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Information Management System for Road Maintenance Management of Strategic Road of Nepal

by

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A THESIS

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The undersigned certify that they have read, recommended to the Institute of Engineering for acceptance, the thesis entitled **"Information Management System for Road Maintenance Management of Strategic Road of Nepal"** submitted by **Ms. Ratna Laxmi Bajracharya (071/MST/261)** in partial fulfillment of the requirements for the award of the degree of Master of Science in Transportation Engineering.

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ABSTRACT

With the increasing length of strategic road network, the road management organization like Department of Roads (DOR) is much concern to maintain its road network to serviceable condition. DOR is working to achieve the goal of "Reduction of Total Transportation Cost" from very beginning of its establishment. The budgetary constrain for maintenance has been one of the main obstacles to obtain the ultimate goal.

During the budgetary constrain only an effective and efficient road maintenance management system can optimize theinvestment for road maintenance. Areliable and accurate information management system is the prerequisite for an effective and efficient road maintenance management system. DOR has also its own information management system. Hence this study has been carried out to findout strength and weakness in existing Information Management System in Department of Roads.

ACKNOWLEDGEMENT

Completing this thesis work has been a wonderful and often overwhelming experience. Many people had some particular importance during the thesis preparation, for their suggestions and work together but also for friendship and patience. I will however restrain this section to academic acknowledgments related to the thesis as a whole.

I am deeply indebted to Professor **Prof. Gautam Bir SinghTamrakar and Er. Vishnu Prasad Shrestha,** who were the mentors of this thesis. Their suggestions, opinions, discussions are very useful and much appreciable.

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Thanks to HMIS, Maintenance Branch, Department of Roads and Road Board Nepal from where I received the data for the thesis work.

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ABBREVIATIONS

ARMP ... . Annual Road Maintenance Plan

DOR ... . Department of Roads

DoLIDAR... ..... . Department of Local Infrastructure Development and Agricultural Roads

IARMP ... . Integrated Annual Road Maintenance Plan

IQL ... . Information Quality Level

HMIS .... Highway Management Information System

HDM ... . Highway Design and Maintenance Standard Model

LRN ... . ….Local Road Network

SRN ... . Strategic Road Network

RCI... .... Road Condition Index

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PART I

CHAPTER 1. INTRODUCTION

1.1 General

Many developing countries are facing the challenges of achieving the goals of infrastructure development despite of the huge investment in road sector. These huge investments mostly poured into the new construction resembling the road network as the blood vessel of country and less attention paid to their maintenance. The roads start to deteriorate from the beginning of its service life which depends upon the traffic, climate and service period. The road condition determines the vehicle operating cost, user cost and social cost hence maintaining the serviceable condition of road is very important for the overall development of country.

In developing countries the maintenance of road network gets less regard as compared to new construction work. Most of the roads in developing countries get priority on the political bases rather than its function ability. Even the investment in the road maintenance fails to maintain serviceability condition. Due to the inefficient maintenance management most of the road seeks frequent maintenance, many roads maintained after the long interval. The maintenance management system is not functioning well due to the lack of efficient information system. The efficient information system is very important for the success of maintenance management for the allocation of resources to the right project in the context of budgetary constrain.

The road maintenance management system in Nepal has been developed over the past three decades. As the efficiency of the management system depends upon the institutional setup and the size of road network. With the increasing length of road network and non-upgraded institutional setup, Nepal is facing the serious problem for the road maintenance management.

1.2 Objective of Study

The main purposes of study are as follows:

1. To assess the road maintenance management system practiced in Nepal for Strategic Road Network.
2. To investigate strength and weakness of existing informationmanagement system of DOR.

3. To assess the compatibility of existing road maintenance management system with selected number of computer based road maintenance management systems for the information needed.

In order to achieve these objectives, the following studies have been carried out.

1. Study of current Highway Information Management System for strategic Road Network of Nepal
2. Study of following computer based road maintenance management systems output
    i) PAVER
    ii) HDM-IV

1.3 Scope and Limitation of Study

1.3.1 Scope of Study

The main objective of the study is to find out strength and weakness in existing Information Management System for the maintenance of **Strategic Road Networks of Nepal** and to identify the necessity improvements required. Hence selected number of computerized maintenance management system with information outputs were studied and examined for compatibility.

1.3.2 Limitation of Study

The limitation of this Study

1. The scope of the study is limited to Strategic Road Networks of Nepal.
2. The data processing of computerized management system is not the part of study.

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CHAPTER 2.ROAD ADMINISTRATION NEPAL

2.1 General

Nepal is a developing country. Due to its remote territory, people are still out of reach of access to road transport facilities. Hence high priority has been given in completing the construction of roads connecting all 75 District Headquarters of the country. Similarly NationalTransport Policy also prioritizes the maintenance and up gradation of transport infrastructure on the basis of traffic density and economic consideration but with the limited budget, it is difficult to allocate sufficient budget in all roads. Hence the maintenance management system plays the important role in keeping all the roads in serviceable condition.

2.2 Classification of Road Network

According to Nepal Road Standard 2070, The Road Network of Nepal is classified administratively and functionally

A. Administrative Classification

National Highways:

National Highways are main roads connecting East to West and North to South of the Nation. These serve directly the greater portion of the longer distance travel, provide consistently higher level of service in terms of travel speeds, and bear the inter-community mobility. These roads shall be the main arterial routes passing through the length and breadth of the country as a whole.

Feeder Roads:

Feeder roads are important roads of localized nature. These serve the community's wide interest and connect District Headquarters, Major economic centers, Tourism centers to National Highways or other feeder roads.

District Roads:

District Roads are important roads within a district serving areas of production and markets, and connecting with each other or with the main highways.

Urban Roads:

Urban Roads are the roads serving within the urban municipalities.

B. Technical/Functional Classification

Class I:

Class I roads are the highest standard roads with divided carriageway and access control (Expressways) with ADT of 20,000 PCU or more in 20 yrs perspective period. Design speed adopted for design of this class of roads in plain terrain is 120 km/h.

Class II:

Class II roads are those with ADT of 5000-20000 PCU in 20 yrs perspective period.

Design speed adopted for design of this class of roads in plain terrain is 100 km/h.

Class III:

Class III roads are those with ADT of 2000-5000 PCU in 20 yrs perspective period.

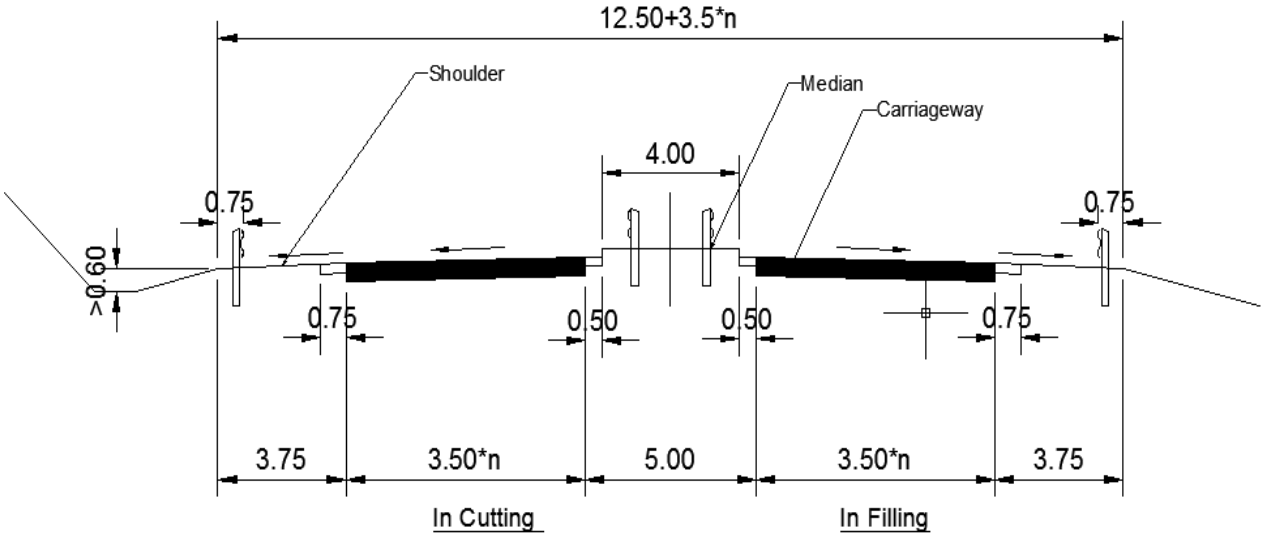
Design speed adopted for design of this class of roads in plain terrain is 80 km/h

Class IV:

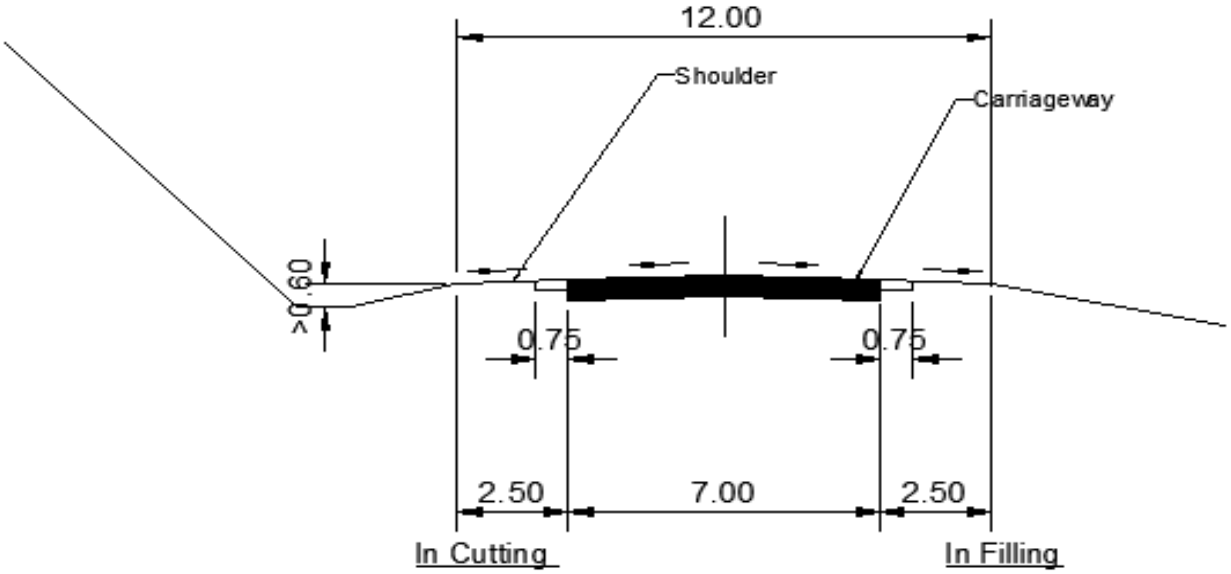
Class IV roads are those with ADT of less than 2000 PCU in 20 yrs perspective period.

Table 2.1 Approximate Correlation between Administrative and Technical/Functional Classification

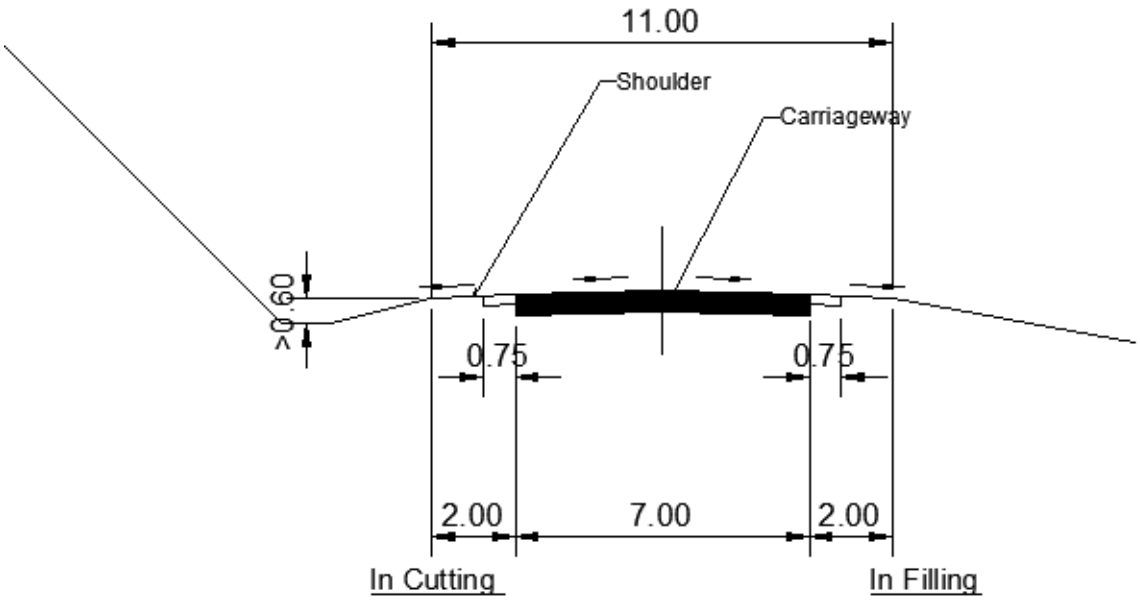
	Plain and Rolling Terrain	Mountainous and steep terrain
National Highways	I,II	II,III
Feeder Roads	II,III	III,IV



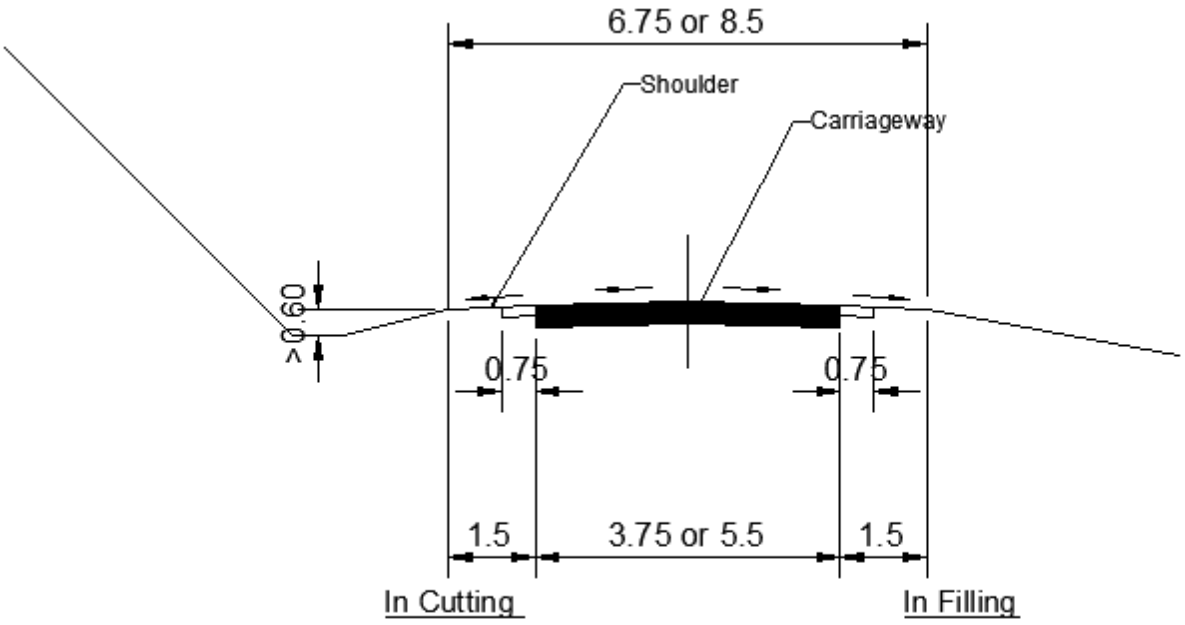
CROSS SECTION OF CLASS I ROAD(n=2,3...)



CROSS SECTION OF CLASS II ROAD



CROSS SECTION OF CLASS III ROAD



CROSS SECTION OF CLASS IV ROAD

2.3 Organization of Road Management

National Highways and Feeder Roads are Strategic Road Network. Ministry of Physical Infrastructure and Transport, Department of Road are the authorized institution for the construction and maintenance of this strategic road network. While remaining roads are under the authorization of Ministry of Federal Affairs and Local Development.

Table 2.2**National Road System Administration Responsibilities**

Responsible Authority	**Executing Agency**	**Road Classification**
Ministry of Physical Infrastructure and Transport	Department of Roads	Central Road System National Highways Feeder Roads (Major) {Multi-Purpose} Feeder Roads (Major) {Sector Specific VIP} Feeder Roads (Major) {Social} Feeder Roads (Minor) {Multi-Purpose} Feeder Roads (Minor) {Social} Hulaki (Postal Roads)
		Urban Road System City Development Roads
Ministry of Federal Affairs and Local Development	District Development Committees	Local Road System District Roads Agriculture Roads Village Roads Mule Tracks/Main Trails
	Village Development Committees	Local Road System Village Trails
	Municipalities	Urban Road System Municipal Roads and Streets (excluding National Highways and Feeder Roads)
Ministry of Agriculture and Co-operatives	Agency to be determined, directed, and funded by MOAC	Central Road System Feeder Roads (Major) {Agriculture} Feeder Roads (Minor) {Agriculture
Authority of the Concerned Sector	Agency to be determined, directed, and funded by Sector Representative Authority	Central Road System Feeder Roads (Major) {Sector Specific} Feeder Roads (Minor) {Sector Specific}

Sources: DOR: Road Classification and Road Responsibilities (2001)

The schematic diagram of SRN, Organization Chart of Ministry of Physical Infrastructure and Transport, Department of Road are attached in Appendix.

2.4 Department of Roads

Department of Roads (DOR) was established in 2027 B. S. after splitting with Public Work Department. It is under the Ministry of Physical Infrastructure. It is a government agency whose main objective is to transfer the government policies for the roads sub-sector into the provision of a service to the travelling public.

The services of DOR comprises but not limited to

1. Construction of Road network according to present and future road transport need of country
2. Maintenance of existing road network to maintain its serviceable condition.
3. Ensure the safety of all road user including pedestrian

DOR established the end goal as ***"the reduction of total road transport costs" (the reduction of the total sum of interdependent costs of road construction, road maintenance and the direct costs to road users (vehicle operating costs))*** according to 8th national plan.

DOR has developed the strategy to achieve this end goal using the principles of Policy Action Planning. Department of Roads has 9 policy options, 51 key measures to achieve 6 objectives which are listed in the table 2.4.1 attached in Appendix

DOR is the executive organization for the maintenance and construction of Strategic Roads. It has five branches namely Maintenance Branch, Planning and Maintenance Branch, Bridge Branch, Foreign Cooperation Branch, and Mechanical Branch. It has 35 Division Offices under Five Regional Directorates for the supervision of maintenance works. The Maintenance Branch, as being the coordinating agency between Regional Directorates and Road Board Nepaland has the important role in maintenance management. The Highway Management Information System Unit is under the Planning and Design Branch. HIMSU is the data bank for the road information of DOR. It is responsible for the collection of road network data such as condition survey data, road inventory, traffic etc.

According to Road Register 2015, the condition of SRN road is shown in Table 2.4 as per condition rating given in the Table 2.3

Table 2.3 **Road Condition Rating Criteria**

SN	**Pavement Condition**	**IRI Range m/Km**
1	Good	0 - 4
2	Fair	4 - 6
3	Poor	6 - 8
4	Bad	>8

Table 2.4 Road Condition of SRN

Condition	**National Highway (Km)**	**Feeder Road (Km)**
Good	276.73	799.74
Fair	450.88	702.62
Poor	1196.12	1854.92
Bad	1355.49	1374.68
Unknown	2289.28	4966.03
Total	5568.50 Km	9398.99

Source: Road Register of ARMP 2015

PART II :(LITERATURE REVIEW)

CHAPTER 3. ROAD MAINTENANCE MANAGEMENT SYSTEMS

3.1 General

Maintenance of the existing roads is very important for sustainable transport system values even more in the condition of limited budget. Maintenance reduces the rate of deterioration and prolongs the life of roads, reduces vehicle operating costs by providing good running surfaces and helps to keep the road open more continuously particularly in wet season.

Road Maintenance comprises of:

1. Identification of defect on roads

2. Selection of best treatment

3. Execution

The best utilization of limited budget for road network maintenance investment can be achieved only with efficient and effective maintenance management system.

A maintenance management system comprises of:

1. Assessing Maintenance Priorities.

2. Determining cost effective maintenance alternatives.

3. Predicting future maintenance needs.

4. Setting up appropriate maintenance standards.

5. Systematic programming of maintenance works.

For the successful maintenance management system, its each component requires the reliable information system containing following elements

1. A reliable and efficient method of data collection

2. An efficient method of data classification

3. An efficient method of data processing and analysis.

4. An easily accessible data storage and updating method.

3.1.1 Road Maintenance Management Level

The road maintenance management system composed of two Levels (Snaith, 1994)

Network Level and Project Level

1. Network Level:

Network Level Analysis is of greater interest of the decision makers and budget directors and it is most powerful features of Maintenance Management System. It involves:

- Identification and raking of candidates pavements for improvement;
- Net-work level budgeting
- Long range budget forecasts
- Network-level pavement condition assessment;
- Forecast of future condition

2. Project Level:

The Project Level Analysis is of greater interest to the technical staff. It involves:

- Assessing the causes of deterioration.
- Determining potential solutions.
- Assessing benefits of the alternatives by life-cycle costing.
- Ultimately selecting and designing the desired solution.

3. Project /Network Interface:

A Level/Organization/ office exist between the Project level and Network level which coordinates the two levels by providing engineering needs to the project level and economic needs to the network level for their smooth operation is characterized as interface level. (Isaac, 1994)

3.2 Component of Road Maintenance Management system

There are many forms of road maintenance management system each appropriate to particular environment, available resources and needs, some operates manually, some are automated or combination of the two. The common feature among all the forms is that they all needs condition data to fulfill their objective (Kerali et al, 1989) of

deciding the economically optimized order of the work according the maintenance need based on two decision criteria (Kamram et al, 1989)

(i) Deterioration rates and

(ii) Serviceability and intervention level.

Thus the road maintenance management system is the correlation of different activities.

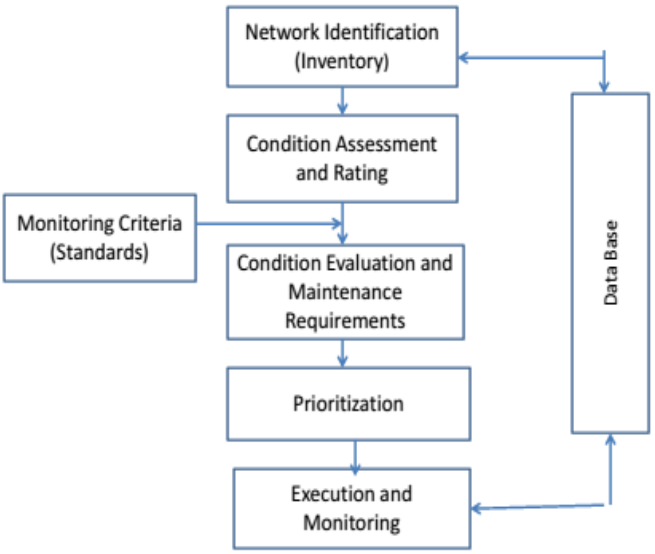


Figure 3.0-1**Typical Road Maintenance Management Framework (Isaac, 1994)**

3.2.1 Network Identification (Inventory)

Road inventory is first step of maintenance management. Road inventory provides the up to date information of the road network to the both network level and project level. For the preparation of road inventory data, road network should be divided into the manageable section regarding to traffic volume type, road geometry, surface type, structural composition, construction history, functional classification and condition. It should incorporate the environmental information, construction material location and overall cost. All the information should be presented in the form of strip map with an appropriate referencing system (Snaith,1994, Road Note 1(TRRL,1987)).

3.2.2 Condition Assessment and Rating

Condition assessment and rating is the information about the structural and the functional condition on deflections, roughness and distress of road network and its severity. It is the important information based on which requirement of maintenance

work is decided. Manual methods and mechanical methods are carried out simultaneously to acquire the reliable information. Pavement condition data can be achieved through three stage of data collection. (Snaith 1994)

1. Identify the critical location of pavement with the whole network survey using Bump Integrator or visual assessment means.
2. Detail analysis of critical sections with manual measurements.
3. Structural survey of most critical section

The road condition assessment methods to achieve the uniform and consistent data are (Isaac 1994)

1. Automated equipment method (Bump Integrator, Benkelman Beam, Deflectometer etc.)
2. Photographic Survey
3. Visual Inspection

The major types of pavement defects and their inspection methods are as follows

i. Roughness:

Roughness is a measure of the longitudinal unevenness of the road and symbol of riding comfort.

There are two classes of method for measuring roughness

Profile measurement: (1) Internal Profilometers, (2) Laser Profilometers

Surface response: (1) Vehicle-mounted Bump Indicator,

(2) Vehicle towed units

ii. Surface Distress:

Surface distress is the defects on the pavement surface in the form of rutting, cracking, and spaling, untreated cracks can lead to water ingress of the base, resulting ultimately in a structural defects

a) Manual Method of Inspection:

Visual inspection to identify defects occurring on the pavement surface and measure their severity and extent

b) Mechanical Method of Inspection:

Transverse profile including rutting is measured by ultra-sonic and laser technology

Cracking: there are various approaches such as photographic image interpretation for defining the severity and extent of surface defects. Currently video cameras are used instead of photographic equipment

iii. Structural Capacity :

Structural Capacity resembles to the load carrying capacity of Pavement which reduces continuously with the age. The process of structural deterioration is effected by influenced with the load, its repetition, material factors and environmental factors

a) Manual Method of Inspection:

Destructive: Trial Pit- thickness logging and assessing properties of materials – CBRetc.

Non-destructive: Benkelman Beam test

Semi-destructive: DCP test

b) Mechanical Method of Inspection:

Impulse load deflection: falling weight deflectometers

Moving load deflection: deflectograph "deflection bowel"

Steady –state vibratory load deflection:

iv. Pavement Texture and Friction:

Pavement Texture and Friction condition of pavement directly affect the comfort and safety of vehicle operation, hence this criteria is also one of important decision criteria of pavement condition.

a) Manual Method of Inspection:

The micro-texture depth of the road pavement surface is measured by using "sand-patch test'

The coefficient of friction mobilized in presence of water between a vehicle tyre and pavement surface, known as skidding resistance is measured

Test results get influenced by speed, rainfall intensity passing traffic

The skidding resistance may also be measured at isolated points with a pendulum tester.

b) Mechanical Method of Inspection:

Macro-texture or texture depth: laser profilometers

Sideways force: SCRIM (Sideway force Coefficient Routine Investigation Machine) or by Stradograph

Braking force: skid trailer or a Stradograph and expressed in braking force coefficient or as a skid number (SN)

3.2.3 Monitoring Criteria (Standards)

Road maintenance management system is required to predict the right activities at the right time which can be possible only with the ability to predict the future road condition and possession of road rating standard and intervention level. The maintenance quality standard specifies the level of deterioration at which what type of treatment is required.

Road rating standards are compared to the road condition indicators for the maintenance treatment decision (Rauhut et al, 1982).

RCI= f(Pavement type, Distress data, Deflection data, Construction history, Traffic, Climate, Pavement layer thickness)

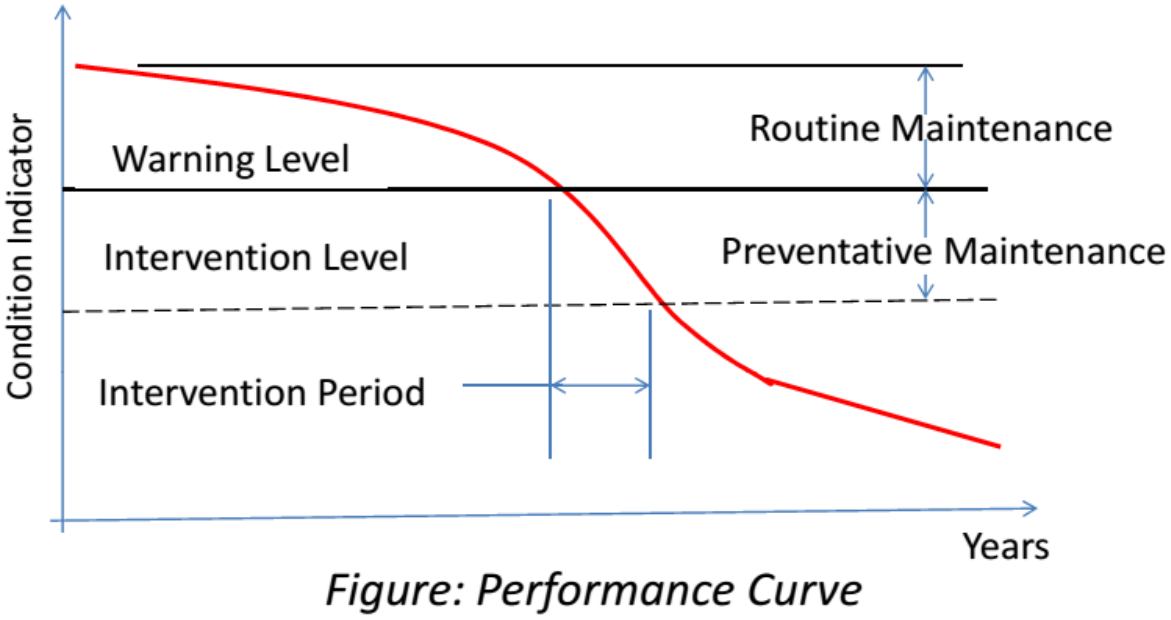


Figure: Performance Curve

Figure 3.0-2 Performance Curve

Source: (Transport road Research, 1987)

3.2.4 Condition Evaluation and maintenance Requirements

Road condition evaluation is the analysis of road condition data to determine the various level, types of defects and their causes for the decision of remedial measures

(Shahin 1980). Condition index, Rate of deterioration, Distress (Causes and severity), Structural capacity (level of deflection), Roughness and Previous maintenance information are the elements of condition evaluation. :

The comparison of the existing pavement condition rating with the standard condition rating should provide the indication of maintenance treatment required as a result of evaluation. The location with the high structural distress where the causes of distress and structural defect is not clear, confirmative conclusion may be carried out with the help of structural investigation such as by coring or Dynamic Cone Penetrometer(DCP) method (Snaith,1994)

3.2.5 Priority Assignment

Prioritization is the main process of road maintenance management and important in the context of limited budget. Prioritization is based on the some rational criteria emphasizing needs and economic return.

Steps of Prioritization:

1st : The road network is divided into sections

2nd : The determination and selection of treatments using intervention levels

3rd: The analysis for different numbers of treatment options per section

4th : The economic analysis of treatment of section

5th : Priorities decisions when there are budget constraints

The typical procedure for a particular set of candidate project is shown in figure

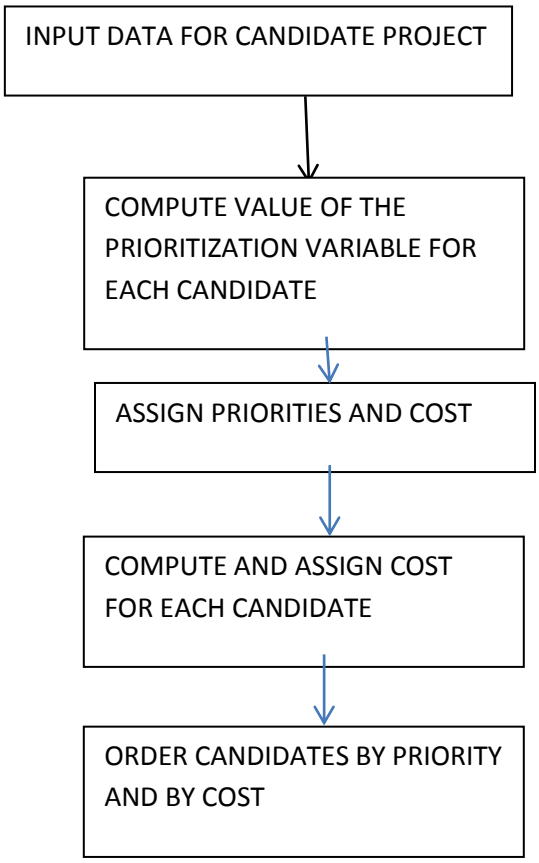


Figure 3.0-3 Prioritization procedure for candidate project

Source: (Pedigo, R et al 1982 referred by Isaac, 1994)

The various factors such as maintenance activity in terms of cost or importance of roads or the both can be taken as the priority variable (Pedigo al 1982). A combine condition rating index with the economic factors in the form of regression equations are desirable for prioritization (Fernando et al, 1983). In the budgetary constraint, the road sections with the higher priority value are listed in ascending order for further execution.

3.2.6 Execution and Monitoring

After the priority assignment, the high priority candidates can receive the budget and schedule is prepared for the work.

Scheduling of the maintenance work is prepared at the beginning of fiscal year by assigning the quantity of maintenance work to be done within the specified time period.

Execution is done either by direct labor or by contractors (most preferred). The public bidding process starts after the approval of program. Direct Labor method is implemented during the period of contractor absence or for the minor maintenance.

The actual quantities of work done are recorded as a report for the future objective.

Reporting has been done in the form of bill of quantities and progress reports at different interval of years.

The quality and quantity of work done is evaluated by comparing with preset standards.

3.2.7 Data Base

The data collected in each step of road maintenance management is stored safely so that it can be used for the future evaluation of road condition, decision on the type and time of treatments and to incorporate in day to day policy decision and project programming. These collected data are important for both network level and project level.

CHAPTER4. INFORMATION MANAGEMENT SYSTEM WITHIN ROAD MAINTENANCE MANAGEMENT SYSTEM

4.1. General

The information is the Key element of management. For day to day operation of management, each component of system required certain information. The amount and intensity of this information depends upon the function of its applicant. The use of specific amount of information data can originate the evolution in management but simultaneously huge amount of unnecessary data can ruined the outcomes. Hence during data design following criteria should be considered

i) Relevance:

The collected data must have direct influence on the causes and the outcomes of the system. The data relevance depends on users; quality could be variable from national to international levels, network level to project level.

ii) Appropriateness:

The data acquiring, processing, and managing should be appropriate to the administration's capacity for maintaining the equipment, conducting surveys and sustaining the data processing.

It also depends on end users:

At the strategic planning stage: It might need network level data where low sampling rate could be appropriate and could be up-dated frequently with minimum expenditure.

At the project preparation stage: It might need more detail information to prepare design and contract quantities. These information many not be relevant after completion project in detail

iii) Reliability:

The reliability of the data depends upon its accuracy, spatial coverage, completeness, repeatability, reproducibility and currency.

iv) Affordability:

The size and quality of data items and its associates must be affordable in terms of financial, physical and human resources.

4.2. Need for Information

Management information is the main part of maintenance management cycle. An efficient and effective management decision is only the outcome of reliable, appropriate and up to date supporting information. For the successful management system information regarding different field is required e.g. network details, traffic and axle loads, costs, road conditions etc. These information data are used to assess physical condition, safety level of service and efficiency. The history of present and past information helps to take decision for the future plan.

Data are therefore needed to provide the basis for management decisions on such aspects for:

- Determination optimum road condition, and the maintenance strategies and expenditures needed to achieve this.
- Determination optimum road condition within actual budget constraints
- Assessment current levels of roads and bridge condition
- Determination appropriate level of investment
- Prioritization capital investment s and investments in maintenance
- Simulation the effects of any improvements on the future condition and performance of the road system
- Estimation the cost of improvements
- Control on-going expenditure

These information provide the basis for the technical departments, financial departments, road users and others during allocation of fund and also help in monitoring the departmental performance and the policy objectives.

4.3. Production and Use of Information

The production of the information initiates with the collection of the data from the different levels of managements system. The main aim of the information production is to utilize it in decision making process. The production and Use of Information Can be listed below

Table 4.1 Information Flow Diagram of Road Maintenance Management System for Strategic Road Network

Input	Related component of Management	Output
Road Characteristics Summary, Budget Estimates, Evaluation Reports, Future workloads, Quality standards, traffic Data etc.	Road Board Nepal/ Ministry of Finance	1. Resource Needs 2. Public information 3. Budget 4. Monitoring
Priority Listing from Regions, Condition Rating, Budget Proposals, Progress report etc.	Maintenance Branch of DOR	1. Performance budgets 2. Performance standards 3. Quality Standard 4. Budget Estimates 5. Evaluation Reports 6. Future Works
Road Condition Characteristics, Traffic Data Candidate Project, Costs, Progress reports, Work and Financial Plans, Contract document, Performance budget, Standards	Regional Director	1. Priority Rating of Project 2. Priority Listing 3. Budget Proposal
Condition Survey, inventories, traffic survey, work measurement, unit cost, performance budget, quantity and quality standards etc.	Project Engineer/ HMIS unit	1. Road Inventory 2. Road Condition Data 3. Traffic Data 4. Candidate Projects 5. Treatment Costs 6. Progress report 7. Work Plans 8. Financial plans 9. contract documents

4.4. Information Quality

The different level of management system needs different types/level of data, hence the World Bank has introduced the concept of information quality levels (IQL) which provides the framework for collecting and using data in different matter when undertaking any particular activity. This concept helps to ensure the collection enough quantity of data with cost effectiveness to enable the appropriate decision.

Table 4.2The concept of information quality levels

IQL-I	Most detailed and comprehensive level of detail, such as a reference Bench Mark for other measurement, fundamental research used in field investigations for an in-depth diagnosis, for detailed preparation and monitoring of sensitive operation, for high class project design, not preferred for network monitoring, data collected using specialized equipment, requires high level of staff skill and institutional reports resources to support and utilize collection method
IQL-II	A level of detail sufficient for comprehensive preparation of works, activities and for standard design methods; for planning, use on sample coverage ,sufficient to distinguish the performance and economic returns of different technical options, require standard acquisition methods for project level and automated acquisition methods for network level surveys, network level programming require reliable institutional support and resources
IQL-III	Sufficient details for planning models and standard programming models for full network coverage; project design, could be collected in network surveys by semi-automated methods or combined automated and manual method
IQL-IV	The basic summary of statistics of inventory, performance and utilization of interest of providers and users, suitable for simple planning and programming model but for project level suitable only for low volume roads, used most basic collection methods using either entirely manual method or partly semi-automated

Source: Paterson and Scullion (1990)

4.5. Mode of Information Flow

The road management system operates with the flow of information in between different functional levels. The production of information at any functional level required relevant input data to process. The information is produced from raw data or some cases from processed data depend upon the functional level in the hierarchy. The information flow from the project level to the network level and vice versa. Generally field data flows from project level to network level while the funds and policy flows from network level to project level. In Road maintenance management system of Nepal, the information such as road inventory, condition survey data prepared by the HMIS unit of DOR and provided to the project and Maintenance Branch through electronic means (computer system), proposal of different maintenance estimates, progress reports from project office to regional office and collectively to Maintenance Branch are shared through electronic means (computer

system) but these information are authorized only through paper work. The information about the budget allocation, program approval is informed through the paper work in authorized manner while other information like paripatras, notices are informed through the official website of DOR.

4.6. Information Flow at Different Levels

As already mentioned the total maintenance management system can be grouped into network level and Project level. The functions of these levels are planning, programming, preparation and operation needs different types of data which are illustrated below

Table 4.3 Functions of different Function Levels

Function Levels	Functions
Network Level	Planning and Programming : Network level requires the information about the road system as a network of links with jurisdictional, functional, traffic demand, physical characteristics, resources and cost for planning (long term decision). Programming involved with the midterm decision and network level data are used for forecasting and budgeting the road works
Project Level	Preparation: Project level prepare the work plan for the specified length of road, decide and design the treatment, prepare the costing, allocation and schedule for road maintenance Operation: Project Level involved in the management activities during different types of maintenance operation such as routine maintenance, recurrent maintenance, specific maintenance, emergency maintenance , equipment management etc.

The network level and project level interchanges their information with each other for their effective performance and the overall success of maintenance management system. The road maintenance management system cannot operate without the smooth flow of information in between its component. The typical flow of information between the network level and project level of Road maintenance management system is shown in Figure 4.1.

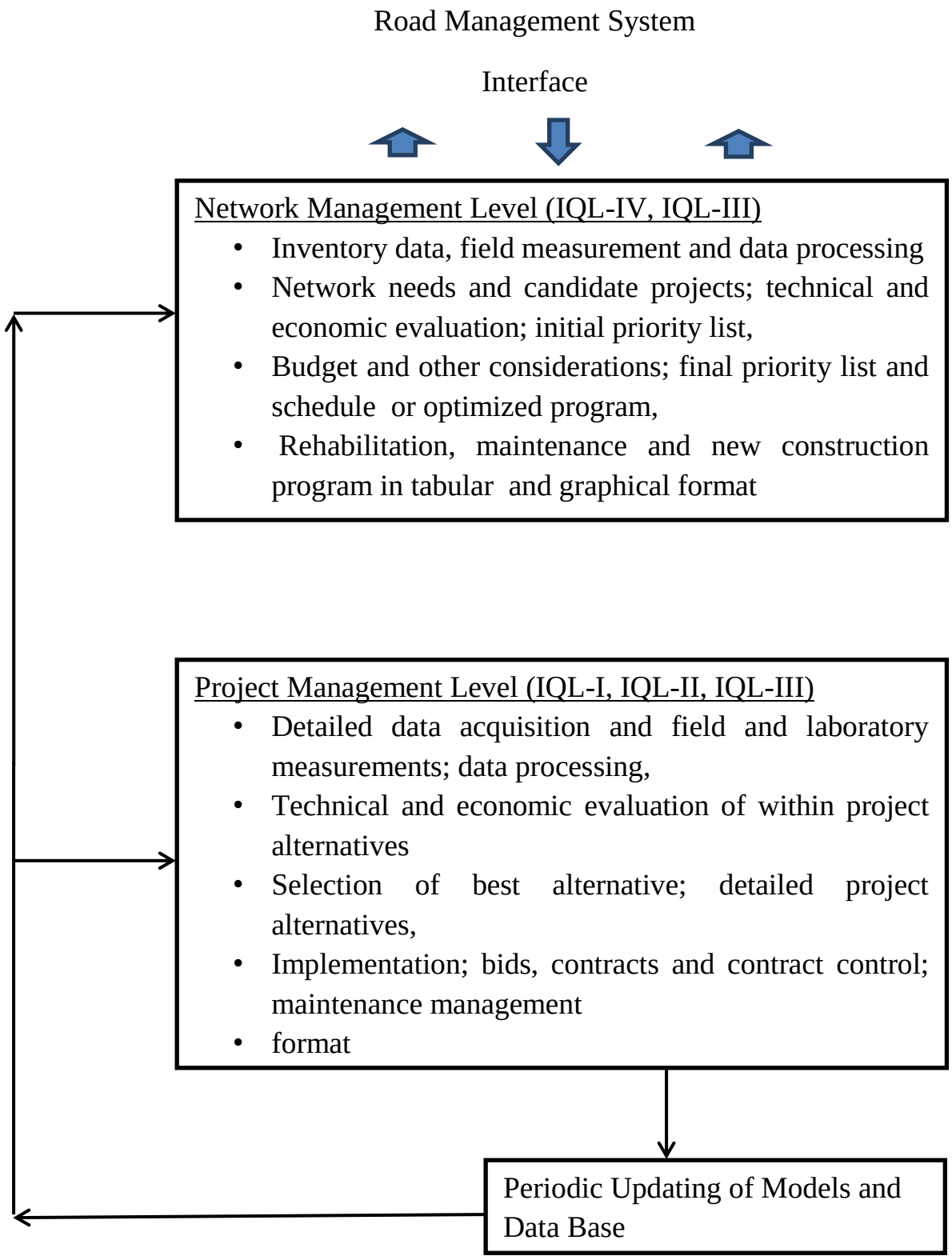


Figure 4.0-1 Information Flow at Different Levels of Road Maintenance Management System

CHAPTER 5. COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEMS

5.1. PAVER Pavement Management System (M.Y. Shahin and S.D. Kohn, 1984):

Paver Management system was developed by US Army Construction Engineer Research Laboratory as pavement management system and successfully tested by different agencies. This system helps engineer by providing decision making procedure for identifying the cost effective maintenance and repair of the roads, facilitates different important capabilities including pavement condition, condition rating, project prioritization, inspection scheduling, determination of present and future network condition but in this chapter certain parts which are useful in Nepal Road Maintenance Management are discussed.

5.1.1 Data Storage and Retrieval:

The paver database is custom design data structure which consist of 12 data groups which are linked together to form the tree structure. The data group consists of various elements of road, road inventory and condition rating which can be easily retrieved according to user needs.

5.1.2 Pavement condition rating

The paver system uses the pavement condition index of structural integrity and operational condition of pavement. According to quantity, severity and types of distress, pavement condition is rated to 0 to 100 which is classified into 7 condition categories from “excellent” to “failed”. These data are basis of decision making during the selection of Maintenance and repair of pavement.

5.1.3 Project Prioritization:

The pavement condition index is the basic need for the prioritization. The pavement section is listed according to increasing order of PCI but information can also be sorted according to pavement surface type, pavement rank, traffic type and volume. Hence prioritization can be used according to agency policy.

5.1.4 Determination of maintenance needs:

According to PCI value, distress type and deterioration rate, the necessity of maintenance of pavement is determined. If the road condition does not required further analysis, routine maintenance is carried out continuously otherwise evaluation is carried out on the basis of structural capacity, roughness, skid resistance and other factors then feasible maintenance and repair needs are identified according to this evaluation and Agency needs/policy.

Table 5.1Information Analysis for PAVER system

Information	IQL
Data base	2/3
Condition rating (PSI)	2
Prioritization	2
Determination of maintenance needs	2

Source: (ISAAC 1994).

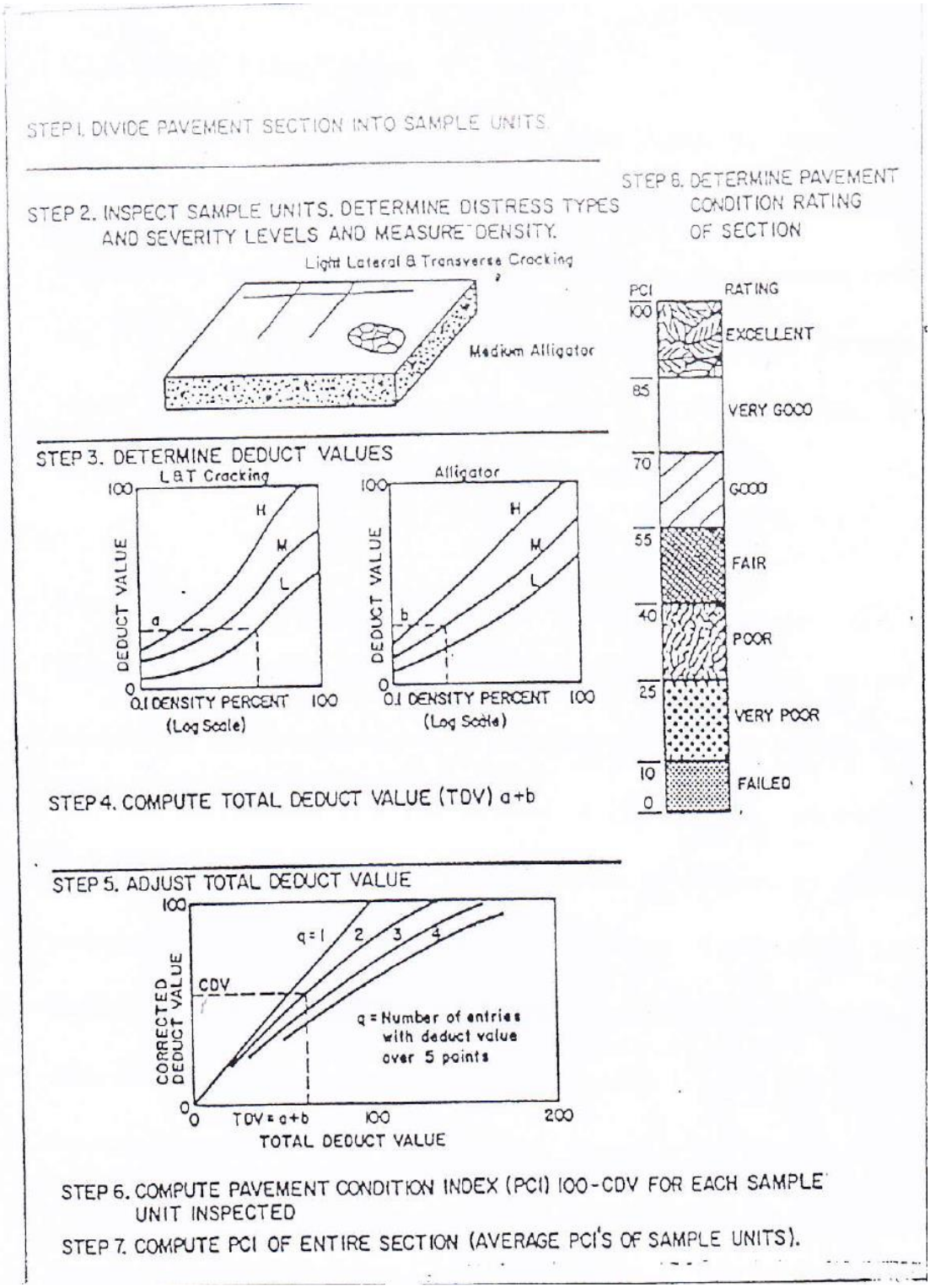


Figure 5.1 steps Involved in the Determination of PCI

source :Shahin et a1, 1982

5.2. Highway Design and Maintenance Standard Model HDM 4(RadrigoArchondo-Callo, Sep 2008):

Highway Design and Maintenance Standard Model 4 is the software which helps in decision making for the strategic planning of road investments with or without budget constrain.. This model helps the road agency to predict the life cycle cost of many different strategies and evaluate the project in terms of economic viability.

The procedure of HDM-4 Analysis is as follows:

1. All the available road network data per homogeneous road section/aggregate data are collected and stored into a rod network database.
2. The road network database or road network aggregate data are analyzed to establish a representative matrix of road classes.
3. The representative matrix cells' length and other attributes are defined.
4. The possible country-specific types of road work are identified and unit costs of the identified types of road work in financial costs and economic costs are estimated.
5. The proper pragmatic project alternatives to be evaluated per matrix cell, considering the condition and traffic load of the roads and current practices in the country are defined.
6. The country-specific road user costs are established.
7. The planning period, evaluation period and discount rate are defined.
8. The input data are entered into HDM-4 and the program is run.
9. The different budget scenarios with HDM-4 are evaluated.
10. From the HDM-4, the output files, the raw results are obtained, the HDM-4 results are imported into Excel to prepare output tables, charts and reports.

The Operation of HDM-4 can be categorized into three phases:

5.2.1Data Input and diagnostic Phase:

The different types of data required by the system is stored into the database in this phase, HDM-4 has 14 input groups as shown in figure **HDM-4 road attributes.** This phase is very easy and initial step but the most crucial part of the operation as the overall result and the evaluation depend upon the analysis of these inputs.

5.2.2 Simulation:

This is the analysis phase of the input data which operate through running HDM-4 program. During simulation the HDM 4 identifies the road work suitable for the nation and determines the types of road work to evaluate for each road class as a function of its traffic load, condition and other specific characteristics but it cannot evaluate more than 400 different road classes and 17 project alternatives per road class.

5.2.3 Economic Evaluation and Reporting Phase:

The HDM-4 evaluate the different budget scenario with the results (can be printed in A4 Paper) according to input data as mentioned above but it does not summarize the results of the comparison of budget scenarios automatically. Thus the results are extracted to excel file to manipulate the HDM-4 results and to present these result in tabular form and charts. In the context of budgetary constrain optimization, the HDM calculations should be checked for its reasonability and to identify possible errors in the input data by reviewing the reports of

(i) Deterioration/Work Effects: Average Roughness by Section

(ii) Cost Streams and Economic Evaluation: Road Agency and User Cost Streams (Undiscounted); and

(iii) Cost Streams and Economic Evaluation: Economic Indicators Summary.

5.2.4 Information Produced:

1. By relating the results of the strategic evaluation for given budget it helps in decision making process for the roads of similar nature.
2. Prepares the report for each road section with the recommended road work, its timing and its financial cost, the road section NPV , the NPV per investment cost ratio, prepare the list by sorting the road sections as per priority per year and per NPV per investment cost ratio.
3. The economic evaluation results per road section and other important considerations are presented as a map which is helpful for decision-making, such as contract packaging and social considerations.

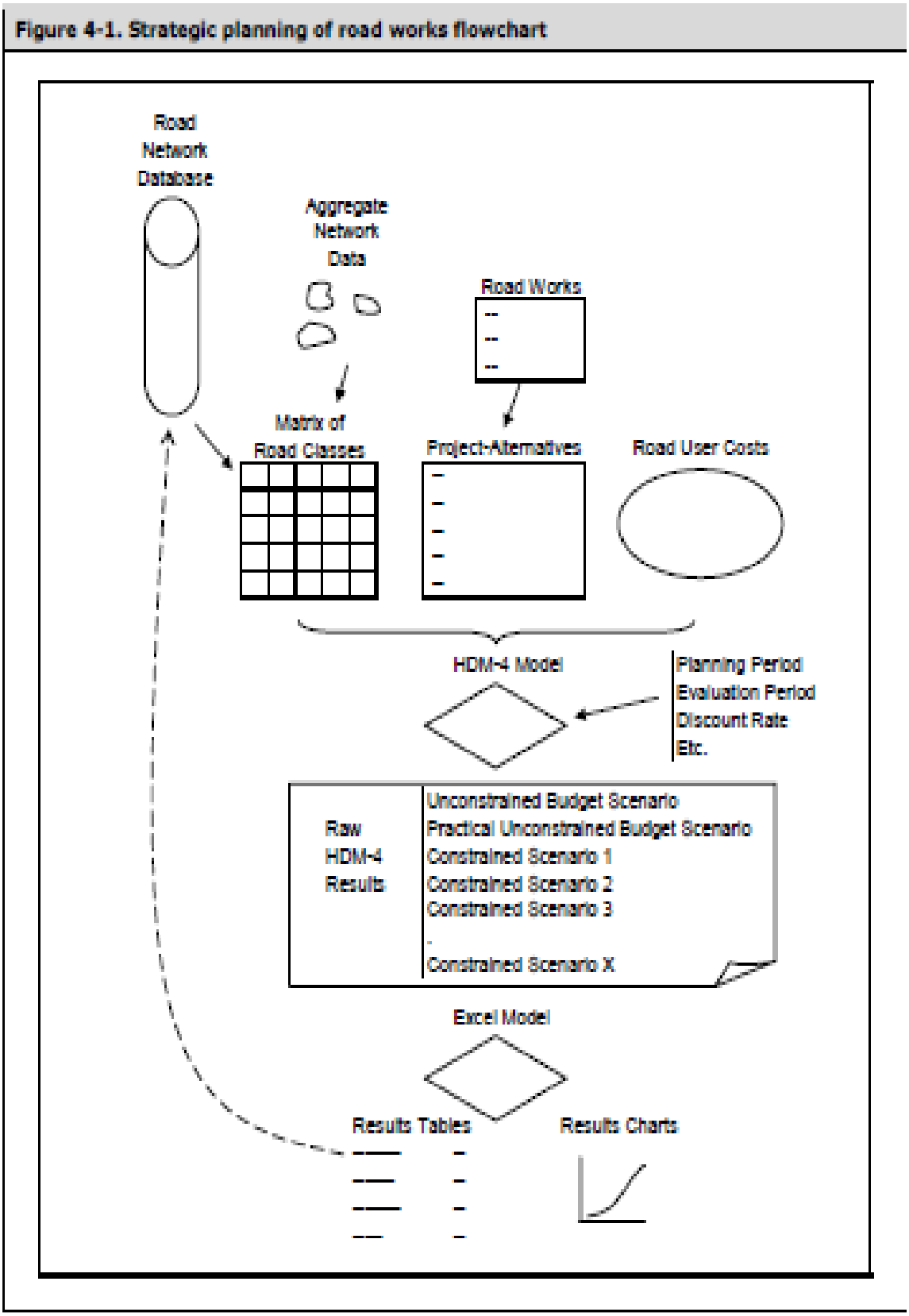


Figure 5.2 Flowchart of HDM -4 Program

(Source: Applying HDM -4 model for strategic planning of road works by RadrigoArchondo-Callo, Sep 2008)

Table 5.1Information Analysis for HDM-4

Simple Aggregate HDM-4 Inputs	**HDM-4 Inputs**	**IQL**
Length (km) Carriageway width (m) Motorized traffic (AADT) Traffic composition per vehicle type (%) Last surfacing year (calendar year) Pavement type Climate zone type Speed flow type Traffic flow pattern type	Length (km) Carriageway width (m) Motorized traffic (AADT) Traffic composition per vehicle type (%) Last surfacing year (calendar year) Pavement type Climate zone type Speed flow type Traffic flow pattern type	2/3 2/3 3 3 2/3 3 3 3 3
Geometry type	Rise + Fall (m/km) Horizontal Curvature (deg/km)	2/3
Structural adequacy type	Benkelman beam (mm) or FWD deflection (mm) or structural number (#) Most recent surfacing thickness (mm) Previous/old surfacing thickness (mm)	2
Ride quality type	Roughness (IRI, m/km)	2
Surface condition type	All structural cracking area (%) Ravelled area (%) Number of potholes (No./km) Mean rut depth (mm) All transverse thermal cracking area (%) Wide structural cracking area (%) Edge break area (m2/km)	2/3
Surface texture type	Texture depth (mm) Skid resistance (SCRIM 50km/hour)	2/3
Road Works History	Last rehabilitation (calendar year) Last construction (calendar year) Last preventive treatment (calendar year)	2/3
Drain type	Drain type	3
Drain condition type	Drain condition type	3
Construction quality type	Construction quality type	2/3

Source: Applying the HDM-4 Modelto Strategic Planning of Road Works Rodrigo Archondo-Callao 2008

PART II - (STUDY DATA AND METHODOLOGY)

CHAPTER 6. ROAD MAINTENANCE MANAGEMENT SYSTEM FOR STRATEGIC ROAD NETWORK IN NEPAL (DOR)

6.1. SRN Road Maintenance Management System

1. Planning :

Road Maintenance Management starts with the planning of Maintenance works. ARMP (Annual Road Maintenance Plan) for next year region wise is proposed in which estimates for next year routine, recurrent, specific, emergency and periodic maintenance according to road inventory and condition survey is prepared by Projects/Division Road Office with the involvement of Road board and Maintenance Branch.

Road Inventory Data provides the information about the physical features of road which is prepared by project office.

Condition Survey Data provides the information about the pavement condition which helps to choose the appropriate treatment method. Condition Survey Data is collected by the HMIS Unit of DOR in Periodic interval (yearly/ 2 years)

2. Budgeting:

The maintenance cost of whole road network is estimated region wise in ARMP (Annual Road Maintenance Plan). The maintenance works to be carried out and budget for next year is finalized as IARMP (Integrated Annual Road Maintenance Plan)

3. Programming:

After the approval of budget in IARMP, Preparation The program for maintenance works of road network is prepared at the beginning of fiscal year from project levels which is approved from Network Level.

4. Execution:

Procurement of work (Contractor or labor basis) is done from Project Level after the approval of program. Execution of Work is done from Project Level

Supervision has been done from project level while monitoring has been done from maintenance branch of Department of Road and Road Board Nepal

5. Reporting:

After completion of the work, reporting has been done to the Department of Road and Road Board Nepal which includes the information about the procurement process, the quantity and types of work performed overall cost of maintenance works. Road Board Nepal monitored the maintenance work through the progress report and partial payment system method.

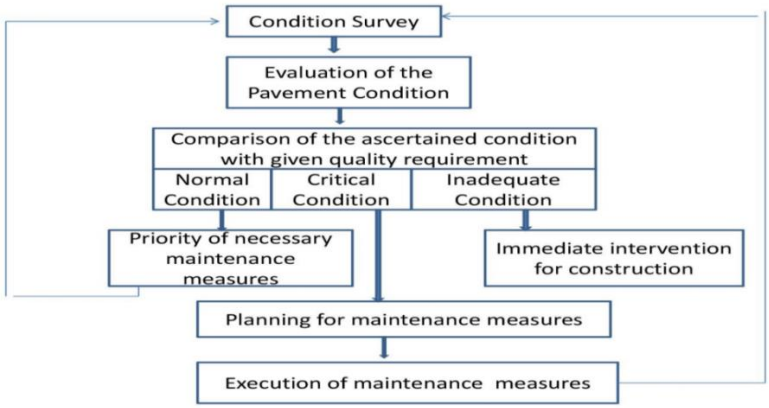


Figure 6.0-1 Road Maintenance Management System

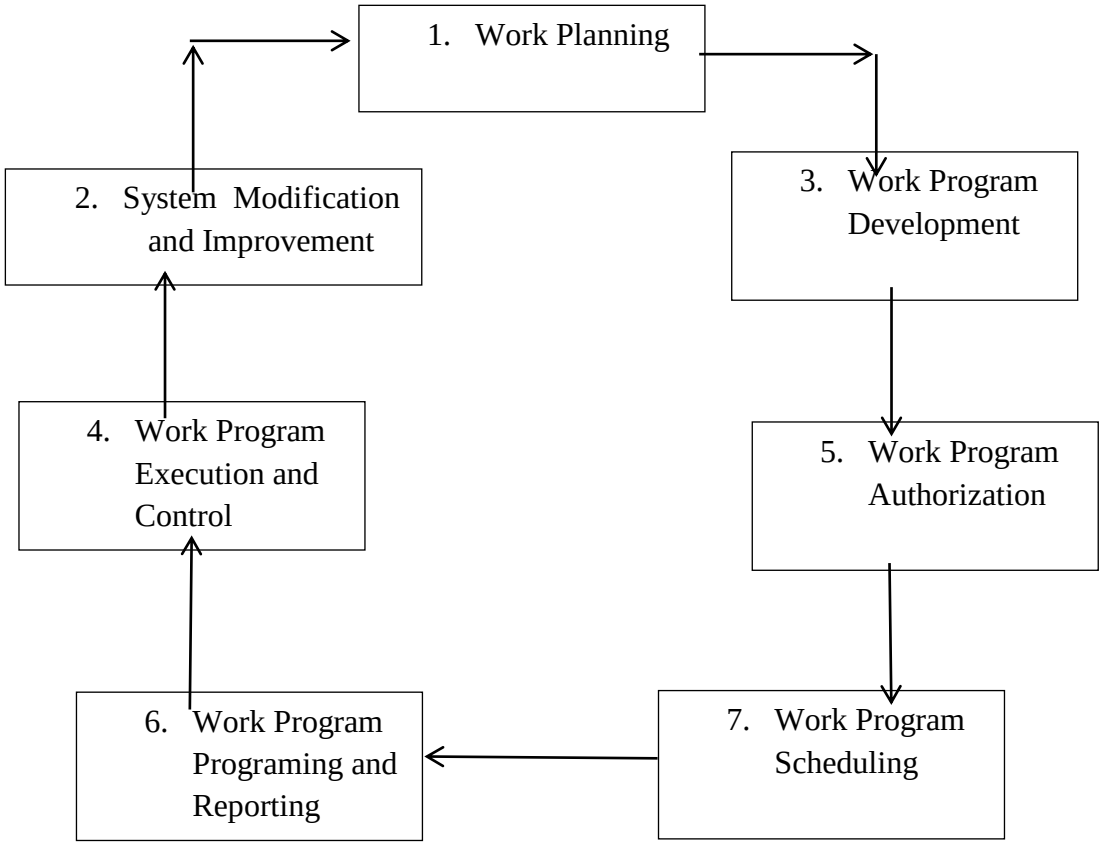


Figure 6.0-2 Road Maintenance Management Cycle

6.2. Definition for Road Maintenance Types

Department of Roads is the responsible organization for the overall maintenance of Strategic Road Network which carried out the different types of maintenance work to maintain the serviceable condition of Roads these maintenance works are listed below.

i. Routine Maintenance :

Routine Maintenance is the small scale maintenance and continuously done throughout the year in order to protect the road surface from the effect of environment and traffic flow. Grass cutting, Drain Clearing, Clearing Bridges and culverts, Minor reshaping of unlined drains, road sweeping, maintaining shoulders, clearing minor slides, clearing furniture etc. minor jobs fall under the routine maintenance. DOR performs routine maintenance by labor based method. Program for routine maintenance is prepared during ARMP. Few small tools like pick, shovel, wheel barrow, crowbar, broom, head pan, grass thrasher are provided to certain number of length worker, supervisor. According to Norms 1 length worker for 5 km of stretch of road in plain area or 1 length worker for 3 km of stretch of road in hilly area and 1 supervisor for 6 length worker is assigned for daily routine maintenance. During rainy season and emergency blockage the gang labors are assigned for the work.

ii. Recurrent Maintenance

Recurrent Maintenance is the repair of minor defects on road pavement, the avoidance of these defects may cause the major deterioration of pavement in the near future. Recurrent Maintenance is required in varying interval during the year and its frequency depends mostly on traffic volume. DOR performs recurrent maintenance generally twice a year; once before starting rainy season and once after the end of rainy season. Repairing of the potholes of paved/unpaved roads, repairing of ruts regarding, patching, edge repair, minor repair of drains retaining wall, check dams, repair and replacement of parapet walls, bridges culverts railing and embankments etc. are the works under recurrent Maintenance. Program and estimate for the recurrent maintenance is also prepared during ARMP. Normally quantity of work to be done in next year is estimated in the percentage basis of total existing quantity according to

the DOR Norms. Recurrent maintenance work is executed by contract based method, in absence of contract it may be executed departmentally

iii. Specific Maintenance

Larger remedial and preventive works to be done to remedy environmental damage (major repair, extensions of retaining wall, drainage structures), new construction of retaining walls, check dams, drain construction, bio engineering, river training work etc. are the specific maintenance works which are carried out only once in a year according to need basis. Program and estimate for the specific maintenance work for next financial year is also proposed in ARMP but traditionally it is observed that deficit budget allocated for the specific maintenance work, hence again program and estimates are revised according to allocated budget in next year. The work is executed through contract.

iv. Emergency Maintenance

The maintenance works to be carried out at any time immediately without pre schedule and information like removal of slides, debris and obstacles, placement of warning signs and diversion works, urgent protection measures to prevent threat or further damage to road and structures are recognized as emergency maintenance works. Certain amount of budget for emergency work is proposed during ARMP according to historic information and experience. This budget is expended on the need basis by labor basis, managing equipment's or need base purchasing.

v. Periodic Maintenance

Periodic Maintenance works is carried out to preserve the structural integrity of road such as resurfacing and re gravelling. The periodic maintenance is carried out at several interval of year which depend upon the road condition. DOR planned for periodic maintenance according to SDI and IRI of Road. In ARMP, program and estimates are prepared for the periodic maintenance of poor condition road and work is executed through contract basis.

vi. Rehabilitation.

The roads with the poor condition, the structural integrity of which cannot be preserved through periodic maintenance are proposed for rehabilitation in ARMP. Rehabilitation is the up gradation of pavement maintenance which

may cost more. Hence there is mostly deficit budget and queue of the road length to rehab are increasing year by year.

6.3. Road Information Requirement at Different Management Levels

From the organization Chart of Department of Roads the hierarchy of functional levels can be divided into four groups

Network Level:

1. Road Board/ Ministry of Finance
2. Maintenance Branch/ Director General

Interference Level:

3. Regional Director

Project Level:

4. Site Engineer/Project Engineer/ Project Chief Engineer

Each Functional level produced different kinds of data in process of pavement management; these data may be the important input for the next step in decision process of maintenance management system. For the maintenance management different types of information are used which is collectively known as Highway Management Information System (HMIS).

The list of information required for the each step of Road Maintenance Management System adopted for SRN is listed in table below

Table 6.1 Information Sets

Application Group	Information Set
Planning	Road Inventory (RI 1) Traffic Information(RI 2) Road Condition Information(RI 3) Candidate Projects (RI 4) Priority Assignment(RI 5) Priority Listing(RI 6) Quality standards(RI 7) Future Work Loads (RI 8) Resource Needs(RI 9) Public Information(RI 10)
Budgeting	Treatment Cost (BI 1) Budget Proposal (BI 2) Budget Estimate (BI 3)
Programing	Project Alternatives (PI 1) Work Schedule (PI 2) Financial Plan (PI 3) Specified Budget (PI 4)
Execution	Contract documents (CI 1)
Reports/Monitoring	Progress Report (MI 1) Evaluation Report (MI 2) Monitor (MI 3)

6.4. Information flow at the Project Level

A. Planning Group :

- A Road Inventory (RI 1) :

  This is the basic collection of data about the basic engineering characteristics of road which includes the key features of each section of road and includes the type of surface and pavement construction, cross section width as well as details of structures, junction and road furniture. It is essential for the planning of inspection and for estimating the extent and cost of necessary work i.e. for preparing the needs based budget.

- Traffic Information (RI 2):

  Information on traffic volume and its classification is very essential for setting priorities of maintenance work at both project level and network level. Traffic information on the strategic road network is collected and recorded by different means in the HMIS branch of Department of Road. Generally road Priorities are set by the regional director and communicate to the project office.

- Road Condition Information (RI 3):

  Road condition is necessary during the planning of annual maintenance or improvement program and setting work schedule. The surface and functional information is collected from the project level (DRO/Project office) by the visual inspection to find out the deterioration rates of road where as the structural information such as SDI/IRIetc. are collected and recorded by HMIS branch of Department of Road. These data are used to compare the condition of road network with passing time in years in terms of good, fair and poor and to gauge the effectiveness of maintenance operation.

- Candidate Projects (RI 4):

  According to the road condition data provided by the HMIS unit, firstly the road sections which need periodic maintenance are separated. Then remaining roads are set for other maintenance projects such as recurrent, specific etc.

- Priority Assignment (RI 5):

  The roads for periodic maintenance are prioritize according to road condition data such as SDI and IRI provided by HMIS unit and other roads gets the priority according to the judgment of project engineer through visual survey.

- Priority Listing (RI 6):

  Priority list of different candidate projects are prepared during ARMP according to the maintenance work group which depends upon the judgment of project engineer but strongly supported by traffic data.

- Public Information (RI 10):

  Public information is important during the prediction of emergency maintenance budget which includes;

  Historical Information: The creation of historic information by keeping the record of maintenance and development work of any section of road section is very useful for the future planning and set up the intervention level.

  Road Closure Information: The historic information about the road closure is important for the project level for emergency maintenance during rainy season.

This information helps to react quickly during emergency condition with the proper planning of material and equipment at appropriate site.

B. Budgeting Group:

After the preparation of Priority list of candidate project and selecting maintenance work for them, their execution cost are prepared for budgetary purpose which needs following information.

- Treatment Cost (BI 1):
  Accurate cost information is necessary for reliable estimation of the future operation cost values for the project level where as the overall cost and cost per km values for the networking level for budget allocation and evaluates the cost benefit analysis. The overall treatment cost is estimated by calculating the quantity of treatment required and its unit cost during ARMP for the candidate project.
- Budget Proposal (BI 2) :
  The estimated treatment costs for the candidate projects are totaled and the sum amount is proposed as the maintenance budget for the next year by the project level.

C. Programming Group:

By observing the past years tradition, full budgetis allocated for routine, recurrent and periodic maintenance as proposed in ARMP but there is deficit in budget for specific, emergency, rehabilitation maintenance. At this situation, project level follows following procedure.

- Project Alternatives (PI 1):
  The maintenance work with deficit budget such as rehabilitation and specific maintenance, the project engineer select some projects among proposed candidate project for that fiscal year according to severity of road condition.
- Work Schedule (PI 2):
  The work schedule for selected candidate projects is prepared in form of bar chart which shows the quantity of the work to be done throughout the year.
- Financial Plan (PI 3):
  The overall financial plan for the candidate project of the fiscal year is prepared in form of program in which the activity to be done and their expected expenses are planed quarterly year basis in tabular form.

D. Execution Group:

After the approval of program from Ministry level, funds are released to the project level under the terms and condition of Road Board Nepal. Then actual works starts according to action plan either by using labor or by contract

- Contract documents (CI 1):

  After the assurance of fund project engineer prepare the estimate of the maintenance activity and its unit cost by rate analysis. Then project office call for the public bidding by providing DOR's standard bidding document and Bill of Quantities informing the quantities of work to be done.

D. Monitor and Reports :

After awarding the contract and during labor basis maintenance work, the project engineer monitor the quality standard of work executed and collects the measurement of work performed. These measurements are used to prepare the bill as well as for the preparation of progress report to the road board and maintenance branch of DOR.

- Progress Report (MI 1) :

  The progress reports are prepared quarterly which shows the target physical activities and expected expenses against the actual work done and actual expenses.

6.5. Information flow at the Network Level

A. Planning Group :

The maintenance requirement of the pavement depends upon the road surface distress but the intervention level at which the pavement distress is selected for the periodic maintenance or for rehabilitation is decided by the network level (Maintenance Branch). During ARMP, the road surface distress data and IRI are provided to the project engineer to prepare the estimate for periodic maintenance and other maintenance work.

- Quality Standard (RI 7) :

  The quality standard defines the threshold at which type of work to be performed, directs how to perform and at what quantity to performed. The standard specification for roads and bridges, standard norms for maintenance work and different paripatras fromDOR, Ministry are the examples of this standard

- Future Work Loads (RI 8)

  DOR prepares the expected cost estimates of maintenance work such as recurrent, specific, periodic, and emergency for the next fiscal year during ARMP which are the future workloads.

- Resource Needs (RI 9):

  After receiving the request for the final proposed maintenance budget through Road board Nepal, Ministry of Finance decided to provide certain budget for the maintenance works and search for the resources may be from the oil taxes, vehicle registration taxes etc.

- Public Information (RI 10):

  Network level required the public information such as accidents, network types, safety regulation etc. to decide the threshold of intervention level and to separate the safety budget.

B. Budget Estimates (BI 3):

  After the receiving the budget proposal from region, Maintenance branch forward this proposal to Road Board and Road board forward to Ministry of finance. Ministry of Finance allocates the budget according to available resources and forward toRoad Board and Road Board handover the allocated budget to Maintenance branch. Then Maintenance branch screen the candidate projects and handover the budget to the project level

C. Programming (BI 4):

  After the receiving the allocated budget through Maintenance branch, The project level prepare the work plan in the form of program according to available fund and submitted to Maintenance branch through regional level for approval. The maintenance branch collects the program from all region and forward it to Road board and MOPIT for the approval. Finally the program is approved from MOPIT.

D. Report /Monitoring:

  After submission of progress report from project level, these reports are summarized in various forms.

- Evaluation Report (MI 2):

  Evaluation reports are in tabular forms which gives the following information Regional output summarizes by project and treatment type for annual and quarter interval Nation output summarizes by region and treatment type for annual and quarter interval

- Monitoring (MI 3):

  The evaluation reports provide the information about the actual condition of road which is monitored against the nation target sets (such as reduction of operating road cost) for road sector.

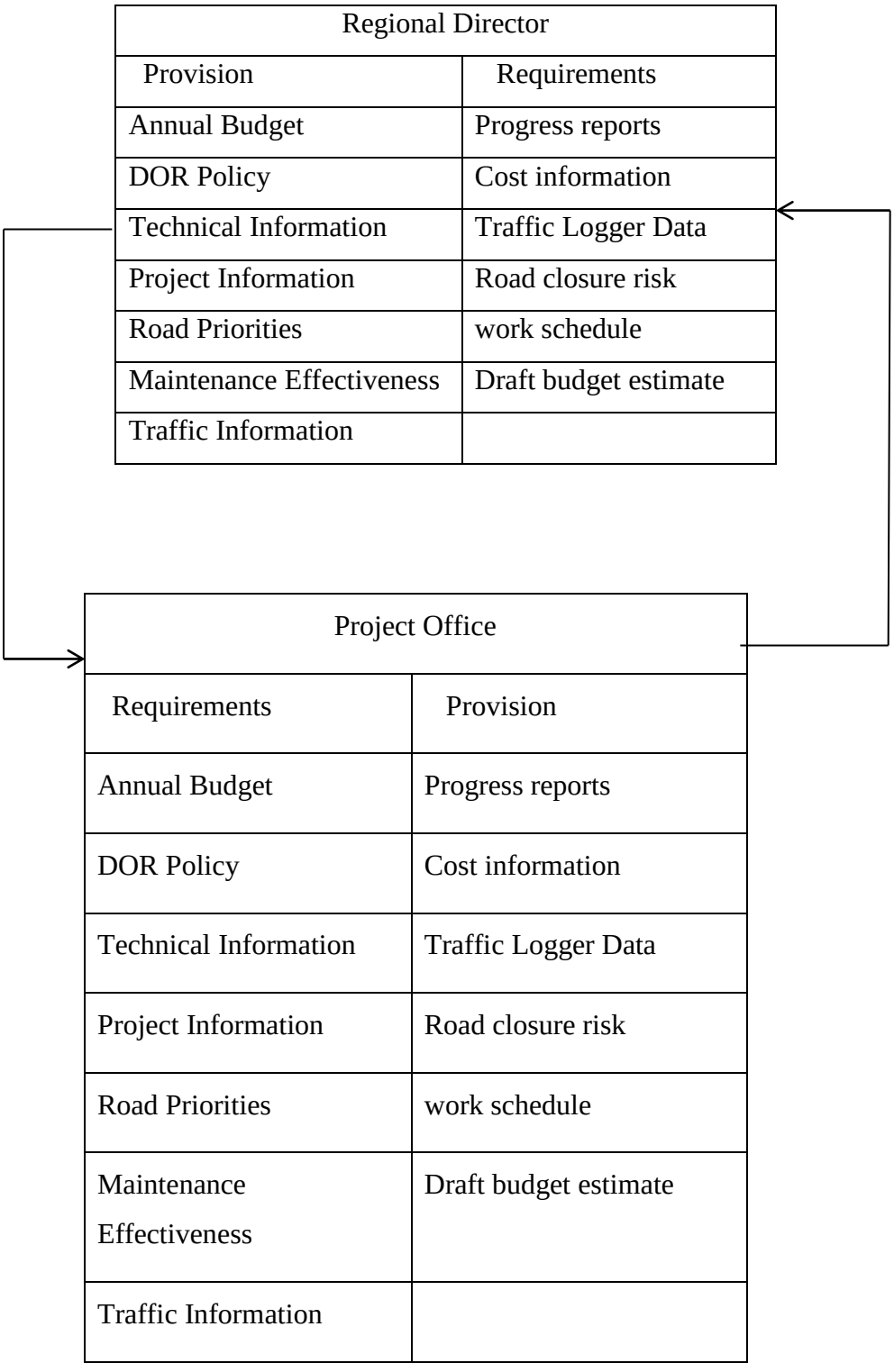


Figure 6.0-3 Information Flow Between Project Office and Regional Director

6.6. Analysis and Determination of Information Requirements

The information required for the network level and project level as described above are produced from the different types of data and different types of

process. In this section analysis is made about the data used, its process and the requirements of information in the current information system.

i. Data requirement:

   The data required for information along with the collection method, presentation and its frequency of collection for whole road network is identified.

ii. Data processing

   For the production of information how the data are processed (calculation), frequency and total volume of work for every cycle of work are presented

iii. Information produced

   In this section, the information produced and used for different levels tried to characterized with the help of World Bank Information Quality level which indicate the accuracy and appropriateness with respect to the consistency of using data.

The analysis of information against these categories are Discussed in Chapter 7

Part IV: DATA ANALYSIS AND RESULTS

CHAPTER 7. EVALUATION

The information system used for the maintenance management of DOR and the two computerized systems (Paver and HHDM-4) are studied simultaneously.

7.1. DOR Information system:

The characteristics of the information system is summarized in above table according to the amount of data required, complexity of calculation, frequency of the calculation, information quality level and the likely volume of work involved.

Table 7.1Information Categories at Project Level

Information	Data	Complexity of Calculation	Frequency of Calculation	Frequency of Use	IQL	Total Volume of Work
RI 1	11			High	3/4	
RI 2	2		low	medium	3	High
RI 3	9			High	3/4	
RI 4	9			Low	4	High
RI 5	4	Low	low	Low	4	High
RI 6	8			High	4	
BI 1	2	Low	low	Low	3/4	Low
BI 2	4			Low	3/4	low
PI 1	-	Medium		Low	3/4	High
PI 2	-	Low		High	3/4	High
PI 3	-	Low		medium	3/4	Low
CI 1	-			medium	3/4	Medium
MI 1	4	Low		medium	3/4	Medium

Table 7.2 Information Categories at Center Level

Information	Data	Complexity of Calculation	Frequency of Calculation	Frequency of Use	IQL	Total Volume of Work
RI 7	4				4	High
RI 8	2		low	High	4	Low
RI 9	4			medium	4	High
BI 3	1			Low	4	Low
PI 4		High	low	Medium	3/4	High
MI 2		High	med.	Medium	4	High

The effectiveness of existing situation of information system is assessed by collecting the detail of each item of information. The findings are summarized in table 7.3 to 7.5 for information under different functional levels.

Table 7.3 for information by the Project Engineer

Table 7.4 for information by the Regional Engineer

Table 7.5 for information by the Central Level of Department of Road

The tables are attached in appendix

The Table 7.3 shows the information about the data required during the function of maintenance which are collectively collected by Project engineer and HMIS Unit but the data collection activities are not sufficient and not frequent. Most of the activities are authorized only through the paper work. The work schedule and financial Plan are seems to be only for formality and most of the time does not match with the reality.

The table 7.4 summarized the information about the prioritization process, but it seems to be no proper practice of prioritization in DOR as all the candidate projects gets budget even in small amount; there is no proper practice of economic analysis.

The Table 7.5 summarized the information about the central level of DOR required, at the present condition there is requirement of different quality standard for maintenance work than development activity. The evaluation reports do not represent the actual scenario.

From the above mentioned tables of analysis of information from different levels, assessment results have been prepared which are summarized in Table 7.10 to 7.13.

Table 7.10 for assessment for the Project Engineer

Table 7.11 for assessment for the Regional Engineer

Table 7.12 for assessment for the Central Levelof Department of Road

The tables are attached in appendix

The table 7.10 shows Project Engineer collect the information about the data required during the function of maintenance instantly and do not recordedproperly for the next use. It is difficult to obtain the updated data on pavement condition. Thus there is need of proper filing and storage computer system. Work schedule and financial plan should be prepared according to available resources.

The Table 7.11 shows that the road importance, traffic flow and pavement condition should be considered during prioritization.

The Table 7.12 shows that there should be separate standard for maintenance work

7.2. The Computerized Road Maintenance Management Systems

The compatibility of DOR information system with two Computerized Road Maintenance Management Systems namely Paver and HDM 4 is assesses by comparing the IQL of data requirements. |The following tables summarizes the comparison for four application groups of RMMS of DOR.

Table 7.6 for Planning

Table 7.7 for Budgeting

Table 7.8 for Programming

Table 7.9 for Reports/Monitoring

Table 7.6 Comparison of IQL for Planning

Information for Road Maintenance Management System	IQL		
	DOR	PAVER	HDM-4
RI1	3/4	2/3	2/3
RI2	3/4	NA	3
RI3	3	2/3	2/3
RI4	4	2	NA
RI5	4	2	NA
RI6	4	2	NA
RI7	4	2	2/3
RI8	4	NA	N/A
RI9	4	NA	N/A

The detail of the data required for paver and HDM-4 is much higher. Most of the data is not required in the HDM-4 system during planning.

Table 7.7 Comparison of IQL for Budgeting

Information for Road Maintenance Management System	IQL		
	DOR	PAVER	HDM-4
BI1	3	NA	3/4
BI2	4	NA	NA
BI3	4	NA	NA

The table shows that paver system does not give any data required for DOR system whereas HDM-4 system provides only data about treatment cost.

Table 7.8 Comparison of IQL for Programming

Information for Road Maintenance Management System	IQL		
	DOR	PAVER	HDM-4
PI1	3/4	NA	NA
PI2	3/4	NA	NA
PI3	3	NA	NA
PI4	3/4	NA	NA

The table shows that paver and HDM-4 system cannot provide the data required for Physical work implementation.

Table 7.9 Comparison of IQL for Monitoring/reporting

Information for Road Maintenance Management System	IQL		
	DOR	PAVER	HDM-4
MI1	4	NA	NA
MI2	4	NA	NA
MI3	4	NA	NA

The table shows that paver and HDM-4 system cannot provide the data required for monitoring.

CHAPTER 8.CONCLUSION AND RECOMMENDATIONS:

8.1. Conclusion:

A. Road Maintenance Management System in DOR

Weakness

1. Data collected are not sufficient and not updated timely
2. Reliability of database is still questionable.
3. The system is still paper-based for authorization and is more time consuming process.
4. Work plans and financial plans are still required to be based on realistic data.
5. There is a significant gap in information sharing on maintenance between DOR, Ministry of Finance and National Planning Commission (NPC).
6. Frequency of recurrent maintenance is still not based on condition data
7. Periodic maintenance intervention is still not based on condition data.
8. Intervention for rehabilitation or strengthening of pavement is not guided by condition data-base.
9. Absence of pavement performance curve
10. The prioritization process is still not fully based on relevant database.

Strength

1. Annual Road Maintenance Plan is prepared on IRI, SDI values and traffic database
2. Limited database are get up-dated
3. The information flow maintained within DOR and Road Board for demand and allocation of fund for routine, recurrent and periodic maintenance.
4. At least structural evaluations are carried out through the consultants for pavement strengthen and rehabilitation,
5. HDM-3 has been used through consultants for road up-grade
6. Despite absence of adequate, relevant and consistent database DOR carry out recurrent, periodic maintenance, and rehabilitation
7. Having HIMS is DOR itself is positive effort to streamline and institutionalize Information Management System within DOR.

B. Data Storage and Processing

1. Road inventory data and pavement condition data are available/stored in computer data base.
2. HMIS collects the data of SDI and IRI separately but these data are not combined to represent the pavement condition with single index.
3. Only initial phase of maintenance planning and budgeting is associated with computerized system but authorized in paper.

C. Computerized Road Maintenance Management System

1. HDM-4 Module carried out economic analysis for prioritization which is not carried out in DOR maintenance management system. This system is useful for calculation of quantities of maintenance works and its cost but the input data must be accurate.
2. Paver system required the diverse and more detailed data than current maintenance system in DOR.

8.2. Recommendation:

The responsibility of Department of Roads is increasing day by day with increasing length of SR N road network and their maintenance and rehabilitation. For the fulfillment of this responsibility the quality and the volume of information required for decision making must be relevant, sufficient, consistent and accurate. The following recommendations are made from the study.

1. The system of data collection and its quality level must be improved so that it can be retrieved easily at the time of requirement which can be done with following steps.

a) Road condition data, traffic data and other relevant data which influence the serviceable condition and function of pavement should be up-dated regularly at least annually and these data should be stored through HIMS.

b) All database should be available in web for field level application

c) The rating of pavement condition should be done according to both structural condition and functional condition for prioritization. Thus the SDI and IRI value should be incorporated to get single Pavement Condition Index.

d) The effectiveness of performed maintenance should be studied through database so that the weakness of present maintenance process can be analyses for future improvement.

2. The system should be developed to inform National Planning Commission about present road condition and future workloads (rehabilitation and reconstruction) to help to prepare midterm and long term plan.
3. The whole process of the road maintenance management should be computerized. The steps and the stages such as planning, programming, contract procedure, work execution and completion, and monitoring and recording should computer-based for data generation and up-date.
4. HIMS should be enhanced to make it compatible for HDM-4 for network level decision making for road up-grade including rehabilitation.

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APPENDIX

ANALYSIS OF INFORMATION REQUIREMENTSROAD MAINTENANCE MANAGEMENT SYSTEM OF DOR

Table 7.3:Analysis of Information Required by Project Engineer

Information	Short Description	Information presentation	Data Required	Method of Collection	Collected By
Road Inventory (RI 1)	Data Set of the Physical feature of Roads	schematic Diagram	Road names	From records	Project Engineer
			Road Length	Measurement by tape/ distance measurement equipment	
			Surface Type	Visual observation	
			Carriageway width	Measurement by tape	
			Shoulder type and width	Measurement by tape/ observation	
			junctions	Records observation	
			Km posts	Records observation	
			Accidents	Accident records	
			Bridges	Records, observation, measurement	
			Culverts	Records, observation, measurement	
			Road signs	observation	
Traffic Information (RI 2)	Traffic Volumes, Axle Load	Table by composition	ADT, Axle vehicles	Road side counts, records from permanent weigh bridges	HMIS Unit through consulting services

Information	Short Description	Information presentation	Data Required	Method of Collection	Collected By
Road Condition Information (RI 3)	Road Condition Data	by section wise tabular presentation	Rutting	visual inspection	PE/HMIS
			Cracks Gravel loss	visual inspection	Project Engineer
			Drain silting	visual inspection	Project Engineer
			Deflection	Benkelman beam	PE/HMIS
			Roughness	Roughmeter III	PE/HMIS
			Structural Damage	visual inspection	PE/HMIS
			Corrugation	visual inspection	PE/HMIS
			Potholes/Depressions	visual inspection	Project Engineer
Candidate Projects (RI 4)	Road Section which needs the treatment	tabular form	Same as RI 3	AS RI 3	
Treatment Cost (BI 1)	Cost of individual treatment works	tabular form	type of treatment	Standards	Project engineer
			length	measured by tape	
			labor cost	according to norms	
			material cost equipment cost		
Budget Proposal (BI 2)	Total treatment cost	tabular form	Same as BI 1	Same as BI 1	
Project Alternatives (PI 1)	Selection of project treatments for execution	tabular form	list of candidate project	selected by its importance	Project engineer
Work Schedule (PI 2)	Work plan for the year	Bar chart and tabular form	finalized candidate projects	simple calculation on quarter year basis	Project engineer
Financial Plan (PI 3)	Total cost for the treatment	table	Time, maintenance activity and its cost	simple calculation on quarter year basis	Project engineer
Contract documents	Document for the		total information about the	Standard documents	Project engineer

Information	Short Description	Information presentation	Data Required	Method of Collection	Collected By
(CI 1)	execution of work		project location , types of work activity to performed, its quantity, quality standard, completion time	from DOR, quantity calculation for treatments as estimate	
Progress Report (MI 1)	Work performed and its expenses during the specific time period	table	Planned work	Work Plan	Project engineer
			Planned expenses	Financial Plan	
			Actual work	Field Measurement	
			Actual Expenses	Field Assessment	

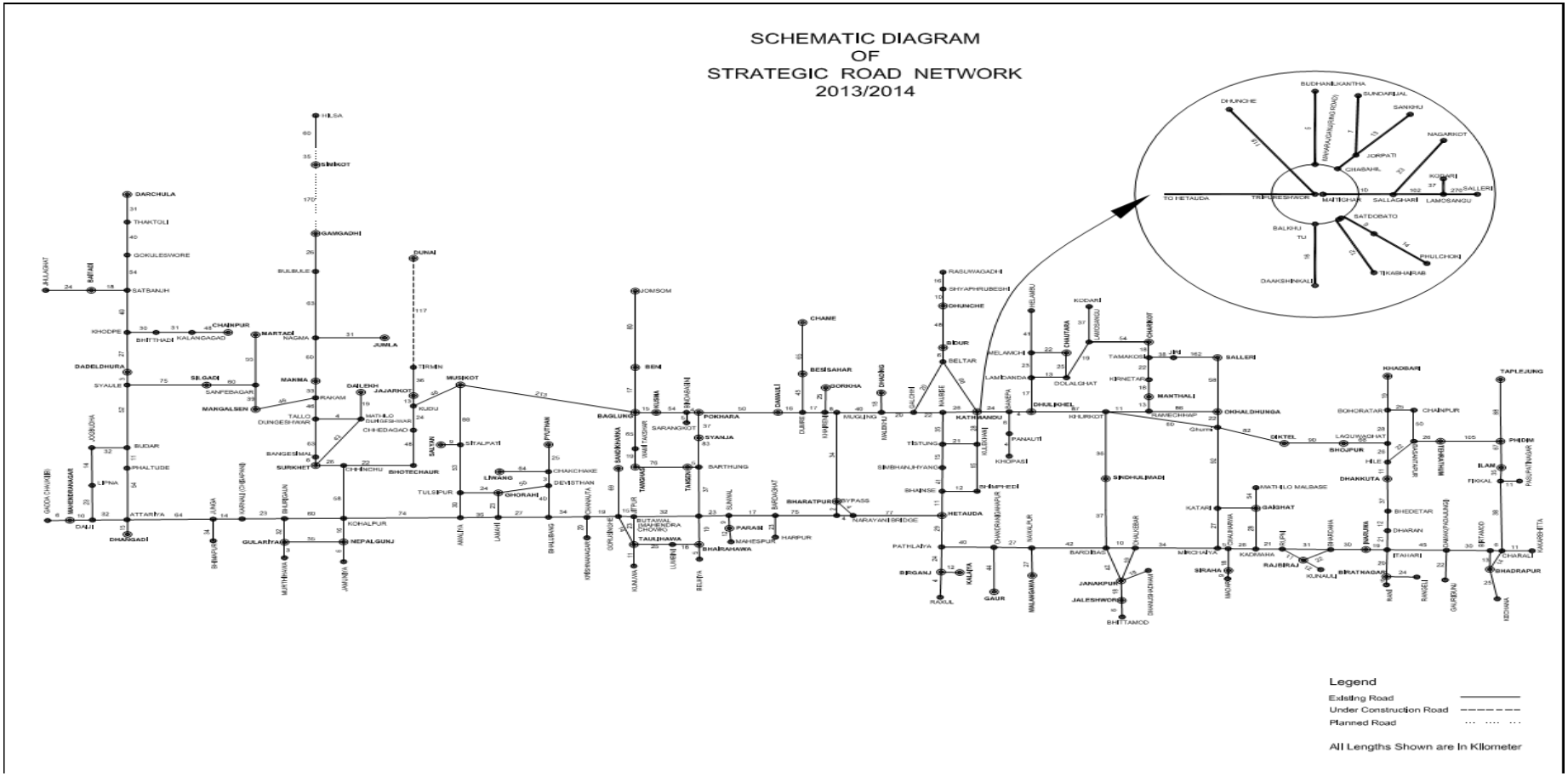
Table 7.4:Analysis of Information Required by Regional Director

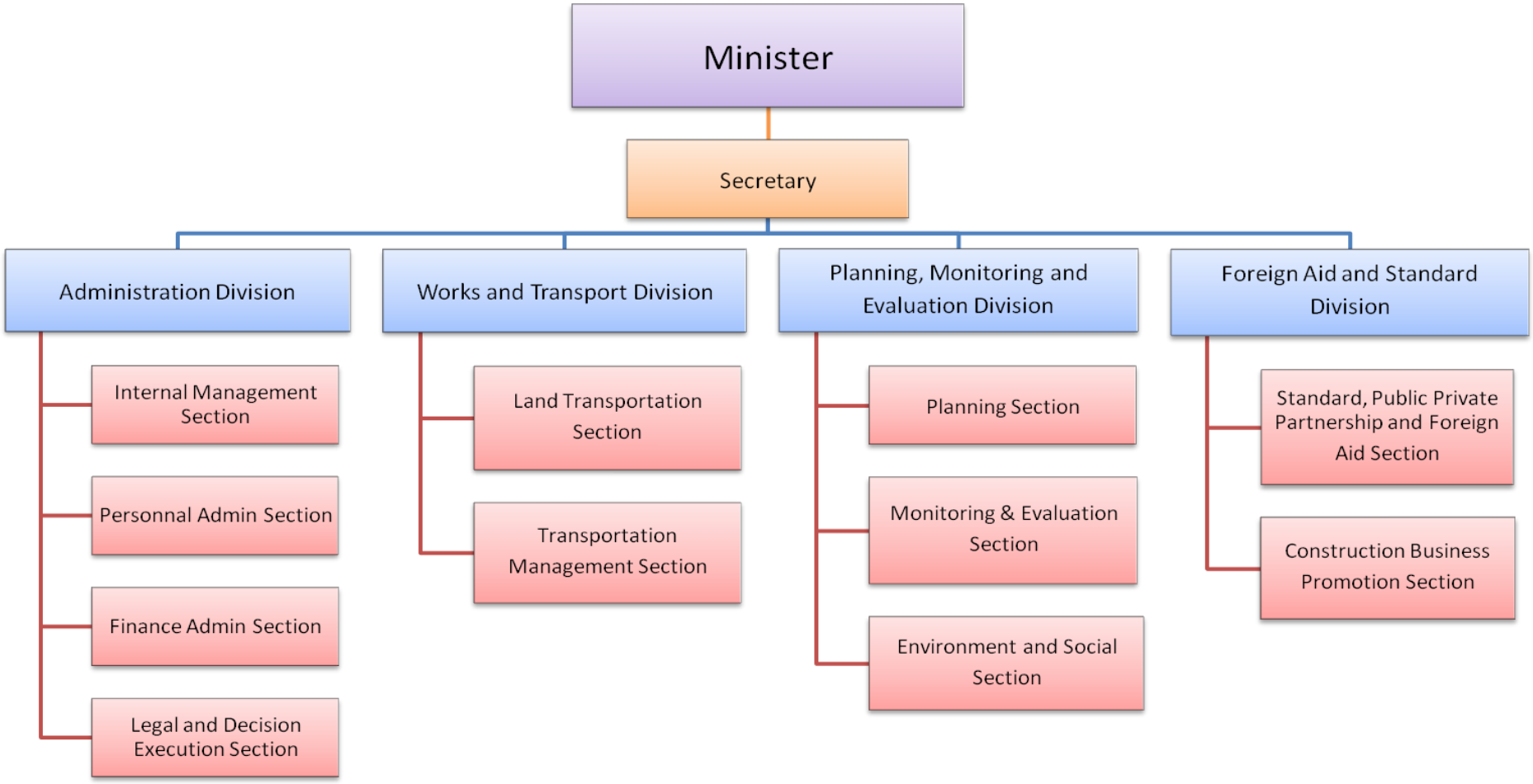
Information	Short Description	Information presentation	Data Required	Method of Collection	Collected By
Priority Assignment (RI 5)	Selection of important Project	tabular form	ADT	Records	HMIS unit
			Road Roughness	Records	
			Road Length	Records	Project Engineer
			Treatment Type	Records	
			Cost	Records	
Priority Listing (RI 6)	Listing in Descending order	In the form of road resister	Road names	From records	
			Section project	From records	
			Section length	From records	
			Surface type	From records	
			Roughness	From records	
			Total cost	From records	
			Condition	From records	

Table 7.5:Analysis of Information Required by Central Level

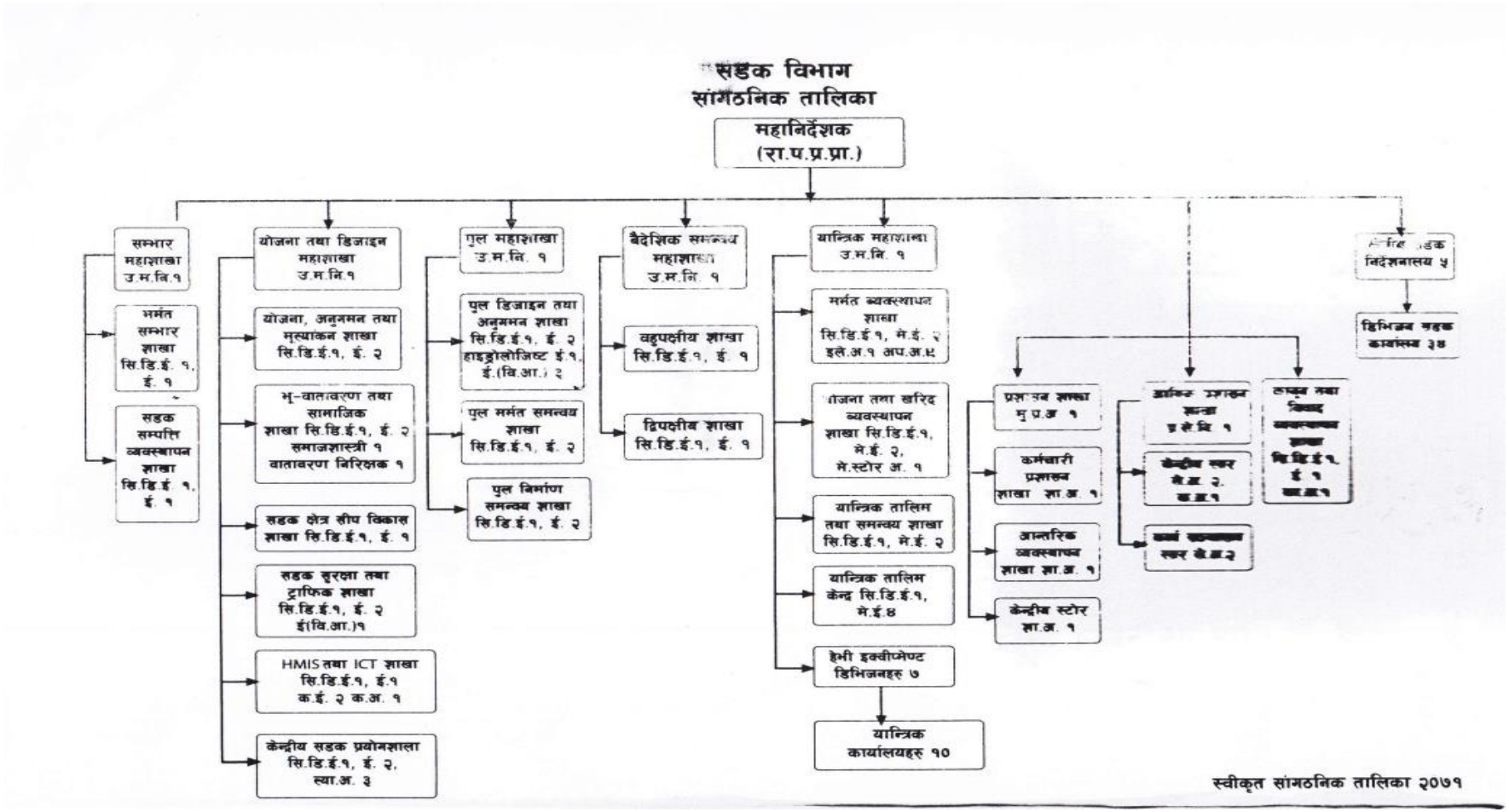
Information	Short Description	Information presentation	Data Required	Method of Collection	Collected By
Quality standards (RI 7)	Expected Condition	Tabular list	Speed	From observation reports	
			Surface Type	Observation reports	
			SDI	HMIS report	
			IRI	HMIS report	
			ADT	HMIS report	
Future Work Loads (RI 8)	List of project for next year	tabular form	Candidate list of projects with treatment type and its cost	Organizing ARMP/ IARMP	
Budget Estimate (BI 3)	Project Cost	tables	Budget from region	Organizing ARMP/ IARMP	
Specified Budget (PI 4)	Allocation of fund for particular activity	tabular form	work plan and financial plan from region	prepared by each project office the forwarded to regional level	
Evaluation Report (MI 2)	Summary of reports	tabular form	Quarterly, annual reports	Prepared by Project office and summarized by regional office	

AVAILABLE DOCUMENTS OFROADMAINTENANCE MANAGEMENTSYSTEM OF DOR


SCHEMATIC DIAGRAM
OF
STRATEGIC ROAD NETWORK
2013/2014
Legend
Existing Road
Under Construction Road
Planned Road
All Lengths Shown are In Kilometer

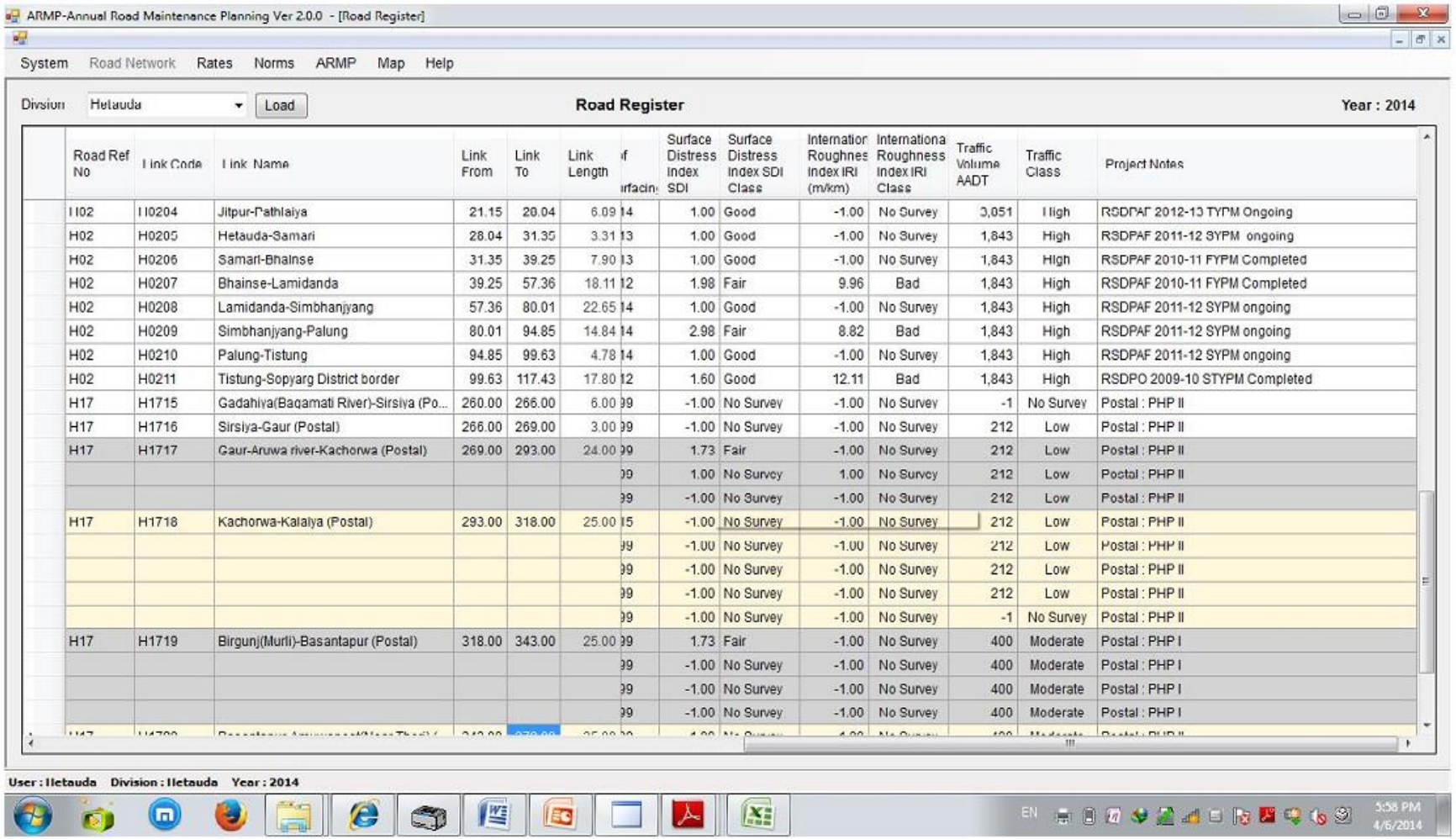


Organization Chart of Ministry of Physical Infrastructure and Transport

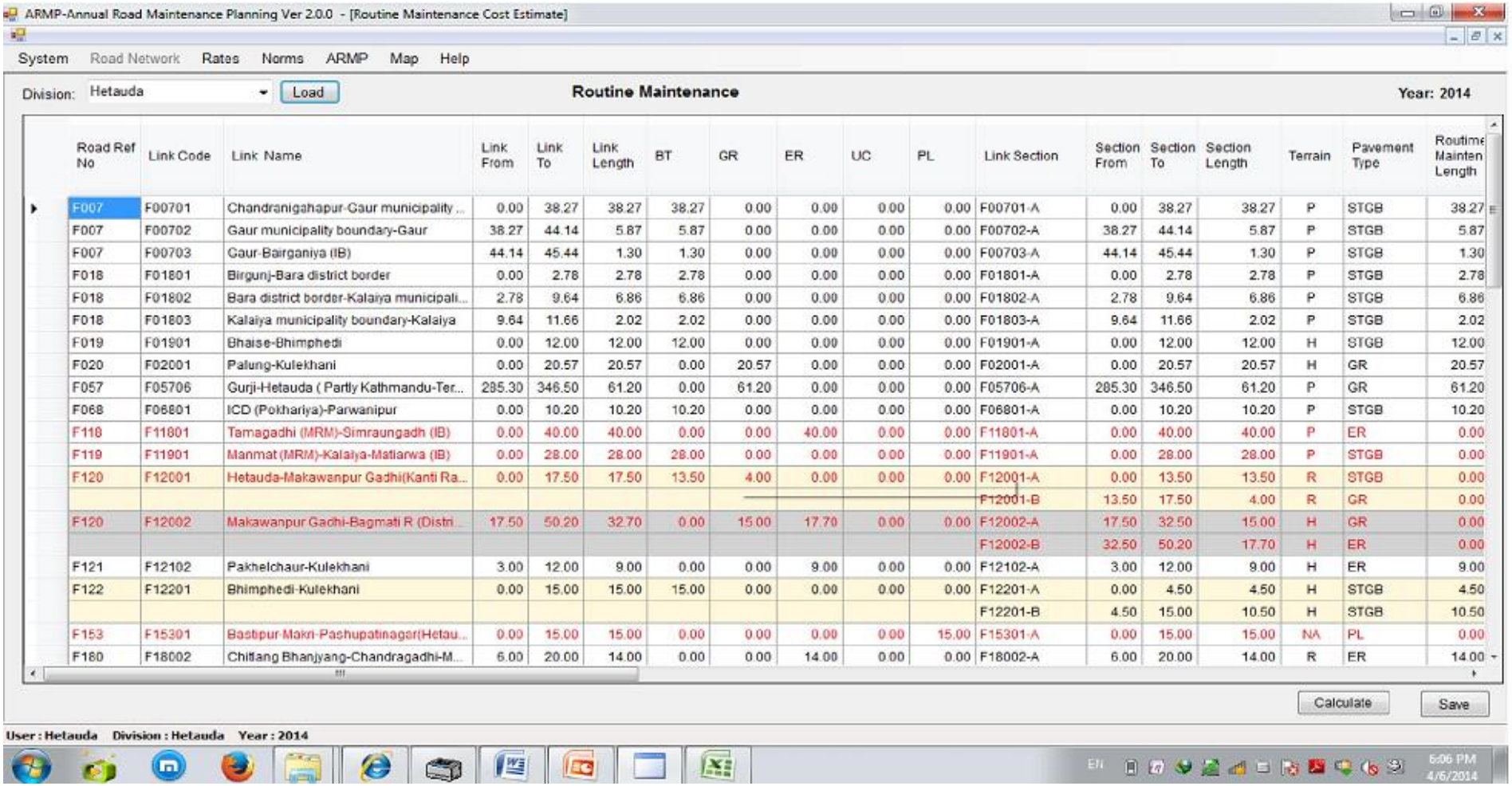


Organization Chart of Department of Roads

Road Register Sample

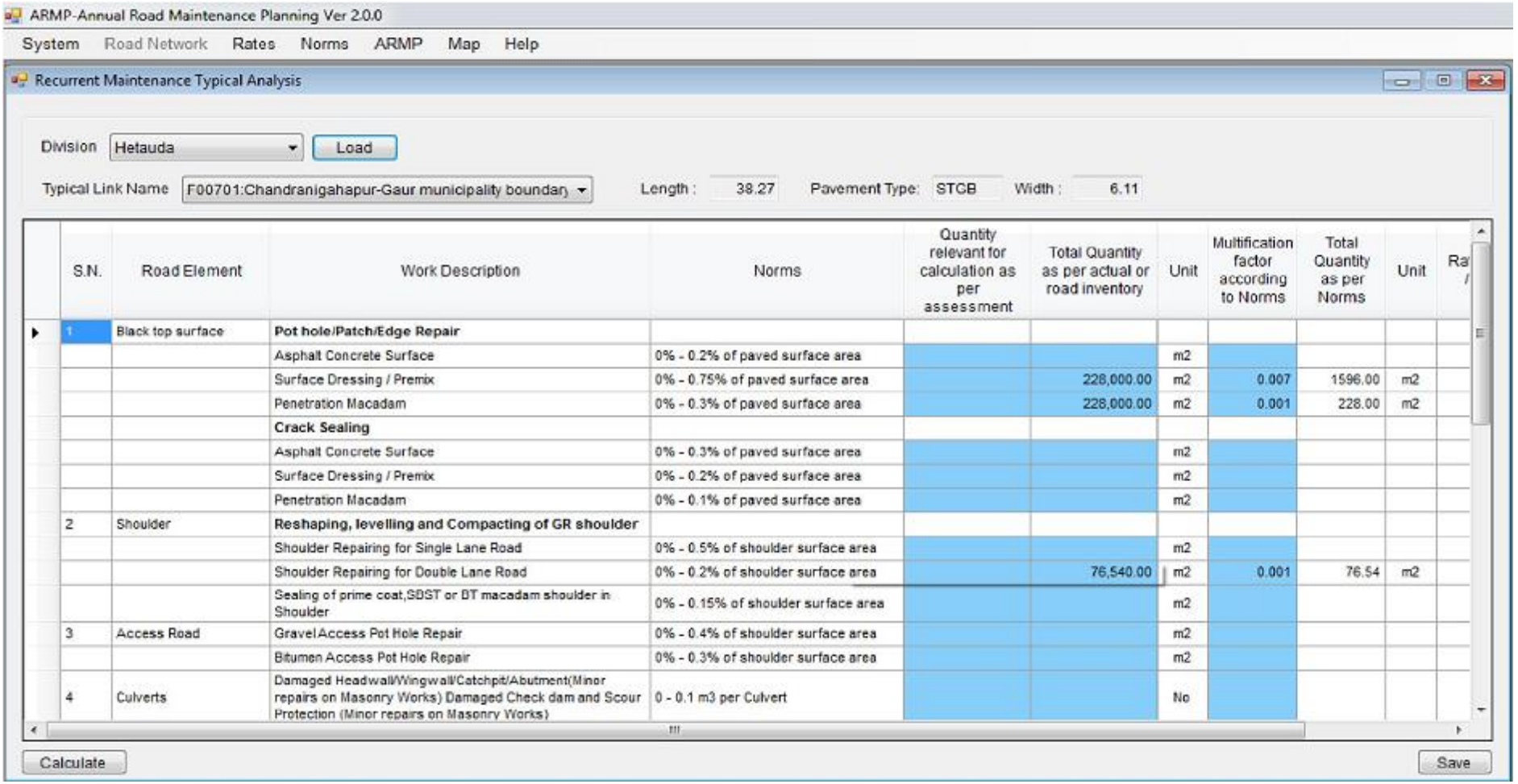


Routine Maintenance Plan Sample



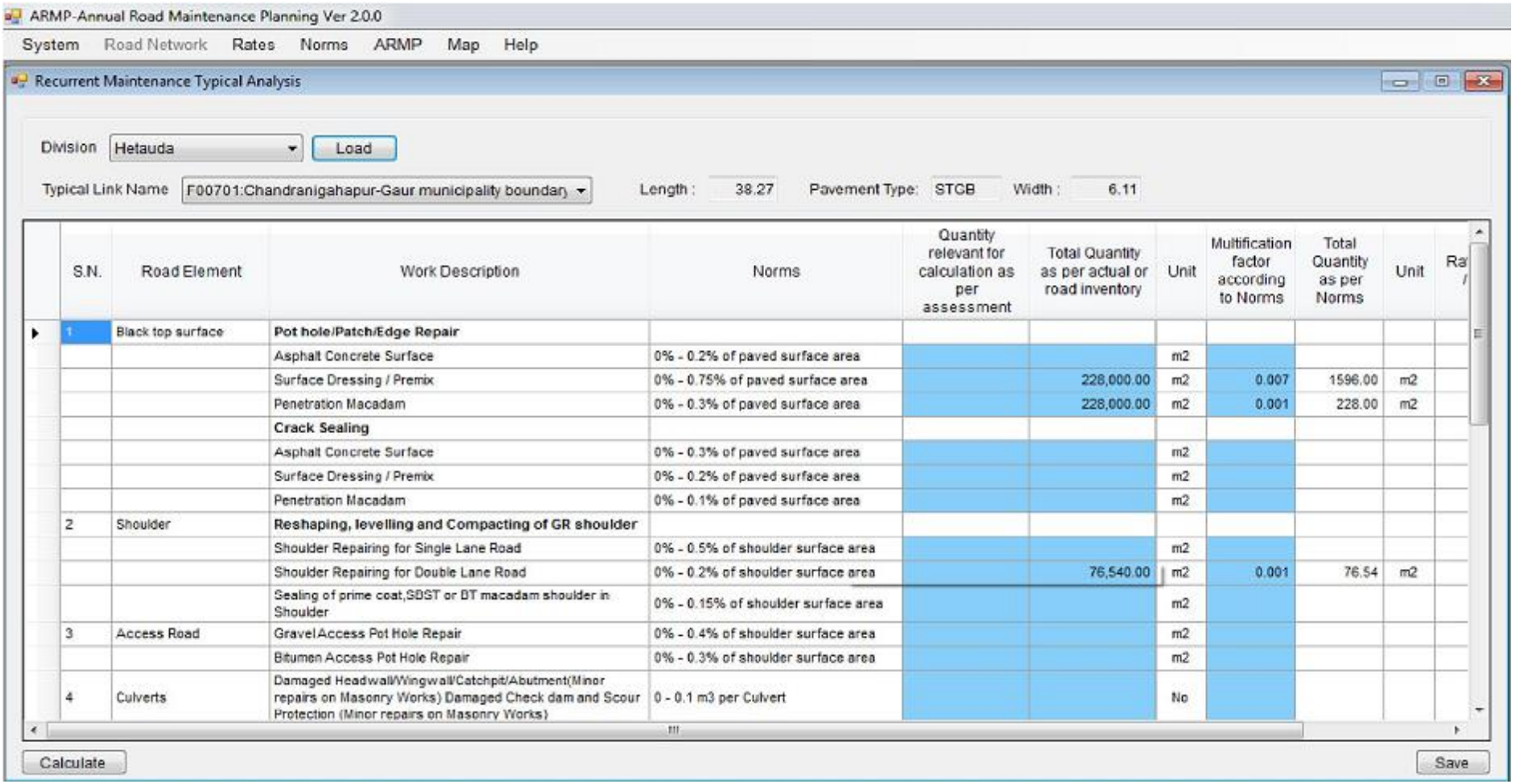
Road Ref No	Link Code	Link Name	Link From	Link To	Link Length	BT	GR	ER	UC	PL	Link Section	Section From	Section To	Section Length	Terrain	Pavement Type	Routine Maintenance Length
F007	F00701	Chandranigahapur-Gaur municipality ...	0.00	38.27	38.27	38.27	0.00	0.00	0.00	0.00	F00701-A	0.00	38.27	38.27	P	STGB	38.27
F007	F00702	Gaur municipality boundary-Gaur	38.27	44.14	5.87	5.87	0.00	0.00	0.00	0.00	F00702-A	38.27	44.14	5.87	P	STGB	5.87
F007	F00703	Gaur-Bairganiya (IB)	44.14	45.44	1.30	1.30	0.00	0.00	0.00	0.00	F00703-A	44.14	45.44	1.30	P	STGB	1.30
F018	F01801	Birgunj-Bara district border	0.00	2.78	2.78	2.78	0.00	0.00	0.00	0.00	F01801-A	0.00	2.78	2.78	P	STGB	2.78
F018	F01802	Bara district border-Kalaiya municipali...	2.78	9.64	6.86	6.86	0.00	0.00	0.00	0.00	F01802-A	2.78	9.64	6.86	P	STGB	6.86
F018	F01803	Kalaiya municipality boundary-Kalaiya	9.64	11.66	2.02	2.02	0.00	0.00	0.00	0.00	F01803-A	9.64	11.66	2.02	P	STGB	2.02
F019	F01901	Bhaise-Bhimphedi	0.00	12.00	12.00	12.00	0.00	0.00	0.00	0.00	F01901-A	0.00	12.00	12.00	H	STGB	12.00
F020	F02001	Palung-Kulekhani	0.00	20.57	20.57	0.00	20.57	0.00	0.00	0.00	F02001-A	0.00	20.57	20.57	H	GR	20.57
F057	F05706	Gurji-Hetauda (Partly Kathmandu-Ter...	285.30	346.50	61.20	0.00	61.20	0.00	0.00	0.00	F05706-A	285.30	346.50	61.20	P	GR	61.20
F068	F06801	ICD (Pokhariya)-Parwanipur	0.00	10.20	10.20	10.20	0.00	0.00	0.00	0.00	F06801-A	0.00	10.20	10.20	P	STGB	10.20
F118	F11801	Tamagadhi (MRM)-Simraungadh (IB)	0.00	40.00	40.00	0.00	0.00	40.00	0.00	0.00	F11801-A	0.00	40.00	40.00	P	ER	0.00
F119	F11901	Manmat (MRM)-Kalaiya-Matiarwa (IB)	0.00	28.00	28.00	28.00	0.00	0.00	0.00	0.00	F11901-A	0.00	28.00	28.00	P	STGB	0.00
F120	F12001	Hetauda-Makawanpur Gadhi(Kanti Ra...	0.00	17.50	17.50	13.50	4.00	0.00	0.00	0.00	F12001-A	0.00	13.50	13.50	R	STGB	0.00
											F12001-B	13.50	17.50	4.00	R	GR	0.00
F120	F12002	Makawanpur Gadhi-Bagmati R (Distri...	17.50	50.20	32.70	0.00	15.00	17.70	0.00	0.00	F12002-A	17.50	32.50	15.00	H	GR	0.00
											F12002-B	32.50	50.20	17.70	H	ER	0.00
F121	F12102	Pakhelchaur-Kulekhani	3.00	12.00	9.00	0.00	0.00	9.00	0.00	0.00	F12102-A	3.00	12.00	9.00	H	ER	9.00
F122	F12201	Bhimphedi-Kulekhani	0.00	15.00	15.00	15.00	0.00	0.00	0.00	0.00	F12201-A	0.00	4.50	4.50	H	STGB	4.50
											F12201-B	4.50	15.00	10.50	H	STGB	10.50
F153	F15301	Bastipur-Makri-Pashupatinagar(Hetau...	0.00	15.00	15.00	0.00	0.00	0.00	0.00	15.00	F15301-A	0.00	15.00	15.00	NA	PL	0.00
F180	F18002	Chitlang Bhanjyang-Chandragadhi-M...	6.00	20.00	14.00	0.00	0.00	14.00	0.00	0.00	F18002-A	6.00	20.00	14.00	R	ER	14.00

Recurrent Maintenance Plan Sample



S.N.	Road Element	Work Description	Norms	Quantity relevant for calculation as per assessment	Total Quantity as per actual or road inventory	Unit	Multification factor according to Norms	Total Quantity as per Norms	Unit	Ra /
1	Black top surface	**Pot hole/Patch/Edge Repair**								
		Asphalt Concrete Surface	0% - 0.2% of paved surface area			m2				
		Surface Dressing / Premix	0% - 0.75% of paved surface area		228,000.00	m2	0.007	1596.00	m2	
		Penetration Macadam	0% - 0.3% of paved surface area		228,000.00	m2	0.001	228.00	m2	
		Crack Sealing								
		Asphalt Concrete Surface	0% - 0.3% of paved surface area			m2				
		Surface Dressing / Premix	0% - 0.2% of paved surface area			m2				
		Penetration Macadam	0% - 0.1% of paved surface area			m2				
2	Shoulder	**Reshaping, levelling and Compacting of GR shoulder**								
		Shoulder Repairing for Single Lane Road	0% - 0.5% of shoulder surface area			m2				
		Shoulder Repairing for Double Lane Road	0% - 0.2% of shoulder surface area		76,540.00	m2	0.001	76.54	m2	
		Sealing of prime coat,SDST or BT macadam shoulder in Shoulder	0% - 0.15% of shoulder surface area			m2				
3	Access Road	Gravel Access Pot Hole Repair	0% - 0.4% of shoulder surface area			m2				
		Bitumen Access Pot Hole Repair	0% - 0.3% of shoulder surface area			m2				
4	Culverts	Damaged Headwall/Wingwall/Catchpit/Abutment(Minor repairs on Masonry Works) Damaged Check dam and Scour Protection (Minor repairs on Masonry Works)	0 - 0.1 m3 per Culvert			No				

Yearly Program Sample



S.N.	Road Element	Work Description	Norms	Quantity relevant for calculation as per assessment	Total Quantity as per actual or road inventory	Unit	Multification factor according to Norms	Total Quantity as per Norms	Unit	Ra /
1	Black top surface	**Pot hole/Patch/Edge Repair**								
		Asphalt Concrete Surface	0% - 0.2% of paved surface area			m2				
		Surface Dressing / Premix	0% - 0.75% of paved surface area		228,000.00	m2	0.007	1596.00	m2	
		Penetration Macadam	0% - 0.3% of paved surface area		228,000.00	m2	0.001	228.00	m2	
		Crack Sealing								
		Asphalt Concrete Surface	0% - 0.3% of paved surface area			m2				
		Surface Dressing / Premix	0% - 0.2% of paved surface area			m2				
		Penetration Macadam	0% - 0.1% of paved surface area			m2				
2	Shoulder	**Reshaping, levelling and Compacting of GR shoulder**								
		Shoulder Repairing for Single Lane Road	0% - 0.5% of shoulder surface area			m2				
		Shoulder Repairing for Double Lane Road	0% - 0.2% of shoulder surface area		76,540.00	m2	0.001	76.54	m2	
		Sealing of prime coat,SDST or BT macadam shoulder in Shoulder	0% - 0.15% of shoulder surface area			m2				
3	Access Road	Gravel Access Pot Hole Repair	0% - 0.4% of shoulder surface area			m2				
		Bitumen Access Pot Hole Repair	0% - 0.3% of shoulder surface area			m2				
4	Culverts	Damaged Headwall/Wingwall/Catchpit/Abutment(Minor repairs on Masonry Works) Damaged Check dam and Scour Protection (Minor repairs on Masonry Works)	0 - 0.1 m3 per Culvert			No				

Progress Report Sample

सडक विभाग

दोस्रो चौमासिक प्रगति प्रतिवेदन

बजेट फाराम नं. ६.१२.४.१

रा. यो.आ.(केयमु) फा. नं. २

पाना नं. १

१. आ. व. : ०७०/०७१

२. बजेट उपशिर्षक नं. : ३३७७१५-३ (४८/४/६९३)

३. मन्त्रालय : भौतिक योजना , निर्माण तथा यातायात व्यवस्था

४. कार्यक्रम । आयोजनाको नाम: टोल सम्भ (हेटौडा चोकर)

५. आयोजना/कार्यालय प्रमुखको नाम :

६. यस अवधिको बजेट रु. :

(क) आन्तरिक (१) नेपाल सरकार :

(२) संस्था :

(३) जनसहभागिता :

(ख) वैदेशीक (१) ऋण :

(२) अनुदान :

७. यस अवधिको खर्च (रु.) :

(क) आन्तरिक (१) नेपाल सरकार :

(२) स्थानिय निकाय / संस्था :

(३) जनसहभागिता :

(ख) वैदेशीक (१) ऋण :

(२) अनुदान :

८. वार्षिक बजेटको तुलनामा खर्च प्रतिशत :

९.शुरु देखि यस अवधिसम्मको कुल खर्च प्रतिशत(कुल लागतको तुलनामा)

१०. विनियोजन प्रतिशतमा (कुल अवधिको तुलनामा) बजेटमा निर्भर

(रकम रु. हजारमा)

क. सं.	कार्यक्रम/क्रियाकलाप	इकाई	आयोजनाको कुल क्रियाकलापको			सम्पूर्ण कार्य मध्ये गत आ.व. सम्मको			वार्षिक लक्ष्य			दोस्रो चौमासिक लक्ष्य			दोस्रो चौमासिक प्रगति			हाल सम्मको प्रगति			आयोजनाको कुल मध्ये हालसम्म			कैफियत
			परिमाण	लागत	भार	सम्पन्न परिमाण	लागत	भारित प्रगति	परिमाण	भार	बजेट	परिमाण	भार	बजेट	परिमाण	भारित	खर्च	परिमाण	भारित	खर्च	सम्पन्न परिमाण	भारित प्रगति	खर्च	
१	२	३	४	५	६	७	८	९	१०	११	१२	१३	१४	१५	१६	१७	१८	१९	२०	२१	२२	२३	२४	२५
(अ) पुँजीगत खर्च अन्तर्गतका कार्यक्रमहरु :																								
१	पक्की नाली निर्माण कार्य	र.मी																						
२	कंक्रीट ड्रेन कभर निर्माण कार्य	र.मी																						
३	रोड फर्निचर (प्रमाणतमाह)	प्र.श.																						
४	कालोपत्रे सडक सुधार कार्य(रीसर्फेस)	व.मि.																						
५	सोल्डर मर्मत	व.मि.																						
६	कालोपत्रे सडक सुधार कार्य(प्याच मर्मत)	व.मि.																						
७	बायोइन्जिनियरिङ	प्र.श.																						
(क) पुँजीगत खर्च कार्यक्रमको जम्मा :																								
(आ) चालु खर्च अन्तर्गतका कार्यक्रमहरु :																								
(ख) चालु खर्च कार्यक्रमको जम्मा :																								
(ग) कार्यक्रम खर्चको जम्मा (क+ख)																								
(घ) उपभोग खर्च																								
(ङ) कार्यालय संचालन खर्च																								
(च) कुल जम्मा खर्च (ग+घ+ङ)																								

चौमासिक प्रगति गणना गर्ने प्रतिवेदन अवधिको भारित प्रगति : महल (ग) को १९/८ X १०० =

वार्षिक प्रगति गणना गर्ने प्रतिवेदन अवधिको भारित प्रगति : महल (ग) को १३/५ X १०० =

आयोजना । कार्यालय प्रमुखको दस्तखत र मिति :

विभागिय । संस्था प्रमुखको दस्तखत र मिति :

प्रमाणित गर्नेको दस्तखत र मिति :

RNDS DATABASE FOR IRI FORMAT

Road Network Database SystemStandard Sheet for Data Collection and Entry

Road Inventory:	Roughometer IRI
Data Source:	Traffic, Surface Distress and Road Roughness Surveys on SRN
Data Collection Date:	
From:	
To:	
Remarks:	

Road:	**Feeder Road**		
Link:	-	Link ID:	
Vehicle No.:	Ba 12 Cha 5848 Mahindra Scorpio	Km	

CHAINAGE (SSRN)		CHAINAGE (Video)		ROUGHNESS	Remarks
From, (Km)	To, (Km)	From, (Km)	To, (Km)	IRI (m/km)	
0 + 000	1 + 000	0 + 000	1 + 000		
1 + 000	2 + 000	1 + 000	2 + 000		
2 + 000	3 + 000	2 + 000	3 + 000		
3 + 000	4 + 000	3 + 000	4 + 000		
4 + 000	5 + 000	4 + 000	5 + 000		
AVERAGE ROUGHNESS OF THE LINK					

RNDS DATABASE FOR SDI FORMAT

PAVEMENT SURFACE DISTRESS INDEX (SDI) SURVEY

Measurement Sheet

Road: **Date:**
Road Ref No:
Link Name:
Link Code:

Terrain	Plain		**Type of Pavement**	STGB	**Weather Conditior**	Sunny
	Rolling			STAM		Cloudy
	Hill			AMGB		After rain
				GR		

SN	(SSRN) Chainage Start	(SSRN) Chainage End	(Video) Chainage Start	(Video) Chainage End	Formation Width (m)					Score		Surface Distress on Bituminous Surface																							Remarks
						Shoulder						Minor											Major												
					Carriage Way	Right (m)	Up /Down (mm)	Left (m)	Up /Down (mm)	Shoulder	Carriageway SDI Score	Percent area	Total Area	Narrow Cracks (CN) (Sq.m)	Line Crack (CL) (Sq.m)	Sealed Crack (CM) (Sq.m)	Ravelling (RA) (Sq.m)	Slickness (S) (Sq.m)	Rutting (RL<15mm) (Sq.m)	Bleeding (B) (Sq.m)	Short Edge Break (ES) (Sq.m)	Patches (M) (Sq.m)	Wide Cracks (CW) (Sq.m)	Scabbing (V) (Sq.m)	Rutting (RL>15mm) (Sq.m)	Average Rut Depth (mm)	Potholes (P) (Sq.m)	Potholes Count (PC)	Exposed Base (G) (Sq.m)	Long Edge Break (EL) (Sq.m)	Corrugation (D) (Sq.m)	Total Area	Percent area	
1																																			
2																																			
3																																			
4																																			
5																																			
6																																			
7																																			
8																																			
9																																			
10																																			
11																																			
Final Scores																																			
Total Area %																																			

RNDS DATABASE FOR TRAFFIC SURVEY FORMAT

Traffic Count Survey

Data Source	Manual		
Data Collection Date			
From	19/11/2014		
To	21/11/2014		
Station No.:	**1**	LINK ID:	**F00101**
Station Name:	**Birtamod South**	Link Name:	Birtamod(MRM)-chandragadhi
Location:	2.5 km south of MRM junction Birtamod-Chandigadhi Road	Surveyed and Supervised By:	TSE/GEOCE JV
Dor Seasonal Factor:	1.04		

Note:
a = Direction of the movement of vehicle from Birtamod To Chandragadhi
b = Direction of the movement of Vehicle from Chandragadhi To Birtamod

Date	Start Time	End Time	Volume of Vehicle																													
			Truck						Bus						Car/Taxi		MC		Utility Vehicles		Tractor		Motorised Three Wheeler		Four Wheel Drive		Power Tiller		Rickshaws		Bullock Cart/Tanga		Total	
			Multi-axle Truck		Heavy		Light		Big		Mini		Micro																				
			a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
19/11/2014	06:00	07:00	0	0	1	-	1	-	-	1	2	2	-	-	2	6	25	55	2	2	2	3											35	69
	07:00	08:00	1	-	1	1	1	-	4	-	2	6	-	1	7	7	49	114	1	4	2	8	-	-	1	2	-	-	1	3	2		72	146
	08:00	09:00	-	-	-	6	1	-	1	1	8	25	2	4	13	15	71	145	2	9	6	9	-	-	1	1	-	1	2		1		108	216
	09:00	10:00	-	-	-	1	6	5	-	-	12	10	3	2	9	15	153	194	10	9	3	6	-	-	-	1	-	-	2	7	2		200	250
	10:00	11:00	-	-	4	-	2	2	1	1	10	10	9	4	27	14	197	177	9	7	3	6	1	-	2	-	1	1	1	4	5		272	226
	11:00	12:00	-	-	3	-	1	2	2	-	13	7	5	2	25	13	197	205	14	5	9	5	-	-	-	7	1	-	7	5			277	251
	12:00	13:00	-	-	-	-	2	2	-	-	7	5	7	2	28	5	212	169	7	-	6	7	-	-	2	6	-	1	6	3	1		278	200
	13:00	14:00	-	-	1	-	2	2	-	-	8	2	8	4	23	7	173	148	12	-	7	6	-	-	1	2	1	-	1	2	2		239	173
	14:00	15:00	-	-	-	-	3	5	-	-	16	8	13	7	30	12	225	140	16	-	8	6	-	-	2	3	-	-	4	6	2		319	187
	15:00	16:00	-	-	1	-	9	13	-	5	15	20	16	25	23	21	223	220	7	12	6	6	-	-	2	4	-	-	10	25	1		313	351
	16:00	17:00	-	-	-	-	4	6	-	4	10	13	11	18	18	6	151	153	18	1	3	6	-	-	1	8	-	-	4	8	1	1	221	224
	17:00	18:00	-	-	-	-	-	3	-	1	1	5	-	3	9	3	64	94	4	-	1	-	-	-	-	-	-	-	1	1			80	110
	Sub Total 6:00-18:00 hrs		**1**	**-**	**11**	**8**	**32**	**40**	**8**	**13**	**104**	**113**	**74**	**72**	**214**	**124**	**1,740**	**1,814**	**102**	**49**	**56**	**68**	**1**	**-**	**12**	**34**	**3**	**3**	**39**	**64**	**17**	**1**	**2,414**	**2,403**
	Sub Total 18:00-6:00 hrs		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**6**	**11**	**44**	**69**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**50**	**80**
	Total Day1		**1**	**-**	**11**	**8**	**32**	**40**	**8**	**13**	**104**	**113**	**74**	**72**	**220**	**135**	**1,784**	**1,883**	**102**	**49**	**56**	**68**	**1**	**-**	**12**	**34**	**3**	**3**	**39**	**64**	**17**	**1**	**2,464**	**2,483**
20/11/2014	**Sub Total 6:00-18:00 hrs**		**-**	**2**	**13**	**-**	**28**	**18**	**17**	**1**	**108**	**72**	**81**	**98**	**285**	**151**	**1,778**	**1,916**	**91**	**68**	**48**	**15**	**-**	**-**	**8**	**23**	**2**	**1**	**20**	**15**	**13**	**1**	**2,492**	**2,381**
	Sub Total 18:00-6:00 hrs		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**16**	**9**	**69**	**203**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**85**	**212**
	Total Day2		**-**	**2**	**13**	**-**	**28**	**18**	**17**	**1**	**108**	**72**	**81**	**98**	**301**	**160**	**1,847**	**2,119**	**91**	**68**	**48**	**15**	**-**	**-**	**8**	**23**	**2**	**1**	**20**	**15**	**13**	**1**	**2,577**	**2,593**
21/11/2014	**Sub Total 6:00-18:00 hrs**		**-**	**-**	**10**	**2**	**25**	**32**	**16**	**-**	**112**	**46**	**47**	**41**	**246**	**101**	**1,994**	**1,836**	**45**	**25**	**31**	**12**	**-**	**-**	**12**	**19**	**3**	**1**	**15**	**11**	**7**	**7**	**2,563**	**2,133**
	Sub Total 18:00-6:00 hrs		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4**	**9**	**68**	**56**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**72**	**65**
	Total Day3		**-**	**-**	**10**	**2**	**25**	**32**	**16**	**-**	**112**	**46**	**47**	**41**	**250**	**110**	**2,062**	**1,892**	**45**	**25**	**31**	**12**	**-**	**-**	**12**	**19**	**3**	**1**	**15**	**11**	**7**	**7**	**2,635**	**2,198**
Total			**1**	**2**	**34**	**10**	**85**	**90**	**41**	**14**	**324**	**231**	**202**	**211**	**771**	**405**	**5,693**	**5,894**	**238**	**142**	**135**	**95**	**1**	**-**	**32**	**76**	**8**	**5**	**74**	**90**	**37**	**9**	**7,676**	**7,274**
Grand Total (a+b)			3		44		175		55		555		413		1,176		11,587		380		230		1		108		13		164		46		14,950	
Average Daily Traffic (ADT)			1		15		58		18		185		138		392		3,862		127		77		0		36		4		55		15		4,983	
Composition (%)			0%		0%		1%		0%		4%		3%		8%		78%		3%		2%		0%		1%		0%		1%		0%		-	
Total ADT excl. MC & Rickshaws			1066																													
Composition excl. MC, rickshaws (%)			0%		1%		5%		2%		17%		13%		37%		-		12%		7%		0%		3%		0%		-		1%		-	
Average Annual Daily Traffic (AADT)			1		15		61		19		192		143		408		4,017		132		80		0		37		5		57		16		5,183	
AADT excl. MC, Rickshaws			1		15		61		19		192		143		408		-		132		80		0		37		5		-		16		1,109	
PCU Factors			4.00		3.00		1.50		3.00		2.50		1.50		1.00		0.50		1.00		1.50		0.75		1.00		1.50		1.00		2.00		-	
AADT in PCUs			4		46		91		57		481		215		408		2,008		132		120		0		37		7		57		32		**3,695**	
AADT in PCUs excl. MC & Rickshaws			4		46		91		57		481		215		408		-		132		120		0		37		7		-		32		**1,629**	

EVALUATION OF INFORMATION REQUIREMENTS FORROAD MAINTENANCE MANAGEMENT SYSTEM OF DOR

Table 7.10: Assessment Result for Project Engineer

Information	Operational Characteristic	Situation Assessment	Required Measure
Road Inventory (RI 1)	Amount of Data	More data required	Computerized system
	Frequency of use	Annually required	proper accessibility to data(systematic filing/storage)
	IQL	timely not updated , once recorded are used for several years	timely collection and update of data annually
Traffic Information (RI 2)	Amount of Data	Data criteria (ADT and Axle load)are sufficient but data collection are not sufficient	Periodic data collection
	Frequency of use	medium, for classification, design	
	IQL	satisfactory	
Road Condition Information (RI 3)	Amount of Data	More data and frequent collection is required	More investigation and frequent data collection is required
	Frequency of use	more required but site visited during execution	Data must be update frequently
	IQL	Inconsistent Data Subjective rating	required standard data collection must be improved to get reliable data

Information	Operational Characteristic	Situation Assessment	Required Measure
Candidate Projects (RI 4)	Amount of Data	All road sections are proposed for maintenance	Proper assessment for actual maintenance is required
	IQL	sufficient	
	volume of work	All road sections are proposed for maintenance	Proper site investigation is required
Treatment Cost (BI 1)	Amount of Data	sufficient	
	Frequency of use	sufficient	
	IQL	sufficient	
Budget Proposal (BI 2)	Amount of Data	sufficient	
	Frequency of use	sufficient	
	IQL	sufficient	
Project Alternatives (PI 1)	Amount of Data	Projects are selected according to budget allocation and subjective judgment	Project selection based prioritization
	Frequency of use	as per requirement	
	IQL	low	accurate data and consistent is required
	volume of work	prepared during Programming	

Information	Operational Characteristic	Situation Assessment	Required Measure
Work Schedule (PI 2)	Amount of Data	limited to formality not based on reality	should be based on reality and resource allocation
	Frequency of use	once in a year	must be update time to time
	IQL	low	
Financial Plan (PI 3)	Amount of Data	limited to formality not based on reality	should be based on reality and resource allocation
	Frequency of use	once in a year	must be update time to time
	IQL	low	
Contract documents (CI 1)	Amount of Data	sufficient	
	Frequency of use	more	
	IQL	sufficient	

Table 7.11:Assessment Result for Regional Director

Information	Operational Characteristic	Situation Assessment	Required Measure
Priority Assignment (RI 5)	Amount of Data	No proper prioritization, tried to allocate the budget for all projector prioritize according to	Proper prioritization should be required according to importance of road, traffic flow and pavement condition
	Frequency of use	only once a year	
	IQL	low	
	volume of work	more	
Priority Listing (RI 6)	Amount of Data	according to road type and IRI value	
	Frequency of use	time to time	
	IQL	satisfactory	

Table 7.12:Assessment Result for Center Level Data

Information	Operational Characteristic	Situation Assessment	Required Measure
Quality standards (RI 7)	Amount of Data	same standard for maintenance and upgrading	separate standard for maintenance and upgrading is required
	Frequency of use	mostly	
	IQL	not sufficient	
Future Work Loads (RI 8)	Amount of Data	sufficient	Periodic data collection
	Frequency of use	sufficient	
	IQL	sufficient	
Specified Budget (PI 4)	Amount of Data	budget separated according to availability of resource	budget separated according to importance of project
	Frequency of use	mostly	
	IQL	sufficient	
Evaluation Report (MI 2)	Amount of Data	not realistic most of the time prepare to release budget	must be based on reliable data
	IQL	sufficient	
	volume of work	more	