table 9.4 shows that all tools have equally higher degree of WMI except the contractor survey. Therefore, all of these tools can be used for collecting data and information for the preparation of the transport plans. If technological issues are not important, the contractor survey can be replaced by the secondary sources of information.

Table 9.4 Data Collection Techniques for the Developed Areas

Total Size of Respondents 17

Tools	Degree of Importance				WMI
Weight	4	3	2	1	
Reconnaissance Survey	12	4		1	3.58
Cordon Survey	7	5	4	1	3.05
Passenger Survey	11	4	1	1	3.47
Freight Carrier Survey	12	4		1	3.58
Contractor Survey	1	4	5	7	1.94
Key Informant Survey	8	8		1	3.35
Passenger Vehicle Survey	6	10	1		3.29

A majority of the respondents have expressed their strong agreement with the proposed tools for the underdeveloped area. Therefore, the relevance of the tools is justified. Similar to the developed areas, the respondents did not appreciate the usefulness of the contractor survey. The opinion regarding the tools for the under-developed areas is shown in Table 9.5.

Table 9.5 Data Collection Techniques for the Underdeveloped Areas

Total Size of Respondents 17

Tools	Degree of Importance				WMI
Weight	4	3	2	1	
Reconnaissance Survey	11	2	3	1	3.35
Cordon Survey	9	4	3	1	3.23
Passenger Survey	8	8		1	3.35
Freight Carrier Survey	11	5	1		3.58
Contractor Survey	2	7	4	4	2.41
Key Informant Survey	9	6	1	1	3.35
Passenger Vehicle Survey	10	5		2	3.35

The affordability of the planning process by the DDCs in terms of time and funds is presented in Table 9.6.

Table 9.6 Affordability of Districts in Terms of Funds and Time

Total Size of Respondents 17

Tools	Fund				Time			
Response	Yes		No		Yes		No	
	f	%	f	%	f	%	f	%
Reconnaissance Survey	10	58.82	7	41.18	7	41.18	10	58.82
Cordon Survey	11	64.70	6	35.30	10	58.82	7	41.18
Passenger Survey	10	58.82	7	41.18	8	47.06	9	52.94
Freight Carrier Survey	11	64.70	6	35.30	11	64.70	6	35.30
Contractor Survey	9	52.94	8	47.06	9	52.94	8	47.06
Key Informant Survey	11	64.70	6	35.30	10	58.82	7	41.18
Passenger Vehicle Survey	12	70.58	5	29.42	12	70.58	6	29.42

As shown in Table 9.6, majority of the respondents has answered that all tools are affordable for the DDC. However, nearly 59 percent respondents have mentioned that the available time of the DDC technicians does not allow them to conduct the reconnaissance survey. Similarly, availability of time does not allow conducting the passenger survey. All other tools are affordable in terms of funds and time. Those respondents who provided a positive response on the affordability also have indicated that other tools like Rapid Rural Appraisal, opinion survey of the people's representatives and questionnaire survey with the VDC could also be useful. More than 76 percent of respondents have indicated that the VDCs should also be consulted for developing the district level road network. Similarly, nearly 71 percent of respondents feel that the Rapid Rural Appraisal (RRA) could be a supplementary tool for collecting information. However, it would be relevant here to mention that there is a large degree of similarity between the Reconnaissance Survey and Rapid Rural Appraisal. Additionally, the opinion of the people's representatives is close to the Key Informant Survey. Therefore, the only new dimension that can be inferred from the discussion is to collect information from the VDCs.

9.2.4 Usefulness of the Analytical Tools

Table 9.7 shows the usefulness of the analytical tools. The prioritization of roads could achieve consensus among the respondents. The respondents are largely convinced of the usefulness of the Centrality Index, district road inventory, thematic maps and spreadsheet packages. The usefulness of GIS is not well appreciated.

Table 9.7 Usefulness of the Analytical Tools

Total Respondents 17

Tools	Degree of Importance				WMI
Weight	4	3	2	1	
Centrality Index	9	5	2		3.23
District Road Inventory	8	9			3.47
Thematic Maps	11	3	2		3.35
Spreadsheet Packages	10	7			3.58
GIS Packages	3	8	1	5	2.53
Prioritization of Roads	17				4.00

A closely associated issue with usefulness of the tools and techniques is the capacity of the DDC to handle them. The capacity of implementation of analytical tools is shown in Table 9.8. Among six different analytical tools, the district road inventory and prioritization of roads are almost unanimous among the respondents. The Centrality Index, thematic maps and spreadsheet packages were considered applicable but needs certain support. Most of the respondents are skeptical about the GIS packages.

Table 9.8 Capacity of Implementation of Analytical Tools

Total Size of Respondents 17

Tools	Capacity of Implementation				WMI
	4 Easily Applicable	3 Applicable	2 Uncertain	1 Not Applicable	
Centrality Index	5	7	3	2	2.88
District Road Inventory	9	5	2	1	3.29
Thematic Maps	4	8	3	2	2.82
Spreadsheet Packages	3	9	5		2.88
GIS Packages	1	8	7	1	2.52
Prioritization of Roads	8	7	2		3.35

9.2.5 Assessment of the Benefits and Approach for Prioritization

Both the policy makers survey and the experts and practitioners survey established that in addition to the direct benefits (like reduction in transportation cost and reduction in traveling time) the indirect benefits and development impact should be included. Nonetheless, incorporating indirect benefits is always controversial. Therefore, in order to further substantiate the argument, the participants were asked to provide their opinion on the possible benefits. The findings are shown in Table 9.9.

Table 9.9 Appropriateness of Criteria for Assessing Benefits

Total Size of Respondents 17

Criteria	Appropriateness (f)					WMI
	5 (High)	4 (Medium)	3 (Low)	2 (Very Low)	1 (Uncertain)	
Savings in transportation Cost	13	2	1	1		4.58
Savings in traveling time	13	2		1		4.41
Reduction in Cost of Production	14	3				4.82
Increase in Volume of Production	14	3				4.82

As shown in Table 9.9, there is a consensus among the respondents regarding the usefulness of the criteria for assessing the benefits.

Similarly, there is a unanimous agreement on the evaluating techniques. Almost all participants agreed that the Economic Net Present Value (ENPV), Economic Internal Rate of Return (EIRR) and Economic Benefit Cost Ratio (EBCR) are appropriate indicators for evaluating the candidate roads in the developed areas.

Identical consensus could be achieved regarding the prioritization criteria for the underdeveloped areas. However, most of the respondents (about 65%) strongly agreed on the intensity of interaction and construction cost as the most appropriate criteria. Accessibility and agricultural potential are considered as moderately appropriate. The respondents are indifferent in terms of environmental impact between appropriate and moderately appropriate. There is only one respondent who mentioned that the intensity of interaction, accessibility and environmental impact are not appropriate indicators for prioritizing the district roads.

Having agreed on the criteria for prioritizing the district roads in developed as well as underdeveloped areas, another question was asked of the participants on whether the criteria for the developed areas can be implemented in the underdeveloped areas. In response to that, question nearly 71 percent of respondents showed a favorable attitude. This means that they consider the ENPV, EIIR and EBCR are equally important for the underdeveloped areas, which can be used independently or as supplementary tools for prioritizing. However, nearly 24 percent of respondents considered the tools not to be appropriate for the underdeveloped areas. Therefore, it can be concluded that the roads should be prioritized according to the stipulated criteria and the order of prioritization and economic viability should be cross-checked with the economic indicators.

9.2.6 Resource Allocation to the Candidate Roads

The district has three different options for allocating the resources as discussed in the previous chapter. The first option is to distribute resources to several projects, which is found a counter-productive effort. The second option is to allocate all available resources to the priority projects. Due to the small amount of annual budget earmarked for the district level roads, it takes a few years to complete a single road and this is not acceptable for the people located in other settlements. The third option is the stage construction, which is implemented gradually by opening up a trail, widening to a track, road construction and water management and bioengineering works. By this strategy, the roads in different locations can be started which provides assurance to the local people that the road is going to be constructed within few years. It shows a commitment by the DDC to construct in a gradual process. On the other hand it also allows natural compaction, soil stabilization and vegetation growth in the excavated stretch. Additionally it also allows the road designers to identify the correct location and dimension of cross drainage structures. However, the stage construction technology is slow so it should be planned for the long term. In this regard, more than 94 percent of respondents have a positive opinion of the stage construction technology.

9.2.7 Administrative Procedures

It is not only the plan that is essential for implementation of district level roads but also the correct administrative procedure in line with the local governance act. It is mandatory for a plan to get approval from the District Council. However, it is not clear whether the DDC should get an endorsement for the proposed plan from the MOLD and NPC or whether simply informing them is sufficient. However, having a high dependence on the central agencies for funding the district level development works, it is not possible for a district to implement the projects independently which warrants getting an endorsement from the central level line agencies. In response to this question, thirty-five percent of respondents feel that the DDC must obtain an endorsement from the MOLD and NPC. Another 41 percent simply agree that an endorsement should be obtained. However, twelve percent of respondents strongly disagree about endorsement from the central level agencies once it is approved by the District Council, as the DDC is an independent local government. This is technically correct but due to the greater reliance on the central level agencies for funding it is practical to get the endorsement of the central agencies thereby ensuring their commitments for local level projects.

9.2.8 Overall Evaluation of the Methodology

A candid opinion was sought from the respondents on their overall reaction to the methodology. Nearly 59 percent of respondents believed that the proposed methodology is very useful. Another 24 percent have the opinion that the exercise is useful. It means 83 percent respondents have a positive opinion regarding the methodology and they believe that the methodology could meaningfully contribute towards a systematic and practical approach for planning of the district level road network. Only 18 percent of respondents indicated that the methodology is useful but requires minor modifications. The suggested improvements are as follows:

- The DDC requires orientation before starting the transport planning exercise.
- The VDCs should be involved in the planning process.
- A tactical and pragmatic approach should be adopted to deal with the MOLD and NPC. As a local government, the DDC is delegated authority to plan and implement the development projects. However, due to the insignificant own source revenue, the DDC is dependent upon the central level grants. Therefore, the DDC should be able to convince the central level agencies in order to acquire additional funds and that needs an endorsement of the plan by the MOLD and NPC.

- Although the perspective plan can be formulated for a longer period of 15-20 years to set the context, the master plan should be formulated for the five years immediately after the formation of the DDC.

9.3 Laboratory Test of the Planning Exercise

A "laboratory test" was conducted to compare the prevailing planning practice with that of proposed methodology. The test process is elaborated in Chapter III. The planning team comprised of the DDC Secretary, Planning Officer, Engineer and three Overseers. The Planning Officer acted as the Chairperson of the exercise.

9.3.1 Validity of the Input Data

The data, which were collected and used for analysis, was provided to the participants for cross- checking. Annex 3.14 shows the data that was provided to the participants. The input data included the inventory of district level roads, tracks and trails, population of the VDCs, District Level Market Centers and their size of population, a hypothetical budget, volume of traffic in major routes in the district and existing and potential facilities in the existing and potential market centers.

The planning team meticulously checked the inventory of the district level roads, tracks and trails. The Overseers were found conversant about the inventory of the transport infrastructures in their respective territory, which is allocated to them by the DDC. After their close scrutinization, the planning team found that the inventory is correct for the base year of 1997. The few additional roads constructed after that time were ignored. They have no disagreement about the population statistics of the villages, which is collected during the population census in 1991. The population of the VDC is not projected.

The identified district level market centers were endorsed by the planning team. A rigorous discussion took place for the population size of the district level market center in 1991 and the growth rate of the population. The Central Bureau of Statistics (CBS) does not maintain the population according to the settlements. The CBS has developed its database according to the VDC. Therefore, the PLRP supported master plan took the concerned VDC population as the population of the market center. However, the boundary of a VDC does not follow the market center. It means a market center can be divided among more than one VDC. Additionally, the VDCs include a large part of the rural settlements. Therefore, the VDC population data as an indicator of the urban population is misleading. In order to overcome this problem, the planning team decided to take the population of the real market area. The planning team could find the unpublished source of settlement data, which was useful for identifying the population of the market centers. A different picture emerged after taking the real population of each market center. A market center, which had a huge population size before, came down to a small market center. Similarly, a comparatively smaller market center appeared to be larger.

The second issue of the market center was the population growth rate. In the previous exercise, a uniform growth rate was taken for all the market centers. The planning team considered this as an unrealistic phenomenon. Some market centers are increasing more rapidly and others are declining due to locational factors. Therefore, the planning team estimated the growth rate based on its field assessment and construction rate of new buildings.

In the methodology the budget was assumed not to be a constraint for preparing and implementing the transport plan. This assumption was considered as unrealistic by the participants. Therefore a realistic budget should be forecasted and district level roads should be prepared within the budget constraint.

Although the volume of traffic was collected directly from the field, the planning team was requested to review the volume of traffic in order to incorporate the seasonal fluctuation and probable distortion of data due to several other factors. The planning team also corrected the volume of traffic based on its field level experience.

The major correction took place in the market centers that will emerge during the period of 15 years and availability of facilities in the respective market centers. The Planning Team added Dhobadi and Jhyalbas as the potential market centers. Besides that, the functions in most of the market centers were revised.

9.3.2 Planning the District Transport Plan According to the Prevailing Practice

The planning team was asked to prepare a long term, medium term and annual transport plan. It was difficult for technical and professional people to assume the role of the politicians. Defining the prevailing practice was also a problem. Should the actually practiced planning methodology be considered as the prevailing practice or the practice prescribed by the PLRP or DOLIDAR be considered as the prevailing practice? Ultimately a decision was made to use the actual practice that takes place in the district planning process as the prevailing practice. The next problem was that the district does not plan for the medium or long term, it only plans for the next year. It was agreed to use the practice that the DDC body would have used if it had to plan for the long term.

When planning team acted as the DDC members, it was noted that they did not look at the map. Also they neither considered the cost nor did they consider the benefits of the road. They also did not have a target date to complete the road. They used their intuitive judgement. It would be misleading to understand that the long-term plan means it will be started after quite a few years. In fact, all the roads that are included in the plan start simultaneously. The exercise continued for about 2 hours. By the end, they came up with a list of roads that is presented in Annex 9.1.

The question that arises is this a plan or simply a shopping list? What are the elements that a plan requires? Do the listed roads confirm the definition of the district road? What is the basis for selecting these roads? Does this list provide accessibility to all the settlements of the district? From these perspectives, the prepared road list is not a plan. However, this is a common way that the DDC selects the roads for new construction. The issue of maintenance is normally ignored, because the district does not have the complete stretch of roads due to the scattered budget. How such a practice distributes budget among different routes is shown in Annex 7.1.

9.3.3 Planning the Roads according to the Proposed Methodology

The planning team reviewed the proposed planning methodologies. The planning team emphasized that an orientation is required for the newly elected DDC members on the importance of transportation planning. Secondly, the planning team suggested that the contractor survey is not required for transportation planning. The information of cost can be collected from secondary sources. Unlike the findings of the questionnaire survey, the planning team thought that the questionnaire survey with the VDCs would not be able to generate meaningful information. On the one hand, the VDC Secretary and Technician are overburdened with their regular tasks and with the information they need to furnish to different agencies and on the other hand, they do not have enough transport related specialized information. Therefore, information should be collected by the transport planning team. However, the VDC Chairman and the Secretary could be the key informants. Moreover, the planning team felt that the estimation of the producer's surplus of each link could be a difficult task. Similarly, the appraisal of the road project could also be a challenging task. However, the planning team could not come up with another logical alternative. Besides that, the planning unit strongly opposed the idea of endorsement of the transport plan by the MOLD and NPC because according to it the District Council is the sovereign body, which has authority for approving the plan. It is not necessary to get further endorsement by the central level agencies because this is against the spirit of decentralization. Only informing the central level agencies should be sufficient.

For the underdeveloped areas, the planning team felt that the economic evaluation is necessary besides the prioritization based on the socio-economic criteria. The argument is in consonance to the questionnaire survey. The revised flow charts of the methodologies are shown in Fig. 9.1 and 9.2.

After refining the methodology, the planning team was provided with the orientation on the DRP Model. They were briefed on the conceptual background and the operational procedure and they were allowed to work on the model. The exercise was not interesting for the Planning Officer. The planning team also could not work on the GIS because of a software problem and their lack of training on it. Nonetheless, the participants admitted that the use of the GIS could be an interesting exercise for solving the transport problems. The existing computer hardware facilities should be supplemented with a digitizer and the GIS software. However, the issue of the DRP Model was a totally different issue. With the existing computer hardware and software facilities and level of knowledge of computer software with the Engineer and Overseer was found enough for handling the DRP Model. Conceptually, it was a bit difficult to understand the idea of gravity modeling. The cost component was easier and interesting for them. There is a scope that the technicians can modify and amend the cost component. The planning team noted that it would not have difficulties in obtaining stationery and other materials for conducting the exercise. In this whole exercise, it was felt that it is technically feasible. However, whether the whole planning team will be motivated enough to prepare and update the plan continuously has remained an open question.

9.3.4 Evaluation of the Test Results

It is difficult to compare the prevailing practice with that of the proposed methodology. The DDC does not follow the procedures recommended by the DTMP, which was prepared under the technical support of the PLRP. However, the District Chairman and a few other members defended their position that the DTMP is followed with minor adjustments. It might be true to some extent because all the roads that were included in the master plan are also included in the annual plans. However, other roads, which were defined as Village Roads are also picked up as the district roads and available resources are fragmented in such a way that no meaningful work can be done on a road. In the FY 2000/2001, the budget is distributed to 39 projects and most of the roads were allocated less than NRs. 200,000 (less than USD 3000). In the context of NRs. 1.8 million (USD 24,000) per km construction cost, the allocated amount can construct about 100 m of road which is a meaningless investment. Therefore, the comparison is between "without" plan and "with" plan. With that respect, the proposed plan is precise, transparent and efficient for updating in comparison to the existing practices.

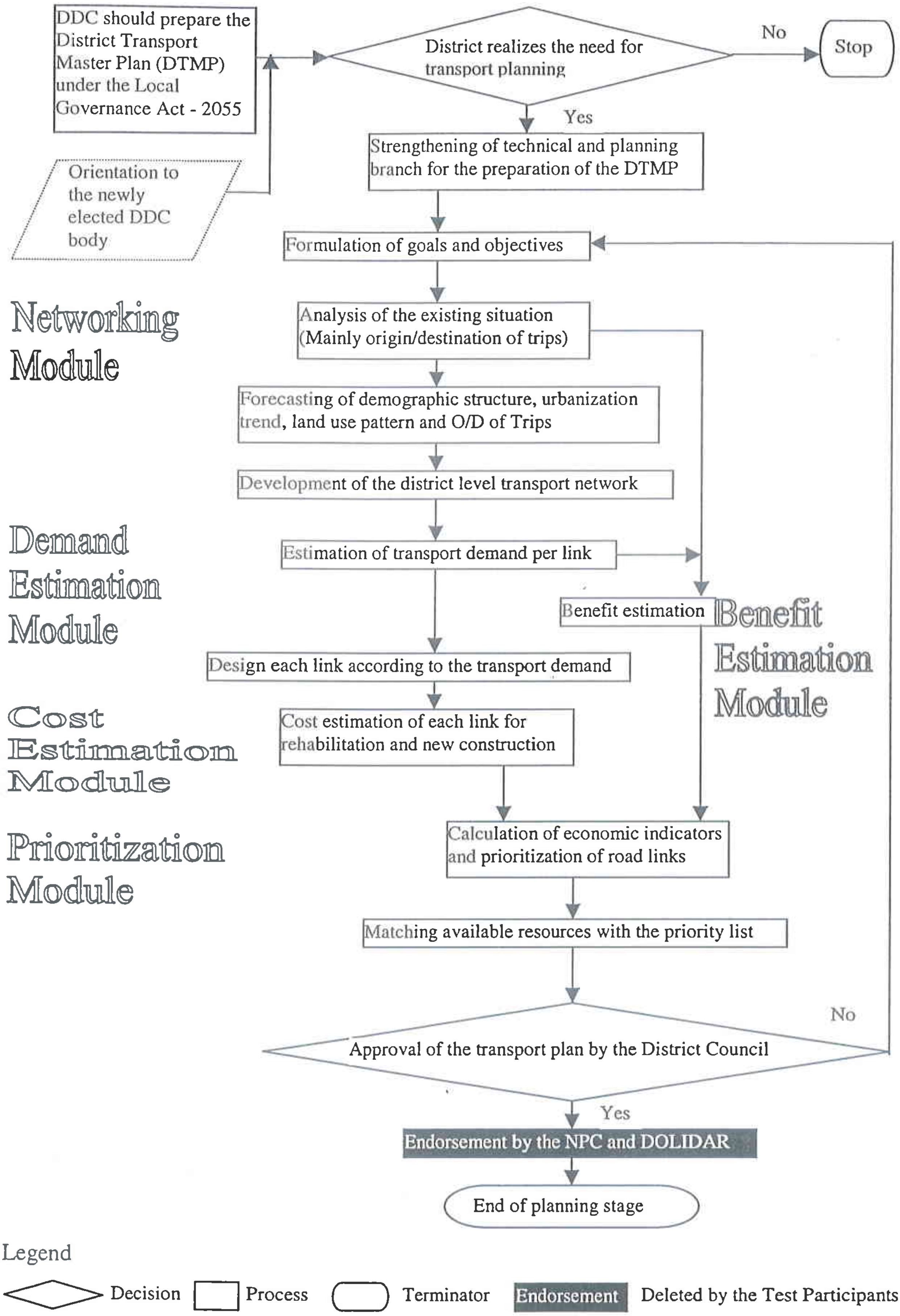


Figure 9.1 Revised Flow Chart on the Methodology for the Developed Areas

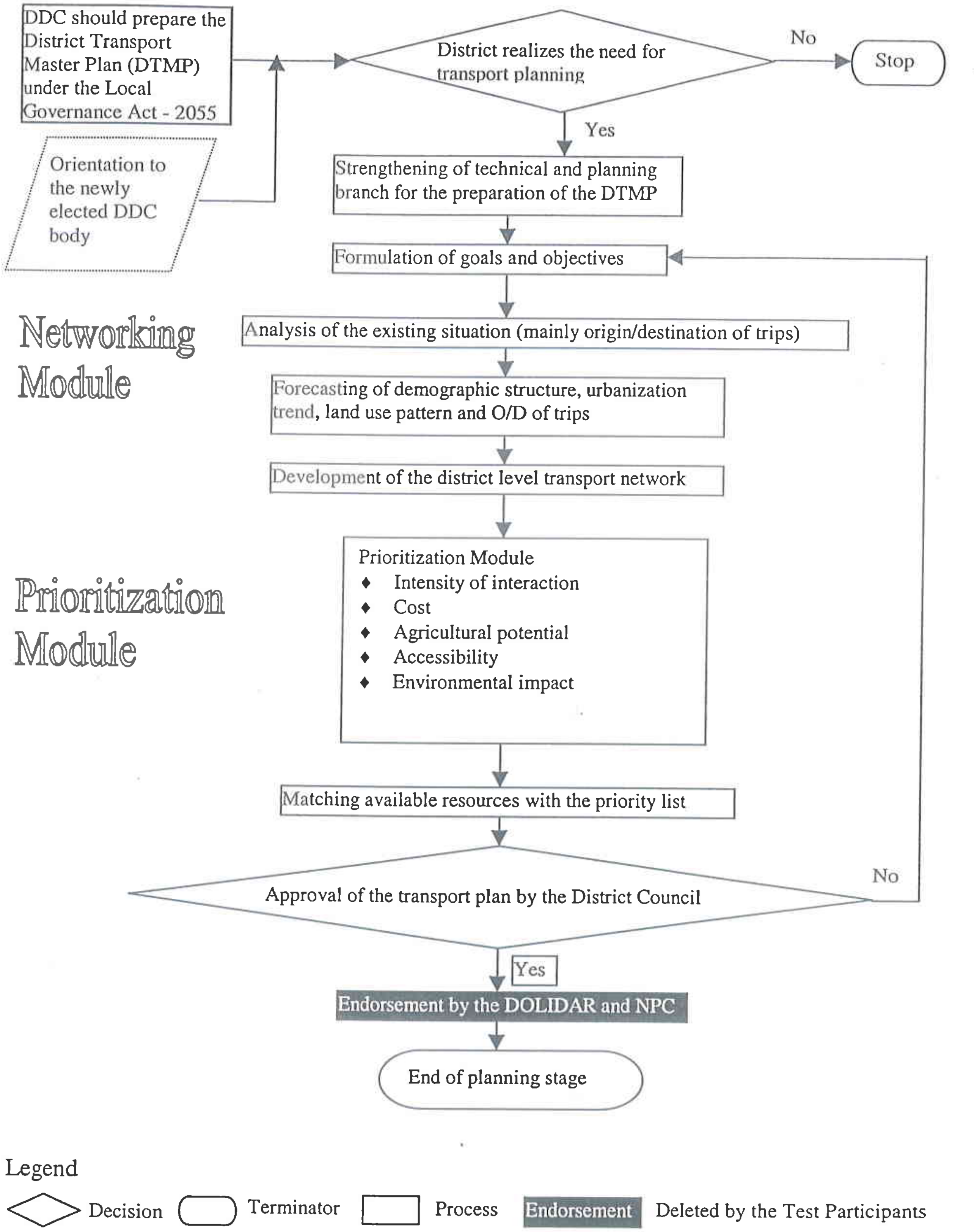


Figure 9.2 Revised Flow Chart of the Methodology for the Underdeveloped Areas

One can compare the proposed methodology with that of the PLRP methodology. In fact, the PLRP methodology was the point of departure for this study. It assimilated all the positive aspects of the PLRP methodology and attempted to improve the weaker points. Although, the PLRP defined the different hierarchy of roads and identified the market centers as the focal points of the road network, it did not select the roads based on the nodal points. The quantification of the Centrality Index was also not used for developing the road network. Another limitation was the lack of demand estimation in each link. Due to the lack of a GIS application, the estimated cultivated area within the Zone of Influence was not accurate and can mislead the result. Most importantly, there was no provision of the economic appraisal, which did not allow for the structural adjustment according to the transport demand. These are the issues that are improved in the proposed methodology. The preparatory cost, consequently, increased from NRs. 290,000 of the PLRP planning exercise to NRs. 356,000 using the proposed methodology, an increase of nearly 23 percent. Similarly, the planning time also increased by two months. However, the precision in analysis is incomparable. Use of GIS, transport demand, cost and benefit estimation based on the well-founded theories and the possibility of scenario projection within a short period of time has increased the level of precision by this method. The proposed methodology uses mostly objective criteria and indicators that make the whole methodology transparent. Moreover, as a computer-aided methodology, it is efficient for updating.

The limitations of other district road planning methodologies including the DOLIDAR approach have already been discussed. The suggested method of collecting data from the VDC is the major limitation of the DOLIDAR approach. The planning team of the simulation exercise also agreed that it is not possible for a Village Secretary and Technician to furnish all the data that they are supposed to furnish. Therefore, they supply information based on their own intuition, which might not be realistic. Similarly, the lack of economic evaluation is another limitation of the DOLIDAR approach.

The methodology suggested through this study and exhibited with the empirical data was considered for the application in preparing the DTMP. It is conceived well for perspective, five-year and annual action plans.

Chapter X
Summary and Conclusions

This chapter presents the summary, findings and conclusions of the study. In addition to that, the scope for further research is also outlined.

10.1 Summary

Due to the lack of an appropriate district level transport network planning and prioritization methodology, the roads in Nepal are not constructed appropriately and the geometric standards of such roads are not synchronized with the transport demand. Similarly, the cost implications of different construction technologies and methodology for assessing the benefits from the improved access are not well established. Therefore, this study attempted to develop a comprehensive methodology for planning and prioritizing the district road links that is both technically sound and operational in the DDC environment of Nepal. The important task of this study was to develop a computer-aided methodology.

In order to accomplish the objectives, this study conducted a sample survey of 46 districts in Nepal from three geographic regions. All Engineers of sample districts were surveyed. Additionally, opinions were also collected from either the DDC Chairpersons or the DDC Secretaries from the sample districts. Parallel to that, an expert and practitioner survey with 28 respondents was conducted. Based on the survey findings and "*state of the art*" of methodologies from the national and international sources, a methodology was prepared. The recommended methodology was endorsed by a national level workshop with some modifications. The modified methodology was tried in the Nawalparasi district of Nepal.

Chapter IV analyzed the strengths, weaknesses, opportunities and threats of the districts in Nepal regarding transport planning process. Based on the SWOT analysis, few strategies were developed. They include operationalizing the decentralization policy of HMGN, to adopt the planned approach in construction and management of the district level transport infrastructure and adoption of the low cost construction technology.

Regarding the networking approach, nearly 66 percent of respondents recommended that in the given condition of existing district level transport infrastructure, the existing and emerging central places, resource potential areas should be the basis for district road networking. Twenty out of 26 respondents believed that the GIS is an appropriate tool for developing the district road networking. However, they do not believe that the DDCs can currently handle such a technology. The majority of the respondents have recommended that the existing traffic survey and estimation of generated and diverted traffic should be the basis for forecasting the transport demand. The respondents' opinion is not clear about the technological problems. About one third of the total respondents have the opinion that the mechanization of construction activities has created socio-economic and environmental problems. On the other hand, some have the opinion that the labor-based technology is time consuming and sometimes expensive. With regards to the benefits of the improved access, the majority of the respondents have recommended to consider the development effect of the transport projects, producer's benefits, poverty alleviation, savings in the transport cost and savings in traveling time. Synthesizing the opinion of experts and practitioners, policy makers and engineers regarding the road project appraisal, it can be stated that in developed areas that have basic road networks, the economic appraisal method should be used. For the underdeveloped areas, the prioritization method is more meaningful. Nonetheless, the existing volume of traffic should be one of the major prioritization criteria. During the pre-testing stage of the methodology, the participants recommended to use the economic appraisal as a supplementary activity to simple prioritization. Therefore, the roads in the underdeveloped areas are also appraised based on the economic criteria.

Based on the strengths, weaknesses, opportunities and threats of the DDCs and the opinion survey of the experts and practitioners, a methodology is developed for planning and prioritization of the district road networks for the developed areas. As the district level planning is an interactive activity between the government technical officials and politicians, it should be clearly reflected in the methodology. Therefore, the district level policy makers outline the goals, policies and prepare the institutional arrangements at the first stage of planning. Within the framework stipulated by the policy makers, the transport planners carry out the technical tasks which include developing the district road networks, projection of transport demand, estimation of construction cost and assessment of the benefits. After the prioritization, the roads are matched with the available funds in the district treasury. The DDC proposes such a plan to be approved by the District Council. After approving the District Transport Plan, the DDC forwards it to the DOLIDAR and National Planning Commission for securing additional funding for implementing the plan.

Most of the activities for planning the underdeveloped areas are similar. However, while developing the road network, the accessible areas should be delineated from the inaccessible areas. A link should be extended from the gateway nodal point to the potential nodal points located at the hinterlands. The process should be continued until the district is fully covered by the accessibility buffer lines as defined by the policy makers. The proposed roads are prioritized by some socio-economic indicators and such prioritization is supplemented by economic criteria.

A District Road Network Planning and Prioritization Model (DRPM) is developed and applied to the Nawalparasi District of Nepal. The DRPM is a spreadsheet-based model supported by GIS packages like Arc Info and Arc View. As discussed in Chapter VI, the model for the developed areas is divided into five modules and the model for the underdeveloped areas is divided into only four modules. The model for the developed areas is also implemented for the roads in under developed areas. The empirical data from the district is fed to both versions of the model and the result is satisfactory.

The comparative analysis showed that the road in the developed area is viable with 7 percent discount rate. All the roads in the underdeveloped areas are not viable economically. However, the economic criteria do not cover the development impact of a road project. Having the financial constraints with the DDC and not having enough economic return from the road projects, it is desirable that the DDC adopt the staged construction technology. Regarding the construction technology, the labor-based technology was found cost effective in comparison to the labor-intensive and capital-intensive technology in the plain area. In the hilly area, the labor-intensive technology is cheaper than labor based and capital intensive technology.

The calculation of benefits is the most sensitive element in the prioritization of the district roads. Therefore, three different scenarios are projected for the developed areas. In all scenarios the ENPV is positive. All roads in underdeveloped area are not feasible in all scenarios.

The methodology was tested in the Nawalparasi district in order to ascertain its validity and reliability. The tests were conducted in pre-testing and final test phase. The pre-testing phase prepared the ground for the final test. During the final test, the DDC unanimously supported the proposed methodology with some minor adjustments. One of the major revealing issues of the final test was that the transport plan should be prepared for the tenure of the elected body in the DDC. It is difficult to get support for continuation for a plan prepared by the previous DDC members.

The laboratory test of the planning exercise was helpful for cross checking the validity of the data used. Several input data were corrected that naturally affected the result. It was an interesting event to observe the simulation exercise of how the prevailing planning exercise takes place. It is entirely intuitive which lacks the basic elements of planning. In contrast, the proposed methodology forced the planning team to think about several intricacies, constraints and possibilities that they felt are more scientific and easier to update.

10.2 Findings

The findings are based on the analytical findings and the test results that were carried out in the Nawalparasi district. Based on the SWOT analysis, the macro-level strategies are outlined that include introducing and implementing the rational transport planning approach for preventing scarce resources fragmented. Having limited resource base, rugged topography and scattered settlement pattern, adoption of the low cost, environment friendly construction technology and consideration of lower level of transport infrastructure is essential. In order to operationalize the devolved authority by the Local Governance Act, it is necessary for the districts to improve the planning and implementation capacity by strengthening the technical and planning professionals by equipping them with efficient planning and implementation tools and techniques. This study developed the planning methodology for District Road Network Planning and Prioritization, which will help the district level technical and planning professionals to plan the district level road network efficiently. The major findings of this study are presented in this section.

10.2.1 The DDCs can minimize the threat of fragmentation of resources by adopting a rational plan and such plan should be formulated involving DDC members and technical and planning staff members.

The fragmentation of resources looks like an internal weakness but it is rooted in the political and social system of the country, therefore it is defined as a threat. In order to maintain the pre-election commitments, the DDC members are forced to acquire large share from the district treasury for development works of their respective constituency. After lobbying for a larger share of district resources, they normally end up with an equal division of the resources provided to all DDC members irrespective of their stated requirements. This tendency has ruined the development trend and has prompted counter-productive results.

Having established the system of scientific prioritization and introducing transparency in decision making, the proposed plan protects resources from being unproductively fragmented and it helps to explore possibilities for generating additional resources. The PLRP planning exercise showed that, the transport plan should be prepared for a period of the current DDC members at the beginning of their tenure.

10.2.2 Nodal points of district and regional importance and existing transport infrastructure based networking model is appropriate for the district level.

The central places and existing roads, tracks and trails are taken as the basis for networking. It is incremental in its characteristics because it recognizes the existing roads, tracks and trails as the basis for networking unlike the comprehensive planning, which ignores the existing situation. Therefore, the solution that it derives can generate the low builder as well as user's cost.

Two versions of networking techniques are proposed, one for developed areas and another for underdeveloped areas. The connection of nodal points is the fundamental issue of the networking in developed areas. The minimization of detouring and elimination the missing links are the principal objectives of the networking in developed areas. On the other hand, providing basic accessibility is the focus for underdeveloped areas. This networking technique is simple, therefore effective for developing the transport network in the rural regional environment of the developing countries. By anticipating the future hierarchy of settlements, the network also accommodates the dynamic phenomenon and its consequence on the transport infrastructure.

10.2.3 The future volume of traffic of the link is a function of intensity of interaction among the nodal points.

Several studies have been conducted with regard to the tendency of trip generation in the urban areas. Besides that, the time series data are also available in the urban areas. Both types of studies are absent in the case of rural transportation. Moreover, the trip generation ratio of one location can not be replicated for other roads because of different land use and settlement patterns. Therefore, this study projected the future volume of traffic based on the intensity of interaction. The Centrality Index is taken as the weight of the population of the nodal points in the region. It indicates that the trip is generated or attracted because of not only the population size but also the numbers of functions available in each nodal point. The projected volume of traffic was convincing to the DDC authorities. Nonetheless, despite its promising attributes, projecting future volume of traffic always contains certain degree of uncertainty. Therefore the future volume of traffic should be used for acquiring the right of way and construction of the cross-drainage structures. The road should be designed for the present and most likely future volume of traffic and it should be upgraded as the volume of traffic increases.

10.2.4 Labor-based technology in the plain area and labor intensive technology in the hilly areas are cost effective.

The labor-based technology, which uses simple equipment, is nearly 5 percent cheaper in comparison to the labor-intensive technology and it is nearly 20 percent cheaper than the capital-intensive technology in the plain area. However, the labor-intensive technology is approximately 18 percent (GTZ, GTZ-SIDEF, RIDP-Kavre and RIDP-Baglung are considered as the labor-intensive projects), cheaper than the labor-based technology in the hilly area. Similarly, it is nearly 21 percent cheaper than capital intensive technology (If RIDP-Baglung and Malekhu Dhadhing Road Project are compared). The cost of labor-based projects is more expensive than the capital-intensive project.

The second and most important finding of the study is that the staged construction technology is unavoidable for the DDCs in Nepal. It is suitable not only from technical viewpoint but also from the availability of financial resources within the district.

10.2.5 Prioritization based on costs and direct benefits of a road project in the developed area and prioritization based on the socio-economic criteria including costs for the underdeveloped area is justified from the perspective of growth and equity objectives of a district

The objective of constructing a new road or rehabilitation of a dilapidated road in the developed area is to reduce the transportation cost and traveling time. Therefore a new road in the developed area should be justified from the direct benefits. In accordance to that the road in developed area was found feasible with the direct benefits. On the other hand, no road in the underdeveloped area was found feasible from the direct benefits. Nonetheless such roads are necessary for providing a minimum level of accessibility to the abutting hinterlands. Having meager resources, however, such roads should be prioritized based on the index of the cost and socio-economic criteria. As it is difficult to estimate the future volume of traffic correctly, the stage construction technology is the appropriate solution. The right of way and cross-drainage structure should be designed for the forecasted volume of traffic. Such approach helps to exploit the growth potential of the developed areas and ensure the minimum accessibility to the inaccessible areas.

10.2.6 The proposed methodology for planning and prioritizing the district road network, its data collection and analytical techniques can generate precise result in comparison to the currently practiced methodologies.

A methodology comprises the data collection techniques and analytical techniques. As a methodology, which was developed based on opinion of the concerned experts, practitioners and policy makers, it is able to address the need of local situations. Besides that it was attempted and tested in the Nawalparasi district of Nepal. Notwithstanding of its costlier and time consuming characteristics in comparison to the present practice, the outputs could reduce the district level road length from 413 km to 164 km by minimizing the detouring and assigning responsibility to the concerned agencies according to the definition of ownership. With a considerable reduction of the road length, the level of accessibility was not compromised.

10.2.7 District Road Network Planning and Prioritization Model (DRPM) is demand driven, useful and user friendly solution for planning and prioritization of the district road network.

The spreadsheet based computer model supported by the GIS software packages for planning and prioritizing the district roads is found to be demand driven, useful and a cheaper solution in comparison to the arduous manual method and specialized models that are designed for solving urban transportation problems. The computer-based packages that were developed for appraising the rural roads during the decade of the seventies are outdated in the context of diminishing confidence on the producer's surplus approach. The Highway Design and Maintenance Model (HDM) is developed mainly for the National Highways and Urban Roads, therefore is difficult to use for the district transportation in the rural context. The test result of the model that was conducted in Nawalparasi district of Nepal also revealed that the model is appropriate for the requirements of the developing countries. Therefore, the DRP Model developed in this study is expected to be useful for prioritizing the district roads in Nepal and other developing countries.

10.3 Conclusions

The District Development Committees in Nepal need an efficient methodology for developing the district and local transport networks, which should be operational within geographical, financial and technical limitations. The recommended methodology is based on the district realities and the "*state of the art*" provides a reasonable solution towards that direction. The centrality index is used for assessing the intensity of interaction, which is applied for estimating the transport demand and for planning the district road network. The computer-aided District Road Network Planning and Prioritization Model (DRPM) facilitated to adopt the appropriate network and design standards, and formulate relevant policies and strategies. Therefore, the methodology can be replicated in other districts of Nepal and other developing countries too. A practitioner's manual based on this study will be helpful for the technicians with the local governments.

10.4 Scope for Further Research

The DRP Model should be further tested in different conditions in order to make it widely applicable. There are quite a few opportunities for further refinement of the model by the introduction of the programming language and integrating it with the GIS tools. The reliability of intensity of interaction for estimating the future volume of traffic should be further substantiated with the empirical evidences. Similarly, there is a scope to investigate the different types of direct and indirect benefits and distribution of benefits among different groups of the society.

References

1. Adler, H.A., 1967. *Sector and Project Planning in Transportation.* Washington D.C.: International Bank for Reconstruction and Development.
2. APROSC (Agricultural Projects Services Center) and JMA (John Mellor Associates), 1995. *Nepal: Agriculture Perspective Plan.* Kathmandu, Nepal: National Planning Commission of Nepal and Asian Development Bank.
3. Archondo-Callo, R., 1999. *Road Economic Decision Model: User Manual.* Washington D.C.: The World Bank.
4. Aronoff, S., 1989. *Geographic Information System – A Management Perspective.* Ottawa, Canada: WDL Publication.
5. Basnet, S. K., 1994. *Roads and the Economic Transformation of Hill Districts: A Comparative Study of Nuwakot and Ilam Districts of Nepal.* An Unpublished Doctoral Dissertation. Bangkok, Thailand: Asian Institute of Technology.
6. Beenhakker H. L., and Lago, A. M., 1983. *Economic Appraisal of Rural Roads: Simplified Operational Procedures for Screening and Appraisal.* World Bank Staff Working Papers, No. 610, Washington D. C.: The World Bank.
7. Beenhakker, H. L., 1987. *Rural Transport Services, A Guide to their Planning and Implementation.* London, U.K: Intermediate Technology Publications.
8. Billheimer, J., and Gary, P., 1973. Network Design with Fixed Variable Cost Elements. *Transportation Science* 17 (1).
9. Bishop, R. N., 1952. *Unknown Nepal,* London. (Cited from Shrestha, B.P. 1967. *The Economy of Nepal.* Vora and Co. Publishers Pvt. Ltd., 3, Round Building, Bombay, India).
10. Blakie, P., Cameron J., and Seddon, D., 1980. *Nepal in Crisis and Stagnation at the Periphery.* London : Oxford University Press.
11. Boffey, J.B., 1982. *Graph Theory in Operation Research.* London: The Macmillan Press Ltd.
12. Caliper Corp., 2001. *TransCad Overview, Jan. 9 2001.* http://www.caliper.com/tcovu.htm
13. Carnemark, C.; Biderman, J., and Bovet, D., 1984. *The Economic Analysis of Rural Road Projects.* Staff Working Papers, No. 241, Washington D.C.: The World Bank.
14. CBS (Central Bureau of Statistics), 1999. *Statistical Year Book of Nepal.* Kathmandu, Nepal.
15. Chaudhari, B.N., 1995, *Budget Speech of F.Y. 2052/53,* Nawalparasi, Nepal: District Development Committee - Nawalparasi.
16. Chen, G., 1998. *Nepal- Proposed Rural Infrastructure Project.* Washington, D.C.: The World Bank.
17. Christaller, W., 1933. *Central Places in Southern Germany.* Englewood Cliff, New Jersey: Prentice Hall, Inc. (Translation to English language by Baskin, C.W. in 1966).
18. Crossley, P. 1999. *An Expert System for the prediction of total vehicle and road operating costs in developing countries.* Silsoe, Bedford, UK: Silsoe College, Carnfield University.
19. DADO (District Agricultural Development Office), 1998. *District Agricultural Development Office at a Glance.* Nawalparasi, Nepal.
20. Dantiz, G. B., and Maier, S.F., 1979. Formulating and Solving the Network Design Problem by Decomposition. *Transportation Research – B 13B*: 5-17.
21. DDC-Nawalparasi (District Development Committee, Nawalparasi), 1993. *Minute of District Council Meeting – 2051.* Nawalparasi, Nepal.
22. Dionne, R., and Florian, M., 1979. Exact and Appropriate Algorithms for Optimal Network Design, *Networks* 9(1): 37-59.
23. Dixon-Fyle, K., 1998. *Accessibility Planning and Local Development: The application possibilities of the IRAP methodology.* Geneva: International Labour Organisation.

24. DOLIDAR (Department of Local Infrastructure Development and Agricultural Roads), 1998a. *DOLIDAR Newsletter*. Kutikhel, Lalitpur, Nepal.
25. DOLIDAR, 1998b. *Implementation Directives of the Agricultural Roads*. Kutikhel, Lalitpur, Nepal.
26. DOLIDAR, 1998c. *Work Norms for labour-based construction work of agricultural and rural roads*. Kutikhel, Lalitpur, Nepal.
27. DOLIDAR, 1999. *Approach for the Development of Agricultural and Rural Roads*. Kutikhel, Lalitpur, Nepal.
28. DOR (Department of Roads), 1995. *Nepal Road Statistics*. Kathmandu, Nepal.
29. DOR, 1988. *Nepal Road Standards (2045)*. Kathmandu, Nepal.
30. DOR, 1994. *Classification and Design Standards for Feeder Roads*. Kathmandu, Nepal.
31. Edmonds, G. A., and Veen, J.J. de, 1992. A Labour-Based Approach to Roads and Rural Transport in Developing Countries. *International Labour Review* 131(1): 95-110.
32. EPL (The Economist Publications Ltd), 1987. *The World in Figures*. London, U. K.
33. ESRI (Environmental Systems Research Institute, Inc.), 1996. *ArcView GIS, The Geographic Information System for Everyone*. U.S.A.
34. Evans, H., 1982. *Urban Functions in Rural Development: The case of the Potosi Region in Bolivia*. Washington D.C.: U.S. Agency for International Development.
35. Francisco, S.A., and Routray, J. K., 1992. *Road Transport and Rural Development: A Case Study in Philippines*. Bangkok, Thailand: Asian Institute of Technology.
36. Garber, N. J., and Hoel, L. A., 1997. *Traffic and Highway Engineering*. Massachusetts: PWS Publishing Company.
37. Garrison, W.L., and Marble, D.F., 1962. *The Structure of Transport Networks*. Evanston, U.S.A.: The Transportation Center at North Western University.
38. Ghosh, A., and Rushton, G. (Eds.), 1987. *Spatial Analysis and Location – Allocation Models*. New York: Van Nostrand Reinhold.
39. GTZ (Gesellschaft fuer Technische Zusammenarbeit), 1993. *Transportation Infrastructure Master Plan for Dhadhing District*. Kathmandu, Nepal: Dhadhing Development Project.
40. Harral, C. G., 1974. *Study of the Substitution of Labor and Equipment in Civil Construction, Staff Working Paper No. 172*. Washington D.C.: International Bank for Reconstruction and Development.
41. Heidemann, C., and Kaira, C. K., 1984. *Transport Planning in Rural Regions in Developing Countries*. In Bechtold K. H. (eds.), *Economics*. Tubingen, Germany: Institute fur Wissenschaftliche Zusammenarbeit.
42. HMGN (His Majesty's Government of Nepal), 1984. *Norms for Rate Analysis of the Construction Activities*. Kathmandu, Nepal: Department of Roads.
43. HMGN, 1992. *District Development Committee Act*. Kathmandu, Nepal.
44. HMGN, 1998. *The Ninth Plan*. Kathmandu, Nepal: National Planning Commission.
45. HMGN, 1998a. *The Local Governance Act – 2055*. Kathmandu, Nepal: Pairawi Publications.
46. HMGN, 2000. *Regulation Governing Financial Administration of the Local Governments*. Kathmandu, Nepal: Legal Books Publishing Committee.
47. HOC (House of Consultants), 1997. *A Study of Labour Wage Rates, Productivity Norms and Income/Expenditure Patterns in 1997 Work Season Under FFWP*. Dhaka, Bangladesh: World Food Programme, Integrated Food for Development Project, The Government of Bangladesh.
48. Howe, J., 1997. *Transport for Poor or Poor Transport?*. Geneva: International Labour Office.
49. Howe, J.D.G.F., 1971. *The Value of Time Savings from Road Investments: A Study in Kenya. RRL Report LR 372*. Berkshire: Road Research Laboratory.

50. Howe, J.D.G.F., 1976. *A report on appropriate transport systems for rural communities in Kenya*. London, U.K: Intermediate Technology Services Ltd.
51. Howe, J.D.G.F., 1977. *Forecasting Rural Road Travel in Developing Countries from Studies of Land Use. TRRL Laboratory Report 754*. Berkshire: Transport and Road Research Laboratory.
52. I.L.O.– Nepal (International Labor Organization), 1997. *A New Horizon for Nepal's Rural Infrastructure Sector: A Strategy for the decentralized, participatory development of Nepal's Rural Road Network*. Lalitpur, Nepal: Technical Assistance Unit, Technical Division, Ministry of Local Development.
53. IRC (Indian Road Congress), 1984. *Guidelines on the Choice and Planning of Appropriate Technology in Road Construction*. New Delhi, India.
54. Irvin, G.W., 1975. *Roads and redistribution: social costs and benefits of labor-intensive road construction in Iran*. Geneva: International Labour Office.
55. ISOHDM (International Study of Highway Development and Management), 2001. *Features of HDM – 4 Software*. http://hdm4.piarc.org/info/HDMfeatures-e.htm.
56. Jain, S.S.; Parida, M., and Khanna, S. K., 1998. Innovative Labour-based Technology for Rural Road Construction. *Indian Highways* 26(1): 63-71.
57. Jenssen, B., (Ed.) 1992. *Planning as a Dialogue: District Development Planning and Management in Developing Countries*. Dortmund, Germany: SPRING Center, University of Dortmund.
58. Jenssen, B., 1992. "Towards Generating District Settlement Patterns – An Introduction of Selected Tools." In (Jenssen, B. (Ed.), 1992) 95-115.
59. Jha, P. K.; Ghimire, G.P.S.; Karmacharya; S. B., Baral, S.R. and Lacoul, P. (Ed.), 1996. *Environment and Bio-diversity: In the context of South Asia*. Kathmandu, Nepal: Ecological Society.
60. Kammeier, H. D., 1996. *LOCNET: A PC Based Locational Analysis and Planning Model and its Conceptual Background*. In (Mohapatra, A.C. & J.K. Routray (Ed.).
61. Kammeier, H.D., 1999. New tools for spatial analysis and planning as components of an incremental planning support system. *Environment and Planning B: Planning and Design, 26*: 365-380.
62. Kansky, K. J., (1963). *Structure of transport networks: relationships between network geometry and regional characteristics. Research Papers, 84*. University of Chicago.
63. Khan, M. L. R., 1984. *Rural Road Planning in Developing Countries, A Network Modeling Approach*. Unpublished Ph. D. Dissertation, Bangkok, Thailand: Asian Institute of Technology.
64. Khan, M.S.A. and Mohit, M.A., 1989. *Development of a Methodology for Upazila level Planning of Rural Roads in Bangladesh*. Dacca, Bangladesh: Bangladesh University of Engineering and Technology.
65. Khisty, C.J., 1990. *Introduction to Transportation Engineering*. U.S.A.: Prentice Hall.
66. Kumar, A., 1980. Use of incremental form of logit models in demand analysis. *Transport Research Record* 775: 21-7.
67. Lal, D., 1978. *Man or Machine*. Geneva: International Labor Office.
68. Lebo, J., and Schelling, D., 1999. *Design and Appraisal of Rural Transport Infrastructure*. http://www.worldbank.org/html/fpd/transport/rural_tr/
69. Leinbach, T. R., 1982. Towards an Improved Rural Transport Strategy: The Needs and Problems of Remote Third World Communities. *Asian Profile*, 10(1): 16-35.
70. Leinbach, T. R., 1995. Transport and Third World Development: Review, Issues, and Prescription. *Transportation Research - A* 29A(5): 337-344.
71. Leinbach, T. R., and Cromley, R. G., 1983. A Goal Programming Approach to Public Investment Decisions: A Case Study of Rural Roads in Indonesia. *Socio-Economic Planning Sciences* 17(1): 1-10.

72. Mahendru, A. K.; Khanna, S. K., and Sikdar, P.K., 1983. Spatial distribution and functional planning of settlement hierarchies in rural road networks. *Indian Highways* 11(7):12-26.
73. Mahendru, A. K.; Sikdar, P. K. and Khanna, S.K., 1989. Rural (Village) Road Network Planning based on Settlement Interaction. *Indian Highways* 17(6): 25-32.
74. McCleary, W.A., 1976. *Equipment versus employment: a social cost benefit analysis of alternative techniques of feeder road construction in Thailand.* Geneva: International Labor Office.
75. Meyer, M.D., 1992. *Financial and Economic Considerations.* In Edwards, J. D. (Ed.).
76. Meyer, W. P.; Acharya, B. N.; Aryal, R.; and Karmacharya, B., 1999. *Green Roads in Nepal.* Kathmandu, Nepal: German Technical Cooperation and Swiss Agency for Development Cooperation.
77. Miah, M. A. Q., 1993. *Applied Statistics: A Course Handbook for Human Settlements Planning*. Bangkok, Thailand: Asian Institute of Technology.
78. Mohapatra A. C., and Routray, J. K. (Ed.), 1998. *Regional Development and Planning.* Jaipur, India: Rawat Publications.
79. Moller, U., 1976. *Economic Evaluation.* In Thagesen, B. (Ed.).
80. Nijkamp, P.; Rietveld, P., and Voogd, H., 1991. *Multiple Criteria Evaluation: Issues and Perspectives.* Elsevier, Amsterdam.
81. NPC (National Planning Commission), 1998. *Ninth Plan (2054-2059).* Kathmandu, Nepal.
82. Ochoa-Rosso, F., 1968. *Applications of Discrete Optimization Techniques to Capital Investment and Network Synthesis Problems.* Research Report R68-42, Cambridge, Mass., U.S.A: M.I.T., Department of Civil Engineering.
83. OECD (Organization for Economic Cooperation and Development), 1974. *Urban traffic models: Possibilities for Simplification.* Paris: OECD Road Research Group.
84. Overgard, K.R., Hoff and Overgard, *Planning Methods*, In (Thagesen, B. (Ed.), 1996).
85. Paudyal, D. P., 1998. *Access Improvement and Sustainable Development: A Case of Rural Road Development in Nepal.* Kathmandu, Nepal: International Center for Integrated Mountainous Development.
86. Petersen, M. S.; Poulsen, T. A.; and Bro., C., 1996. *The World Bank HDM Model.* In (Thagesen, B. (Ed.). 1996).
87. Petts, R., 1999. *Handbook of Intermediate Equipment for Road Works in Developing Countries.* United Kingdom: Management of Appropriate Road Technology.
88. PLRP, 1997a. *Work Report on District Transport Master Plan – Nawalparasi.* Butwal, Nepal.
89. PLRP, 1997b. *Work Report on Classification and Design Standards for District Roads.* Butwal, Nepal.
90. PLRP, 1997c. *Work Report on District Transport Master Plan – Rupandehi.* Butwal, Nepal.
91. Price, W. L., 1971. *Graphs and Networks: An Introduction.* London: Butterworth and Co. Ltd.
92. Rapp, E. 1997. *Comprehensive Impact Assessment of a Local Road Programme in Nepal.* Eschborn, Germany: German Agency for Technical Cooperation (GTZ).
93. Regmi, M.C., 1987. *An Economic History of Nepal (1846-1901).* Varanashi, India: Nath Publishing House.
94. Ridley, T. M., 1968. An Investment Policy to reduce the travel time in transportation network. *Transportation Research* 2 (4): 409-424.
95. Rieger, H., and Bhadra, B., 1979. *Comparative Evaluation of Road Construction Techniques in Nepal.* Kathmandu, Nepal: Center for Economic Development and Administartion.

96. Routray, J. K., 2000. Local Development Planning: Methodologies and Operational Issues in Nepal. *Regional Development Studies* 6:131-150.
97. Roy, P., and Patil, B.R., 1977. *Manual for Block Level Planning*. Meerut, India: The Macmillan Company of India Limited.
98. Sakko, J., 1997. *Socio-Economic Impact Survey on the Intervention of the Labor Based Rural Infrastructure and Maintenance Project in Siem Reap Province, Cambodia.* Bangkok, Thailand: International Labor Organization, ASIST – Asia Pacific.
99. Sarma, P. K.; Routray, J. K., and Singh, D. K., 1984. Spatial Analysis of Hierarchy of Market Centers and Domestic Market Potential Surface of Central Assam (India). *The Indian Journal of Marketing Geography* 2(1) : 45-64.
100. Schaffner, U., 1987. *Road Construction in Nepal Himalaya: The Experience from the Lamosangu-Jiri Road Project, ICIMOD Occasional Paper No. 8*. Kathmandu, Nepal: Integrated Center for Integrated Mountain Development.
101. Scott Wilson Kirkpatric and Partners, 1974. *Study of the Substitution of Labor and Equipment in Civil Construction: Phase: III, Technical Report No. 1.* Washington D.C.: International Bank for Reconstruction and Development.
102. Scott, A. J., 1969. The Optimum Network Problems: Some Computational Procedures. *Transportation Research* 3(2).
103. Seddon, D., 2000. *Rural Access Impact Review*. Kathmandu, Nepal: Rural Access Promotion Programme.
104. Shone, M. and Brudefors, U., 1997. *The Productivity of Labor-based Infrastructure Works*. Nairobi, Kenya: ILO, Advisory Support, Information Services and Training.
105. Shone, M., 1994. *Labour and Development in Cambodia.* Cambodia: Employment Generation Programme.
106. Shrestha, C. B., 1997a. *Experience Report on Transport Planning and Institutional Strengthening.* Butwal, Nepal: PLRP.
107. Shrestha, H.R. and Bharati, G. N. M., 1996. *Eco-design Approach to Hill Roads: An Appropriate Strategy to Preserve Mountain Environment*. In Jha, P. K. et al. (Ed.), 1996.
108. Shrestha. C. B., 1997b. *Manual for the Preparation of a District Transportation Master Plan*. Butwal, Nepal: PLRP.
109. SiDEF (Sustainable Infrastructure Development Foundation), 1998a. *District Transport Master Plan – Palpa District*. Kathmandu, Nepal: Helvetas- Nepal.
110. SiDEF (Sustainable Infrastructure Development Foundation), 1998b. *District Transport Master Plan – Bajhang District*. Kathmandu, Nepal: Helvetas- Nepal.
111. Singh, D.V.; Gupta, A .K. and Kumar, P., 1997. Planning Practices for Rural Roads in India – A critical review. *Indian Highways* 25(2): 5-13.
112. Solanki, R.S.; Gorti, J.K. and Southworth, F., 1998. Using Decomposition in large-scale Highway Network Design with a quasi-optimization Heuristic. *Transportation Research – B* 32 (2): 127 – 140.
113. Sossalau, A. B.; Hassan, A.; Carter, M. and Wickstorm, G., 1978. *Quick response urban travel estimation techniques and transformation parameters*. Washington D. C.: National Cooperative Research Program, Transport Research Board.
114. Southworth, F., and Peterson, B. E., 2000. Intermodal and International Freight Network Modeling, *Transportation Research – C*. 8C(1-6): 147-166.
115. Steenbrink, P.A., 1974. *Optimization of Transport Networks*. London: John Wiley and Sons, Ltd.
116. Stock, E.A. and Veen, J. de, 1996. *Expanding Labor-based Methods for Road Works in Africa.* World Bank Technical Paper No. 347, Washington D.C: The World Bank.
117. SW (Scott Wilson), 1997. *Nepal Rural Transportation Position Paper*. Kathmandu, Nepal: Department for International Development, Southeast Asia Development Division.

118. Taylor, M.A.P.; Woolley, J. E., and Zito, R., 2000. Integration of the Global Positioning System and Geographic Information Systems for Traffic Congestion Studies, *Transportation Research – C* 8C(1-6): 257-285.

119. Teodorovic, D., 1986. *Transportation Networks: A Quantitative Treatment*. New York: Gordon and Breach Science Publishers.

120. Thagesen, B., (Ed.) 1996. *Highway and Traffic Engineering in Developing Countries*. London: E. and FN Spon.

121. Thunen, J. H. Von, 1826. *Der Isolierte Staat in Beziehung auf Landwirtschaft und Nationaloekonomie*. Berlin, Germany.

122. Tracey-White, J. and Vaidya, K., 1998. *Planning Framework for Sub-Project Screening and Selection*. Phnom Penh, Cambodia: I.T. Transport Ltd.

123. TRRL (Transport and Road Research Laboratory), 1988. *A Guide to Road Project Appraisal*. Crowthrone, Berkshire, United Kingdom.

124. UNCHS (United Nations Center for Human Settlements), 1985. *Guidelines for the Planning of Rural Settlements and Infrastructure: Road Networks*. Nairobi, Kenya.

125. UNDP, 1992. *Project Document of the Pilot Labor Based District Road Rehabilitation and Maintenance Project*. Kathmandu, Nepal.

126. UOF (University of Florida), 2000. *McTrans*. Transportation Research Center, Florida, USA.

127. Van der Tak, and Roy, A., 1971. *The Economic Benefits of Road Transport Projects. World Bank Staff Occasional Paper No. 13*, Washington D.C.: World Bank.

128. Veen, J. de and. Thagesen, B., 1996. *Labor-Based Construction*. In (Thagesen, B. (Ed.). 1996) 338 - 360.

129. WB (World Bank), 1994. *Staff Appraisal Report: Nepal: Road Maintenance and Rehabilitation Project, Report No. 12192-Nep*. Energy and Infrastructure Operations Division, Country Department I, South Asia Region, Washington D.C., U.S.A.

130. World Bank, 1992. *Nepal: Expenditure in the Road Sector, Report No. 10988 – NEP*. Washington D.C., U.S.A: South Asia Country Department I, Energy and Infrastructure Operation Division, The World Bank.

131. World Bank, 1993. Nepal: Expenditure in Road Sector. Washingoton D.C., U.S.A.: International Bank for Reconstruction and Development.

132. WSA and SMEC, 1996. *Master Plan for Strategic Road Network and Rural Transport, Vol. III – Rural Transport*. Kathmandu, Nepal: Road Maintenance and Rehabilitation Project, Department of Roads.

133. You, J., and Kim, T. J., 2000. Development and Evaluation of a Hybrid Travel Time Forecasting Model, *Transportation Research – C* 8C (1-6): 231-256.

134. Zimmermann, J. and Rajbahandari, B.C., 1995. *A Historical Overview of Expansion of Roads in Nepal and Development of Department of Roads*. Lalitpur, Nepal: A Paper Presented in a Talk Program on 5 June, 1995 in Swiss Development Cooperation.

Model for Developed Areas

Index of Worksheets

Sheet No.	Table No.	Contents
A	1	Matrix of Present Centrality Index
	2	Centrality Index of Regional Market Centers
B	3	Matrix of Future Centrality Index
	4	Future Centrality Index of Regional Market Centers
C	5	District Road Inventory
	6	Identification of the Shortest Routes
D	7	Origin-Destination Matrix through the Shortest Route
	8	Present Intensity of Interaction among the Market Centers
	9	Future Origin-Destination Matrix through the Shortest Route
	10	Future Intensity of Interaction
E	11	Assignment of Present Intensity of Interaction to Each Link on Existing Road Networks
	12	Assignment of Future Intensity of Interaction of Each Link on Present and Proposed Roads
F	13	Base Year Volume of Traffic
G	14	Intensity of Interaction and Volume of Passengers
	15	Intensity of Interaction and Volume of Freight
	Fig. 1	Relationship between IOI and Volume of Passengers
	Fig. 2	Relationship between IOI and Volume of Freight
H	16	Traffic Growth of Passengers
	17	Projected Traffic Growth of Freight
I	18	Per Hour Hiring Rate of Equipment
	19	Hourly Rates of Laborers
	20	Unit Price of Materials
J	21	Construction Norms
K	22	Unit Construction Cost
	23	Construction Cost of Proposed Road Projects
L	24	Annual Maintenance Cost of Existing Roads
	25	Per Km Maintenance Cost
	26	Annual Construction and Maintenance Cost of the Proposed Road
M	27	Transportation Cost
	28	Traffic Composition
	29	Per Km Travelling Speed
	30	Savings in Transportation Cost
	31	Benefits from Savings in Travelling Time
N	32	Total Transport Benefits
	33	Aggregation of Net Costs and Benefits
	34	Prioritization of Road Links

Table 1 Matrix of Present Centrality Index

No.	Market Center	Population, 1991@	Population, 2001*	Educational		Health		Commercial							Industries						
				College	Voc. School	Hospital	Private Clinic	HH Goods	Hardware	Medical Shop	Eletronic Shop	Textile Shop	Agri. Traders	Milk Colletion	Agro-based Industries	Forest Based Industries	Textile & Leather	Service Industries	Mech. Febrication	Agri. Service Center	Centrality Index
1	Parasi	5,607	7,177	1.0	1.0	1.0	3.0	9.0	3.0	10.0	4.0	7.0	2.0	1.0	2.0	2.0	0.0	8.0	4.0	1.0	70.95
2	Kawasoti	5,994	9,764	1.0	1.0	1.0	2.0	8.0	2.0	5.0	3.0	5.0	4.0	1.0	3.0	1.0	0.0	7.0	2.0	1.0	55.76
3	Bardhaghat	8,035	11,334	1.0	0.0	0.0	3.0	7.0	2.0	4.0	2.0	6.0	2.0	0.0	1.0	1.0	0.0	0.0	1.0	0.0	34.20
4	Mukundapur	3,154	4,239	0.0	0.0	0.0	2.0	9.0	2.0	4.0	3.0	3.0	3.0	1.0	2.0	1.0	1.0	4.0	0.0	1.0	38.51
5	Sunwal	3,178	5,177	0.0	0.0	0.0	1.0	5.0	1.0	2.0	2.0	3.0	2.0	1.0	2.0	1.0	0.0	2.0	1.0	0.0	26.00
6	Gaindakot	8,424	15,086	0.0	0.0	0.0	2.0	4.0	2.0	2.0	2.0	1.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	0.0	24.87
7	Tribeni	3,342	4,278	0.0	0.0	0.0	1.0	3.0	1.0	2.0	2.0	5.0	1.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	17.78
8	Maheshpur	1,952	2,499	0.0	0.0	0.0	1.0	6.0	1.0	2.0	2.0	6.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	20.68
9	Naya Belhani	2,762	4,088	0.0	0.0	0.0	2.0	3.0	2.0	2.0	2.0	4.0	1.0	1.0		1.0	0.0	2.0	1.0	0.0	23.67
11	Gopigunj	2,948	4,364	0.0	0.0	0.0	1.0	3.0	1.0	1.0	1.0	3.0	1.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	13.66
12	Dumkibas	2,197	3,099	0.0	0.0	0.0	2.0	4.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	16.23
13	Pragatinagar	6,213	9,649	0.0	0.0	0.0	3.0	3.0	2.0	3.0	2.0	3.0	1.0	1.0	2.0	0.0	0.0	1.0	1.0	0.0	24.65
14	Chormara	2,787	4,125	0.0	0.0	0.0	1.0	3.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	12.93
	Total Functions			3.0	2.0	2.0	24.0	67.0	20.0	40.0	27.0	48.0	20.0	7.0	17.0	9.0	4.0	30.0	12.0	4.0	
	Median Population			9764	8471	8471	4364	4364	4770	4364	4364	4364	4321	5177	5177	6177	4239	4364	9649	5708	
	Weight			2.30	2.00	2.00	1.03	1.03	1.13	1.03	1.03	1.03	1.02	1.22	1.22	1.46	1.00	1.03	2.28	1.35	

@ Population based on the population census.

* Population growth rate is based on the executive judgement of the DDC officials.

Table 2 CI of Regional Market Centers

No.	Market Centers	Population	CI
1	Parasi	7,177	71
2	Bardhaghat	11,334	34
3	Sunwal	5,177	26
4	Tribeni*	14,278	38
5	Maheshpur*	10,499	41
6	Gopigunj	4,364	14
7	Butwal*	54,179	200
8	Bhairahawa*	48,306	150

CI = Centrality Index

* Population and CI approximate and outside from the district.

Table 3 Matrix of Future Centrality Index *

			Educational		Health		Commercial							Industries						
Market Center	Population, 2001	Population, 2016[a]	College	Voc. School	Hospital	Private Clinic	HH Goods	Hardware	Medical Shop	Electronic Shop	Textile Shop	Agri. Traders	Milk Collection	Agro-based Industries	Forest Based Industries	Textile & Leather	Service Industries	Mech. Fabrication	Agri. Service Center	Centrality Index
Parasi	7,177	9,660	1.0	2.0	1.0	10.0	20.0	10.0	20.0	12.0	20.0	7.0	1.0	10.0	5.0	2.0	20.0	10.0	4.0	182.7
Kawasoti	9,764	14,141	3.0	3.0	2.0	6.0	15.0	10.0	15.0	9.0	15.0	10.0	3.0	8.0	10.0	2.0	14.0	10.0	3.0	171.5
Bardhaghat	11,334	16,415	2.0	2.0	1.0	10.0	15.0	10.0	8.0	6.0	10.0	5.0	2.0	5.0	8.0	4.0	4.0	8.0	3.0	128.1
Amarapuri	4,239	6,139	1.0	1.0	0.0	4.0	12.0	5.0	6.0	4.0	6.0	5.0	3.0	4.0	4.0	3.0	7.0	2.0	3.0	81.2
Sunwal	5,177	7,497	2.0	2.0	2.0	6.0	15.0	10.0	10.0	6.0	8.0	4.0	2.0	4.0	5.0	1.0	5.0	4.0	1.0	105.6
Gaindakot	15.086	21,849	2.0	2.0	1.0	4.0	5.0	3.0	4.0	4.0	5.0	2.0	2.0	7.0	5.0	5.0	10.0	12.0	5.0	106.4
Tribeni	4,278	5,349	1.0	1.0	0.0	1.0	5.0	3.0	4.0	5.0	8.0	2.0	1.0	2.0	1.0	1.0	4.0	2.0	2.0	50.9
Maheshpur	2,499	3,124	0.0	1.0	0.0	2.0	8.0	2.0	3.0	6.0	10.0	2.0	1.0	1.0	0.0	1.0	2.0	2.0	0.0	46.2
Naya. Belhani	4,088	5,921	1.0	1.0	0.0	4.0	6.0	4.0	4.0	4.0	8.0	3.0	2.0	2.0	3.0	0.0	4.0	3.0	2.0	61.6
Gopigunj	4,364	5,456	1.0	1.0	0.0	4.0	5.0	3.0	5.0	5.0	6.0	5.0	1.0	3.0	4.0	1.0	3.0	4.0	2.0	65.2
Dumkibas	3,099	4,488	0.0	1.0	0.0	2.0	8.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	3.0	1.0	2.0	3.0	2.0	48.9
Pragatinagar	9,649	13,974	1.0	1.0	0.0	2.0	7.0	5.0	5.0	5.0	5.0	5.0	4.0	5.0	4.0	1.0	3.0	3.0	1.0	68.9
Chormara	4,125	5,552	1.0	1.0	1.0	5.0	6.0	4.0	5.0	3.0	4.0	3.0	2.0	3.0	3.0	1.0	2.0	2.0	1.0	57.0
Dhurkot	8,112	10,142	0.0	0.0	0.0	1.0	3.0	2.0	2.0	1.0	4.0	2.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	24.2
Dedgaon	1,667	2,084	1.0	1.0	1.0	1.0	6.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	33.8
Bulingtar	3,934	4,992	1.0	2.0	0.0	1.0	2.0	1.0	2.0	1.0	3.0	2.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	27.3
Thambensi	469	595	0.0	0.0	0.0	1.0	2.0	1.0	1.0	1.0	2.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	15.2
Dhobadi	357	454	0.0	0.0	0.0	1.0	2.0	1.0	1.0	1.0	2.0	2.0	0.0	1.0	1.0	0.0	1.0	2.0	1.0	20.0
Jhyalbas	2,106	3,051	1.0	0.0	0.0	1.0	4.0	3.0	3.0	2.0	3.0	2.0	1.0	2.0	1.0	0.0	1.0	2.0	1.0	33.2
Total Functions			19	22	9	66	146	82	103	79	124	65	31	62	60	24	86	74	35	
Median Population			6,030	5,921	9,660	5,552	5,552	5,552	5,552	5,552	5,552	5,552	5,737	5,737	5,921	6,139	5,552	5,552	5,737	
Weight[b]			2.30	2.00	2.00	1.03	1.03	1.13	1.03	1.03	1.03	1.02	1.22	1.22	1.46	1.00	1.03	2.28	1.35	

*The planning period is considered to be 15 years. Therefore the future centrality index indicates the situation after 15 years.

[a] The population growth rate varies according to the growth tendency of the urban center.

[b] The weight is adopted from the present centrality index in order to make it comparable.

Table 4 Future CI of Market Centers

No	Market Center	Future Pop.	CI
1	Parasi	9,660	183
2	Bardhaghat	16,415	128
2	Sunwal	7,497	106
3	Tribeni*	18.037	76
4	Maheshpur*	13,275	71
6	Gopigunj	5.456	65
7	Butwal*	68,745	350
8	Bhairahawa*	61,293	300

CI = Centrality Index

* CI and Population Approximate and outside from the district.

ID	Road	Length Km	Surface	Road Class	Present Status	Avg. Speed Km/hr*
1	Mahendra Highway	94.8	BT	NH	All Weather	45
2	Sunwal-Parasi	8.9	BT	FR	All Weather	40
3	Parasi - Maheshpur	12.0	BT	FR	All Weather	40
4	Parashi-Mahoo (Bhairahawa)	7.4	Gravel	DR	All Weather	30
5	Parasi - Gopigunj	13.3	Gravel	DR	All Weather	30
6	Bardhaghat- Gopigunj	9.0	Gravel	FR	All Weather	30
7	Canal Road	32.0	Gravel	CR	All Weather	30
8	Gopigunj - Tribeni	17	Gravel	FR	All Weather	30
9	Tribeni-Maheshpur	20.9	Earth	DR	Seasonal	

* Average speed of a Bus is taken as the representative speed.

Table 6 Identification of the Shortest Routes

Origin	Destination	Route Options		Shortest Route		Shortest Time Route Length	Possibility of Shortening	Length after Shortening	Remarks
		1	2	Physical (Km)	Time (min.)				
Parasi	Bardhaghat	5,6	2,1	24	36	26	No	NA	
Parasi	Sunwal	2		9	14	9	No	NA	
Parasi	Tribeni	5,8		32	64	32	No	NA	
Parasi	Maheshpur	3		12	18	12	No	NA	
Parasi	Gopigunj	5		15	30	5	No	NA	
Parasi	Butwal	2,1		30	41.5	30	No	NA	
Parasi	Bhairahawa	4		21	42	21	No	NA	
Bardhaghat	Gopigunj	6		9	18	9	No	NA	
Bardhaghat	Sunwal	1		17	23	17	No	NA	
Bardhaghat	Tribeni	6,8		26	52	26	No	NA	
Bardhaghat	Maheshpur	6,5,3		48	66	48	Yes	23	New Construction
Bardhaghat	Butwal	1		38	51	38	No	NA	
Bardhaghat	Bhairahawa	1	6,5,4	45	90	62	No	NA	
Sunwal	Tribeni	1,6	2,5,8	41	75	43	No	NA	
Sunwal	Maheshpur	2,3		21	32	21	No	NA	
Sunwal	Gopigunj	1,6	2,5	24	41	24	No	NA	
Sunwal	Butwal	1		21	28	21	No	NA	
Sunwal	Bhairahawa	1	2,4	30	40	45	No	NA	
Tribeni	Maheshpur	9		21			Yes	21	New Construction
Tribeni	Gopigunj	8		17	34	17	No	NA	
Tribeni	Butwal	8,6,1	8,5,2	62	103	64	No	NA	
Tribeni	Bhairahawa	8,5,4		53	106	53	No	NA	
Maheshpur	Gopigunj	5,3		27	48	27	Yes	13	New Construction
Maheshpur	Butwal	3,2,1		42	60	42	No	NA	
Maheshpur	Bhairahawa	3,4		30	60	30	No	NA	
Gopigunj	Butwal	6,1	5,2,1	45	69	47	No	NA	
Gopigunj	Bhairahawa	5,4		36	72	36	No	NA	
Butwal	Bhairahawa	1		24	32	24	No	NA	

Table 7 Origin-Destination Matrix through the Shortest Route (in Km)

arket Centers	C.I.	Population	Parasi	Bardhaghat	Sunwal	Tribeni	Maheshpur	Gopigunj	Butwal	Bhairahawa
C.I.			71	34	26	38	41	14	200	150
rasi	71	7177	0	26	9	32	12	15	30	21
ardhaghat	34	11334		0	17	26	18	9	38	62
unwal	26	5177			0	43	21	26	21	45
ribeni	38	14278				0	21	17	64	53
aheshpur	41	10499					0	14	42	30
opigunj	14	4364						0	47	30
utwal	200	54179							0	24
hairahawa	150	48306								0

Table 8 Present Intensity of Interaction among the Market Centers

arket Centers	C.I.	Population	Parasi	Bardhaghat	Sunwal	Tribeni	Maheshpur	Gopigunj	Butwal	Bhairahawa
C.I.			71	34	26	38	41	14	200	150
rasi	71	7,177	0	0.29	0.85	0.27	1.51	0.13	6.13	8.37
ardhaghat	34	11,334		0	0.18	0.31	0.49	0.29	2.91	0.73
unwal	26	5,177			0	0.04	0.13	0.01	3.31	0.48
ribeni	38	14,278				0	0.53	0.11	1.43	1.39
aheshpur	41	10,499					0	0.13	2.62	3.44
opigunj	14	4,364						0	0.29	0.48
utwal	200	54,179							0	136.31
hairahawa	150	48,306								0

Table 9 Future Origin-Destination Matrix through the Shortest Routes

arket Centers	C.I.	Population	Parasi	Bardhaghat	Sunwal	Tribeni	Maheshpur	Gopigunj	Butwal	Bhairahawa
C.I.			183	128	106	76	71	65	350	300
rasi	183	9660	0	26	9	32	12	15	30	21
rdhaghat	128	16415		0	17	26	18	9	38	62
nwal	106	7497			0	43	21	26	21	45
beni	76	18037				0	21	17	64	53
heshpur	71	13275					0	14	42	30
pigunj	65	5456						0	47	30
twal	350	68745							0	24
airahawa	300	61293								0

Table 10 Future Intensity of Interaction among the Market Centers

rket Centers	C.I.	Population	Parasi (1)	Bardhaghat (2)	Sunwal (3)	Tribeni (4)	Maheshpur (5)	Gopigunj (6)	Butwal (6)	Bhairahawa (7)
C.I.			183	128	106	76	71	65	350	300
asi (1)	183	9,660	0	5.49	17.25	2.36	11.59	2.73	47.19	73.60
dhaghat (2)	128	16,415		0	5.76	4.33	5.83	9.23	35.04	10.06
wal (3)	106	7,497			0	0.59	1.70	0.42	43.18	7.19
eni (4)	76	18,037				0	2.96	1.73	8.04	8.96
eshpur (5)	71	13,275					0	1.72	12.90	19.32
igunj (6)	65	5,456						0	3.87	7.26
val (7)	350	68,745							0	449.74
rahawa (8)	300	61,293								0

: Numbers in paranthesis indicate reference number of the market centers.

Table 11 Assignment of Present Intensity to Each Link on Existing Road Networks

ID	Link	Routes using the link	Assignment of intensity
1	Mahendra Highway	2, 1-7, 2-3, 2-7, 2-8, 3-4, 3-6, 3-7, 3-8, 4-7, 5-7, 6-7, 7-8	18.43
2	Sunwal-Parasi	1-2, 1-7, 1-8, 3-5, 5-7	10.02
3	Parasi - Maheshpur	1-5, 3-7, 3-8	7.70
4	Parashi-Mahoo (Bhairahawa)	1-8, 4-8, 5-8, 6-8	13.68
5	Parasi - Gopigunj	1-4, 1-6, 4-8, 6-8	2.27
6	Bardhaghat- Gopigunj	2-4, 2-5, 3-4, 3-6, 4-7, 6-7	2.57
8	Gopigunj - Tribeni	1-4, 2-4, 4-6, 4-7, 4-8, 3-4	3.55
9	Tribeni-Maheshpur	4-5	0.53

Table 12 Assignment of Future Intensity to Each Link on Present and Proposed Roads

ID	Link	Routes using the link	Assignment of intensity
1	Mahendra Highway	2, 1-7, 2-3, 2-7, 2-8, 3-4, 3-6, 3-7, 3-8, 4-7, 5-7, 6-7, 7-8	179.72
2	Sunwal-Parasi	1-2, 1-7, 1-8, 3-5, 5-7	84.52
3	Parasi - Maheshpur	1-5, 3-7, 3-8	45.50
4	Parashi-Mahoo (Bhairahawa)	1-8, 4-8, 5-8, 6-8	109.14
5	Parasi - Gopigunj	1-4, 1-6, 4-8, 6-8	21.32
6	Bardhaghat- Gopigunj	2-4, 2-5, 3-4, 3-6, 4-7, 6-7	23.08
8	Gopigunj - Tribeni	1-4, 2-4, 4-6, 4-7, 4-8, 3-4	26.01
9	Tribeni-Maheshpur	4-5	2.96

Table 13 Base Year Volume of Traffic

	Transport Routes								
	1[a]	2[b]	3[c]	4[d]	5[d]	6[e]	7[g]	8	9[h]
Length (km.)	95	9	12	7	13	9	32	17	21
Tra. Mode									
Passenger									
Bus		18	8	14	0.49	43	0	32	4
Mini Bus		4	2	4	0.76	1	0	0	0
Jeep		147	40	30	18	60	15	45	6
Auto		25	10	50	5	14	12	11	0
Motorcycle		225	100	110	104		120	0	30
Pedestrian			55	50	100	150	85	113	146
Bicycle		700	800	700	930	600	700	450	408
T. Passengers[1]	0	1241913	658825	739125	517713	1140443	420115	855332	298753
Freight									
Truck		95	40	60	13	103	10	77	6
Tractor		100	60	65	28	43	30	32	10
Bullock Cart		15	35	36	17	8	40	6	30
Mules			0	0	0		0	0	
Porter			0	10	4	0	0	0	0
T. Freight[2]	0	1961875	976375	1299765	380948	1753825	383250	1315369	197100

Source: Transport Survey, 2000

a= National Road, No traffic counted.

Source: [a, b] - Department of Roads, [c, k] - Field Survey

[1] = Number of Passengers [2] = Freight load in quintal (100 kg.)

Table 14 IOI and VOP

	IOI	VOP
2	10	1,241,913
3	8	658,825
4	14	739,125
5	2	517,713
6	3	1,140,443
9	1	298,753

Figure 1 Relationship between IOI and Volume of Passengers

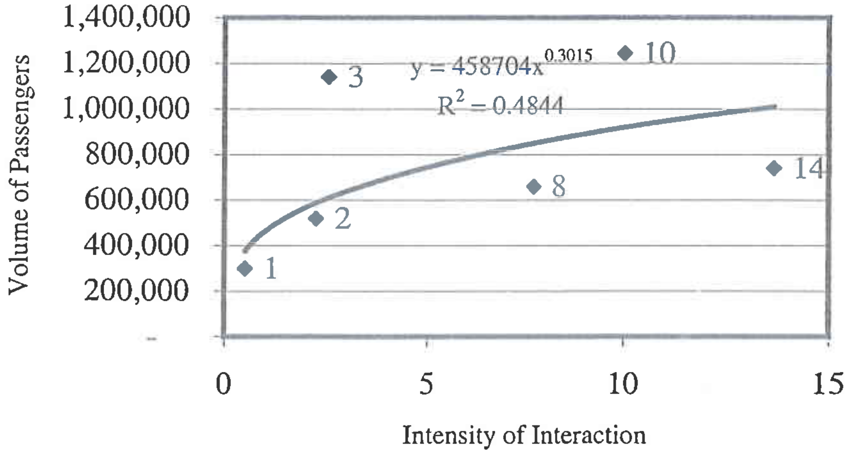


Table 15 IOI and VOF

	IOI	VOF
2	10	1,961,875
3	8	976,375
4	14	1,299,765
5	2	380,948
6	3	1,753,825
9	1	197,100

Figure 2 Relationship between IOI and VOF

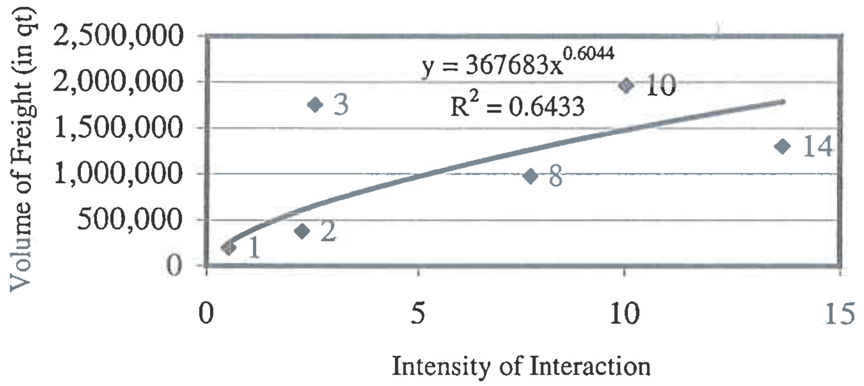


Table 16 Projected Traffic Growth of Passengers

Routes	Length (km.)	Base Year Passengers	Forecasted Passengers	Growth Rate	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	95																		
2	9	1,241,913	1,747,870	2.30%	1,270,532	1,299,811	1,329,764	1,360,408	1,391,758	1,423,830	1,456,642	1,490,210	1,524,551	1,559,683	1,595,625	1,632,396	1,670,014	1,708,498	1,747,870
3	12	658,825	1,450,211	5.40%	694,407	731,911	771,440	813,104	857,019	903,305	952,091	1,003,512	1,057,710	1,114,835	1,175,046	1,238,508	1,305,398	1,375,901	1,450,211
4	7	739,125	1,887,936	6.45%	786,809	837,569	891,604	949,124	1,010,356	1,075,538	1,144,925	1,218,788	1,297,417	1,381,118	1,470,219	1,565,069	1,666,037	1,773,520	1,887,936
5	13	517,713	1,153,868	5.49%	546,127	576,100	607,719	641,072	676,257	713,372	752,524	793,825	837,393	883,352	931,834	982,976	1,036,925	1,093,835	1,153,868
6	9	1,140,443	1,181,806	0.24%	1,143,154	1,145,873	1,148,598	1,151,329	1,154,067	1,156,811	1,159,562	1,162,319	1,165,083	1,167,854	1,170,631	1,173,415	1,176,205	1,179,002	1,181,806
8	17	855,332	636,523	-1.95%	838,648	822,290	806,252	790,525	775,106	759,988	745,164	730,629	716,378	702,405	688,705	675,271	662,100	649,186	636,523
9	21	298,753	655,839	5.38%	314,831	331,774	349,630	368,447	388,276	409,172	431,193	454,399	478,854	504,625	531,783	560,403	590,563	622,346	655,839

Table 17 Projected Traffic Growth of Freight

Routes	Length (km.)	Base Year Freight	Forecasted Freight	Growth Rate	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	95																		
2	9	1,961,875	5,371,858	6.95%	2,098,142	2,243,874	2,399,728	2,566,407	2,744,663	2,935,301	3,139,179	3,357,219	3,590,403	3,839,784	4,106,486	4,391,712	4,696,750	5,022,974	5,371,858
3	12	976,375	3,694,809	9.28%	1,066,960	1,165,950	1,274,124	1,392,334	1,521,511	1,662,673	1,816,931	1,985,501	2,169,711	2,371,011	2,590,987	2,831,372	3,094,059	3,381,118	3,694,809
4	7	1,299,765	6,269,548	11.06%	1,443,520	1,603,175	1,780,488	1,977,412	2,196,116	2,439,009	2,708,766	3,008,359	3,341,086	3,710,614	4,121,012	4,576,800	5,082,999	5,645,185	6,269,548
5	13	380,948	2,336,583	12.85%	429,912	485,170	547,531	617,907	697,328	786,958	888,109	1,002,260	1,131,084	1,276,466	1,440,534	1,625,691	1,834,647	2,070,460	2,336,583
6	9	1,753,825	2,451,371	2.26%	1,793,416	1,833,901	1,875,300	1,917,634	1,960,923	2,005,189	2,050,455	2,096,742	2,144,075	2,192,476	2,241,969	2,292,580	2,344,333	2,397,255	2,451,371
8	17	1,315,369	2,634,732	4.74%	1,377,717	1,443,021	1,511,421	1,583,062	1,658,099	1,736,693	1,819,013	1,905,234	1,995,542	2,090,131	2,189,203	2,292,972	2,401,659	2,515,498	2,634,732
9	21	197,100	709,084	8.91%	214,661	233,788	254,618	277,304	302,012	328,921	358,227	390,145	424,906	462,765	503,997	548,903	597,809	651,074	709,084

Table 18 Per Hour Hiring Rate of Equipment

Amount in NRs

No.	Equipment	Capacity	Rate		Fuel Con.
			DOR	Market	Rate
1	Air Compressor	150 to 275 CFM	160	150	
2	Asphalt Mixer (Bel Mix)		550		
3	Asphalt Paver		830		
4	Asphalt Plant	Upto 10 Ton	400		
5	Asphalt Plant	40Ton/Hour	6200		
6	Back Hoe Loader	Up to 85 HP	600	750	8
7	Bitumin Distributor	4 to 6 KL	850	700	10
8	Bitumin, Heater	Up to 2 KL	90	187.5	15
9	Boring Rig		1360		
10	Broom Road, Towed		120		
11	Compactor, Hand Towed		50		
12	Crane, Mobile	5 to 10 Ton	2040		
13	Crane, Mobile	10+ to 15 Ton	2330		
14	Crusher, Stone	50 to 100 HP	100		
15	Dozer, Track	120 to 180 HP	1230	1600	
16	Dozer, Track	180+ to 240 HP	3000		
17	Dozer, Wheel	150+ to 225 HP	2090		
18	Excavator, Track		1210		
19	Excavator, Wheel	Up to 110 HP	1240	750	10
20	Fork Lift, Truck	Up to 2.5 Ton	270		
21	Generator	Up to 10 KVA	50		
22	Generator	10+ to 30 KVA	130		
23	Generator	250 KVA	230		
24	Generator	420 KVA	360		
25	Grader, Motor	80 to 145 HP	1000	1000	12
26	Loader, Wheel	1 to 1.75 CUM	660	875	10
27	Loader, Wheel	1.75+ to 2.5	920		
28	Maintainer	Up to 75 HP	350		
29	Mini Dumper	Up to 1 Cu M	170		
30	Mixer, Concrete		310	300	
31	Pile Driver		3400		
32	Rock Drill (Engine)		60		
33	Rock Drill (Pneumatic)		50		
34	Roller 3 Wheel	Up to 12 Ton	290		
35	Roller Pneumatic	Up to 20 Ton	800		8
36	Roller VIB, Pedistrian	Up to 0.5 Ton	70	150	4
37	Roller VIB, Self Prop.	Up to 3 Ton	430	500	5
38	Roller VIB, Self Prop.	3 Ton +	800	875	8
39	Roller VIB, Sheep Foot	Up to 10 Ton	660	1000	8
40	Roller VIB, Towed	Up to 7 Ton	520		
41	Sprayer, Emulsion	Up to 1 KL	170		
42	Spreader Chips, Self Pro.		740		
43	Tractor	Up to 85 HP	390	125	3.5
44	Trailer, Tractor	10+ to 20 Ton	1660		11
45	Truck Flat Bed	Up to 150 HP	420	225	5
46	Truck Flat Bed/Crane	Up to 7 Ton	530		
47	Truck, Tipper	Up to 150 HP	440	312	5
48	Truck, Tipper	From 150 HP+	860		
49	Vibrator (Engine)		30		
50	Water Pump	Up to 6" Dia.	110	62.5	1.5
51	Water Tanker	Up to 6 KL	550		
52	Welding, Arc	10 to 30 KVA	100		

ource: Department of Roads

Table 19 Hourly Rates of Laborers

Amount in NRs.

No.	Laborer Type	Rate
1	Foreman	50
2	Operator	75
3	Driver up to 10 Ton	40
4	Skilled Labor	18.75
5	Labor	10

Table 20 Unit Price of Materials

Amount in NRs

No.	Materials	Unit	Rate
1	Cement Ordinary Portland	t.	5,500
2	Steel Reinforcement grade 300	t.	
3	Steel Reinforcement grade 400	t.	29,000
4	Coarse Concrete Aggregate 19 mm.	cu. m.	384
5	Fine Concrete Aggregate	cu. m.	384
6	Sand	cu. m.	275
7	Crushed Rock for Base Course	cu. m.	
8	Laterite	cu. m.	323
9	Lime	t.	
10	Diesel	lt.	24
11	Stone	cu. m.	350

Table 21 Construction Norms

Amount in NRs.

Table 21.1 Earthwork Excavation

No.	Description	Unit	Qty	Rate	Amount
1	Materials				
	Sub-Total		0	0	0
2	Equipment				
2.1	Backhoe PC 200	WH	8	750	6,000
2.2	10 Wheel Dump Truck	WH	24	440	10,560
	Sub-Total				16,560
3	Labourers				
3.1	Foreman	WH	8	50	400
3.2	Operator	WH	32	75	2,400
3.3	Check Grade	WH	16	75	1,200
3.4	Dump Man	WH	48	10	480
	Sub-Total				4,480
4	Fuel				
4.1	Backhoe PC 200	WH	64	26	1,664
4.2	10 Wheel Dump Truck	WH	120	26	3,120
	Sub-Total				4,784
5	Lubricant Oil @10% of Fuel				478
Total					26,302
	Estimated Output	cu.m.	400	65.76	26,302

Table 21.2 Embankment

No.	Description	Unit	Quantity	Rate	Amount
1	Materials				
2	Equipment				-
2.1	Motor Grader	WH	8	1,000	8,000
2.2	Roller Vibratory, Pedistrian	WH	8	150	1,200
2.3	Roller Vib. Smooth Drum	WH	8	800	6,400
2.4	Water Truck	WH	8	550	4,400
2.5	Flat Bed Truck	WH	8	420	3,360
	Sub-Total				23,360
3	Labourers				
3.1	Foreman	WH	8	50	400
3.2	Operator	WH	64	75	4,800
3.3	Skilled Labor	WH	32	19	600
3.4	Laborer	WH	64	10	640
	Sub-Total				6,440
4	Fuel				
4.1	Motor Grader	WH	96	26	2,496
4.2	Roller Vibratory, Pedistrian	WH	32	26	832
4.3	Roller Smooth Drum	WH	64	26	1,664
4.4	Water Truck	WH	40	26	1,040
4.5	Flat Bed Truck	WH	40	26	1,040
	Sub-Total				7,072
5	Lubricant Oil @10% of Fuel				707
Total					37,579
Estimated Output		cu.m.	750	50.11	37579

Compaction Factor assumed to be 1.5

Table 21.3 Sub-Base

No.	Description	Unit	Quantity	Rate	Amount
1	Materials				
1.1	Gravel	cu.m.	488	323.4	157804.56
	Sub-Total				157804.56
2	Equipment				
2.1	Motor Grader	WH		1000	8000
2.2	Roller Vibratory, Pedistrian	WH	8	70	560
2.3	Steel Roller	WH	8	800	6400
2.4	Water Truck	WH	8	420	3360
2.5	Flat Bed Truck	WH	8	420	3360
	Sub-Total				21680
3	Laborers				
3.1	General Foreman	WH	8	10.00	80
3.2	Foreman	WH	8	50.00	400
3.3	Operator	WH	64	75.00	4800
3.4	Skilled Labor	WH	32	18.75	600
3.5	Laborer	WH	48	10.00	480
	Sub-Total				6360
4	Fuel				
4.1	Motor Grader	WH	96	26	2496
4.2	Roller Vibratory, Pedistrian	WH	32	26	832
4.3	Steel Roller	WH	64	26	1664
4.4	Water Truck	WH	40	26	1040
4.5	Flat Bed Truck	WH	40	26	1040
	Sub-Total				7072
5	Lubricant Oil @10% of Fuel				707.2
Total					193624
Estimated Output		cu.m.	305	634.8	193624

Compaction Factor assumed to be 1.6

Assumption: 8 Working hours in a day

Table 22 Unit Construction Cost

Amount in NRs.

SN	Particulars	Unit	Cost/Unit
1	Earthwork Excavation	Cum.	66
2	Embankment including Compacti	Cum.	50
3	Pipe Culverts		
	60 cm dia.		3,975
	90 cm dia.		7,196
4	Slab Culverts		
	Span upto 2m.	nos.	345,044
	Span 3 m	nos.	445,057
	Span 4 m or more	nos.	568,408
5	Causeways	rm.	12,679
6	Subgrade Preparation	sqm.	22
7	Sub-base (20 cm. Thick)	Cum.	635
8	Base (10 cm. Thick)	Cum.	
9	Single Surface Dressing	sqm.	

Source: Rate Analysis of Sheet H and WSA, 1996

Table 23 Construction Cost of Proposed Road Projects

Amount NRs. In ,000

No.	Particulars	Unit	Quantities		Route No.								Amount
					1	2	3	4	5	6	7	8	
			Category I	Category II	94.8	8.9	12	7.4	13.3	25.8	32	20.9	
1	E/W Embankment	Cum	7500	5750	National Highway (Construction Completed)	Feeder Road (Construction Completed)	Feeder Road (Construction Completed)	District Road (Construction Completed)	District Road (Construction Completed)	Feeder Road (Construction Completed)	Canal Road (Construction Completed)	156,750	7,854
2	Pipe Culverts												
	60 cm dia	nos.	2	2								42	166
	90 cm dia	nos.	1	1								21	150
	(Length of PC along format	m	9	7								188	
3	Slab Culverts												
	Span upto 2 m.	nos.											
	Span upto 3 m.	nos.	0.5	0.5								10	4,651
	Span 4 m. or more	nos.	0.3	0.3								6	3,564
4	Causeways	rm	10	10								209	2,650
5	Sub-Grade Preparation	Sqm.	5500	3900								114,950	505
6	Sub-base	Sqm.	5500	3900								114,950	14,595
7	Base	Sqm.	3500	3050								73,150	
8	Surface Dressing	Sqm.	3500	3050								73,150	
Total Cost													34,135
Per Km. Cost													1,633

Table 24 Annual Maintenance Cost of Existing Road*

Amount in NRs, 000

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Route	L. (Km.)	Peri.*	Rou.	Rou.	Rou.	Peri.	Rou.	Rou.	Rou.	Peri.	Rou.	Rou.	Rou.	Peri.	Rou.	Rou.
1																
2	95															
3	9															
4	12															
5	7	1,081	130	143	157	1,740	190	209	230	2,548	278	306	336	3,730	407	448
6	13	1,950	234	257	283	3,140	343	377	414	4,597	502	552	607	6,731	734	808
7	9															
8	32															
9	21															
Total		3030.246	364	400	440	4880.2	532	586	644.2	7145.2	779	857.4	943	10461.2	1141.23	1255

Note: Although the National Highways and the Feeder Roads are part of the district level road network, the DDC is not responsible for the construction and maintenance those roads. Therefore those roads are excluded from the financial and economic analysis. The prices are appreciated by 10 percent annually for accomodating the rate of inflation.

* Route No. 8 New Construction.

Table 25 Per Km Maintenance Cost

NRs ,000

Type	First Category	Second Category
Routine	18	9
Periodic	146	110

Source: PLRP, 1997

Note: The price of 1997 given in the DTMP by the PLRP is appreciated to the price of 2000 at the rate of 10 percent per annum.

Table 26 Annual Construction and Maintenance Cost of the Proposed Road*

Amount in NRs, 000

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Route	L. (Km.)	Peri.*	Rou.	Rou.	Rou.	Peri.	Rou.	Rou.	Rou.	Peri.	Rou.	Rou.	Rou.	Peri.	Rou.	Rou.
1																
2	95															
3	9															
4	12															
5	7															
6	13															
7	9															
8	32															
9	21	34,135	367	404	445	4,482	538	592	651	6,562	787	866	953	9,608	1,153	1,268
Total		34,135	367	404	445	4,482	538	592	651	6,562	787	866	953	9,608	1,153	1,268

* Routine and recurrent maintenance are carried out every year.

The periodic maintenance is carried out every fifth year. The road life is assumed to be 15 years.

Table 27 Transport Cost

(NRs./Person/Km) and (NRs./quintal/Km)

Rs. in ,000

Tra. Mode	Without	With
Passenger		
Bus		0.00045
Mini Bus		0.0005
Jeep	0.001	0.00083
Auto	0.001	0.00083
Motorcycle	0.0026	0.002
Pedestrian	0.002	
Bicycle	0.00185	0.0017
Freight		
Truck	0.00034	0.00029
Tractor	0.0007	0.0006
Bullock Cart	0.0015	0.0012
Mules		
Porter	0.0048	

Table 28 Traffic Composition[1]

Tra. Mode	AADT Without	Pass. & quintal	Ratio	AADT With	Pass. & quintal	Ratio
Passenger						
Bus	0	0	0	0.49	12.13	0.01
Mini Bus	0	0	0	0.76	7.55	0.01
Jeep	3	13.53	0.02	18	90.18	0.07
Auto	0	0	0	5	14.43	0.01
Motorcycle	17	25.55	0.04	104	155.26	0.12
Pedestrian	146	146.00	0.25	100	100.18	0.08
Bicycle	408	407.50	0.69	930	929.91	0.71
T. Passengers		593	1		1310	1
Freight						
Truck	0	0	0	13	336.13	0.48
Tractor	5	50.30	0.40	28	278.85	0.40
Bullock Cart	15	73.98	0.60	17	85.33	0.12
Mules		0	0	0	0.00	0.00
Porter	0	0	0	4	2.29	0.003
T. Freight		124.275	1		702.592	1

[1] Road No. 5 is taken for the "with" situation.

2 Road No. 8 is under investigation.

Table 29 Per Km Traveling Speed

Tra. Mode	Without	With
Passenger		
Bus		30
Mini Bus		35
Jeep	30	40
Auto		45
Motorcycle	20	40
Pedestrian	4	5
Bicycle	8	10
Freight		
Truck	15	30
Tractor	12	20
Bullock Cart	5	7
Mules		NA
Porter		NA

Table 30 Savings in Transportation Cost

Tra. Route	Length (Km)	Without*		With		Difference		Total
		Passengers	Freight	Passengers	Freight	Passenger	Freight	
1								
2	95							
3	9							
4	12							
5	7							
6	13							
7	9							
8	32							
9	21	6,405	2,640	4,995	1,173	1,411	1,467	2,877

* The transportation cost also include the cost for the generated traffic at the existing rate without the road situation.

Note: The first year volume of traffic of passengers and freight is taken for calculating the savings in transportation cost.

Table 31 Benefits from Savings in Travelling Time

NRs.in , 000

Transport Route	Length (Km.)	Without		With		Difference		Total Savings (days)		Valuation of Time Savings		Total Savings
		Passenger	Freight	Passenger	Freight	Passenger	Freight	Passengers	Freight#	Passengers*	Freight	
1												
2	95											
3	9											
4	12											
5	7											
6	13											
7	9											
8	32											
9	21	988,039	342,868	301,850	119,258	686,189	223,611	85,774	27,951	12,008	3,913	15,921

* Only 25% of labor wages is considered to be saved due to the underemployment situation.

\# The unit of freight is converted to quintal and 1 quintal is considered as one person.

Table 32 Total Transport Benefits

R. N.	Benefits	
	Savings in Tra. Cost	Savings in Time
1		
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	2,877	15,921

Table 33 Aggregation of Net Costs and Benefits

Yr. / R.N.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9	-38,231	18,431	18,395	18,354	14,317	18,261	18,207	18,148	12,237	18,011	17,933	17,846	9,191	17,646	17,531

Table 34 Prioritization of the Road Links

Expected Rate of Return 7%

R.N.	ENPV	Rank	EIRR	Rank	BCR	Rank	C. Rank
1							
2	0.00		#NUM!		#VALUE!		
3	0.00		#NUM!		#VALUE!		
4	0.00		#NUM!		#VALUE!		
5	0.00		#NUM!		#VALUE!		
6	0.00		#NUM!		#VALUE!		
7	0.00		#NUM!		#VALUE!		
8	0.00		#NUM!		#VALUE!		
9	102,930		46%		3.88		

Appendix 2

Model for Under Developed Areas Based on Prioritization Criteria

Index of Worksheets

Sheet No.	Table No.	Contents
A	1	Matrix of Present Centrality Index
	2	Present Centrality Index of Market Centers (Regional Level)
B	3	Matrix of Future Centrality Index
	4	Future Centrality Index of Market Centers (Regional Level)
C	5	District Road Inventory
	6	Base Year Two Way AADT in Each Link
D	7	Origin and Destination of the Market Centers
	8	Present Intensity of Interaction among the Market Centers
E	9	Future Intensity of Interaction among the Market Centers
F	10	Cultivated Area within the Zone of Influence
	11	Interaction among the Nodal Points
	12	Prioritization of the Proposed Roads

Table 1 Matrix of Present Centrality Index

No.	Market Center	Population, 1991@	Population, 2001*	Educational: College	Educational: Vocational School	Health: Hospital	Health: Private Clinic	Commercial: HH Goods	Commercial: Hardware	Commercial: Medical Shop	Commercial: Eletronic Shop	Commercial: Textile Shop	Commercial: Agri. Traders	Commercial: Milk Colletion	Industries: Agro-based Industries	Industries: Forest Based Industries	Industries: Textile & Leather	Industries: Service Industries	Industries: Mechcanical Febrication	Agri. Service Center	Centrality Index
1	Parasi	5,607	7,177	1.0	1.0	1.0	3.0	9.0	3.0	10.0	4.0	7.0	2.0	1.0	2.0	2.0	0.0	8.0	4.0	1.0	71
2	Kawasoti	5,994	9,764	1.0	1.0	1.0	2.0	8.0	2.0	5.0	3.0	5.0	4.0	1.0	3.0	1.0	0.0	7.0	2.0	1.0	56
3	Bardhaghat	8,035	11,334	1.0	0.0	0.0	3.0	7.0	2.0	4.0	2.0	6.0	2.0	0.0	1.0	1.0	0.0	0.0	1.0	0.0	34
4	Amarapuri	3,154	4,239	0.0	0.0	0.0	2.0	9.0	2.0	4.0	3.0	3.0	3.0	1.0	2.0	1.0	1.0	4.0	0.0	1.0	39
5	Sunwal	3,178	5,177	0.0	0.0	0.0	1.0	5.0	1.0	2.0	2.0	3.0	2.0	1.0	2.0	1.0	0.0	2.0	1.0	0.0	26
6	Gaindakot	8,424	15,086	0.0	0.0	0.0	2.0	4.0	2.0	2.0	2.0	1.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	0.0	25
7	Tribeni	3,342	4,278	0.0	0.0	0.0	1.0	3.0	1.0	2.0	2.0	5.0	1.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	18
8	Maheshpur	1,952	2,499	0.0	0.0	0.0	1.0	6.0	1.0	2.0	2.0	6.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	21
9	Arun Khola	2,762	4,088	0.0	0.0	0.0	2.0	3.0	2.0	2.0	2.0	4.0	1.0	1.0		1.0	0.0	2.0	1.0	0.0	24
11	Gopigunj	2,948	4,364	0.0	0.0	0.0	1.0	3.0	1.0	1.0	1.0	3.0	1.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	14
12	Dumkibas	2,197	3,099	0.0	0.0	0.0	2.0	4.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	16
13	Pragatinagar	6,213	9,649	0.0	0.0	0.0	3.0	3.0	2.0	3.0	2.0	3.0	1.0	1.0	2.0	0.0	0.0	1.0	1.0	0.0	25
14	Chormara	2,787	4,125	0.0	0.0	0.0	1.0	3.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	13
	Total Functions			3.0	2.0	2.0	24.0	67.0	20.0	40.0	27.0	48.0	20.0	7.0	17.0	9.0	4.0	30.0	12.0	4.0	
	Median Population			9764	8471	8471	4364	4364	4770	4364	4364	4364	4321	5177	5177	6177	4239	4364	9649	5708	
	Weight			2.30	2.00	2.00	1.03	1.03	1.13	1.03	1.03	1.03	1.02	1.22	1.22	1.46	1.00	1.03	2.28	1.35	

@ Population based on the population census

* Population growth rate assumed to be 2.04 during the period of 1991-2001

Table 2 Present Centrality Index of Regional Market Centers

No.	Market Centers	Pop.	C.Index	Remarks
1	Gaindakot	81,990	200	CI of Narayanghat included
2	Mukundapur	4,239	39	
3	Chormara	4,125	13	
4	Naya Belhani	4,088	24	
5	Dumkibas	3,099	16	
6	Jhadewa	5,500	8	CI approximate
7	Rukshe Bhanjyang	2,148	7	CI approximate
8	Dedgaon	3,461	7	CI approximate
9	Kawaswati	9,764	56	
10	Pragatinagar	9,649	25	
11	Jhyalbas	3,375	6	
12	Thambensi	3,362	5	
13	Hupsekot	3,690	5	
14	Bulintar	3,934	6	

Table 3 Matrix of Future Centrality Index *

No.	Market Center	Population, 2001	Population, 2016a	Educational		Health		Commercial							Industries							
				College	Voc. School	Hospital	Private Clinic	HH Goods	Hardware	Medical Shop	Electronic Shop	Textile Shop	Agri. Traders	Milk Collection	Agro-based Industries	Forest Based Industries	Textile & Leather	Service Industries	Mech. Fabrication	Agri. Service Center	Centrality Index
1	Parasi	7,177	9,660	1.0	2.0	1.0	10.0	20.0	10.0	20.0	12.0	20.0	7.0	1.0	10.0	5.0	2.0	20.0	10.0	4.0	183.7
2	Kawasoti	9,764	14,141	3.0	3.0	2.0	6.0	15.0	10.0	15.0	9.0	15.0	10.0	3.0	8.0	10.0	2.0	14.0	10.0	3.0	172.5
3	Bardhaghat	11,334	16,415	2.0	2.0	1.0	10.0	15.0	10.0	8.0	6.0	10.0	5.0	2.0	5.0	8.0	4.0	4.0	8.0	3.0	128.9
4	Mukundapur	4,239	6,139	1.0	1.0	0.0	4.0	12.0	5.0	6.0	4.0	6.0	5.0	3.0	4.0	4.0	3.0	7.0	2.0	3.0	81.4
5	Sunwal	5,177	7,497	2.0	2.0	2.0	6.0	15.0	10.0	10.0	6.0	8.0	4.0	2.0	4.0	5.0	1.0	5.0	4.0	1.0	106.0
6	Gaindakot	15,086	21,849	2.0	2.0	1.0	4.0	5.0	3.0	4.0	4.0	5.0	2.0	2.0	7.0	5.0	5.0	10.0	12.0	5.0	107.6
7	Triheni	4,278	5,349	1.0	1.0	0.0	1.0	5.0	3.0	4.0	5.0	8.0	2.0	1.0	2.0	1.0	1.0	4.0	2.0	2.0	51.1
8	Maheshpur	2,499	3,124	0.0	1.0	0.0	2.0	8.0	2.0	3.0	6.0	10.0	2.0	1.0	1.0	0.0	1.0	2.0	2.0	0.0	46.4
9	Naya Belhani	4,088	5,921	1.0	1.0	0.0	4.0	6.0	4.0	4.0	4.0	8.0	3.0	2.0	2.0	3.0	0.0	4.0	3.0	2.0	61.9
10	Gopigunj	4,364	5,456	1.0	1.0	0.0	4.0	5.0	3.0	5.0	5.0	6.0	5.0	1.0	3.0	4.0	1.0	3.0	4.0	2.0	65.6
11	Dumkibas	3,099	4,488	0.0	1.0	0.0	2.0	8.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	3.0	1.0	2.0	3.0	2.0	49.2
12	Pragatinagar	9,649	13,974	1.0	1.0	0.0	2.0	7.0	5.0	5.0	5.0	5.0	5.0	4.0	5.0	4.0	1.0	3.0	3.0	1.0	69.2
13	Chormara	4,125	5,552	1.0	1.0	1.0	5.0	6.0	4.0	5.0	3.0	4.0	3.0	2.0	3.0	3.0	1.0	2.0	2.0	1.0	57.2
14	Dhurkot	8,112	10,142	0.0	0.0	0.0	1.0	3.0	2.0	2.0	1.0	4.0	2.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	24.3
15	Dedgaon	1,667	2,084	1.0	1.0	1.0	1.0	6.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	34.0
16	Bulingtar	3,934	4,992	1.0	2.0	0.0	1.0	2.0	1.0	2.0	1.0	3.0	2.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	27.4
17	Thambesi	469	595	0.0	0.0	0.0	1.0	2.0	1.0	1.0	1.0	2.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	15.3
18	Dhobadi	357	453	0.0	0.0	0.0	1.0	2.0	1.0	1.0	1.0	2.0	2.0	0.0	1.0	1.0	0.0	1.0	2.0	1.0	20.2
19	Jhyalbas	2,106	3,050	1.0	. 0.0	0.0	1.0	4.0	3.0	3.0	2.0	3.0	2.0	1.0	2.0	1.0	0.0	1.0	2.0	1.0	33.4
	Total Functions			19	22	9	66	146	82	103	79	124	65	31	62	60	24	86	74	35	
	Median Population			6,030	5,921	9,660	5,552	5,552	5,552	5,552	5,552	5,552	5,552	5,737	5,737	5,921	6,139	5,552	5,552	5,737	
	Weight			2.30	2.00	2.00	1.03	1.03	1.13	1.03	1.03	1.03	1.02	1.22	1.22	1.46	1.00	1.03	2.38	1.35	

*The planning period is considered to be 15 years. Therefore future centrality index indicates the situation after 15 years.

a The population growth rate will be 1.06 during the planning period.

Table 4 Future Centrality Index of Market Centers (Regional)

No	Market Center	Future Pop.	CI	Remarks
1	Gaindakot	166,881	308	
2	Mukundapur	6,139	81	Three centers combined
3	Chormara	5,552	57	
4	Naya Belhani	5,921	62	
5	Dumkibas	4,488	49	
6	Dhurkot	7,042	25	Palpa, CI approximate
7	Rukshe Bhanjyang	2,725	20	Palpa, CI approximate
8	Dedgaon	2,084	34	Tanahun,CI approximate
9	Kawaswoti	14,141	172	
10	Pragatinagar	13,974	69	
11	Jhyalbas	3050	33	CI estimated
12	Thambensi	595	15	CI estimated
13	Hupsekot	4,682	12	CI estimated
14	Bulintar	4,992	15	CI estimated

CI = Centrality Index

Pop. = Population

Table 5 District Road Inventory

ID	Road	Length (km.)		Surface	Road
		GIS	DOR/PLRP		Class
1	Dumkibas - Jhadewa (Dhurkot)	25.0	26.5	E	DR
2	Naya Belhani - Ruksebhanjyang (Majhkot)	14.3	18.5	E	MT
3	Chormara - Jhyalbas	11.0		E	DR
4	Jhyalbas - Hupsekot	12.7		E	MT
5	Kawasoti - Dedgaon	29.0	28.0	E	MT
6	Mukundapur - Thambensi	18.3		E	MT
7	Dhobadi - Bulintar	12.9		E	MT
Road Inventory		123.2			

Dumkibas - Jhadewa (Dhurkot): The final destination of the road is Jhadewa. However, at the first stage road construction upto Dhurkot is planned. Similarly, the final destination of the road originating from Naya Belhani is Ruksebhanjyang, in the first phase, the road will be constructed upto Majhkot.

Table 6 Base Year Two Way AADT in Each Link

Trn. Mode	Transport Routes						
	1	2	3	4	5	6	7
Length (km.)	25.0	14.3	33.5	12.7	29.0	18.3	12.9
Passenger							
Bus	5	0	3	0	0	0	0
Mini Bus	0	0	3	0	0	0	0
Jeep	3	0	5	0	5	6	0
Auto	0	0	0	0	0	0	0
Motorcycle	0	0	0	0	0	0	0
Bicycle	0	0	0	0	0	0	0
Pedistrian	19	130	10	120	180	30	220
T. Passenger[1]	86191.1	47450	101123	43800	83220	32850	80300
Freight							
Truck	2	1	3	0	5	2	2
Tractor	6	6	7	0	10	4	7
Mules	0	7	0	0	0	0	5
Porter	30	15	10	90	36	65	85
T. Freight	66430	53837.5	85063.3	13140	127896	62561	80847.5

Assumptions on carrying capacity of Passengers: Bus - 40, Mini Bus - 25, Auto - 3, Jeep - 10, Motorcycle - 1.5, Bicycle - 1, Pedestrian - 1
Carrying capacity of Freight in quintal (100kg.): Truck - 40, Tractor - 15, Mules - 0.8, Porter - 0.6
[1] = The given figures of AADT is multiplied with the assumed carrying capacity and the AADT is multiplied with 365 days in a year for annual calculations.

167

Table 7 Origin and Destination of the Market Centers

Market Centers	C.I.	Pop.	Gaindakot	Mukundapur (	Chormara	Naya Belhani	Dumkibas	Jhadewa	R. Bhan.	Dedgaon	Kawaswati	Pragatinagar	Jhyalbas	Thambensi	Hupsekot	Bulintar
C.I.			200	39	13	24	16	8	7	7	56	25	6	5	5	6
Gaindakot	200	81,990	0	15	44	52	62	80	70	62	33	27	88	33	68	47
Mukundapur	39	4,239		0	29	37	47	65	55	51	18	5	55	18.3	53	32
Chormara	13	4,125			0	8	18	36	26	40	11	17	11	47	23.7	25
Naya Belhani	24	4,088				0	10	28	18	48	19	25	19	55	32	33
Dumkibas	16	3,099					0	18	28	58	29	35	29	65	42	43
Dhurkot	8	5,500						0	17	76	47	53	29	65	60	79
Rukshe Bhanjyang	7	2,148							0	62	37	43	37	36	50	47
Dedgaon	7	3,461								0	29	35	51	65.3	63.3	15.3
Kawaswati	56	9,764									0	6	22	36.3	34.5	26.6
Pragatinagar	25	9,649										0	28	23.3	40.5	19.7
Jhayalbas	6	3,375											0	58	11	36
Thambensi	5	3,362												0	71	50
Hupsekot	5	3,690													0	49
Bulintar	6	3,934														0

Table 8 Present Intensity of Interaction among the Market Centers

Market Centers	C.I.	Pop.	Gaindakot	Mukundapur	Chormara	Naya Belhani	Dumkibas	Jhadewa	R. Bhan.	Dedgaon	Kawaswati	Pragatinagar	Jhyalbas	Thambensi	Hupsekot	Bulintar
C.I.			893	160	75	85	77	25	20	150	319	85	6	5	5	6
Gaindakot	199.87	81990	0.00	12.72	0.45	0.59	0.21	0.11	0.05	0.10	8.19	5.35	0.04	0.25	0.07	0.18
Mukundapur	38.51	4239		0.00	0.010	0.012	0.004	0.002	0.0008	0.002	0.27	1.55	0.001	0.008	0.001	0.004
Chormara	12.93	4125			0.00	0.08	0.008	0.002	0.001	0.0008	0.24	0.04	0.009	0.0004	0.002	0.002
Naya Belhani	23.67	4088				0.00	0.05	0.005	0.004	0.0010	0.15	0.04	0.0054	0.0005	0.002	0.002
Dumkibas	16.23	3099					0.0000	0.007	0.0010	0.0004	0.03	0.010	0.001	0.0002	0.0005	0.0006
Jhadewa	8.00	5500						0.00	0.002	0.0002	0.01	0.004	0.001	0.0002	0.0002	0.0002
Rukshe Bhanjyang	7.00	2148							0.00	0.0001	0.006	0.002	0.0002	0.0002	0.0001	0.0002
Dedgaon	7.00	3461								0.00	0.02	0.005	0.0002	0.0001	0.0001	0.002
Kawaswati	55.76	9764									0.00	3.60	0.02	0.007	0.008	0.018
Pragatinagar	24.65	9649										0.00	0.006	0.007	0.003	0.01
Jhayalbas	6.00	3375											0.00	0.0001	0.00	0.0004
Thambensi	5.00	3362												0.00	0.000	0.0002
Hupsekot	5.00	3690													0.00	0.0002
Bulintar	6.00	3934														0.00

Table 9 Future Intensity of Interaction among the Market Centers

Market Centers	C.I.	Pop.	Gaindakot	Mukundapur	Chormara	Naya Belhani	Dumkibas	Dhurkot	R. Bhan.	Dedgaon	Kawaswati	Pragatinagar	Jhyalbas	Thambensi	Hupsekot	Bulintar
CI			308	81	57	62	49	25	20	34	172	69	33	15	12	15.00
Gaindakot	308	166881	0	122	8	6.96	2.95	1.41	0.57	0.95	114.97	68	0.67	0.43	0.62	1.74
Mukundapur	81	6139		0	0.19	0.13	0.05	0.02	0.01	0.01	3.76	19	0.02	0.01	0.01	0.04
Chormara	57	5552			0	1.82	0.22	0.04	0.03	0.014	6.40	1.06	0.27	0.0013	0.03	0.04
Naya Belhani	62	5921				0	0.81	0.08	0.06	0.011	2.48	0.57	0.10	0.0011	0.02	0.03
Dumkibas	49	4488					0	0.12	0.02	0.005	0.64	0.17	0.03	0.0005	0.01	0.009
Dhurkot (Jhadewa)	25	7042						0	0.03	0.002	0.19	0.06	0.02	0.0004	0.003	0.002
Rukshe Bhanjyang	20	2725							0	0.001	0.10	0.03	0.004	0.0004	0.001	0.002
Dedgaon (Bhimad)	34	2084								0	0.21	0.06	0.003	0.0002	0.001	0.023
Kawaswati	172	14141									0	65	0.51	0.017	0.12	0.26
Pragatinagar	69	13974										0	0.13	0.016	0.03	0.19
Jhayalbas	33	3050											0.0	0.0003	0.05	0.006
Thambensi	15	595												0.0	0.0001	0.00
Hupsekot	12	4682													0	0.002
Bulintar	15	4992														0

Table 10 Cultivated Area within the Zone of Influence (Ha.)

ID	Road	Length (km.)	Area (Ha.)	Area per Km.
1	Kawasoti - Dedgaon	29.0	6942	239
2	Dhobadi - Bulingtar	12.9	3054	237
3	Mukundapur - Thambensi	18.3	2796	153
4	Dumkibas - Dhurkot	25.0	3255	130
5	Jhyalbas - Hupsekot	12.7	1409	111
6	Arun Khola - Majhkot	14.3	1385	97
7	Chormara - Jhyalbas	11.0	Road already constructed	

Land area derived from the GIS.

Table 11 Interaction Among the Nodal Points

ID	Road	Length (km.)	Interaction
1	Kawasoti - Dedgaon (Bhimad)	29.0	0.21
2	Dhobadi (Kawasoti) - Bulintar	12.9	0.26
3	Mukundapur - Thambensi	18.3	0.01
4	Chormara - Jhyalbas	11.0	0.27
5	Dumkibas - Dhurkot (Jhadewa)	25.0	0.12
6	Naya Belhani - Majhkot (Ruksekot)	14.3	0.06
7	Jhyalbas - Hupsekot	12.7	0.05

Table 12 Prioritization of the Proposed Roads[1]

R. No.	Road Name	Parameters				Total Score	Rank
		Agri. Potential	Interaction	Accessibility	Environmental Impact		
	Weight	0.3	0.45	0.15	0.1	1	
1	Dumkibas - Dhurkot (Jhadewa)	0.16	0.26	0.075	0.05	0.55	III
2	Kawasoti - Dedgaon (Bhimad)	0.3	0.45	0.15	0.06	0.96	I
3	Jhyalbas - Hupsekot	0.14	0.10	0.15	0.05	0.44	V
4	Chormara - Jhyalbas[2]						
5	Kawasoti (Dhobadi) - Bulintar	0.30	0.57	0.15	0.03	1.04	II
6	Mukundapur - Thambensi	0.19	0.03	0.15	0.06	0.43	VI
7	Naya Belhani - Ruksebhanjyang (Majhkot)	0.12	0.14	0.15	0.07	0.48	IV

[1]The quantification of the prioritization criteria will be as follows:

Agricultural Potential = The largest land area gets the full score and other links get proportionately less score.

Interaction = The highest interaction obtains the full score and score decreases proportionately.

Accessibility = This indicator can be divided into three categories as: Inaccessible - the area which remains inaccessible throughout the year in accordance to the definition is called as inaccessible area. Such areas gets the highest score. The area if gets accessible during the dry season and gets inaccessible during the rainy season it should get 50% of the highest score. If the area is within the ZOI of fully accessible road, it gets zero score.

Environmental Impact = One should use the executive judgement of the experts for the environmental impact.

[2] Road is already constructed.

Appendix 3

Model for Under Developed Areas Based on Economic Analysis

Index of Worksheets

Sheet No.	Table No.	Contents
A	1	Matrix of Present Centrality Index (Within the district)
	2	Centrality Index of Market Centers (Regional Level)
B	3	Matrix of Future Centrality Index (Within the District)
	4	Future Centrality Index of Market Centers (Regional)
C	5	District Road Inventory in the Developed Areas
D	6	Origin and Destination of the Matrix among the Market Centers
	7	Present Intensity of Interaction among the Market Centers
E	8	Future Intensity of Interaction among the Market Centers
	9	Future Aggregated Interaction by Links
F	10	Base Year Two Way AADT in Each Link
G	11	Intensity of Interaction (IOI) and Volume of Passenger (VOP)
	12	Intensity of Interaction (IOI) and Volume of Freight (VOF)
	Fig. 1	Relationship Between IOI and VOP
	Fig. 2	Relationship Between IOI and VOF
H	13	Projected Traffic Growth of Passengers (With Road)
	14	Projected Traffic Growth of Freight (With Road)
I	15	Per Hour Hiring Rate of Equipment
	16	Hourly Rates of Laborers
	17	Unit Price of Materials
J	18	Construction Norms
K	19	Geometric Standard for District Roads in Hilly Areas
	20	Typical Quantities of Major Works per Km of District Roads in Hilly Areas
L	21	Unit Cost for New Construction in Hilly Areas
M	22	Construction Cost for Proposed Road Projects
N	23	Annual Construction and Maintenance Cost
	24	Per Km Maintenance Cost
O	25	Traffic Composition
P	26	Transport Cost
	27	Per Km. Travelling Speed
	28	Per Km. Travelling Time
	29	Savings in Transportation Costs
	30	Benefits from Savings in Travelling Time
Q	31	Total Transport Benefits
	32	Aggregation of Net Costs and Benefits
	33	Prioritization of the Proposed Roads

Table 1 Matrix of Present Centrality Index (Within the District)

No.	Market Center	Population, 1991@	Population, 2001*	Educational		Health		Commercial							Industries							
				College	Vocational School	Hospital	Private Clinic	HH Goods	Hardware	Medical Shop	Eletronic Shop	Textile Shop	Agri. Traders	Milk Colletion	Agro-based Industries	Forest Based Industries	Textile & Leather	Service Industries	Mechcanical Febrication	Agri. Service Center	Centrality Index
1	Parasi	5,607	7,177	1.0	1.0	1.0	3.0	9.0	3.0	10.0	4.0	7.0	2.0	1.0	2.0	2.0	0.0	8.0	4.0	1.0	71
2	Kawaswati	5,994	9,764	1.0	1.0	1.0	2.0	8.0	2.0	5.0	3.0	5.0	4.0	1.0	3.0	1.0	0.0	7.0	2.0	1.0	56
3	Bardhaghat	8,035	11,334	1.0	0.0	0.0	3.0	7.0	2.0	4.0	2.0	6.0	2.0	0.0	1.0	1.0	0.0	0.0	1.0	0.0	34
4	Amarapuri	3,154	4,239	0.0	0.0	0.0	2.0	9.0	2.0	4.0	3.0	3.0	3.0	1.0	2.0	1.0	1.0	4.0	0.0	1.0	39
5	Sunwal	3,178	5,177	0.0	0.0	0.0	1.0	5.0	1.0	2.0	2.0	3.0	2.0	1.0	2.0	1.0	0.0	2.0	1.0	0.0	26
6	Gaindakot	8,424	15,086	0.0	0.0	0.0	2.0	4.0	2.0	2.0	2.0	1.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	0.0	25
7	Tribeni	3,342	4,278	0.0	0.0	0.0	1.0	3.0	1.0	2.0	2.0	5.0	1.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	18
8	Maheshpur	1,952	2,499	0.0	0.0	0.0	1.0	6.0	1.0	2.0	2.0	6.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	21
9	Arun Khola	2,762	4,088	0.0	0.0	0.0	2.0	3.0	2.0	2.0	2.0	4.0	1.0	1.0		1.0	0.0	2.0	1.0	0.0	24
11	Gopigunj	2,948	4,364	0.0	0.0	0.0	1.0	3.0	1.0	1.0	1.0	3.0	1.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	14
12	Dumkibas	2,197	3,099	0.0	0.0	0.0	2.0	4.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	16
13	Pragatinagar	6,213	9,649	0.0	0.0	0.0	3.0	3.0	2.0	3.0	2.0	3.0	1.0	1.0	2.0	0.0	0.0	1.0	1.0	0.0	25
14	Chormara	2,787	4,125	0.0	0.0	0.0	1.0	3.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	13
	Total Functions			3.0	2.0	2.0	24.0	67.0	20.0	40.0	27.0	48.0	20.0	7.0	17.0	9.0	4.0	30.0	12.0	4.0	
	Median Population			9764	8471	8471	4364	4364	4770	4364	4364	4364	4321	5177	5177	6177	4239	4364	9649	5708	
	Weight			2.30	2.00	2.00	1.03	1.03	1.13	1.03	1.03	1.03	1.02	1.22	1.22	1.46	1.00	1.03	2.28	1.35	

@ Population based on the population census.

* Population growth rate assumed to be 2.04 during the period of 1991-2001.

Table 2 Present Centrality Index of Regional Market Centers

No.	Market Centers	Pop.	CI	Remarks
1	Gaindakot	81,990	199.87	CI of Narayanghat included
2	Mukundapur	4,239	38.51	
3	Chormara	4,125	12.93	
4	Naya Belhani	4,088	23.67	
5	Dumkibas	3,099	16.23	
6	Jhadewa	5,500	8.00	CI approximate
7	Rukshe Bhanjyang	2,148	7.00	CI approximate
8	Dedgaon	3,461	7.00	CI approximate
9	Kawaswati	9,764	55.76	
10	Pragatinagar	9,649	24.65	
11	Jhyalbas	3,375	6.00	
12	Thambensi	3,362	5.00	
13	Hupsekot	3,690	5.00	
14	Bulintar	3,934	6.00	

CI = Centrality Index

Table 3 Matrix of Future Centrality Index *(Within the District)

No.	Market Center	Population, 2001	Population, 2016ᵃ	Educational		Health		Commercial							Industries						
				College	Voc. School	Hospital	Private Clinic	HH Goods	Hardware	Medical Shop	Electronic Shop	Textile Shop	Agri. Traders	Milk Collection	Agro-based Industries	Forest Based Industries	Textile & Leather	Service Industries	Mech. Fabrication	Agri. Service Center	Centrality Index
1	Parasi	7,177	9,660	1.0	2.0	1.0	10.0	20.0	10.0	20.0	12.0	20.0	7.0	1.0	10.0	5.0	2.0	20.0	10.0	4.0	182.7
2	Kawaswati	9,764	14,141	3.0	3.0	2.0	6.0	15.0	10.0	15.0	9.0	15.0	10.0	3.0	8.0	10.0	2.0	14.0	10.0	3.0	171.5
3	Bardhaghat	11,334	16,415	2.0	2.0	1.0	10.0	15.0	10.0	8.0	6.0	10.0	5.0	2.0	5.0	8.0	4.0	4.0	8.0	3.0	128.1
4	Mukundapur	4,239	6,139	1.0	1.0	0.0	4.0	12.0	5.0	6.0	4.0	6.0	5.0	3.0	4.0	4.0	3.0	7.0	2.0	3.0	81.2
5	Sunwal	5,177	7,497	2.0	2.0	2.0	6.0	15.0	10.0	10.0	6.0	8.0	4.0	2.0	4.0	5.0	1.0	5.0	4.0	1.0	105.6
6	Gaindakot	15,086	21,849	2.0	2.0	1.0	4.0	5.0	3.0	4.0	4.0	5.0	2.0	2.0	7.0	5.0	5.0	10.0	12.0	5.0	106.4
7	Tribeni	4,278	5,349	1.0	1.0	0.0	1.0	5.0	3.0	4.0	5.0	8.0	2.0	1.0	2.0	1.0	1.0	4.0	2.0	2.0	50.9
8	Maheshpur	2,499	3,124	0.0	1.0	0.0	2.0	8.0	2.0	3.0	6.0	10.0	2.0	1.0	1.0	0.0	1.0	2.0	2.0	0.0	46.2
9	Naya Belhani	4,088	5,921	1.0	1.0	0.0	4.0	6.0	4.0	4.0	4.0	8.0	3.0	2.0	2.0	3.0	0.0	4.0	3.0	2.0	61.6
10	Gopigunj	4,364	5,456	1.0	1.0	0.0	4.0	5.0	3.0	5.0	5.0	6.0	5.0	1.0	3.0	4.0	1.0	3.0	4.0	2.0	65.2
11	Dumkibas	3,099	4,488	0.0	1.0	0.0	2.0	8.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	3.0	1.0	2.0	3.0	2.0	48.9
12	Pragatinagar	9,649	13,974	1.0	1.0	0.0	2.0	7.0	5.0	5.0	5.0	5.0	5.0	4.0	5.0	4.0	1.0	3.0	3.0	1.0	68.9
13	Chormara	4,125	5,552	1.0	1.0	1.0	5.0	6.0	4.0	5.0	3.0	4.0	3.0	2.0	3.0	3.0	1.0	2.0	2.0	1.0	57.0
14	Dhurkot	8,112	10,142	0.0	0.0	0.0	1.0	3.0	2.0	2.0	1.0	4.0	2.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	24.2
15	Dedgaon	1,667	2,084	1.0	1.0	1.0	1.0	6.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	33.8
16	Bulingtar	3,934	4,992	1.0	2.0	0.0	1.0	2.0	1.0	2.0	1.0	3.0	2.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	27.3
17	Thambesi	469	595	0.0	0.0	0.0	1.0	2.0	1.0	1.0	1.0	2.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	15.2
18	Dhowadi	357	453	0.0	0.0	0.0	1.0	2.0	1.0	1.0	1.0	2.0	2.0	0.0	1.0	1.0	0.0	1.0	2.0	1.0	20.0
19	Jhyalbas	2,106	3,050	1.0	0.0	0.0	1.0	4.0	3.0	3.0	2.0	3.0	2.0	1.0	2.0	1.0	0.0	1.0	2.0	1.0	33.2
	Total Functions			19	22	9	66	146	82	103	79	124	65	31	62	60	24	86	74	35	
	Median Population			6,030	5,921	9,660	5,552	5,552	5,552	5,552	5,552	5,552	5,552	5,737	5,737	5,921	6,139	5,552	5,552	5,737	
	Weightᵇ			2.30	2.00	2.00	1.03	1.03	1.13	1.03	1.03	1.03	1.02	1.22	1.22	1.46	1.00	1.03	2.28	1.35	

*The planning period is considered to be 15 years. Therefore future centrality index indicates the situation after 15 years.

[a] The population growth rate will be 1.06 during the planning period.

[b] The weight of the present Centrality Index is taken.

Table 4 Future Centrality Index of Market Centers (Regional)

No	Market Center	Future Pop.	CI	Remarks
1	Gaindakot	166,881	306.38	
2	Mukundapur	6,139	81.21	Three centers combined
3	Chormara	5,552	57.02	
4	Naya Belhani	5,921	61.58	
5	Dumkibas	4,488	48.86	
6	Dhurkot	7,042	25.00	Palpa, CI approximate
7	Rukshe Bhanjyang	2,725	20.00	Palpa, CI approximate
8	Dedgaon	2,084	33.78	Tanahun,CI approximate
9	Kawaswoti	14,141	171.49	
10	Pragatinagar	13,974	68.87	
11	Jhyalbas	3050	33.18	CI estimated
12	Thambensi	595	15.24	CI estimated
13	Hupsekot	4,682	12.00	CI estimated
14	Bulintar	4,992	15.00	CI estimated

CI = Centrality Index

Pop. = Population

Table 5 District Road Inventory in the Under-Developed Areas

ID	Road	Length (km.)		Surface	Road
		GIS	DOR/PLRP		Class
1	Dumkibas - Jhadewa (Dhurkot)	25.0	26.5	E	DR
2	Naya Belhani - Ruksebhanjyang (Majhkot)	14.3	18.5	E	MT
3	Chormara - Jhyalbas	11.0		E	DR
4	Jhyalbas - Hupsekot	12.7		E	MT
5	Kawasoti - Dedgaon	29.0	28.0	E	MT
6	Mukundapur - Thambensi	18.3		E	MT
7	Dhobadi - Bulintar	12.9		E	MT
Road Inventory		123.2			

Dumkibas - Jhadewa (Dhurkot): The final destination of the road is Jhadewa. However, at the first stage road construction upto Dhurkot is planned. Similarly, the final destination of the road originating from Naya Belhani is Ruksebhanjyang, in the first phase, the road will be constructed upto Majhkot.

Table 6 Origin and Destination Matrix among the Market Centers

Market Centers	F.I.	Pop.	Gaindakot	Mukundapur	Chormara	Naya Belhani	Dumkibas	Jhadewa	R. Bhan.	Dedgaon	Kawaswati	Pragatinagar	Jhyalbas	Thambensi	Hupsekot	Bulintar
FI			200	39	13	24	16	8	7	7	56	25	6	5	5	6
Gaindakot	200	81,990	0	15	44	52	62	80	70	62	33	27	88	33	68	47
Mukundapur	39	4,239		0	29	37	47	65	55	51	18	5	55	18.3	53	32
Chormara	13	4,125			0	8	18	36	26	40	11	17	11	47	23.7	25
Naya Belhani	24	4,088				0	10	28	18	48	19	25	19	55	32	33
Dumkibas	16	3,099					0	18	28	58	29	35	29	65	42	43
Dhurkot	8	5,500						0	17	76	47	53	29	65	60	79
Rukshe Bhanjyang	7	2,148							0	62	37	43	37	36	50	47
Dedgaon	7	3,461								0	29	35	51	65.3	63.3	15.3
Kawaswati	56	9,764									0	6	22	36.3	34.5	26.6
Pragatinagar	25	9,649										0	28	23.3	40.5	19.7
Jhayalbas	6	3,375											0	58	11	36
Thambensi	5	3,362												0	71	50
Hupsekot	5	3,690													0	49
Bulintar	6	3,934														0

Table 7 Present Intensity of Interaction among the Market Centers

Market Centers	C.I.	Pop.	Gaindakot	Mukundapur	Chormara	Naya Belhani	Dumkibas	Jhadewa	R. Bhan.	Dedgaon	Kawaswati	Pragatinagar	Jhyalbas	Thambensi	Hupsekot	Bulintar
CI			200	39	13	24	16	8	7	7	56	25	6	5	5	6
Gaindakot	199.87	81990	0.00	12.72	0.45	0.59	0.21	0.11	0.05	0.10	8.19	5.35	0.04	0.25	0.07	0.18
Mukundapur	38.51	4239		0.00	0.010	0.012	0.004	0.002	0.0008	0.002	0.27	1.55	0.001	0.008	0.001	0.004
Chormara	12.93	4125			0.00	0.08	0.008	0.002	0.001	0.0008	0.24	0.04	0.009	0.0004	0.002	0.002
Naya Belhani	23.67	4088				0.00	0.05	0.005	0.004	0.0010	0.15	0.04	0.0054	0.0005	0.002	0.002
Dumkibas	16.23	3099					0.0000	0.007	0.0010	0.0004	0.03	0.010	0.001	0.0002	0.0005	0.0006
Jhadewa	8.00	5500						0.00	0.002	0.0002	0.01	0.004	0.001	0.0002	0.0002	0.0002
Rukshe Bhanjyang	7.00	2148							0.00	0.0001	0.006	0.002	0.0002	0.0002	0.0001	0.0002
Dedgaon	7.00	3461								0.00	0.02	0.005	0.0002	0.0001	0.0001	0.002
Kawaswati	55.76	9764									0.00	3.60	0.02	0.007	0.008	0.018
Pragatinagar	24.65	9649										0.00	0.006	0.007	0.003	0.01
Jhayalbas	6.00	3375											0.00	0.0001	0.00	0.0004
Thambensi	5.00	3362												0.00	0.000	0.0002
Hupsekot	5.00	3690													0.00	0.0002
Bulintar	6.00	3934														0.00

Table 8 Future Intensity of Interaction among the Market Centers

Market Centers	C.I.	Pop.	Gaindakot	Mukundapur	Chormara	Naya Belhani	Dumkibas	Dhurkot	R. Bhan.	Dedgaon	Kawaswati	Pragatinagar	Jhyalbas	Thambensi	Hupsekot	Bulintar
CI			306	81	57	62	49	25	20	34	171	69	33	15	12	15.00
Gaindakot	306	166881	0	121	8	6.89	2.92	1.41	0.57	0.94	113.85	67	0.67	0.43	0.62	1.73
Mukundapur	81	6139		0	0.19	0.13	0.05	0.02	0.01	0.01	3.73	19	0.02	0.01	0.01	0.04
Chormara	57	5552			0	1.80	0.21	0.04	0.03	0.014	6.34	1.05	0.26	0.0013	0.03	0.04
Naya Belhani	62	5921				0	0.80	0.08	0.06	0.011	2.45	0.56	0.10	0.0011	0.02	0.03
Dumkibas	49	4488					0	0.12	0.02	0.005	0.63	0.17	0.03	0.0005	0.01	0.009
Dhurkot (Jhadewa)	25	7042						0	0.03	0.002	0.19	0.06	0.02	0.0004	0.003	0.002
Rukshe Bhanjyang	20	2725							0	0.001	0.10	0.03	0.004	0.0004	0.001	0.002
Dedgaon (Bhimad)	34	2084								0	0.20	0.06	0.003	0.0001	0.001	0.023
Kawaswati	171	14141									0	65	0.51	0.017	0.11	0.26
Pragatinagar	69	13974										0	0.12	0.016	0.03	0.19
Jhayalbas	33	3050											0.0	0.0003	0.05	0.006
Thambensi	15	595												0.0	0.0001	0.00
Hupsekot	12	4682													0	0.002
Bulintar	15	4992														0

Table 9 Future Aggregated Interaction by Link

ID	Length km	Interaction
1	25.0	0.12
2	14.3	0.06
3	11.0	0.26
4	12.7	0.05
5	29.0	0.20
6	18.3	0.01
7	12.9	0.26

Table 10 Base Year Two Way AADT in Each Link

Mode	Transport Routes						
	1	2	3	4	5	6	7
Length (km.)	25.0	14.3	33.5	12.7	29.0	18.3	12.9
Passenger							
Bus	5	0	3	0	0	0	0
Mini Bus	0	0	3	0	0	0	0
Jeep	3	0	5	0	5	6	0
Auto	0	0	0	0	0	0	0
Motorcycle	0	0	0	0	0	0	0
Bicycle	0	0	0	0	0	0	0
Pedistrian	19	130	10	120	180	30	220
T. Passenger[1]	86191	47450	101123	43800	83220	32850	80300
Freight							
Truck	2	1	3	0	5	2	2
Tractor	6	6	7	0	10	4	7
Mules	0	7	0	0	0	0	5
Porter	30	15	10	90	36	65	85
T. Freight	66430	53838	85063	13140	127896	62561	80848

Assumptions on carrying capacity of Passengers: Bus - 40, Mini Bus - 25,
Auto - 3, Jeep - 10, Motorcycle - 1.5, Bicycle - 1, Pedestrian - 1
Carrying capacity of Freight in quintal (100kg.): Truck - 40, Tractor - 15,
Mules - 0.8, Porter - 0.6

[1] = The given figures of AADT is multiplied with the assumed carrying capacity and the AADT is multiplied with 365 days in a year for annual calculations.

Table 11 IOI and VOP

ID	Interaction	VOP
1	0.007	86191
2	0.004	47450
3	0.009	101123
4	0.003	43800
5	0.016	83220
6	0.008	32850
7	0.018	80300

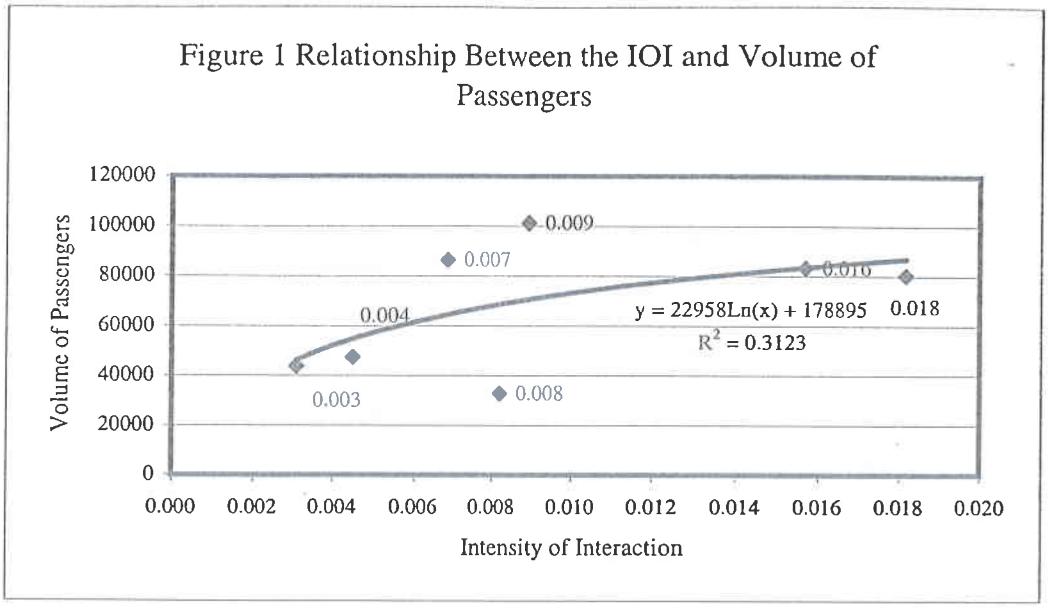


Table 12 IOI and VOF

ID	Interaction	VOF
1	0.007	66430
2	0.004	53838
3	0.009	85063
4	0.003	13140
5	0.016	127896
6	0.008	62561
7	0.018	80848

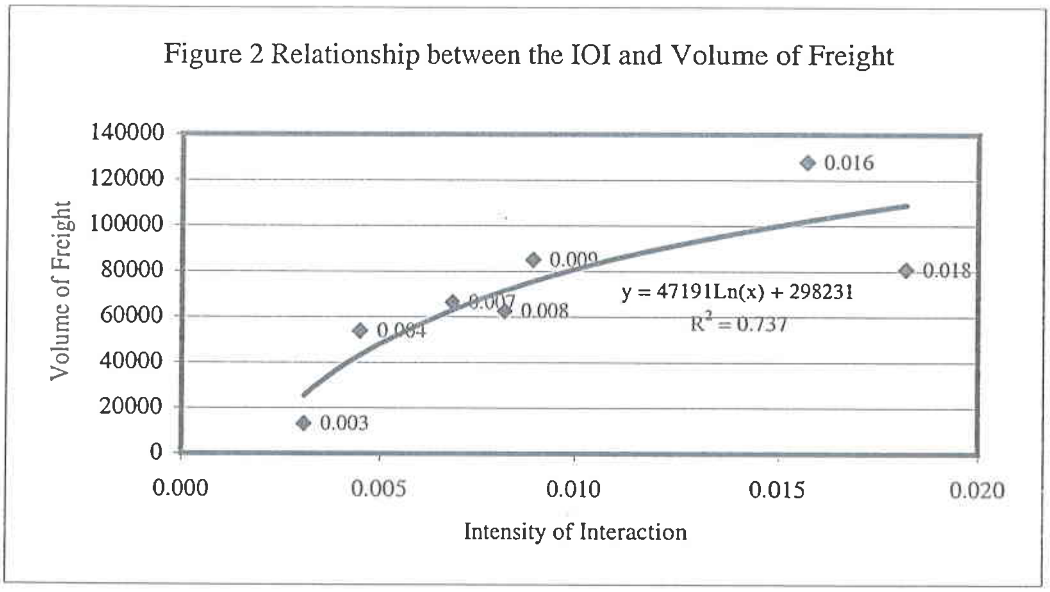


Table 13 Projected Traffic Growth of Passengers (With Road)

Link	Length (km.)	Base Year Passengers	Forecasted Passengers	Growth Rate	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	25	86,191	130,057	2.78%	88,588	91,051	93,583	96,185	98,860	101,609	104,434	107,338	110,323	113,391	116,544	119,784	123,115	126,539	130,057
2	14	47,450	114,811	6.07%	50,329	53,383	56,622	60,058	63,702	67,567	71,667	76,015	80,628	85,520	90,709	96,213	102,051	108,243	114,811
3	11	101,123	148,388	2.59%	103,742	106,428	109,184	112,012	114,912	117,888	120,941	124,073	127,286	130,582	133,964	137,433	140,992	144,643	148,388
4	13	43,800	108,693	6.25%	46,536	49,443	52,531	55,813	59,299	63,003	66,939	71,120	75,563	80,283	85,298	90,626	96,287	102,302	108,693
5	29	83,220	142,287	3.64%	86,250	89,389	92,644	96,016	99,512	103,134	106,889	110,780	114,813	118,993	123,324	127,814	132,467	137,289	142,287
6	18	32,850	80,061	6.12%	34,860	36,993	39,257	41,659	44,208	46,913	49,783	52,829	56,062	59,492	63,132	66,995	71,094	75,445	80,061
7	13	80,300	147,668	4.14%	83,628	87,095	90,705	94,464	98,380	102,457	106,704	111,127	115,733	120,530	125,526	130,729	136,147	141,791	147,668

Table 14 Projected Traffic Growth of Freight (With Road)

Link	Length (km.)	Base Year Freight	Forecasted Freight	Growth Rate	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	25	66,430	197,843	7.55%	71,443	76,835	82,633	88,869	95,576	102,789	110,546	118,889	127,861	137,510	147,888	159,048	171,051	183,960	197,843
2	14	53,838	166,504	7.82%	58,046	62,584	67,477	72,752	78,439	84,571	91,182	98,310	105,996	114,282	123,216	132,848	143,234	154,431	166,504
3	11	85,063	235,523	7.03%	91,039	97,435	104,280	111,606	119,446	127,838	136,819	146,430	156,717	167,727	179,510	192,121	205,618	220,063	235,523
4	13	13,140	153,927	17.83%	15,483	18,243	21,495	25,327	29,843	35,163	41,432	48,818	57,521	67,776	79,859	94,096	110,871	130,637	153,927
5	29	127,896	222,983	3.78%	132,725	137,735	142,935	148,332	153,932	159,743	165,774	172,033	178,528	185,268	192,262	199,521	207,053	214,871	222,983
6	18	62,561	95,074	2.83%	64,331	66,151	68,023	69,948	71,927	73,962	76,054	78,206	80,419	82,694	85,034	87,440	89,914	92,458	95,074
7	13	80,848	234,042	7.34%	86,784	93,157	99,998	107,341	115,224	123,685	132,768	142,517	152,983	164,217	176,276	189,221	203,116	218,031	234,042

Table 15 Per Hour Hiring Rate of Equipment

Amount in NRs

No.	Equipment	Capacity	Rate		Fuel Con.
			DOR	Market	Rate
1	Air Compressor	150 to 275 CFM	160	150	
2	Asphalt Mixer (Bel Mix)		550		
3	Asphalt Paver		830		
4	Asphalt Plant	Upto 10 Ton	400		
5	Asphalt Plant	40Ton/Hour	6200		
6	Back Hoe Loader	Up to 85 HP	600	750	8
7	Bitumin Distributor	4 to 6 KL	850	700	10
8	Bitumin, Heater	Up to 2 KL	90	187.5	15
9	Boring Rig		1360		
10	Broom Road, Towed		120		
11	Compactor, Hand Towed		50		
12	Crane, Mobile	5 to 10 Ton	2040		
13	Crane, Mobile	10+ to 15 Ton	2330		
14	Crusher, Stone	50 to 100 HP	100		
15	Dozer, Track	120 to 180 HP	1230	1600	
16	Dozer, Track	180+ to 240 HP	3000		
17	Dozer, Wheel	150+ to 225 HP	2090		
18	Excavator, Track		1210		
19	Excavator, Wheel	Up to 110 HP	1240	750	10
20	Fork Lift, Truck	Up to 2.5 Ton	270		
21	Generator	Up to 10 KVA	50		
22	Generator	10+ to 30 KVA	130		
23	Generator	250 KVA	230		
24	Generator	420 KVA	360		
25	Grader, Motor	80 to 145 HP	1000	1000	12
26	Loader, Wheel	1 to 1.75 CUM	660	875	10
27	Loader, Wheel	1.75+ to 2.5	920		
28	Maintainer	Up to 75 HP	350		
29	Mini Dumper	Up to 1 Cu M	170		
30	Mixer, Concrete		310	300	
31	Pile Driver		3400		
32	Rock Drill (Engine)		60		
33	Rock Drill (Pneumatic)		50		
34	Roller 3 Wheel	Up to 12 Ton	290		
35	Roller Pneumatic	Up to 20 Ton	800		8
36	Roller VIB, Pedistrian	Up to 0.5 Ton	70	150	4
37	Roller VIB, Self Prop.	Up to 3 Ton	430	500	5
38	Roller VIB, Self Prop.	3 Ton +	800	875	8
39	Roller VIB, Sheep Foot	Up to 10 Ton	660	1000	8
40	Roller VIB, Towed	Up to 7 Ton	520		
41	Sprayer, Emulsion	Up to 1 KL	170		
42	Spreader Chips, Self Pro.		740		
43	Tractor	Up to 85 HP	390	125	3.5
44	Trailer, Tractor	10+ to 20 Ton	1660		11
45	Truck Flat Bed	Up to 150 HP	420	225	5
46	Truck Flat Bed/Crane	Up to 7 Ton	530		
47	Truck, Tipper	Up to 150 HP	440	312	5
48	Truck, Tipper	From 150 HP+	860		
49	Vibrator (Engine)		30		
50	Water Pump	Up to 6" Dia.	110	62.5	1.5
51	Water Tanker	Up to 6 KL	550		
52	Welding, Arc	10 to 30 KVA	100		

Source: Department of Roads

Table 16 Hourly Rates of Laborers

Amount in NRs

No.	Laborer Type	Rate
1	Foreman	50
2	Operator	75
3	Driver up to 10 Ton	40
4	Skilled Labor	18.75
5	Labor	10

Table 17 Unit Price of Materials

Amount in NRs

No.	Materials	Unit	Rate
1	Cement Ordinary Portland	t.	6,000
2	Steel Reinforcement grade 300	t.	
3	Steel Reinforcement grade 400	t.	29,000
4	Coarse Concrete Aggregate 19 mm.	cu. m.	384
5	Fine Concrete Aggregate	cu. m.	384
6	Sand	cu. m.	275
7	Crushed Rock for Base Course	cu. m.	
8	Laterite	cu. m.	323
9	Lime	t.	
10	Diesel	lt.	27
11	Stone	cu. m.	350

Table 18 Construction Norms (Amount in NRs.)

Table 18.1 Earthwork Excavation

No.	Description	Unit	Qty	Rate	Amount
1	Materials				
	Sub-Total		0	0	0
2	Equipment				
2.1	Backhoe PC 200	WH	0	750	0
2.2	10 Wheel Dump Truck	WH	0	440	0
	Sub-Total				0
3	Labourers				
3.1	Foreman	WH	0	50	0
3.2	Operator	WH	0	75	0
3.3	Check Grade	WH	0	75	0
3.4	Dump Man	WH	0	19	0
3.5	Skilled Labor	WH	0	17.5	0
3.6	Unskilled Labor	WH	8	8.75	70
	Sub-Total				70
4	Fuel				
4.1	Backhoe PC 200	WH	0	26	0
4.2	10 Wheel Dump Truck	WH	0	26	0
	Sub-Total				0
5	Lubricant Oil @10% of Fuel				0
Total					70
Estimated Output		cu.m.	1	49	70
7.3.15.2.	Soft Rock	cu.m.	1	210	
7.3.15.3.	Hard Rock	cu.m.	1	1694	

Table 18.2 Sub-Base

No.	Description	Unit	Quantity	Rate	Amount
1	Materials				
1.1	Gravel	Sq.m.	0.32	323.37	103.4784
	Sub-Total				103.4784
2	Equipment				
2.1	Motor Grader	WH	0	1000	0
2.2	Roller Vib., Pedistrian	WH	0.018	70	1.26
2.3	Steel Roller	WH	0.018	800	14.4
2.4	Water Truck	WH	0.018	550	9.9
2.5	Flat Bed Truck	WH	0	420	0
	Sub-Total				26
3	Laborers				
3.1	General Foreman	WH	0	50.00	0
3.2	Foreman	WH	0	50.00	0
3.3	Operator	WH	0.054	75.00	4.05
3.4	Skilled Labor	WH	0	17.50	0
3.5	Laborer	WH	1.21	8.75	10.59
	Sub-Total				15
4	Fuel				
4.1	Motor Grader	WH	0	26	0
4.2	Roller Vib., Pedistrian	WH	0.072	26	43.99
4.3	Steel Roller	WH	0.144	26	87.98
4.4	Water Truck	WH	0.09	26	54.99
4.5	Flat Bed Truck	WH	0	26	0
	Sub-Total				187
5	Lubricant Oil @10% of Fuel				18.70
Total					349
Estimated Output		cu.m.	1	349.339	349

Compaction Factor assumed to be 1.6

Assumption: 8 Working hours in a day

Table 18.3 Embankment

No.	Description	Unit	Qty	Rate	Amount
1	Materials				
2	Equipment				
2.1	Motor Grader	WH	0	1,000	0
2.2	Roller Vibratory, Pedistrian	WH	0	150	0
2.3	Roller Vib. Smooth Drum	WH	0	800	0
2.4	Water Truck	WH	0	550	0
2.5	Flat Bed Truck	WH	0	420	0
	Sub-Total				0
3	Labourers				
3.1	Foreman	WH	0	50	0
3.2	Operator	WH	0	75	0
3.3	Skilled Labor	WH	0	18	0
3.4	Laborer	WH	8	9	70
	Sub-Total				70
4	Fuel				
4.1	Motor Grader	WH	0	26	0
4.2	Roller Vibratory, Pedistrian	WH	0	26	0
4.3	Roller Smooth Drum	WH	0	26	0
4.4	Water Truck	WH	0	26	0
4.5	Flat Bed Truck	WH	0	26	0
	Sub-Total				0
5	Lubricant Oil @10% of Fuel				0
Total					70
Estimated Output		cu.m.	2	35	70

Compaction Factor assumed to be 1.5

Table 19 Geometric Standard for District Roads in Hilly Areas

No	Particulars	Category I	Category II	Remarks
1	Formation Width (m)	4.5	4	4 m and 3.5 m at moderate and steep slopes for Category I & II respectively
2	Carriageway Width (m)	3.5	3	
3	Drain Width (m)	0.8-0.6	0.8-0.6	Side drains can be excluded at places with steep and rocky slopes
4	Ruling Gradient (%)	7	10	
5	Maximum Gradient (%)	12	15	Surface to be gravelled/stone pitched at steep sections
6	Camber on the Earthen Surface	4	5	
	Camber on the Gravelled Surface	3	4	
7	Minimum radius of horizontal curve (m)	15	10	
8	Height of Embankment	NA	NA	

Source: WSA & SMEC, 1996

Notes: Category I: Truck Standard Road, Category II = Tractor/Trailer Standard Road

Table 20 Typical Quantities of Major Works per Km of District Roads in Hilly Areas

No.	Particulars	Unit	Quantities	
			Category I	Category II
1	E/W including drains cutting			
	Ordinary Soil	Cum	1960	1640
	Boulder Mixed Soil/Hard Soil	Cum	5950	4970
	Soft Rock	Cum	430	360
	Hard Rock	Cum	170	150
2	Retaining Walls (Dry and Banded)	Cum	1000	800
3	Masonry for Drains (DRRM + Pointing)	m	800	500
4	Pipe Culverts			
	60 cm dia	nos.	2	1
	90 cm dia	nos.	1	0.5
	(Length of PC along formation)	m	5.5	5
5	Slab Culverts			
	Span upto 2 m.	nos.	0.5	0.5
	Span upto 3 m.	nos.	0.3	0
	Span 4 m. or more	nos.	0.3	0
6	Scuppers	nos.	0.5	2.5
7	Causeways	rm	3	3
8	Sub-Grade Preparation	Sqm.	3920	3450
9	Sub-base	Sqm.	3920	3450
10	Base	Sqm.	3500	3050
11	Surface Dressing	Sqm.	3500	3050

Source: WSA & SMEC, 1996

Table 21 Unit Cost for New Construction in Hilly Areas

Amount in Rs.

SN	Particulars	Unit	Cost/Unit
1	Earthwork Excavation		
1.1	Ordinary Soil	Cum.	48.95
1.2	Boulder Mixed Soil	Cum.	64.00
1.3	Soft Rock	Cum.	210.00
1.4	Hard Rock	Cum.	1,694.00
1.5	Ditch Cutting in Boulder Mixed Soil	Cum.	103.00
2	Structural Backfill with Selected Material	Cum.	0.00
3	Embankment including Compaction	Cum.	35.00
4	Retaining Walls	Cum.	849.00
5	Masonry for Drains	Cum.	622.00
6	Pipe Culverts		
	60 cm dia.		4,414.26
	90 cm dia.		7,993.99
7	Slab Culverts		
	Span upto 2m.	nos.	383,381.91
	Span 3 m	nos.	494,507.10
	Span 4 m or more	nos.	631,561.50
8	Scuppers	nos.	79,647.04
9	Causeways	rm.	14,084.64
10	Subgrade Preparation	sqm.	21.96
11	Sub-base (20 cm. Thick)	Cum.	349.34
12	Base (10 cm. Thick)	Cum.	
13	Single Surface Dressing	sqm.	

Source: Rate Analysis of Sheet F and WSA, 1996

The rates which are not included in the rate analysis are adopted from the WSA, 1996 but the price is adjusted the inflation of annual 10%.

Table 22 Construction Cost of Proposed Road Projects

Amount Rs. In ,000

No.	Particulars	Unit	Quantities		Route No.							Amount (Route No.)						
					1	2	3	4	5	6	7	1	2	3	4	5	6	7
			Category I	Category II	25.0	14.3	11.0	12.7	29.0	18.3	12.9	25.0	14.3	11.0	12.7	29.0	18.3	12.9
1	Earthwork including drain cutting	Cum			0	0	0	0	0	0	0							
	Ordinary Soil	Cum	1960	1640	49000	28028	21560	24892	56840	35868	25,284	2398.601	1372	1055.38	1218.49	2782.38	1755.776	1238
	Boulder Mixed Soil/Hard Soil	Cum	5950	4970	148750	85085	65450	75565	172550	108885	76,755	9520	5445.44	4188.8	4836.16	11043.2	6968.64	4912
	Soft Rock	Cum	430	360	10750	6149	4730	5461	12470	7869	5,547	2257.5	1291.29	993.3	1146.81	2618.7	1652.49	1165
	Hard Rock	Cum	170	150	4250	2431	1870	2159	4930	3111	2,193	7199.5	4118.11	3167.78	3657.35	8351.42	5270.034	3715
2	E/W Embankment	Cum	800	600	20000	11440	8800	10160	23200	14640	10,320	700	400	308	356	812	512	361
3	Retaining Walls (Dry and Banded)	Cum	1000	800	25000													
4	Masonry for Drains	rm	800	500														
4	Pipe Culverts				0	0	0	0	0	0	0							
	60 cm dia	nos.	2	2	50	28.6	22	25.4	58	36.6	26	221	126	97	112	256	162	114
	90 cm dia	nos.	1	1	25	14.3	11	12.7	29	18.3	13	200	114	88	102	232	146	103
	(Length of PC along formation)	m	9	7	225	128.7	99	114.3	261	164.7	116							
5	Slab Culverts																	
	Span upto 2 m.	nos.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Span upto 3 m.	nos.	0.5	0.5	12.5	7.15	5.5	6.35	14.5	9.15	6	6,181	3,536	2,720	3,140	7,170	4,525	3,190
	Span 4 m. or more	nos.	0.3	0.3	7.5	4.29	3.3	3.81	8.7	5.49	4	4,737	2,709	2,084	2,406	5,495	3,467	2,444
6	Scuppers	nos.	0.5	2.5	12.5	7.15	5.5	6.35	14.5	9.15	6	996	569	438	506	1155	729	514
7	Causeways	rm	10	10	250	143	110	127	290	183	129	3,521	2,014	1,549	1,789	4,085	2,577	1,817
8	Sub-Grade Preparation	Sqm.	5500	3900	137500	78650	60500	69850	159500	100650	70,950	3,020	1,727	1,329	1,534	3,503	2,210	1,558
9	Sub-base	Sqm.	5500	3900	137500	78650	60500	69850	159500	100650	70,950	9,607	5,495	4,227	4,880	11,144	7,032	4,957
10	Base	Sqm.	3500	3050	87500	50050	38500	44450	101500	64050	45,150							
11	Surface Dressing	Sqm.	3500	3050	87500	50050	38500	44450	101500	64050	45,150							
Total Cost												50,557	28,919	22,245	25,683	58,647	37,008	26,088
Per Km. Cost												2,022	2,022	2,022	2,022	2,022	2,022	2,022
	First Stage											2,528	1,446	1,112	1,284	2,932	1,850	1,304
	Second Stage											12,639	7,230	5,561	6,421	14,662	9,252	6,522
	Third Stage											20,223	11,568	8,898	10,273	23,459	14,803	10,435
	Fourth Stage											15,167	8,676	6,674	7,705	17,594	11,102	7,826

Table 23 Annual Construction and Maintenance Cost*

Amount in NRs, 000

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Route	Length (Km)	Construction Cost	Rou.	Rou.	Rou.	Rou.	Perio.	Rou.	Rou.	Rou.	Rou.	Perio.	Rou.	Rou.	Rou.	Rou.
1	25.0	50557	439	483	531	584.6	5895	707	778	855.9	941.5	9493.7	1139	1253	1378.5	1516
2	14.3	28919	251	276	304	334.4	3372	405	445	489.6	538.6	5430.4	651.7	716.8	788.5	867
3	11.0	22245	193	213	234	257.2	2594	311	342	376.6	414.3	4177.2	501.3	551.4	606.54	667
4	12.7	25683	223	245	270	297	2995	359	395	434.8	478.3	4822.8	578.7	636.6	700.27	770
5	29.0	58647	510	560	617	678.2	6838	821	903	992.9	1092	11013	1322	1454	1599.1	1759
6	18.3	37008	322	354	389	427.9	4315	518	570	626.5	689.2	6949.4	833.9	917.3	1009.1	1110
7	12.9	26088	227	249	274	301.7	3042	365	402	441.7	485.8	4898.8	587.9	647	711.3	782

Rou. = Routine Maintenance, Peri. = Periodic Maintenance

Table 24 Per Km Maintenance Cost

Amount in NRs ,000

Type	First Category	Second Category
Routine	18	9
Periodic	146	110

Source: PLRP, 1997

Note: The price of 1997 given in the DTMP by the PLRP is appreciated to the price of 2000 at the rate of 10 percent per annum.

* Routine and recurrent maintenance are carried out every year.

The periodic maintenance is carried out every fifth year.

The road life is assumed to be 15 years.

Table 25 Traffic Composition

Tra. Mode	Without														With						
	AADT							Passengers and Freight (in qt.)							Passengers (Nos.) and Freight (in qt.)						
Passenger	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Bus	5	0	3	0	0	0	0	182.4	0	130.8	0	0	0	0	53153	30197	62245	27922	51750	20916	50177
Mini Bus	0	0	3	0	0	0	0	0	0	81.75	0	0	0	0	0	1	2	3	4	5	6
Jeep	3	0	5	0	5	6	0	34	0	54.5	0	48	60	0	7973	4530	9337	4188	7762	3137	7527
Auto	0.13	0	0	0	0	0	0	0.39	0	0	0	0	0	0	177	101	207	93	172	70	167
Motorcycle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7087	4026	8299	3723	6900	2789	6690
Bicycle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10631	6039	12449	5584	10350	4183	10035
Pedestrian	19	130	10	120	180	30	220	19.35	130	10	120	180	30	220	8859	5033	10374	4654	8625	3486	8363
T. Passengers	86191	47450	101123	43800	83220	32850	80300	86191	47450	101123	43800	83220	32850	80300	88,588	50,329	103,742	46,536	86,250	34,860	83,628
Freight																					
Truck	2	1	3	0	5	2	2	80	48	130.8	0	192	80	80	51439.2	41793.3	65548.18	11147.5	95561.7	46318.38	62485
Tractor	6	6	7	0	10	4	7	90	90	98.25	0	144	65.4	105	13574.2	11028.8	17297.44	2941.69	25217.7	12222.9	16489
Mules	0	7	0	0	0	0	5	0	3.5	0	0	0	0	2.5							
Porter	30	15	10	90	36	65	85	12	6	4	36	14.4	26	34	5715.46	4643.7	7283.131	1238.61	10618	5146.486	6942.8
T. Freight	66430	53838	85063	13140	127896	62561	80848	66430	53838	85063.3	13140	127896	62561	80848	71,443	58,046	91,039	15,483	132,725	64,331	86,784

Table 26 Transport Cost
(NRs./Person/Km) and (NRs./quintal/Km)

Rs. in ,000

Tra. Mode Passenger	Without	With
Bus	0.00075	0.00042
Mini Bus	0.00065	0.00045
Jeep	0.0012	0.0008
Auto	0.0012	0.0008
Motorcycle	0.0029	0.002
Bicycle	0.00185	0.0017
Pedestrian	0.002	
Freight		
Truck	0.00034	0.00025
Tractor	0.0007	0.0006
Mules	0.00048	
Porter	0.0048	0.0048

Table 27 Per Km Traveling Speed

Tra. Mode Passenger	Without	With
Bus		30
Mini Bus		35
Jeep	30	40
Auto		45
Motorcycle	20	40
Bicycle	8	10
Pedestrian	4	5
Freight		
Truck	15	30
Tractor	12	20
Mules	3	
Porter	3	

Table 28 Per Km Traveling Time (In hours)

Tra. Mode Passenger	Without*	With
Bus	0.25	0.03
Mini Bus	0.25	0.03
Jeep	0.0333	0.0250
Auto	0.25	0.02
Motorcycle	0.05	0.03
Bicycle	0.13	0.10
Pedestrian	0.25	0.20
Freight		
Truck	0.07	0.03
Tractor	0.08	0.05
Mules	0.33	
Porter	0.33	

* In without situation, having no Bus, Mini Bus and

Table 29 Savings in Transportation Cost

Transport Route	Length (Km.)	Without* Passengers	Freight	With Passengers	Freight	Difference Passenger	Freight	Total[1]
1	25.0	2011	1349	1527	707	484	642	563
2	14.3	1484	573	496	336	988	237	613
3	11.0	958	532	748	411			0
4	12.7	1217	801	408	80	809	721	765
5	29.0	4778	2490	1725	1517	3,053	973	2,013
6	18.3	919	1321	440	471	479	850	665
7	12.9	2266	1248	744	455	1,522	793	1,157

[1]Vehicles use only 50 percent of total road length at a trip.

Table 30 Benefits from Savings in Traveling Time (NRs. in ,000)

Transport Route	Length (Km.)	Without Passenger	Without Freight	With Passenger	With Freight	Difference Passenger	Difference Freight	Total Savings (days) Passengers	Total Savings (days) Freight#	Valuation of Time Savings Passengers*	Valuation of Time Savings Freight	Total Savings
1	25.0	437402	161640	124675	59833.74	312727	101807	39091	12726	1368	445	1814
2	14.3	142146	75121	40516	27807.06	101630	47313	12704	5914	445	207	652
3	11.0	225385	90629	64242	33547.92	161143	57082	20143	7135	705	250	955
4	12.7	116733	17795	33272	6587.064	83462	11208	10433	1401	365	49	414
5	29.0	494023	348336	140809	128941.9	353214	219394	44152	27424	1545	960	2505
6	18.3	126016	106542	35915	39438.17	90101	67104	11263	8388	394	294	688
7	12.9	213083	101316	60733	37503.89	152350	63813	19044	7977	667	279	946

* Only 25% of labor wages is considered to be saved due to the underemployment situation.

\# The unit of freight is converted to quintal and 1 quintal is considered as one person.

Table 31 Total Transport Benefits

R. N.	Benefits Savings in Tra. Cost	Savings in Time	Total Benefits
1	563	1814	2,376
2	613	652	1,264
3	0	955	955
4	765	414	1,179
5	2,013	2505	4,518
6	665	688	1,352
7	1,157	946	2,103

Assumptions:

The transport benefits will increase 50 percent of the increase in volume of traffic.

Table 32 Aggregation of Net Costs and Benefits (Consumer and Producer Surplus)

Yr. / R.N.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-50557	1937	1893	1845	1792	-3518	1669	1598	1520	1435	-7117	1237	1123	998	860
2	-28919	1013	988	960	930	-2108	860	819	775	726	-4166	613	547	476	397
3	-22245														
4	-25683	956	934	909	882	-1815	820	784	744	701	-3644	601	543	479	409
5	-58647	4008	3957	3901	3840	-2320	3697	3615	3525	3426	-6495	3196	3064	2919	2759
6	-37008	1031	999	963	925	-2963	835	783	726	663	-5597	519	435	343	243
7	-26088	1876	1854	1829	1801	-939	1738	1702	1661	1617	-2796	1515	1456	1392	1321

Table 33 Prioritization of the Road Links

Expected Rate of Return: 7%

R.N.	ENPV	Score	EIRR	Score	BCR	Score	C. Score	Ranking
1	-41,813				0.19			
2	-24,694				0.22			
3								
4	-21,469				0.24			
5	-34,109				0.30			
6	-33,771				0.09			
7	-14,409				0.30			

Appendix IV

Annexes Numbered According to the Respective Chapters

Evolutionary Process of Roads in Nepal

Time Period	Major Issues	Main Programs/Projects	Remarks
1953-1956	- Connecting Kathmandu, the capital city with the Indian Railway heads. - Mainly security interest of India to build the road	- Tribhuvan Highway	The first motorized road in Nepal.
1958 - 1962	- Construction of roads in a planned manner. - Construction of north-south roads connecting the Indian railway heads with the Nepalese hinterlands.	- Regional Transportation Organization (RTO)	The organization could not complete a single road satisfactorily, because of its internal conflicts.
1962-1975	- Strategic highways mainly intended to connect the strategic locations of the country and connecting main urban centers to the Indian railway head and border with China. Focus was to ensure national security, integrity and unity. The economic benefit thereof was the by-product.	- Sunauli–Pokhara - Naubise – Pokhara - Dhanghadi– Dadeldhura - East – West Highway	Mainly supported by the Governments of China, India, U.S.A., USSR and U.K.
1975-1990	-Environment friendly road construction using labor based technology	- Lamsangu – Jiri - Local Road Improvement Programme – Palpa - Dhadhing Development Project	Supported by GTZ (Germany) and SDC (Switzerland)
1990 -	- Decentralization of road works to the local governments and construction of the regional transport infrastructure using labor based construction technology in an environment friendly manner.	- PLRP - RIDP	Supported by the WB, UNDP, ADB

Construction and Maintenance Cost for Different Types of Roads

a. Construction Costs for a Fair –Weather Earth Road applying the Green Road Concept

Particulars	Construction cost (%)	Cons. cost (NRs,per km)	(US$ per km)
Labor costs	65%	780,000	12,000
Construction material	15%	180,000	2,770
Tools and Equipment and Transport costs	10%	120,000	1,850
Construction Supervision, Social mobilization overhead	10%	120,000	1,850
Construction Costs	100%	1,200,000	18,470

Source: Meyer et al. 1999

b. Summary of Costs per kilometer of Rural Roads

SN	Particulars	Cost per kilometer (Rs.)			
		Hills		Plains	
		Category - I	Category - II	Category - I	Category - II
1	First stage construction: Fair Weather Earth Road	1,800,500	1,547,000	727,500	582,500
2	Second stage construction: Fair Weather Gravel Road	2,242,000	1,936,000	1,304,000	988,000
3	Third Stage: All Weather Gravel Road	2,856,500	2,210,000	1,614,500	1,298,500
4	Fourth stage: All Weather Sealed Road	3,645,000		228,2000	
	Upgrading Costs				
1	Improvement of existing impassable earth track Upgrading to Fair Weather Earthen Road	1,202,000	1,050,500	467,500	383,000
2	Improvement of existing Fair Weather Earthen Road to Fair Weather Gravel Road	745,500	752,000	758,000	557,500
3	Improvement of existing Fair Weather Earthen Road to All Weather Gravel Road	1,263,500	903,500	1,068,000	867,500
4	Improvement of existing Fair Weather Gravel Road to All Weather Gravel Road	713,000	445,000	572,000	516,500
5	Improvement of existing All Weather Gravel Road to All Weather Sealed Road	1,049,500		861,000	

Source: WSA and SMEC, 1996

Category I: Truck Standard

Category II: Tractor/ Trailer Standard

Note: Category II in the Terai shall be open to truck traffic also, 1 USD = NRs. 65

c. Annual Road Maintenance Costs

No.	Road and Maintenance Type	Hill Areas (Rs./km.)	Terai (Rs./km.)
1	Earth Road		
	Recurrent	42,375	32,616
2	Gravel Road		
	Recurrent	42,375	32,616
	Periodic	73,131	60,943
	Total	115,506	93,558
3	Paved Road		
	Recurrent	17,756	10,293
	Periodic	40,754	33,962
	Total	58,510	44,255

Source: WSA and SMEC, 1996

Rural Transport Planning Methodology: An Overview

No.	Methodology	Identification of basic goals	Network Analysis	Transport Demand	Technology Choice	Selection/Prioritization	Maintenance Concept	Overall assessment
	<u>International</u>							
1.	International Bank for Reconstruction and Development (1967)	IBRD methodology emphasizes the goal formulation. Transport should be integrated with the development goals.	No direct network model recommended but it recommends the collection of basic transport inventory and identification of the trip production and attraction centers	Identification of the trip production and attraction centers and translate output and population data into traffic both by volume and origin and destination and ultimately modal split (Three step model)	No consideration of the technological choice	Economic evaluation	No emphasis on the maintenance	The main weakness of this methodology is to ignore the technological aspect in relation to the demand and no provision for the maintenance.
2.	Roy and Patil (1977)	It is an integrated plan so it automatically includes the development goals	A wholesale policy for connecting the villages and service centers. However, the quality of road surface depends on the linkages between the different hierarchy of settlements	Emphasis on only the agriculture transport demand	No emphasis on the technological options	Since all villages and service centers must be connected no prioritization or economic evaluation required.	No maintenance concept introduced	This is a supply-oriented methodology and not having overview on the technological and maintenance issues are other limitations.
3.	United Nations Center for Human Settlements (1985)	UNCHS has dealt with the synchronization of national sub-national and local level development objectives.	• Network Development Procedures - Collection and mapping of existing transport system networks. Collection and mapping of information concerning natural conditions - Evaluation of existing and proposed land use and settlement plans - Assessment of existing and projected travel demand - Development of road network options	• It has recommended the demand estimation tools as the travel surveys (Household Survey, Community Survey, Road Side Survey, Traffic Counts etc.) • It has emphasized to identify travel pattern, magnitude, frequency and timing and travel distance.	No emphasis on the construction and maintenance costs.	Ranking and economic analysis according to requirement	No emphasis on the maintenance	It is quite comprehensive in terms of goals, network and demand analysis. In terms of prioritization as well it is sound. But not giving emphasis on technological and maintenance issues are the main limiting points.
4	Methodology described by Beenhakker (1987)	Strongly emphasized	No network concept but the accessibility concept is introduced.	It introduces the transport demand in the holistic way. No direct calculation but tries to satisfy	He has introduced the low cost technology.	The study has presented eight different approaches of the financial	Maintenance concept emphasized.	It attempts to provide trip-producing entities where it is demanded. But it is not possible for the central level goods and services because those facilities do not get threshold demand

				transport demand by supplying facilities where it is needed.		evaluation. But emphasized on the producer's surplus approach.		in the local area. Therefore the methodology lacks the network approach in planning.
5	International Labour Organisation (1998) Nepal	Scope of planning deals with the basic goals	No network concept but problem oriented	Transport demand is estimated indirectly	No emphasis on technology choice	Ranking	Not mentioned categorically	It might be appropriate for village or community level not for the district level RR
7	GTZ – Nepal (1990)	The rural road package was one of the components of the integrated project. Therefore development goal was articulated.	Purely intuitive	No transport demand analysis	Labor based technology	Ranking based on specified technology		- Purely intuitive network and no demand estimation are the limitations of this methodology. - Blanket application of labor based technology could be questionable.
8.	Methodologies Developed by Basnet (1994)	Not mentioned explicitly	Follows the existing main trading routes	Proposed to calculate on the basis of agricultural surplus	Not emphasized	Not emphasized	Not emphasized	Not having the network approach, calculation of agricultural transport demand and emphasis, no prioritization and maintenance concept are the main limitations.
9.	Priority Investment Plan (1996)	The plan has analyzed the development requirement of the transport services.	Not dealt with the networks.	Traffic count	Traditional technology	Economic analysis	Not emphasized	The methodology is sound in terms of economic analysis but it should be supplemented by the network concept to be useful in the district level transport planning.
10	ILO – Nepal	It has not elaborated	It has adopted the settlement interaction based network model.	It does not calculate the transport demand but the demand for road construction by the village is considered as the demand.	Not elaborated.	Prioritization.	Maintenance strongly highlight.	No direct transport demand and only prioritization for implementation are the major limitations of this methodology.
11.	Pilot Labor Based District Road Rehabilitation and Maintenance Project (1997)	The study starts from the problem identification, objective setting and formulation of policies.	It has adopted the settlement interaction based network approach.	Population and cultivated land within 3 km either side of the road is considered as the quasi-indicator of demand.	Stated the labor based technology but the technology is not defined	Ranking on the basis of prioritization criteria	The maintenance works is integrated with the investment planning.	Although it has relatively comprehensive networking approach, lack of demand estimation and economic evaluation are the main limitations of this methodology.

Rural Transportation Study

DDC Engineer Survey

The Asian Institute of Technology, Bangkok, Thailand is undertaking a study on rural transportation in Nepal. The findings of this study may be helpful to the District Development Committee, Ministry of Local Development and Ministry of Works and Transport for better planning the rural transport infrastructure. Therefore your contribution to make this study a success is highly appreciated.

1. Name of the Respondent: ______________________ 2. Position and Level: ______________
3. District ______________________ 4. Date: ______________

A. General Information

1. How many personnel are working in the technical section at present?

Position	Number	Employer*	Years of Experience
Engineer			
Overseer			
Supervisor			

* 1 = MOLD 2 = DDC 3 = Other

2. Out of the total working days in a year, how approximately do you and other technical staff allocate time? (Please indicate in percentage)

No.	Involvement	Engineers	Overseers	Supervisors
1	Routine Works			
2	Planning			
3	Budgeting			
4	Engineering Survey			
5	Socio-economic Survey			
6	Construction supervision			
7	Others, Specify.............			
Total		100%	100%	100%

3. Can you spare some time for long term planning?

Yes No

It yes, how much time in a year can you spare your time: ______________ days

4. Can you generate enough resources for long term planning?

Yes No

5. Have you and your staff obtained any on-the-job training?

Yes No

If yes, give details.

Person	Training	Duration	Organization	Place

6. How is your and your staff's computer literacy in general? Please tick (√) if yes and check (×) if no

Computer Software	Engineer	Overseer 1	Overseer 2	Overseer 3
Word Processing				
Spreadsheet				
Database				
GIS				
Drawing Packages				
Others				

7. Do you have construction equipment at your disposal?

Yes No

It yes, please describe.

Equipment	Nos.	Year of Procurement	Procure ment Cost	Annual Maintenance Cost	Annual Working Hours	Present Condition
Truck						
Tractor						
Water Tanker						
Roller 8-10 Ton						
Roller 2 Ton						
Bulldozer						

8. What engineering equipment do you have?

Equipment		Year of Procurement	Source	Cost	Utilization (approx. working days during the last year)	Present Condition
Surveying Equipment	Theodolite					
	Levelling Machine					
	Plane Table					
	Ranging Rod and Chain					
Computer Related Equipment	Computer					
	Printer					
	Plotter					
Drawing Equipment	Drawing Board (Simple)					
	Drawing (adjustable)					
	Lettering Set					
	Drawing Pen					

9. Could you please give details of the Rural Road Projects that were constructed during the last three years?

Project	Length	Construction Cost	Present Status	Approximate daily traffic (No)

10. Who was the implementing agency?

Project	Implementing Agency	Problems, if any

11. What is the maintenance arrangement for all the Rural Transport Infrastructure Projects? Please also mention the problems of each system, if any.

____

____

B. Present Planning Practices

1. Do you use the networking concept while planning the rural road?

Yes No

If yes, how did you develop it?

____

____

____

If no, why not?

____

____

____

2. Do you estimate the transport demand of the proposed new or rehabilitation project?

Yes No

If yes, how do you estimate?

____

____

If no, do not you feel that it is necessary?

3. Which norms and specifications do you follow for estimating the cost?

____

____

4. Do you think that the norms and specification are appropriate for your task on your hand?

Yes No

Please give reasons: ____

____

5. Is there any possibility to reduce the costs by any other construction technology?

Yes No

If yes, please specify them____

____

6. Do you estimate the benefits of the road project?

Yes No

If yes, how do you estimate the benefits?

---

7. If you estimate the benefits, are they realized after the road construction?

Yes No

Please give reasons: ____________________

---

8. Are you satisfied with the prioritization criteria specified in the District Development Committee Act?

Yes No

Please give reasons: ____________________

---

9. Which evaluation technique do you think is appropriate for rural roads?

Ranking Method
Economic Evaluation
Others, please specify ____________

C. Possible Improvements in Planning Methodology

1. What kinds of maps are available of your district?

No.	Map	Scale	Year

2. Which mapping technique is useful for the DDCs in the given environment?
   - Use of available maps for analysis
   - Manual thematic maps to be prepared by the DDC personnel
   - GIS based thematic map
   - Others
3. What type of database system could be operational in your DDC?
   - Simple road length with an identity on the map
   - Detailed road inventory (including geometric standards, pavement standards and road conditions.
   - Database created in the GIS environment
   - Others

4. How to determine the nodal points for developing the networks of Rural Transport Infrastructure?

____

____

____

____

5. Which is the appropriate method for measuring the future transport demand and why?

---

6. Which data collection technique would be useful for estimating the transport demand?

____

____

____

____

7. Do you see some scope to improve the construction technology?

Yes No

If yes, tick in the appropriate box in the following table.

No.	Activities	Improvement in Working Procedure	Improvement in Tools and Equipment	Improvement in the use of Construction Materials
1	Road embankment in camber			
2	Camber formation of carriageway and shoulder			
3	Gravel spreading			
4	Aggregate crushing			
5	Compaction of gravel in sub-base			
6	Blacktopping Works			

8. Do you design the geometric and pavement structures according to the demand condition?

Yes No

If yes, how do you do it?

____

____

9. Which approach is appropriate for estimating the transport benefits?

Savings in transport cost on the basis of volume of traffic

Savings in Vehicle Operating Cost and monetary value of time savings

Total user's benefit and development impact of the transport infrastructure

I don't know

10. Which method is appropriate for evaluating the Rural Transport Infrastructure?

Multi-criteria Ranking Method

Economic Evaluation

Combination of Multi-criteria prioritization and economic evaluation

I don't know

11. Would it be useful for you to get a computer model for evaluating the Rural Road Projects?

Yes No

12. Please feel free to mention any' issue that is not covered in above but is essential to develop the methodology?

____

____

____

____

____

Thank you for your kind cooperation.

Rural Transportation Study

Policy Maker Survey

The Asian Institute of Technology, Bangkok, Thailand is undertaking a study on rural transportation in Nepal. The findings of this study may be helpful to the District Development Committee, Ministry of Local Development and Ministry of Works and Transport for better planning the rural transport infrastructure. Therefore your contribution to make this study a success is highly appreciated.

1. Name of the Respondent: ______________________ 2. Position and Level: ____________

3. District ______________________ 4. Date: ______________________

A. **Present Situation**

1. Have you prepared the District Transport Master Plan (DTMP) in your district?

Yes No

If yes, which year? ______________

2. If you have prepared the DTMP, have you followed it for allocating the annual budget?

Yes No

3. Could you please recall the projects planned and implemented during the last Fiscal Year (1998/99)?

No.	Project	Contract Amount (Rs.)	Implemented as per Schedule?

4. If majority of the projects could not be implemented according to the initial plan, what is the reason?

Budget did not arrive on time
Contract procedure took longer time than anticipated
Insufficient supervision due to lack of staff
Incapable contractor
Others, if any ______________

5. Do you have developed the maintenance plan?

Yes No

6. Do you refer the maintenance plan while developing the annual budget?

Yes No

7. Do you refer the maintenance plan while developing the annual budget?

Yes No

8. How much budget did you allocate in F.Y. 1998/99 for maintenance works?

Types of Maintenance	Amount
Routine Maintenance	
Periodic Maintenance	
Emergency Maintenance	
Rehabilitation Works	

B. Future Planning

1. How is the condition of the rural road inventory in your opinion?

Satisfactory Unsatisfactory

If it is satisfactory, how are you managing the inventory system?

Manual record keeping
Computer based database management
Others

If it is unsatisfactory, how are you planning to maintain in future?

Manual record keeping
Computer based database system
Others

If your choice is the computer based database management, can you procure the hardware as well as software?

Yes No

If no, how will you manage to procure then?

If yes, can you hire the competent manpower to operate the computer system?

Yes No

2. Will centralization or regionalization of the computer work be the better solution?

Yes No

3. Do you think that it is better idea to privatize the computer-related works?

Yes No

4. Which would be the appropriate approach for planning the district level Rural Road?
By DDC Engineers and Overseers
By DoLIDAR
By hiring private consultant
Others

5. Do you think that the Rural Transportation Infrastructure be justified by the transport demand?

Yes No

If no, please give reason: ____________________

---

6. In which field do you think can the labor-based technology be further promoted?

---

7. Have you considered relaxing the construction norms and specifications for the Rural Roads? If yes please elaborate.

---

8. On the one hand government has been insisting to promote the labor based construction technology, on the other hand it is allowing tax exemption on the import of construction equipment. Is this not a controversial issue?

Yes No

If no, please give reason: ____________________

____

9. What items should be considered as the benefits of the Rural Roads?

Savings in the transportation cost
Savings in travel time
Development effect of the Rural Roads
Others, please specify

10. How to measure the development effect of a Rural Roads?

____

____

11. Which do you think is the appropriate approach to evaluate Rural Road Projects?

Ranking
Economic Evaluation
Ranking and Economic Evaluation
No prioritization

Rural Transportation Study
Checklist for Interviewing Experts and Practitioners

1. Name of the Respondent: ____________________ 2. Position and Level: __________
3. Project/Office: ____________________________ 4. Date: ____________________

A. Background Information

1. **Involvement in the Rural Road Projects**
   - Project/ Office
   - Years of Involvement
   - Position

2. Main objectives of the respondent's project (all included in No. 1)
3. Most successful approaches
4. Main problem areas
5. Respondent's evaluation on the project in terms of its objectives
6. Specific responsibility of the respondents

B. Opinion Regarding the Appropriate Approach in Transport Network Planning

I. Transport Network

1. Appropriate Rural Road networking technique
2. Introduction of GIS for developing the network
3. Capacity of the Districts to procure and install GIS facilities
4. Capacity to retain the qualified manpower for handling the GIS

II. Demand Estimation

1. Appropriateness of the demand estimation method
2. Data collection technique
3. Cost of the each type of data collection technique
4. Time required for each type of data collection technique
5. Possibility of computer application in demand estimation

III. Construction Technology

1. Main weak points of the present construction technology
2. Scope of the improvement in specifications and norms
3. Possibility of identifying the appropriate mix of labor and capital
4. Institutional and legal obstacles to adopt the new technology
5. Compatibility of the new technology with the transport demand
6. Capability of the DDC technical manpower to handle with new construction technology

IV. Benefits of the Improved Access

1. Road as a basic need or economic product
2. Items to be included in the benefits
3. Data collection techniques
4. Time and cost of Data collection

5. Affordability of the DDC for time and cost
6. Method of Analysis

V. Evaluation

1. Evaluation Techniques
2. Required data and availability to suit the techniques
3. Compatibility of manpower
4. Computer application in evaluation

VI. Any other important aspects?

Annex 3.4

Road Observation Record Sheet

Road:	Section:
Surveyed by:	Date:

Constructed by:		Year of Construction:
Presently maintained by:		Annual Maintenance Cost:
Approx. AADT: heavy:	Light:	Manual and Animal Drawn Vehicles:

Sketch of RAI showing
Approximate alignment,
Node connection to
Other RAI and physical
Feature. Km

RAI Width									
Cleared width									
Sharp curve									
Steep gradient									
RAI Surface type									
Drainage Structure									
Condition									
RAI Surface									
Road side drainage									
Terrain									
Natural Soils									
Gravel pits									
Village/Settlements									
Population									
Agriculture crops									
Feature limiting access									
Suggested Solution									

Annex 3.5

Cordon Survey

1. Station: ____________ 2. Travel Date: ____________
3. Hour beginning ____ am/pm 4. Hour end: ______am/pm 4. Observer: ____________

5. Observation

No.	Vehicle	Number Vehicle	Freight Type and Quantity	Nos. of Persons (Approx. in Ton)
1	Bus			
2	Mini Bus			
3	Jeep			
4	Automobile			
5	Truck			
6	Tractor			
7	Motorcycle			
8	Rickshaw			
9	Bullock Cart			
10	Bicycle			
11	Pedestrians			
10	Porters			

Rural Transportation Study

Passenger Vehicle Survey Form

The Asian Institute of Technology, Bangkok, Thailand is undertaking a study on rural transportation in this district. The findings of this study may be helpful to the District Development Committee, Ministry of Works and Transport and Ministry of Local Development for better planning the rural transport infrastructure. Therefore your contribution to make this study a success is highly appreciated.

1. Interview No.: ____________________
2. Vehicle No.: ____________________ 3. Transport Route: ____________________
4. Location: VDC: ____________________ Ward No.: _______ Local Place: ____________
5. Geographic Location: ☐ Terai ☐ Inner Terai ☐ Hill
6. Interviewer: ______________ Date: ______________ Time: ___________

A. Carrier's Information

8. General Information

Vehicle	Make Year	Capacity	Unit	Origin	Destination	One way travel time
Bus						
Minibus						
Jeep						
Rickshaw						

9. Do you have a time schedule on the route?

Yes No Not applicable

If yes what is the frequency? ____________________

If no, do you have a queuing system?

Yes No Not applicable

If no, how are you managing? ____________________

B) Information on Transport Demand

10. What is the length of the route: __________km

11. What is the distribution of number of passengers traveling in your vehicle?

Vehicle	Day by Time									
	06 -09		09 -12		12 - 15		15 - 18		18 - 21	
	1	2	1	2	1	2	1	2	1	2
Bus										
Minibus										
Jeep										
Rickshaw										

1. Market to Hinterland 2. Hinterland to market

12. Does the number of passengers fluctuate according to the month of a year?
If yes, please specify.

	1	2	3	4	5	6	7	8	9	10	11	12
Bus												
Minibus												
Jeep												
Rickshaw												

1, 2, 3,...... refers to months beginning from January.

13. How much is your one way fare? ____________________

14. How many vehicles by type ply on your route?

Type of vehicle	Numbers

15. Do you think there is a demand for additional vehicles on the route that you operate?

Yes no

If yes, estimate the demand___________

If no, give reasons:____

C. Cost Information

16. How much was the initial investment for purchasing this vehicle?

Amount ________________ Year __________________________

17. How much is the annual maintenance cost?

Amount: __________________________

18. How much is your daily operating cost?

Description	Amount	
	Dry Season	Wet Season
Gasoline		
Wages of Driver		
Wages of Cleaner		
Depreciation		
Total		

D. Participation in Planning, Construction and Management of the Rural Roads

19. How do you perceive the condition of this road?

Very bad bad moderately good good excellent

20. Do you know who maintains this RTI?

21. Have you contributed something for maintenance?

Yes No

If yes, when and how much? ____

If no, No body asked for it

others please specify____.

22. Are you willing to pay more if you are offered a better road?

Yes No

If yes, do you think your transport association would be willing to take over the responsibility for maintenance?

- No
- Yes, but if some agency supports technically and financially
- Yes, but if some agency supports technically
- Yes, it can take the whole responsibility.

23. Do you have something to say for the betterment of this transport infrastructure?____________________

____

____

Thank you very much for your kind cooperation.

Rural Transportation Study

Freight Carrier Survey Form

The Asian Institute of Technology, Bangkok, Thailand is undertaking a study on rural transportation in this district. The findings of this study may be helpful to the District Development Committee, Ministry of Works and Transport and Ministry of Local Development for better planning the rural transport infrastructure. Therefore your contribution to make this study a success is highly appreciated.

1. Interview No.: ____ 3. Vehicle No.: ____________
4. Location: VDC: ______________________ Ward No.: ________ Local Place: ______________
5. Transport Route: ____
6. Geographic Location: ☐ Terai ☐ I nner Terai ☐ Hill
7. Interviewer: ________________ Date: ________________ Time: ____________

A. Vehicle Information

8. General Information

Vehicle	Make Year	Capacity	Unit	Origin	Destination	One way Travel Time
Truck						
Tractor						
Bullock Cart						
Mules						

9. What is the frequency of operation in this route?

10. What do you transport mainly?

Market - Hinterland	Approximately %	Hinterland - Market	Approximately %

10. Does the volume of freight fluctuate according to the month of a year?

☐ Yes ☐ No

If yes, please specify.

Months	1	2	3	4	5	6	7	8	9	10	11	12
Volume in Ton												

Numbers in the table indicates the months in the year, starting from January.

11. How do you charge to your customers?

☐ Trip Basis ☐ Weight and distance basis

12. How much is your fare rate? ______________

B) Vehicle's Cost Information

13. Initial Investment: ________________ 14. Year of Procurement: ____________________
15. Number of Fleet: ________________ 16. Annual Maintenance cost, if applicable: ________
17. Carrier's per trip operating cost

Motorized Vehicle			Non-motorized Carrier		
	Dry Season	Wet Season		Dry Season	Wet Season
Gasoline			Expenses for meals		
Wages of Driver			Expenses for accommodation		
Wages of Cleaner			Wages of Mule steward		
Depreciation					

C. Characteristics of freight?

18. Who is the owner of the commodities that you are transporting?

	Location of the Owner
Tradesman	____________
Ordinary Household	____________
Cooperative/ Cooperative	____________

19. When do you get maximum load?

Market - Hinterland		Hinterland - Market	
Month	Why?	Month	Why?

20. How many cargo vehicles/ Porters/ Mules plying in this route? ____________

21. Do you think there is a demand for additional carriers on the route that you operate?

Yes No

If yes, what would be the demand? ____________ if no, give reasons:

D. Participation in Planning, Construction and Management of the Rural Roads.

22. How do you perceive the condition of this road?

Very bad bad moderately good good excellent

23. Do you know who maintains this road?

---

24. Have you contributed something for maintenance?

Yes No

If yes, when and how much? ____________

If no, No body asked for it
others please specify.

25. Are you willing to pay more if you are offered the better road?

Yes No

If yes, do you think the transport association would be willing to take over the responsibility for maintenance?

No
Yes, but if some agency supports technically and financially
Yes, but if some agency supports technically
Yes, it can take the whole responsibility.

26. Do you have something to say for the betterment of this transport infrastructure?

Thank you very much for your kind cooperation.

Rural Transportation Study
Porter Survey Form

The Asian Institute of Technology, Bangkok, Thailand is undertaking a study on rural transportation in this district. The findings of this study may be helpful to the District Development Committee, Ministry of Works and Transport and Ministry of Local Development for better planning the rural transport infrastructure. Therefore your contribution to make this study a success is highly appreciated.

1. Market Center: ____________________ 2. Date: ____________ 3. Time: ______________
4. Approximate age of the porter: __________ 5. Sex: __________

6. Where are you taking this load to? ____

7. Which villages did you visit during last one month? ______________________________

8. Do you get load also for other villages than mentioned above? Yes No

If yes, where? ____

9. What are you transporting now? ____

10. What type of freight do you get normally?
Household goods Construction materials Agricultural inputs others

11. How much is your rate for transportation, in kg-km: _ Dry season______________ Wet Season_________
(include also if he gets free meal from the owner)

12. How much load are you carrying now? ___________ kg.

13. How much is the average load size? ____________ kg.

14. Do you get load while returning to this market center from the villages during last one month?

Yes No

If yes, how frequently? every time once in every 2 visits once in every 3 visits once in every 4 visits

15. What type of load do you get?

agricultural output Herbs Others

16. How much is your daily expense?

Meals: _________ Accommodation _________ Tea/snacks: _________ Others _________

17. How many other porters also work in this route? ____________ Nos.

Thank you,

Rural Transportation Study
Passenger Survey From

The Asian Institute of Technology, Bangkok, Thailand is undertaking a study on rural transportation in this district. The findings of this study may be helpful to the District Development Committee, Ministry of Works and Transport and Ministry of Local Development for better planning the rural transport infrastructure. Therefore your contribution to make this study a success is highly appreciated.

1. Transport Route:________________________ 2. Place of Interview____________ 3. Date: __________
4. Time: ______________ 5. Mode of Transport: Pedestrian Bicycle/ Rickshaw Motorcycle Three Wheeler/ Jeep Minibus/ Bus Others

6. Approximate age: ________ 7. Sex: Male Female

8. Purpose of the visit: official medical educational agricultural Social

9. From where did you come today?

____

10. Where do you want to go?

____

11. Are you accompanying some luggage? Yes No
If yes, what type and how much?

Type	Quantity
Agricultural	
Household	
Other	

11. How did you come and how you intend to go?

Trip sector	Mode of Transport	Travel Cost	Unit	Travel time	Waiting time
Home – Stop 1					
Stop 1 – Stop 2					
Stop 2 – Stop 3					
Stop 3 – Destination					

13. Could you remember your travel pattern during last one year?

Destination	Purpose	Accompanying Luggage, if any	Volume of luggage	Unit	Mode of travel	Tentative travel cost

Thank you very much for your kind cooperation.

Rural Transportation Study

Contractor Survey Form

The Asian Institute of Technology, Bangkok, Thailand is undertaking a study on rural transportation in this district. The findings of this study may be helpful to the District Development Committee, Ministry of Works and Transport and Ministry of Local Development for better planning the rural transport infrastructure. Therefore your contribution to make this study a success is highly appreciated.

1. Name of the company: ______________ 2. Class: ____________ 3. Owner: ___________
4. Interviewee: ________________ 5. Post of Interviewee: ____________
5. Location: VDC/ Municipality ________7. Ward No: ________ 8. Local place __________
9. Date: ____________ 10. Time _______11. Interviewer ____________

12. Could you please name your construction project / the project supervised by you during the last year.

Project Name	Contract Amount In Rs. ooo	Actual Amount In Rs. ooo

13. Do you / the contractor under your supervision own some equipment?

Yes No

If yes, please give following information.

Equipment	Year of Procurement	Investment

14. Could you give the record of working hours, maintenance cost and operating cost of all equipment since you / or your contractor procured?

14.1. Equipment: _________________

Year	Working hours	Market rate per working hour	Per hour operating cost[⊕]	Overhead cost #
1				
2				
3				
4				
5				
6				
7				
8				
9				
1o				

Operating cost includes: Spares and consumables, servicing and repair, fuel and lubricants and operator's wages

Overhead cost include:

-Offices, workshop, tools and other facilities
-Supervisory, management and clerical personnel
-Supervision and support vehicles
-Taxes levies etc.
-Insurance
-Stores and other stock

- Banking and other finance charges not relating to the equipment items
- Administration training, safety and other contingency items

14.2. Equipment: ____________________

Year	Working hours	Market rate per working hour	Per hour operating cost[⊖]	Overhead cost[‡]
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

14.3. Equipment: ____________________

Year	Working hours	Market rate per working hour	Per hour operating cost[⊖]	Overhead cost[‡]
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

14.4. Equipment: ____________________

Year	Working hours	Market rate per working hour	Per hour operating cost[⊖]	Overhead cost[‡]
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

14.5. Equipment: ____________________

Year	Working hours	Market rate per working hour	Per hour operating cost[⊖]	Overhead cost[‡]
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

15. What is the composition of labor and equipment in your currently on- going construction for the following works?

	Road embankment formation in camber	Gravel spreading	Gravel compaction	Aggregate crushing		Black topping
				For base course	For black topping	
Labor component						
Skilled labor						
Unskilled labor						
Operator/s						
Equipment ®						
1						
2						
3						
4						
5						
6						

® Only motorized equipment should be included. Hand tools not necessary to include.

16. If overall contribution of labor exceeds 50% of total work volume, what is the reason for employing labor?

____

____

____

____

____

17. If overall contribution of capital intensive equipment exceeds 50% of total works volume what are the reason for employing equipment?

____

____

____

____

____

18. What do you think are the major problems of construction industries involved in the rural road sector?

____

____

____

Thank you for your kind cooperation.

Rural Transportation Study
Labor Productivity Measurement Form

1. Road Project: ______________________ 2. District: ____________________
3. Village: ______________________ 4. Chainage of Survey Site: __________
5. Field Engineer: ______________________ 6. Supervisor: ____________________

---

7. Construction Type: New Construction Rehabilitation Maintenance
8. Funding Agency: Government
International Lending Agency
Bilateral Donor Agency
Other
9. Implementation Mode: Local Small Contractor
National Contractor
NGO
Forced Account
Other

10. Labor Productivity Measurement
10.1. Basic Earthwork Excavation

Particulars	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Gang Size: Men Women						
Start time						
End time						
Break time						
Worked hours						
Soil type*						
Tools and Equipment						
Output (m^3) Prework Measurement Postwork Measurement						
Weather (Write Number) 1. Overcast 2. Rain 3. Fine						

* A= Hard B = Firm C = Soft D = Slusky

10.2. Lift and Lead Activity

Particulars	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Gang Size: Men Women						
Start time						
End time						
Break time						
Worked hours						
Tools and Equipment						
Output (m^3) Prework Measurement Postwork Measurement						
Weather (Write Number) 4. Overcast 5. Rain 6. Fine						

10.3. Gravel Spreading

Particulars	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Gang Size: Men Women						
Start time						
End time						
Break time						
Worked hours						
Tools and Equipment						
Output (m^3) Prework Measurement Postwork Measurement						
Weather (Write Number) 7. Overcast 8. Rain 9. Fine						

10.4. Aggregate Crushing

Particulars	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Gang Size: Men Women						
Start time						
End time						
Break time						
Worked hours						
Tools and Equipment						
Output (m^3) Prework Measurement Postwork Measurement						
Weather (Write Number) 10. Overcast 11. Rain 12. Fine						

10.5. Compaction of Gravel

Particulars	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Gang Size: Men Women						
Start time						
End time						
Break time						
Worked hours						
Tools and Equipment						
Output (m^3) Prework Measurement Postwork Measurement						
Weather (Write Number) 13. Overcast 14. Rain 15. Fine						

11. What is the basis for payment?

Daily wages
Piece work
Mix of daily wages and piecework

12. If laborers are paid on the basis of daily wages, how much do they get?

Men: Rs. ___________
Women: Rs. ________
Children: Rs.________ (Children indicates below 16 years)

13. If laborers are paid on the piecework basis, how much do they get?

Description	Rate in Rs.
Earthwork excavation (m^3)	
Lift and Lead (m^3, m)	
Gravel Spreading (m^2)	
Aggregate Crushing (m^3)	
Compaction (m^3)	

14. Any other relevant issues:

____
____
____
____

Thank you for your kind cooperation.

Rural Transportation Study

Key Informant Survey

Informant: ______________________ Position: ______________________
VDC: ______________________ Ward No: ______________________
Locality: ______________________ Date: ______________________

1. Which market center do your villagers visit to purchase the following commodities?

Commodities	Market Center	Transport Route
Fertilizer		
Seed and Agri-Equipment		
Clothing		
Daily necessities (oil, salt, spices etc.)		

2. Does your village produce surplus agricultural produce?

Yes No

If yes, what are the commodities and where do they sell?

Commodities	Market Centers	Transport Route
Rice		
Wheat		
Fruits		
Vegetables		
Milk		
Others		

3. Where do your villagers normally visit for medical treatment?

Market Centers	Transport Route

4. Do your villagers commute daily for employment to some of the market centers? If yes, please indicate in the following table.

Market Centers	Transport Route

5. How many people from your village visit administrative centers for administrative purpose? (Administrative purpose means to register land, for legal purpose, to pay tax etc.)

Administrative Center	Transport Route

6. Could you please mention the approximate volume of daily traffic of each mode of transport?

Transport Route	Mode of Transport	Volume of Traffic			
		Rainy	Autumn	Winter	Spring
1					
2					
3					
4					
5					
6					
7					

7. Do you have further detail information on the transport characteristics?

T. Route and Mode	Unit Ton/Person	Approximate trip load	Route Length (km)	Road Surface	Travel Time

8. Are there any other issues that you would like to mention regarding the transportation in this area? If yes please mention in the space given below.

___

___

___

Thank you,

Test Questionnaire of the Methodology for Regional Road Network Planning and Prioritization

(DDC Members, Secretary, Planning Officer and Engineer)

1. Could you please prioritize the agencies given below to take initiative preparing the district road transport plan?

No.	Agency	Priority*
1	DDC	
2	DDC with the active guidance from the central level line agency	
3	DDC with the support from the central level line agency and other agencies (INGO, NGO, Donor agencies)	
4	Continuation of the present practice (Selection and prioritization of roads by the elected people's representatives)	
5	Any other institution (Please Specify)______________	

*1 – 5 scale; top priority 5 and lowest priority 1

2. Could you please prioritize the agencies given below for implementing the district road transport plan?

No.	Agency	Priority*
1	DDC	
2	DDC with the active guidance from the central level line agency	
3	DDC with the support from the central level line agency and other agencies (INGO, NGO, Donor agencies)	
4	Continuation of the present practice (Selection and prioritization of roads by the elected people's representatives)	
5	Any other institution (Please Specify)______________	

*1 – 5 scale; top priority 5 and lowest priority 1

3. What are the major reasons for not fully complying with the transport plans which are prepared with the active participation and acceptance of the DDC? (The PLRP supported master plan was prepared with the active participation and acceptance of the DDC body)

   Lower degree of consensus.
   Imposition by the project and central line agencies.
   Change of members of the local government.
   Political and social compulsions.
   Inappropriate methodology of the previous plan.
   Others please specify______________________

4. How do you intend to prepare manpower for planning and implementing the transport network? Please tick in the appropriate cell.

Options	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
By providing training to the existing Manpower					
By demanding additional support from the DOLIDAR					
By recruiting the additional employees by the DDC					
By securing the external support for the initial phase					
Others if any________________					

5. Is it appropriate to distinguish the developed areas and under developed areas based on the density of road (Density of Road = 0.17 as the demarcating point) for developing the methodology?

   Yes No

6. What do you think about the following tools for collecting information in the developed areas of the district? (The definition of each tool will be explained during the meeting). Please tick in the appropriate box.

Tools for Data Collection	Required	Desirable	Uncertain	Not Necessary
Reconnaissance Survey				
Cordon Survey				
Passenger Survey				
Freight Carrier Survey				
Contractor Survey				
Key Informant Survey				
Passenger Vehicle Survey				

7. What do you think about the following tools for analyzing the existing situation of the under-developed areas of the district? (The definition of each tool will be explained during the meeting). Please tick in the appropriate box.

Tools for Data Collection	Required	Desirable	Uncertain	Not Necessary
Reconnaissance Survey				
Cordon Survey				
Passenger Survey				
Freight Carrier Survey				
Contractor Survey				
Key Informant Survey				
Passenger Vehicle Survey				

8. Can district afford such types of surveys in terms of funds and time? (Please tick in the appropriate cell)

Tools for Data Collection	Fund		Time	
	Yes	No	Yes	No
Reconnaissance Survey				
Cordon Survey				
Passenger Survey				
Freight Carrier Survey				
Contractor Survey				
Key Informant Survey				
Passenger Vehicle Survey				

9. If no, what could be other options?

- ☐ Group discussion in the probable route among the villagers
- ☐ Opinion of the people's representatives
- ☐ Questionnaire survey with the VDCs
- ☐ Others, please specify________________

10. What is the usefulness of the tools mentioned below?

Analytical Tools	Extremely Useful	Useful	Uncertain	Not Useful
Centrality Index				
District Road Inventory				
Thematic Maps				
Spread Sheet Packages				
GIS Packages				
Prioritization of Roads				

11. If the tools in No. 9 are extremely useful or useful, do you have capacity for application?

Analytical Tools	Easily Applicable	Applicable	Uncertain	Not applicable
Centrality Index				
District Road Inventory				
Thematic Maps				
Spread Sheet Packages				
GIS Packages				
Prioritization of Roads				

12. Does the result of the networking methodology, which is based on existing and potential nodal points and road links, seem to be appropriate from your intuitive judgement?

Yes No

13. If not what are the shortcomings in it? Please specify.

---

14. What do you think about the criteria for assessing benefits that need to be included in the appraisal of the district level road projects in the developed areas?

Benefits	High	Medium	Low	Very Low	Uncertain
Savings in the transportation cost					
Savings in the traveling time					
Reduction in the cost of production of the agricultural goods					
Increase in the volume of production					
Others					

15. Which indicators are appropriate for evaluating the roads in the developed areas?

Indicators	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Economic Net Present Value					
Economic Internal Rate of Return					
Economic Benefit Cost Ratio					

16. If not provide the alternate criteria for such evaluation?

---

17. Do you think the proposed prioritization criteria are suitable for the under-developed areas?

Criteria	Weight	Appropriate	Moderately Appropriate	Not Appropriate
Intensity of Interaction	0.30			
Accessibility	0.15			
Agricultural Potential	0.25			
Construction Cost	0.20			
Environmental Impact	0.10			

18. Do you think same criteria of the developed areas could be used for the under-developed areas as well?

Yes No

19. If the criteria for the prioritization are not suitable what is your suggestion?

____
____
____
____

18. Do you agree with the stage construction technology, which is implemented gradually by opening up a trail, widening to a track, road construction and water management and bioengineering works?

Yes No

20. If yes, the resources will be allocated consecutively starting with the high priority project to the low priority project. Is that acceptable for you?

Yes No

21. If no, what is the alternative option?

- ❑ Continue the present practice of equitable resource allocation to all the DDC members.
- ❑ Allocate all the resources to the first
- ❑ priority project and allocate to the second once the first is completed.
- ❑ Others, please specify ______________________

22. What do you think about the endorsement of the proposed plan by the National Planning Commission and Department of Local Infrastructure Development and Agricultural Roads?

- ❑ Strongly Agree
- ❑ Agree
- ❑ Undecided
- ❑ Disagree
- ❑ Strongly Disagree

23. What is your overall comment on the methodology?

- ❑ Very Useful
- ❑ Useful
- ❑ Useful with modification
- ❑ Uncertain

24. Please specify if you have any other subjective comment.

____
____
____
____

Thank you for your kind cooperation.

Input Data for Simulation of the Methodology

1. Inventory of District Level Roads, Tracks and Trails

1.1 Roads

Code No.	Road	Length (Km.)	Surface (Km.)			Remarks
			BT	Gravel	Earth	
003	Parasi - Maheshpur	12.4	12.4			
005	Mahoo - Triveni	30.5	0.7	15.5	14.3	
007	Sunwal - Tanawa	18.45		8.07	10.43	
008	Sanai - Manjhariya	7.75			7.75	
009	Bhumahi - Parasi	8.1			8.1	
010	Harkatta - Parasi	5.5			5.5	
011	Ujjaini - Chimantola	6.9			6.9	
013	Basa - Piprahiya	16.6		13.6	3	
014	Chisapani - Majhauni	9.0		5.1	3.9	
024	Triveni - Katahawa	9.4		7.8	1.5	
028	Makar - Daunne	8.05			8.05	
030	Triveni - Maheshpur	19.75		8.4	11.35	
031	Dumkibas - Koldandi	10.25		0.5	9.75	
032	Dumkibas - Dhurkot	16.0			16.0	
034	Arunkhola - Rampur	6.5			6.5	
035	Arunkhola - Chormara	9.5		3.9	5.65	
036	Chormara - Jhyalbas	34.8		27.9	6.9	
094	Lokaha - Hattikhor	14.9		13.0	1.9	
079	Daldale - Munde	5.2		1.1	4.1	
056	16 No. - Belbas	3.97		3.97		
132	Danda – Tharu Village	5.75		5.75		
016	Parasi - Bhusar	8.0			8.0	
170	Marchawa – Birta Sadak	5.5			5.5	
283	Sunwal – Mohan Pokhari	5.5		3.0	2.5	
243	Panchanagar - Maheshpur	17.5			17.5	
265	Pokharpali - Amraut	8.0		1.0	7.0	
228	Ujjaini - Ramgram	1.5			1.5	

1.2 Main Trails

T001	Gaindakot – Dhodani	6				
T002	Suryanagar – Dada Bensi	26				
T003	Matkuri – Thambensi	25.5				
T004	Maiji – Bulintar	29				
T005	Munde – Bulintar	25				
T006	Dhaubadi – Atrauli	15				
T007	Lapak – Dedgaon Tar	14				
T008	Hatthikhor – Dedgaon Tar	28				
T009	Jhyalbas – Rakuwa	25				
T010	Jhyalbas – Bekhachap	20				
T011	Chormara – Mahuwadanda	15.2				
T012	Arunkhola – Mahuwadanda	16.5				
T013	Arunkhola – Bekhachap	.16				
T014	Damar – Arunkhola Gaun	15.2				
T015	Dumkibas – Rakachuli	18				
T016	Koltandi – Chidiya	14				
T017	Bhutaha – Khumbari	24				
T018	Bhumahi – Pipalchap Danda	12.5				
T019	Bankatti – Gerwadi	10.5				
T020	Sunwal – Mahalpokhari	12				

2. **Population by the Village Development Committee**

No.	Village Development Committee	Nos. of HH	Total Population
1	Agryouli	1393	8820
2	Amarapuri	967	5451
3	Amraud	738	4710
4	Badahara Dubauliya	856	5255
5	Baidauli	649	4216
6	Banjhariya	853	5211
7	Benimanipur	1113	6399
8	Bharatipur	439	2533
9	Bhujhawa	717	4663
10	Bulingtar	501	3215
11	Dandajheri Tandi	302	2196
12	Dawane Devi	2058	10833
13	Dedgaon	513	2975
14	Deurali	1627	10537
15	Devachuli	916	5768
16	Devagawa	602	3880
17	Dhobadi	607	4077
18	Dhurkot	651	3847
19	Dibyapuri	887	4968
20	Dumkibas	1236	6948
21	Gaindakot	2347	12874
22	Gairmi	714	4645
23	Guthi Parsauni	855	5338
24	Guthisuryapura	638	4372
25	Hakui	573	3726
26	Harpur	684	4401
27	Humsekot	472	3015
28	Jahada	1110	6532
29	Jamuniya	1004	6605
30	Jamwad	748	4908
31	Jaubari	455	3076
32	Kawaswati	1169	6511
33	Kolhuha	1025	6292
34	Kotathar	367	2747
35	Kudiya	1252	7564
36	Kumarwarti	698	4155
37	Kusma	754	4861
38	Mainaghat	440	2758
39	Makar	2780	15206
40	Manari	647	4630
41	Manjhariya	427	2977
42	Mithukaram	392	2240
43	Mukundapur	1406	7631
44	Naram	405	2834
45	Narayani	1188	7234
46	Narashi	768	4639
47	Nayabelhani	1795	9786
48	Paklihawa	1153	7891
49	Palhi	625	4133
50	Panchanagar	1023	6238
51	Parasi	1320	7281
52	Parsauni	832	4709
53	Pithauli	1084	5957
54	Pragatinagar	1640	9591
55	Pratappur	889	5645
56	Rajahar	1387	7839

57	Rakachuli	508	3168
58	Rakuwa	419	2248
59	Ramnagar	1532	9126
60	Rampur Khadauna	506	3665
61	Rampurwa	542	3689
62	Ratnapur	385	2936
63	Ruchang	454	2884
64	Rupauliya	1128	6331
65	Sakrauli	658	3964
66	Sanai	814	5208
67	Sarawal	553	3942
68	Shivmandir	2362	12948
69	Somani	783	5202
70	Sunwal	2720	14166
71	Swathi	1610	9982
72	Tamasariya	1195	6942
73	Thulo Khairatawa	543	3385
74	Tilakpur	667	4440
75	Tribenisusta	1477	7830
76	Unwach	600	3745
77	Uppalo Arkhala	418	3033

Source: Population Census, 1991

3. District Level Market Centers and their Population Size

No.	Market Centers	Population, 1991	Population, 2001
1	Parasi	7281	8910
2	Kawasoti	6551	8017
3	Bardhaghat (Daunnedevi)	10833	13257
4	Mukundapur/Rajahar/16 No.	15470	18932
5	Sunwal	14166	17336
6	Gaindakot/Narayanghat	82659	15755
7	Triveni Susta	7830	9582
8	Maheshpur	4401	5386
9	Arun Khola/Naya Belhani	9786	11976
10	Gopugunj	5645	6908
11	Dumkibas	6948	8503
12	Pragatinagar	9591	11737
13	Chormara	6942	8496
14	Sardi Bagaincha	6399	8112
15	Dedgaon	2975	3771
16	Bulingtar	3215	4075
17	Thambensi	2747	3482
18	Butwal	44272	54179
19	Bhairahawa	39473	48306

4. Hypothetical Budget

Amount in NRs. ,000

No.	Budget Source	Total Amount	Amount for the Road	Remarks
1	Own Source Revenue	15,000	7,500	50% of the revenue
2	MOLD Block Grant	10,000	10,000	
3	Donor's Fund	50,000	50,000	
4	People's Participation	1000	1000	
5	Toll Tax	1000	1000	
6	Constituency Development Program	40,000	20,000	50% of the available budget
	Total Amount	117,000	89,500	

5. List of Maps to be Supplied

5.1. Topography and Drainage System
5.2. Land Use
5.3. Distribution and Hierarchy of Market Centers
5.4. District Level of Inventory of Tracks, Trails and Trails
5.5. Distribution of Settlements

6. Volume of Traffic in the Main Routes of the Developed Areas (West from the Daunne Hill)

Main District Level Routes

ID	Road	Length (km.)		Surface	Road Class
		GIS	DOR/PLRP		
1	Mahendra Highway	94.8	98.0	BT	NH
2	Sunwal-Parasi	8.9	9.0	BT	FR
3	Parasi - Maheshpur	12.0	12.0	BT	FR
4	Parashi-Mahoo	7.4	7.0	Gravel	DR
5	Parasi-N. Chowk	13.3	13.7	Gravel	DR
6	Bardhaghat- Triveni	25.8		Gravel	FR
7	Canal Road	32.0		Gravel	CR
8	Tribeni-Maheshpur	20.9	19.8	Earth	DR

Base Year Volume of Traffic

	Transport Routes							
	1[a]	2[b]	3[c]	4[d]	5[d]	6[e]	7[g]	8[h]
Length (km.)	95	9	12	7	13	26	32	21
Tra. Mode								
Passenger								
Bus		18	8	10	0.49	43	0	0
Mini Bus		2	2	4	0.76	0	0	0
Jeep		147	40	48	18	60	15	3
Auto		25	10	50	5	14	12	0
Motorcycle		150	80	110	104		89	17
Pedestrian			55	50	100	150	85	146
Bicycle		900	600	700	930	600	700	408
T. Passengers[1]	0	**877825**	447125	582175	**478010**	**790955**	**375768**	**216288**
Freight								
Truck		95	40	60	13	103	0	0
Tractor		71	60	65	28	43	19	5
Bullock Cart		15	35	36	17	8	25	15
Mules			0	0	0		0	
Porter			0	10	4	5	0	0
T. Freight[2]	0	1153400	**647875**	**852640**	256446	1112520	114975	45360

a= National Road, No traffic counted.
Source: [a, b] - Department of Roads, [c, k] - Field Survey
[1] = Number of Passengers [2] = Freight load in quintal (100 kg.)

Road Inventory in the Underdeveloped Areas

ID	Road	Length (km.)		Surface	Road
		GIS	DOR/PLRP		Class
1	Dumkibas - Dhurkot	25.0	26.5	E	District Road
2	Arun Khola - Majhkot	14.3	18.5	E	Main Trail
3	Chormara - Jhyalbas	11.0		E	District Road
4	Jhyalbas - Hupsekot	12.7		E	Main Trail
5	Kawasoti - Dedgaon	29.0	28.0	E	Main Trail
6	Mukundapur - Thambensi	18.3		E	Main Trail
7	Dhobadi - Bulingtar	12.9		E	Main Trail
Road Inventory		123.2			

Base Year Two Way AADT in Each Link in the Underdeveloped Areas

Tra. Mode	Transport Routes						
	1	2	3	4	5	6	7
Length (km.)	25.0	14.3	33.5	12.7	29.0	18.3	12.9
Passenger							
Bus	5	0	3	0	0	0	0
Mini Bus	0	0	3	0	0	0	0
Jeep	3	0	5	0	5	3	0
Auto	0	0	0	0	0	0	0
Motorcycle	11	4	12	0	36	20	0
Bicycle	22	84	371	0	438	33	0
Pedistrian	19	390	104	300	180	10	160
T. Passenger[1]	68810	174981	231501	109500	254040	32251	58400
Freight							
Truck	13	1	3	0	5	11	0
Tractor	9	6	7	0	10	4	0
Mules	0	120	0	0	0	0	0
Porter	62	7	15	120	36	386	85
T. Freight	165035	69423	57090	26280	86724	200002	18615

Assumptions on carrying capacity of Passengers: Bus - 25, Mini Bus - 10, Auto - 3, Jeep - 5, Motorcycle - 1.5, Bicycle - 1, Pedestrian - 1 Carrying capacity of Freight in quintal (100kg.): Truck - 25, Tractor - 10, Mules - 0.8 quintal, Porter - 0.6 quintal

[1] = The given figures of AADT is multiplied with the assumed carrying capacity and the AADT is multiplied with 365 days in a year for annual calculations.

7. Facilities in the District Level Market Centers

Facilities Available in the Market Centers (1997)

Market Center	Educational		Health		Commercial							Industries					Agri. Service Center
	College	Voc. School	Hospital	Private Clinic	HH Goods	Hardwarê	Medical Shop	Eletronic Shop	Textile Shop	Agri. Traders	Milk Colletion	Agro-based Ind.	Forest Based Ind.	Textile & Leather	Service Industries	Mech. Febri.	
Parasi	1	1	1	3	9	3	10	4	7	2	1	2	2	0	8	4	1
Kawasoti	1	1	1	2	8	2	5	3	5	4	1	3	1	0	7	2	1
Bardhaghat (Daunnedevi)	1	0	0	3	7	2	4	2	6	2	0	1	1	0	0	1	0
Muk.pur/Raj./16 No.	0	0	0	2	9	2	4	3	3	3	1	2	1	1	4	0	1
Sunwal	0	0	0	1	5	1	2	2	3	2	1	2	1	0	2	1	0
Gaindakot	0	0	0	2	4	2	2	2	1	0	0	1	1	2	2	2	0
Tribeni Susta	0	0	0	1	3	1	2	2	5	1	0	1	0	0	1	0	0
Maheshpur	0	0	0	1	6	1	2	2	6	1	0	0	0	0	1	0	0
Arun Khola (Naya Belhani)	0	0	0	2	3	2	2	2	4	1	1		1	0	2	1	0
Gopigunj	0	0	0	1	3	1	1	1	3	1	0	1	0	0	1	0	0
Dumkibas	0	0	0	2	4	1	2	1	1	1	1	1	0	0	0	0	1
Pragatinagar	0	0	0	3	3	2	3	2	3	1	1	2	0	0	1	1	0
Chormara	0	0	0	1	3	0	1	1	1	1	0	1	1	1	1	0	0

Availability of Facilities after 15 Years

Market Center	Educational		Health		Commercial							Industries					Agri. Service Center
	College	Voc. School	Hospital	Private Clinic	HH Goods	Hardware	Medical Shop	Electronic Shop	Textile Shop	Agri. Traders	Milk Collection	Agro-based Industries	Forest Based Industries	Textile & Leather	Service Industries	Mechanucal Febrication	
Parasi	2	3	1	7	20	7	10	8	12	5	1	3	1	1	10	6	1
Kawasoti	3	3	1	6	15	5	8	7	10	10	2	8	3	2	8	5	2
Bardhaghat (D'devi)	2	1	0	5	10	4	4	6	8	3	1	3	3	0	1	1	0
Mukundapur	0	0	0	4	12	3	4	4	6	3	2	3	2	6	7	2	0
Sunwal	1	1	0	3	10	4	3	4	6	5	1	2	1	0	3	3	0
Gaindakot	0	2	0	1	5	3	2	3	2	2	1	5	4	8	10	12	0
T. Susta/Balmiki Nagar	0	0	0	1	3	1	1	5	8	2	0	2	0	0	2	1	0
Maheshpur/Thutibari	0	0	0	2	7	2	3	6	10	2	0	0	0	1	2	2	
Arun Khola (N. Belhani)	1	1	0	4	6	4	3	4	8	3	1	2	2	0	2	3	
Gopigunj	0	0	0	2	4	2	2	2	4	3	0	2	0	0	1	1	
Dumkibas	0	1	0	2	8	3	3	3	3	2	1	2	1	0	0	1	1
Pragatinagar	1	1	0	2	5	3	2	3	4	2	1	2	0	2	3	3	
Chormara	0	0	0	1	4	1	2	2	2	2	1	2	3	1	1	1	0
Sardi Bagaincha	0	0	0	1	3	2	2	1	2	2	0	0	1	0	1	1	1
Dedgaon	0	1	0	1	4	2	2	1	2	1	0	0	0	0	1	1	0
Bulingtar	1	0	0	1	2	1	1	1	2	2	0	0	0	0	1	1	0
Thambesi	0	0	0	1	2	1	1	0	2	1	0	0	0	0	1	1	0

8. Questions on the Input Data

8.1. Are the input data valid in your judgement?

Yes No

8.2. If no, could you please make the correction.

8.3. Do you agree with the projected population?

8.4. What do you think about the future trend of urbanization, land use and availability of public and private facilities in and around the district?

8.5. How the traffic flow of each of the route would be affected with the improved access? Could you please explain with justifications?

9. Methodological Documents to be Supplied

9.1. Flow Charts of the Proposed Methodology for the Developed and Under-Developed Areas

9.2. Structure of the Model for the Developed and Under-Developed Areas

9.3. Spreadsheet Based Model for Developed and Under-Developed Areas

Annex 3.15

Guidelines for the Simulation Exercise

1. All participants will be considered as one planning team. They should nominate one coordinator and assign specific responsibility to the specific person according to his or her area of expertise.
2. The planning team will set the time schedule for the simulation exercise. However, it should not exceed two days.
3. The participants should read the given data carefully. If necessary, they can amend or correct the input data. They can even add additional data if it is required.
4. At the beginning of the exercise, the objectives of the exercise, the outline of the proposed methodology will be briefly explained. Besides that, an overview will be given about the proposed methodology.
5. In the first stage of the exercise, the participants will be asked to conduct the planning exercise "Business as Usual". The planning team will act as the policy makers i.e. the DDC members. In the second half of the exercise, the planning team shall act as the technical team who have to implement the decisions taken by the policy makers. In accordance to the given mandate, they plan the construction and maintenance of the district level road network.
6. In the second stage, the planning team follows the proposed planning methodology. Similar to the step 5, they take the policy decisions that are required for the model. Then they start to work with the RNP Model. They can ask question whenever they encounter with the problem.
7. After producing the outputs, the planning session ends.

Annex 3.16

Checklist for the Open Ended Discussion with the Engineer and Planning Officer

1. Conceptual Clarity

1.1. Functions of GIS that can be used for the purpose of transportation planning
1.2. Inventorization of the District Level Road Network
1.3. Present and Potential Centrality Index
1.4. Intensity of Interaction among the Nodal Points
1.5. Assignment of Intensity to a Link
1.6. Equipment-Based and Labor-based Construction Norms
1.7. Geometric Standard and Typical Quantities of Per Km Road Works
1.8. Maintenance, Rehabilitation and new Construction
1.9. Estimation of Benefits from the Improved Access
1.10. Economic Indicators of the Financial Performance
1.11. Ability to interpret the output

2. Technical Capability

2.1. Handling GIS Software Packages (Arc Info, Arc View)
2.2. Knowledge of Spreadsheet Packages
2.3. Availability of Hardware and Software Facilities
2.4. Availability of stationery required for operating the computer
2.5. Availability of time to work with the computer
2.6. Other pertinent issues

Annex 3.17

Format for Recording the Questions and Discussion while Conducting the Experiment

1. Networking
2. Demand Estimation
3. Cost Estimation
4. Benefit Assessment
5. Prioritization Criteria for the Under Developed Areas
6. Decision Making Process
8. Other Pertinent Issues

Annex 3.18

Check list for the Final Output of the Simulation Exercise

1. The list of roads in their priority order according to the "Business as Usual" and according to the proposed methodology. It should include the annual plan, five-year plan and perspective plan for about the period of 15 years.
2. Explanation of the differences, if any, between two methodologies in terms of cost, time, degree of difficulties and other pertinent issues.
3. Source of Budget including the existing and the proposed sources with justifications.

Densities of Population by District

No.	District	Ecological Belt[1]	Population of 1991	Area (Km^2)	Densities of Population
1	Achham	H	198188	1680	117.97
2	Arghakhanchi	H	180884	1193	151.62
3	Baglung	H	232486	1784	130.32
4	Baitadi	H	200716	1519	132.14
5	Bajhang	M	139092	3422	40.65
6	Bajura	H	92010	2188	42.05
7	Banke	T	285604	2337	122.21
8	Bara	T	415718	1190	349.34
9	Bardiya	T	290313	2025	143.36
10	Bhaktapur	H	172952	119	1453.38
11	Bhojpur	H	198784	1507	131.91
12	Chitwan	T	354488	2218	159.82
13	Dadeldhura	H	104647	1538	68.04
14	Dailekh	H	187400	1502	124.77
15	Dang	T	354413	2955	119.94
16	Darchula	M	101683	2322	43.79
17	Dhadhing	H	278068	1926	144.38
18	Dhankuta	H	146386	891	164.29
19	Dhanusha	T	543672	1180	460.74
20	Dolakha	M	173236	2191	79.07
21	Dolpa	M	25013	7889	3.17
22	Doti	H	167168	2025	82.55
23	Gorkha	M	252524	3610	69.95
24	Gulmi	H	266331	1149	231.79
25	Humla	M	34383	5655	6.08
26	Ilam	H	229214	1703	134.59
27	Jajarkot	H	113958	2230	51.10
28	Jhapa	T	593737	1606	369.70
29	Jumla	H	75964	2531	30.01
30	Kailali	T	417891	3235	129.18
31	Kalikot	H	88805	1741	51.01
32	Kanchanpur	T	257906	1610	160.19
33	Kapilbastu	T	371778	1738	213.91
34	Kaski	H	292945	2017	145.24
35	Kathmandu	H	675341	395	1709.72
36	Kavrepalanchowk	H	324329	1396	232.33
37	Khotang	H	215965	1591	135.74
38	Lalitpur	H	257086	385	667.76
39	Lamjung	H	153697	1692	90.84
40	Mahottari	T	440146	1002	439.27
41	Makawanpur	H	314599	2426	129.68
42	Manang	M	5363	2246	2.39

43	Morang	T	674823	1855	363.79
44	Mugu	M	36364	3535	10.29
45	Mustang	M	5363	2246	2.39
46	Myagdi	H	100552	2297	43.78
47	Nawalparasi	T	436217	2162	201.77
48	Nuwakot	H	245260	1121	218.79
49	Okhaldunga	H	139457	1074	129.85
50	Palpa	H	236313	1373	172.11
51	Panchthar	H	175206	1241	141.18
52	Parbat	H	143547	494	290.58
53	Parsa	T	372524	1353	275.33
54	Pyuthan	H	175469	1309	134.05
55	Ramechhap	H	188064	1546	121.65
56	Rasuwa	M	36744	1544	23.80
57	Rautahat	T	414005	1126	367.68
58	Rolpa	H	179621	1879	95.59
59	Rukum	H	15554	2877	5.41
60	Rupandehi	T	522150	1360	383.93
61	Salyan	H	181785	1462	124.34
62	Sankhuwasabha	M	141903	3480	40.78
63	Saptari	T	465668	1363	341.65
64	Sarlahi	T	492798	1259	391.42
65	Sindhuli	H	223900	2491	89.88
66	Sindhupalchowk	H	261025	2542	102.68
67	Siraha	T	460746	1188	387.83
68	Solukhumbu	M	97200	3312	29.35
69	Sunsari	T	463481	1257	368.72
70	Surkhet	H	225768	2451	92.11
71	Syangja	H	293526	1164	252.17
72	Tanahun	H	268073	1546	173.40
73	Taplejung	M	120053	3646	32.93
74	Terhathum	H	102870	679	151.50
75	Udayapur	H	221256	2063	107.25

[1] T = Terai, H = Hill, M = Mountain

Densities of Road by District

No.	District	Road Length (km)	Area (Km^2)	Road Densities
1	Achham	44	1680	0.03
2	Arghakhanchi	131	1193	0.11
3	Baglung	4	1784	0.00
4	Baitadi	154	1519	0.10
5	Bajhang	5	3422	0.0015
6	Bajura	0	2188	0.00
7	Banke	295	2337	0.13
8	Bara	171	1190	0.14
9	Bardiya	214	2025	0.11
10	Bhaktapur	125	119	1.05
11	Bhojpur	0	1507	0.00
12	Chitwan	459	2218	0.21
13	Dadeldhura	125	1538	0.08
14	Dailekh	60	1502	0.04
15	Dang	349	2955	0.12
16	Darchula	21	2322	0.0090
17	Dhadhing	155	1926	0.08
18	Dhankuta	108	891	0.12
19	Dhanusha	242	1180	0.21
20	Dolakha	114	2191	0.0520
21	Dolpa	0	7889	0
22	Doti	140	2025	0.07
23	Gorkha	69	3610	0.0191
24	Gulmi	112	1149	0.10
25	Humla	0	5655	0
26	Ilam	272	1703	0.16
27	Jajarkot	0	2230	0.00
28	Jhapa	546	1606	0.34
29	Jumla	0	2531	0.00
30	Kailali	344	3235	0.11
31	Kalikot	0	1741	0.00
32	Kanchanpur	154	1610	0.10
33	Kapilbastu	283	1738	0.16
34	Kaski	264	2017	0.13
35	Kathmandu	528	395	1.34
36	Kavrepalanchowk	169	1396	0.12
37	Khotang	0	1591	0.00
38	Lalitpur	290	385	0.75
39	Lamjung	54	1692	0.03
40	Mahottari	235	1002	0.23
41	Makawanpur	326	2426	0.13
42	Manang	0	2246	0

43	Morang	489	1855	0.26
44	Mugu	0	3535	0
45	Mustang	0	2246	0
46	Myagdi	0	2297	0.00
47	Nawalparasi	219	2162	0.10
48	Nuwakot	194	1121	0.17
49	Okhaldunga	0	1074	0.00
50	Palpa	210	1373	0.15
51	Panchthar	150	1241	0.12
52	Parbat	24	494	0.05
53	Parsa	143	1353	0.11
54	Pyuthan	114	1309	0.09
55	Ramechhap	0	1546	0.00
56	Rasuwa	102	1544	0.0661
57	Rautahat	123	1126	0.11
58	Rolpa	48	1879	0.03
59	Rukum	0	2877	0.00
60	Rupandehi	238	1360	0.18
61	Salyan	128	1462	0.09
62	Sankhuwasabha	2	3480	0.0006
63	Saptari	267	1363	0.20
64	Sarlahi	221	1259	0.18
65	Sindhuli	60	2491	0.02
66	Sindhupalchowk	174	2542	0.07
67	Siraha	178	1188	0.15
68	Solukhumbu	0	3312	0
69	Sunsari	291	1257	0.23
70	Surkhet	248	2451	0.10
71	Syangja	144	1164	0.12
72	Tanahun	175	1546	0.11
73	Taplejung	32	3646	0.0088
74	Terhathum	32	679	0.05
75	Udayapur	156	2063	0.08

Source: CBS, 1997 and DOR, 1995

Own Source Revenue of the Districts (Fiscal Year 1995/96)

Amount in NRs., 000

No.	District	Local Tax	Other Revenue[1]	Total Own Source Revenue	Ecological Belt
1	Achham	404	369	773	H
2	Arghakhanchi	1317	246	1563	H
3	Baglung	499	613	1112	H
4	Baitadi	NA	NA	NA	H
5	Bajhang	17	390	407	M
6	Bajura	91	83	174	H
7	Banke	4416	1011	5427	T
8	Bara	399	4777	5176	T
9	Bardiya	3538	461	3999	T
10	Bhaktapur	8853	1095	9948	H
11	Bhojpur	590	295	885	H
12	Chitwan	NA	NA	NA	T
13	Dadeldhura	1102	45	1147	H
14	Dailekh	242	26	268	H
15	Dang	1069	25	1094	T
16	Darchula	91	150	241	M
17	Dhadhing	10379	478	10857	H
18	Dhankuta	127	2532	2659	H
19	Dhanusha	2896	361	3257	T
20	Dolakha	21	3338	3359	M
21	Dolpa	255	20	275	M
22	Doti	217	978	1195	H
23	Gorkha	745	0	745	M
24	Gulmi	1070	9148	10218	H
25	Humla	218	1070	1288	M
26	Ilam	3127	2263	5390	H
27	Jajarkot	132	250	382	H
28	Jhapa	10940	7495	18435	T
29	Jumla	233	2427	2660	H
30	Kailali	5719	574	6293	T
31	Kalikot	74	597	671	H
32	Kanchanpur	10800	2603	13403	T
33	Kapilbastu	584	3952	4536	T
34	Kaski	8652	668	9320	H
35	Kathmandu	20493	130	20623	H
36	Kavrepalanchowk	2258	9609	11867	H
37	Khotang	452	367	819	H
38	Lalitpur	310	7937	8247	H
39	Lamjung	766	118	884	H
40	Mahottari	1781	90	1871	T
41	Makawanpur	128	1960	2088	H
42	Manang	21	41	62	M

43	Morang	883	2515	3398	T
44	Mugu	28	912	940	M
45	Mustang	863	352	1215	M
46	Myagdi	180	44	224	H
47	Nawalparasi	3056	1187	4243	T
48	Nuwakot	1143	341	1484	H
49	Okhaldunga	NA	NA	NA	H
50	Palpa	1188	104	1292	H
51	Panchthar	1310	239	1549	H
52	Parbat	789	28	817	H
53	Parsa	260	5924	6184	T
54	Pyuthan	231	372	603	H
55	Ramechhap	340	73	413	H
56	Rasuwa	53	138	191	M
57	Rautahat	1181	5546	6727	T
58	Rolpa	115	109	224	H
59	Rukum	35	132	167	H
60	Rupandehi	8855	1367	10222	T
61	Salyan	379	586	965	H
62	Sankhuwasabha	96	21648	21744	M
63	Saptari	213	978	1191	T
64	Sarlahi	264	883	1147	T
65	Sindhuli	285	1146	1431	H
66	Sindhupalchowk	368	3472	3840	H
67	Siraha	NA	NA	NA	T
68	Solukhumbu	222	504	726	M
69	Sunsari	920	7410	8330	T
70	Surkhet	617	3049	3666	H
71	Syangja	63	353	416	H
72	Tanahun	4088	53	4141	H
73	Taplejung	403	2174	2577	M
74	Terhathum	105	497	602	H
75	Udayapur	1487	655	2142	H

OSR= Own Source Revenue, NA = Data not available, T = Terai, H = Hill, M = Mountain

[1] Other revenue includes service charge, sales of natural resources like sand, gravel, slate etc., rent from the assets of DDC.

Source: Office of Account Controller, 2000

District Level Survey Results

1 Reasons for Non-Implementation of Project Activities (N=46)

Ecological Belt	Budget	Contract	Supervision	Contractor	Others	Total
Mountain	1	0	0	0	1	2
Hill	13	4	7	3	10	37
Terai	12	1	6	3	5	27
Total	26	5	13	6	16	66
%	39.39	7.58	19.70	9.09	24.24	100.00

Source: Field Survey, 2000

2 Average Number of Technicians (N= 46)

Ecological Belt	Engineer	Overseer	Sub-Overseer
Mountain	1.00	4.50	4.50
Hill	1.22	3.56	5.19
Terai	1.29	4.12	5.94

Source: Field Survey, 2000

3 Status of DTMP Preparation (N=46)

Ecological Belt	Nos. of DTMP Districts
Mountain	1
Hill	12
Terai	7
Total	20

Source: Field Survey, 2000

4 Maintenance Plan (N=46)

Ecological Belt	Maintenance Plan
Mountain	0
Hill	8
Terai	7
Total	15
% of Total Sample	32.61

Source: Field Survey. 2000

5 Networking Concept (N = 46)

Ecological Belt	Networking Concept
Mountain	1
Hill	7
Terai	5
Total	13
% of Total Sample	28.26

Source: Field Survey, 2000

6 Need of Transport Demand in the Opinion of Engineer (N = 46)

Ecological Belt	Transport Demand	% of Sample Size
Mountain	2	4.35
Hill	18	39.13
Terai	16	34.78
Total	36	78.26

Source: Field Survey, 2000

7 Transport Demand from the Perspective of Policy Makers by the Ecological Belt (N=46)

Ecological Belt	Favorable Opinion	% of Total Sample
Mountain	1	2.17
Hill	25	54.35
Terai	15	32.61
Total	41	89.13

Source: Field Survey, 2000

8 Specification Producing Agencies and Follower Districts (N=46)

Ecological Belt	Total	MOLD	MOWT
Mountain	2		2
Hill	27	4	23
Terai	17	3	14
Total	46	7	39

Source: Field Survey, 2000

9 Appropriateness of Norms and Specifications (N=46)

Ecological Belt	Appropriateness of Norms
Mountain	1
Hill	10
Terai	6
Total	17

Source: Field Survey, 2000

10 Possibility of Reducing Cost (N=46)

Ecological Belt	Nos. of Districts
Mountain	0
Hill	18
Terai	13
Total	31

Source: Field Survey, 2000

11 Satisfied Districts with the Prioritization criteria (N=46)

Ecological Belt	Satisfied Districts
Mountain	0
Hill	6
Terai	2
Total	8

Source: Field Survey, 2000

Required Equipment with Different Hierarchy of Contractors

No.	Equipment	Required Numbers of Equipment with Different Class of Contractors			
		A	B	C	D
1	Theodolite	2	1		
2	Level	4	2	2	1
3	Dump Truck or Truck	2	1		
4	Water Pump	3	2	2	1
5	Concrete Mixture	3	2	1	
6	Vibrator	5	4	3	1
7	Lab. Equipment	1 Set	1		
8	Back Hoe, Excavator, Bulldozer	Any one	Any one		
		At least required number among the following equipment			
9	Loader	4	2	1	
10	Bitumene Distributor/ Sprayer				
11	Water Tanker/ Sprayer				
12	Motor Grader				
13	Three Wheel Roller				
14	One Ton Roller				
15	Pneumatic Roller				
16	Bitumen Paver				
17	Asphalt Mix Plant				
18	Crane				
19	Fork Lift				
20	Crusher				
21	Compactor				
22	Vibrating Roller				
23	Hydraulic Augur				
24	Winch				
25	Building Hoist				

Technically Feasible Construction Methods

Activity	Job Parameter	Available Construction Methods: LBT	Equipment	Intermediate: Hill	Intermediate: Terai
Excavation	Ordinary Soil	Spade, Pick Showel	Bulldozer, Scrapper	Spade, Pick Showel	Tractor towed grader
	Soft Rock	Crowbar, Chisel Hammer	Dozer - Ripper	Crowbar, Chisel Hammer	Crowbar, Chisel Hammer
	Hard Rock	Crowbar, Chisel Hammer	Machine drilling Blasting	Machine drilling Blasting	Machine drilling Blasting
Loading Hauling Unloading	Haul 0 - 100m	Head Basket Wheel Barrow Pack Animals	Dozer, Wheeled Loader	Head Basket Wheel Barrow	Tractor towed grader
	Haul 100 -1000m	Pack Animals Animal Cart Tractor Trailer	Scraper with or without pusher, Loader/Excavator into Dump Truck	TractorTrailer	Tractor Trailer
	Over 1 Km.	Tractor Trailer Flat Bet Truck	Loader/Excavator into Dump Truck	Tractor Trailer Flat Bet Truck	Tractor Trailer Flat Bet Truck
Watering		Tractor drawn Water Tank	Self-propelled Water Tank	Tractor drawn Water Tank	Tractor drawn Water Tank
Spreading Soil or Aggregate		Hoe, rake Showel	Grader	Hoe, rake,Showel Tractor towed Grader	Hoe, rake,Showel Tractor towed Grader
Production of Stone Aggregate		Hammer	Crushing Plant with integrated Screens and conveyor loaded by wheeled loader	Hammer	Hammer
Compaction	Embankment	Hand Compaction Vibratory Compactor	Power Roller	Vibrating Compactor	Vibrating Compactor
	Sub-grade	2 ton power roller	8-10 Ton Roller	8-10 Ton Roller	8-10 Ton Roller
	Sub-base	3 ton power roller	8-10 Ton Roller	8-10 Ton Roller	8-10 Ton Roller
Bitumen Carpet		Tar boiler, mechanical mixer, hand laid	Hot-mix plant, paver-finisher	Tar boiler, mechanical mixer, hand laid	Tar boiler, mechanical mixer, hand laid

Annex 6.1

Correlation Between Density of Road and Other Parameters

District	E_Belt	Pop_91	Area	Rd_Length	DOP	DOR	Literacy Rate
Achham	H	198188	1680	44	117.97	0.03	0.23
Arghakhanchi	H	180884	1193	131	151.62	0.11	0.43
Baglung	H	232486	1784	4	130.32	0.00	0.41
Baitadi	H	200716	1519	154	132.14	0.10	0.35
Bajhang	M	139092	3422	5	40.65	0.00	0.27
Bajura	H	92010	2188	0	42.05	0.00	0.25
Banke	T	285604	2337	295	122.21	0.13	0.34
Bara	T	415718	1190	171	349.34	0.14	0.28
Bardiya	T	290313	2025	214	143.36	0.11	0.29
Bhaktapur	H	172952	119	125	1453.38	1.05	0.58
Bhojpur	H	198784	1507	0	131.91	0.00	0.41
Chitwan	T	354488	2218	459	159.82	0.21	0.53
Dadeldhura	H	104647	1538	125	68.04	0.08	0.36
Dailekh	H	187400	1502	60	124.77	0.04	0.29
Dang	T	354413	2955	349	119.94	0.12	0.40
Darchula	M	101683	2322	21	43.79	0.01	0.41
Dhadhing	H	278068	1926	155	144.38	0.08	0.32
Dhankuta	H	146386	891	108	164.29	0.12	0.49
Dhanusha	T	543672	1180	242	460.74	0.21	0.30
Dolakha	M	173236	2191	114	79.07	0.05	0.34
Dolpa	M	25013	7889	0	3.17	0.00	0.23
Doti	H	167168	2025	140	82.55	0.07	0.28
Gorkha	M	252524	3610	69	69.95	0.02	0.43
Gulmi	H	266331	1149	112	231.79	0.10	0.47
Humla	M	34383	5655	0	6.08	0.00	0.20
Ilam	H	229214	1703	272	134.59	0.16	0.52
Jajarkot	H	113958	2230	0	51.10	0.00	0.23
Jhapa	T	593737	1606	546	369.70	0.34	0.56
Jumla	H	75964	2531	0	30.01	0.00	0.25
Kailali	T	417891	3235	344	129.18	0.11	0.30
Kalikot	H	88805	1741	0	51.01	0.00	0.19
Kanchanpur	T	257906	1610	154	160.19	0.10	0.41
Kapilbastu	T	371778	1738	283	213.91	0.16	0.29
Kaski	H	292945	2017	264	145.24	0.13	0.57
Kathmandu	H	675341	395	528	1709.72	1.34	0.70
Kavrepalanchowk	H	324329	1396	169	232.33	0.12	0.39
Khotang	H	215965	1591	0	135.74	0.00	0.40
Lalitpur	H	257086	385	290	667.76	0.75	0.62
Lamjung	H	153697	1692	54	90.84	0.03	0.47
Mahottari	T	440146	1002	235	439.27	0.23	0.26
Makawanpur	H	314599	2426	326	129.68	0.13	0.38
Manang	M	5363	2246	0	2.39	0.00	0.43

Morang	T	674823	1855	489	363.79	0.26	0.49
Mugu	M	36364	3535	0	10.29	0.00	0.22
Mustang	M	5363	2246	0	2.39	0.00	0.48
Myagdi	H	100552	2297	0	43.78	0.00	0.39
Nawalparasi	T	436217	2162	219	201.77	0.10	0.39
Nuwakot	H	245260	1121	194	218.79	0.17	0.31
Okhaldunga	H	139457	1074	0	129.85	0.00	0.39
Palpa	H	236313	1373	210	172.11	0.15	0.48
Panchthar	H	175206	1241	150	141.18	0.12	0.44
Parbat	H	143547	494	24	290.58	0.05	0.52
Parsa	T	372524	1353	143	275.33	0.11	0.32
Pyuthan	H	175469	1309	114	134.05	0.09	0.33
Ramechhap	H	188064	1546	0	121.65	0.00	0.30
Rasuwa	M	36744	1544	102	23.80	0.07	0.23
Rautahat	T	414005	1126	123	367.68	0.11	0.24
Rolpa	H	179621	1879	48	95.59	0.03	0.28
Rukum	H	15554	2877	0	5.41	0.00	0.29
Rupandehi	T	522150	1360	238	383.93	0.18	0.40
Salyan	H	181785	1462	128	124.34	0.09	0.30
Sankhuwasabha	M	141903	3480	2	40.78	0.00	0.48
Saptari	T	465668	1363	267	341.65	0.20	0.35
Sarlahi	T	492798	1259	221	391.42	0.18	0.26
Sindhuli	H	223900	2491	60	89.88	0.02	0.33
Sindhupalchowk	H	261025	2542	174	102.68	0.07	0.29
Siraha	T	460746	1188	178	387.83	0.15	0.29
Solukhumbu	M	97200	3312	0	29.35	0.00	0.39
Sunsari	T	463481	1257	291	368.72	0.23	0.44
Surkhet	H	225768	2451	248	92.11	0.10	0.42
Syangja	H	293526	1164	144	252.17	0.12	0.51
Tanahun	H	268073	1546	175	173.40	0.11	0.50
Taplejung	M	120053	3646	32	32.93	0.01	0.46
Terhathum	H	102870	679	32	151.50	0.05	0.55
Udayapur	H	221256	2063	156	107.25	0.08	0.38

Correlation between DOP and DOR 0.95

Correlation between DOP and Literacy Rate 0.53

Source: CBS, 1991 and DOR, 1995

Annex 7.1

Present Practice of Budget Allocation

NRs. in ,000

No.	Cash Flow	Fiscal Year					
	Forecasted Cash Inflow	96/97	97/98	98/99	99/00	00/01	01/02
1	HMG Grant allocated for the District Road					3300	
2	Block Grant for the District Roads	3300	3300	3300	3300	3300	
3	Local Development Construction Program					5900	
4	Rural Infrastructure Project (World Bank and DDC)				2208	12647	
5	Agricultural Road Program (ADB)			2365	2051	3500	
6	DDC Own Source Revenue					600	
7	Specific Grant		1100			0	
	Total Revenue					29247	
	Forecasted Cash Outflow						
	Total Maintenance Liabilities					2735	
	Disposable Capital					26512	
	New Construction and Rehabilitation Projects1						
1	Daldale - Dhobadi					1168	
2	Kawasoti - Taruwa Thana					500	
3	Dumkibas - Pidari - Dhurkot					924.9	
4	Maheshpur - Bhujahawa - Suryapura					450	
5	Harkatawa - Parasi					1600	
6	Kumarwarti - Gochada					75	
7	Arun Khola - Rampur					1400	
8	Panchanagar - Jamunaha - Pipara					400	
9	Kushma - Pipara - Palhi					275	
10	Hattikhor - Baluwadanda - Kumsot					250	
11	Makar Daunne Culvert					150	
12	Aarkhala - Pragatinagar					150	
13	Triveni - Arunkhola					150	
14	Amarapuri - Dandajheri					100	
15	Majhauni - Chisapani - Badsare					150	
16	Pokharpali - Nanai - Raksaha					614	
17	Ujjaini - Chimantola					2457	
18	Pusauli - Amhawa (Dhanewa Bridge)					750	
19	Kawasoti - Shivabasti					200	
20	Bardhaghat - Paldanda - Suryanagar					300	
21	Narsahi - Badrighat					200	
22	Sunwal - Gothadi					300	
23	Mahendra Rajmarg - Matkuri					300	
24	Ratanpuri - Bhattari					200	
25	Lokhaka - Pithauli - Tigartop					200	
26	Dumkibas - Dandajhor - BeniManipur - Dhurkot					400	
27	Approach Road to Rajahar 3					150	
28	Arun Khola - Dhare Simal - Rakachuli					200	
29	Guthi Parsauni - Ramnagar - Narshahi					200	
30	Rajahar - Dandajheri Mule Track					200	
31	Maheshpur - Hattiban - Hulaki Sadak					200	
32	Basa - Piprahiya					2725	
33	Chisapani - Majhauni					3141	
34	Chormara - Jhyalbas					1387	
35	Danda - Gochada - Koluha					1035	
36	Makar - Baruwa					111.8	
37	Khairahani - Bhujahawa					2000	
38	Naya Belhani - Parsauni - Chormara					1000	
39	Gaindakot Agricultural Ring Road					500	
	Total Allocated Budget					26512	

Allocation of All Available Resources on Priority Roads

NRs. in .000

No.	Cash Flow	Fiscal Year														
	Forecasted Cash Inflow	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Internal Sources															
1	Road Sector Expenses from the Own Source Revenue (15%)	2042	2162	2718	2900	3289	3618	3980	4369	4816	5297	5827	6410	7160	7051	7756
2	25% of the Constituency Development Program	439.25	483	531.5	584.5	643	707.25	778	855.75	941.5	1035.5	1139.25	1253	1379	1516	1668
3	Toll Tax	463	486	510	536	563	591	620	651	684	717	753	741	830	872	916
4	Peoples Participation	677	745	820	1173	1290	1419	1561	1717	2182	2400	2640	2900	3195	3747	4122
5	Block Grant	3300	3531	3778	4043	4326	4628	4952	5299	5670	6067	6492	6946	7432	7952	8509
	Total Internal Revenue	6922	7407	8358	9236	10111	10964	11891	12892	14293	15517	16851	18250	19996	21139	22971
	External Sources															
	Rural Infrastructure Program (WB and DDC)	12647	12647	12647	12647											
	Agricultural Road Program (ADB)	3500	3500	3500	3500											
	Total External Revenue	16147	16147	16147	16147											
	Total Revenue	23069	23554	24505	25383	10111	10964	11891	12892	14293	15517	16851	18250	19996	21139	22971
	Forecasted Cash Outflow															
	Total Maintenance Liabilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Disposable Capital	23069	23554	24505	25383	10111	10964	11891	12892	14293	15517	16851	18250	19996	21139	22971
	New Construction and Rehabilitation Projects															
1D	Triveni - Maheshpur			34,135	9,630	15,754										
	Disposable Capital			-9,630	15,754	25,864										
5UD	Kawasoti - Dedgaon					58,647										
	Disposable Capital					-32,782	-21,818	-9,927	2,965	17,258						
7UD	Dhobadi - Bulintar									26,088						
	Disposable Capital									-8,829	6,687	23,539				
1UD	Dumkibas - Dhurkot											50,557				
	Disposable Capital											-27,019	-8,769	11,227	32365	
2UD	Naya Belhani - Ruksebhanjyang														28,919	
	Disposable Capital														3,446	26,418
6UD	Mukundapur - Thambensi															
	Disposable Capital															
4UD	Jhyalbas - Hupsekot															
	Disposable Capital															

Norms for the Road Construction

Agency	Earthwork Excavation			Embankment	Sub-Base Course (Quarry Gravel)		
	Ordinary Soil	Soft Rock	Hard Rock				
	Labor	Labor	Labor	Labor	Skilled Labor	Labor	Equipment
Unit	MD	MD	MD	MD	MD	MD	Hrs.
Department of Roads[1,2,3,4,5]	0.70	3.00	24.20	0.50		1.21	0.018
DOLIDAR [6,7,8]	0.60	4.00	17.00	0.25	0.05	0.95	0.018
GTZ	0.70	5.00	20.00	0.70		0.65	
GTZ-SIDEF	0.35	2.00	21.00				
RIDP-Kavre	0.68	1.51	1.75				
RIDP-Baglung	0.32	0.67	1.67				
MDRP	0.91			0.59			
Contractor Survey (Average.)	0.56	1.75	4.00	1.00			
Mean	0.60	2.56	12.80	0.61	0.05	0.94	0.018
Standard Deviation	0.19	1.52	9.92	0.27	0.00	0.28	0.00

[1] E/W excavation includes the transportation up to 10 m and lift of 1.5 m. and quantity is assumed 1 Cum.

[2] Hard rock is classified based on requirement of Chiseling. For the hard rock that does not require chisel needs 3 nos. of labor per cum. and the hard rock which needs chiseling requires 24.2 nos. of laborers. However, the hard rock that does not need chiseling is rare. Therefore, the required manpower is taken that needs chiseling. The next assumption is that no blasting is allowed. The quantity is assumed 1 Cum.

[3] The embankment includes the haulage of 10 m. and filling of the material in the layer of 15 cm. and watering and manual compaction. It does not include the transport of water. The quantity is assumed 1 Cum.

[4] The layer of sub-base is assumed to be 20 cm. The quantity is assumed 1 Sq.m.

[5] Collection of natural gravel within the distance of 10 m. and spreading it on the road surface. Collection requires 1 Pd per Sq.m. and spreading requires 0.21 person-day per square meter.

[6] Excavation includes the satisfactory disposal of all materials up-to 50 m. along the lead route.

[7] The DOLIDAR has distinguished the norms for hill and plain area. For the safety reason, higher side quantity is taken.

[8] Embankment excludes the earthwork excavation.

District Level Transport Plan According to the Prevailing Practice

Nawalparasi District

No.	Road	Phase
1	Gaindakot – Kali Gandaki – Rampur	15
2	Daldale – Dhobadi – Dedgaon	15
3	Arkhala – Bulintar – Kotthar	15
4	Dhowadi – Ruchang – Rakuwa	15
5	Hattikhor – Baluwa Danda – Kumsot	5
6	Arun Khola – Damar – Rampur	15
7	Mahendra Highway – Pidari – Dhurkot	5
8	Dumkibas – Dandajhor – BeniManipur – Dhurkot	15
9	Triveni – Dumkibas	15
10	Arusha Khola – Triveni	15
11	Illi – Ritthe Mule Track	5
12	Lokaha – Pithauli – Tiger Top	5
13	Arun Khola – Rakachuli	5
14	Alok Chakrapath	5
15	Maheshpur – Bhujahawa – Suryapura	15
16	Bardhaghat – Paldanda – Suryanagar	5
17	Narshahi – Badrighat	5
18	Guthi Parsauni – Ramnagar – Narsahi	5
19	Harkatta – Parasi (Manjhariya)	5
20	Kushma (Parsiya) – Palhi (Lukupuruwa)	5
21	Chisapani – Laguhanawa – Makar – Belhani – Paldanda	5
22	Sunawal – Gothadi	15
23	Khairatawa – Baidauli – Guthi Parsauni	5
24	Pusauli – Amahawa	5
25	Approach Road to Rajahar – 3	1
26	Barkol – Charchare – Bulintar – Dandajheri Mule Track	5
27	Maheshpur – Hattiban Postal Road	5
28	Sanahi - Manjhariya	5
29	Parashi – Birpuruwa	5
30	Sarawal – Gobrahiya	5
31	Bhaktipur – Mudera – Germi	5
32	Mahendra Highway – Matkuri	5
33	Hulaki - Jamunaha	5
34	Shivamandir – Hasaura	5
35	Gaindakot – Hardi	5
36	Dhodani – Kota	5
37	Chasapani – Majauni	1
38	Basa – Piprahiya	1
39	Ujjani - Chimantola	1
40	Pokharpali – Raksaha – Nanai – Mahab Khola	5
41	Naya Belhani – Parsauni – Chormara (Shivanagar)	1
42	Gaindakot Agricultural Road	5