Analyzing the Maintenance Practices of Rural Road Network

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Abstract

Building New Road costs lots of money. Three tiers of Government have been emphasized the Road infrastructure in the policy. The Deteriorating condition of the Road Infrastructure poses enormous challenges to planners and managers in terms of financing, logistics in various aspects. There could have many road links necessary for maintenance work for smooth functioning. Road authority has problems addressing Priorities Road on maintenance planning due to limited funding. This research mainly focuses on identifying the different aspects of maintenance, intervention required, analyze the maintenance practices, and develop the priority list of maintenance of the road. Data was based upon rapid condition survey and questionnaire to concerned authority at Road Types ($A0_1$ to $A0_5$) with considering factors Maintenance cost, Surface condition, Road users and Traffic volume and subsequent supportive documents as maintenance Guidelines, Norms, and Specifications. This study was found there is a huge gap between budget requirement and budget allocated for the maintenance whereas rapid growth in traffic volumes attracts more frequent maintenance some of the major findings from this study include: huge financial investment is made in road opening and construction but there is total ignorance on the maintenance of the road. The researcher, therefore, recommends the introduction of appropriate arrangements for maintenance of the road, which help in the reduction of the cost of vehicle operation, slowing road deterioration to increase the lifespan of the road and make available safe and reliable transport services.

Keywords: *Infrastructure, Maintenance cost, Prioritization, Rapid condition survey, Transportation,*

I. INTRODUCTION

Road Infrastructure is considered to be the backbone of the overall socio-economic development of the nation. 90% of Nepali people rely on Road transport for the movement of goods and Services. Road maintenance includes the activities which are to be performed for the road related physical structures to achieve their regular, effective, sustainable operation and ensure serviceability. A rural road may be defined as a motorable road or tracked owned regulated and maintained by a local governing institution. Rural road network structurally designed for low traffic facilities' connecting the nearest economic center, town, district headquarters, or strategic road(1). In the context of Nepal, we have 57,632 km of rural roads. Among them, 25,728 km is district road and 31904 km is village road. Where only 28 % of district road (7,180 km) are all weathered and still 72 % (18,548 km) roads are fair-weathered road which is due to lack of timely maintenance and many of these roads were not properly engineered and often un-maintainable(2). Road deterioration is generally slow at first and not very visible, taking the form of wear and tear and minor damage to the road surface and the drainage system as indicated below (Figure 1 at phase A). Proper maintenance may not be carried out during this phase and as a result, the road starts to deteriorate from very good to a fair condition. The deterioration tends to accelerate as the road base and the foundation of the physical road structure starts to become affected (phase B in Figure 1). This is especially due to water, which no longer flows safely away from the road as a result of deformation of the road camber and damage to the drainage system. The water causes damage through

erosion or remains on the road and weakness it, resulting in greater damage being caused by vehicles. During this phase, the damage to the road quickly spreads causing longer travel times and more damage to vehicles until the entire road can be said to be in poor condition as the road condition becomes very poor, fewer and fewer vehicles use the road until traffic and transport cease altogether when the road is no longer motorable(Phase Cin Figure1). (3)
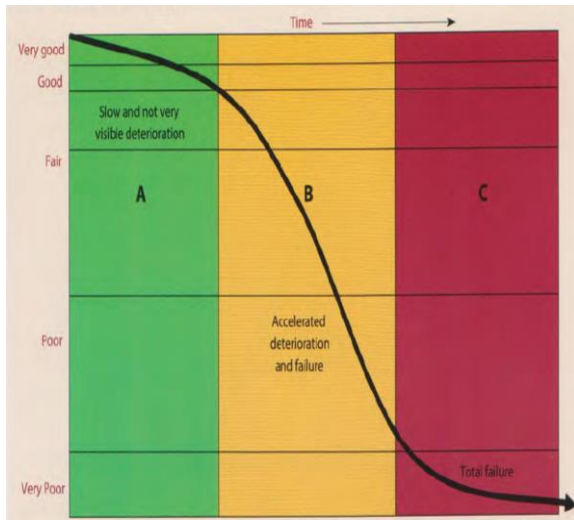

Figure 1.Road Deterioration Cycle(3)

The water, snow, and traffic are the main reason for road deterioration. Water and snow cause deterioration of road surface, shoulder, and the road base as well as damage to physical road structure due to washed away of road base material and damage the strength of structure(4). Traffic also causes deterioration of the road through the loss of surface material deformation of the surface by vehicle tires resulting in potholes rut and corrugation. Road maintenance programs generally are divided into three categories routine maintenance, periodic maintenance, and the rehabilitation of roads, slab culverts, and bridges. Although the budgets for these maintenance activities are planned prudently, based on the engineer's estimate, changes usually occur in the work plans after the maintenance work starts(5).

II. MATERIAL AND METHODS

The process adopted to carry out the study to reach the objectives can be summarized under the following points

A. Selection of the Road Types

Five no's of roads were selected having their code A_{01} to A_{05}. These roads are the most important rural road in Annapurna rural municipality of the Kaski district (6).

These are important because they serve about 25,926 population of with 926 no's of the vehicle using these roads daily(7). These entire five roads are connected to the major growth center, tourism center, and national highway (Pokhara-Baglung). Selected roads of this rural municipality (Table 1) have sufficient width and acceptable gradient in many sections. The vehicle is pliable all-weather except in worst condition

Table 1. Description of selected roads

S.N.	Road Name	Road code	Length (km)	Alignment location / Ward No
1	Birethati-Syaulibajar-Chane Road	$A0_1$	8.85	8 and 10
2	Kade – Bhadaure Road	$A0_2$	6.10	3,4 and 5
3	Naudada-Serachaur-Saureni-thulachaur-Karkiko-Tahara-Naudada Road	$A0_3$	8.74	1 and 2
4	Dhikurpokhari-Dharapani-Bhadaure Road	$A0_4$	6.11	3,4 and 5
5	Naudada-Sarankot Road	$A0_5$	1.80	Naudada, Fallapani

(Source: Field Survey 2019)

B. Rapid Condition Survey

A rapid condition survey was conducted to collect the existing different aspects of failure on the pavement. The researcher developed the rapid condition survey form which was filled during the field survey. In this form names of road, width, terrain type, date of survey, type of maintenance needed, condition of side drain, pavement type settlement passes, proposed and the existing structure of the road, vehicle, etc. were filled up for each road. The condition found on almost gravel road was blockage of side drain, cross drainage structure loss of gravel, corrugation, and loss of camber on pavement surfaces, potholes formation, a landslide on some locations, and failure of roadside on some section. Similarly, in the case of bituminous paved road blockage of cement concrete drain, potholes, crack formation on the pavement surface, and disappearance of roadside paint was observed.

C. Maintenance Cost

For the calculation of volume and cost required for maintenance simple mathematical tool excel was used. GPS was used to track the location of the road which help to find the exact length of road surveyed, similarly google earth was used to generate the route of the road for the preparation of a map of the road surveyed. Road maintenance norms/ road maintenance group guidelines, DOR norms, District rate of Kaski district 2076 were used for the analysis of different maintenance work of road. From the data of the rapid condition survey, different types of the volume of maintenance work were determined. Cost estimates of all types of maintenance work were calculated from their respective rate and quantity based on the field survey.

D. Interview for traffic survey

A traffic survey was carried out in every starting and ending point of road most of the interview was carried out with focal person who were involved in collecting vehicle tax (Patake Sawari Kar)operatedby municipality.Similary,shopkeeper's local road users and/or other knowledgeable persons along the road were also interviewed to obtain an estimate of the number of vehicles making use of the road.Interview were also done with local peoples to know the road coverage settlement area durig survey it was helpful to know the settlement name where the road passes and it was helpful to find out the numberof population using that road.Traffic data was collected to determine the ranking of maintenance interventions for these roads.Distinction was made between different vehicle categories as perNepal Rural Road Standards 2071 as heavier vehicles tend to cause more damage to the road.

E. Ranking and Prioritization

Four factors (road maintenance cost, road type, road users and traffic volume)were considered for selection of priority road for maintenance. Among them ratio of annual road maintenance cost and traffic volume are important factor. They are calculated based on field survey data Norm's specification and traffic survey .The ratio of these two factor (Annual maintenance cost per Annual vehicleusing that particular road)meansroad which required lowest maintenance cost for maximum flow of vehicle so lowest ratio of road gets priority for maintenance. Similarly other two factors were collected based on interview and extract from secondary sources during condition survey of roads. Type of road surfaceand number of vehicles using the road were important for road selection for maintenancebecause everyone want to use the smooth paved surface meeting with geometric standards as result number of vehicles using that road also increased so the amount of traffic on a particular road is an important factor for establishing priorities for repairs and maintenance.As a result of smooth paved surface road side population density also increases at that alignment so road users becomes also higher as compared to others roads(8).All types of annual maintenance cost as per condition survey required to maintain the selected five roads were already calculated. Similarly no of vehicle using each road were identified based on the traffic survey and was converted to VPD using the Equivalency factor of each vehicle category as per Nepal Rural Road Standards 2071.Ratio of Annual Maintenance cost to Annual Vehicle was calculated for every road and each type of maintenance work.

IV. RESULTS AND DISCUSSION

Result and discussion were based on the condition survey data, secondary data taken from different sources. Surface condition of all selected road are presented in Table 2.

Table 2.Length of Road based on surface condition

Road Code	Road Name	Black Topped (Km)	Earthen (km)	Gravelled (Km)	All Weather Road(Km)	Fair weather (km)	Total (Km)
A$_{01}$	Birethanti-syaulibazar -Chane Road	-	0.5	8.35	8.35	0.5	8.85
A$_{02}$	Kande-Bhaudare Road	-	-	6.10	6.10	-	6.10
A$_{03}$	Naudanda-Serachaur-Saureni Karki -Tahara - Nuadada Road	-	7.0	1.74	1.74	7.0	8.74
A$_{04}$	Dhikurpokhari-Dharapani-Bhadaure Road	-	0.5	5.61	5.61	0.5	6.11
A$_{05}$	Naundanda-Sarangkot Road	1.80	-	-	1.80	-	1.80
Total		**1.80**	**8.00**	**21.80**	**23.60**	**8.00**	**31.60**

(Source: Field Survey, 2019)

During Rapid condition survey Traffic survey was carried out in every starting and ending of the road to know an estimated number of vehicle flows by using of road. Weighted of each category of vehicle and Vehicle data are presented in Table 3and 4respectively.

Table 3. Weight of Vehicle Category

Type	Weight(Equivalency Factor)
Motorcycle	0.5
Car-Jeep- Minibus	1
2W TractorTowed trailers standard	2.0
4W TractorTowed trailers standard	3.0
Truck-Bus(Upto 15 tonnes gross)	4
Light truck upto 2.5 tonnes gross	1.5
Bus up to 40 passengers Minibus	3.0
Bus over 40 Passengers	4.0

(Source:Nepal Rural Road Standards, 2071)

Table 4. Traffic Volume of Selected Road

S.N.	Code	Name of the Road	Length (km)	Motorcycle	Car-Jeep-Minibus	Tractor	Truck-Bus	PCU	VPD
1	A_{01}	Birethanti-syaulibazar -Chane Road	8.85	100	80	25	13	232	218
2	A_{02}	Kande-Bhaudare Road	6.10	20	15	10		45	45
3	A_{03}	Naudanda-Serachaur-SaureniKarki -Tahara -Nuadada Road	8.74	2	1	1	1	8	5
4	A_{04}	Dhikurpokhari-Dharapani-Bhadaure Road	6.11	10	7	5	2	30	24
5	A_{05}	Naundanda-Sarangkot Road	1.80	500	120	10	4	406	634

(Source: Field Survey, 2019)

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A. Budget requirement and prioritization of road

For the preparation of budget requirements of maintenance works volume of work and rate was calculated. Volume of maintenance work was calculated based on the data collected during. Rapid Condition Survey, whereas rate of maintenance work were obtained from rate analysis, using the norms of DOR, DoLIDAR, Road maintenance Group Guidelines District and Rural municipality rate of kaski F.Y.2075/76 .Based on the rate analysis rate of each item of maintenance activities were calculated which was helpful to calculate the cost required for all types of maintenance work required for selected roads as shown in Table 5.

Table 5. Total Budget Required for Maintenance

S.N	Code	Existing length (km)	Emergency (NPR)	Routine + Recurrent (NPR)	Specific (NPR)	Periodic (NPR)	Total (NPR)
	Total	31.60	283,116	4,998,802	11,107,581	34,258,464	50,647,962
1	A01	8.85	272,995	1,038,640	2,569,780	11,512,505	**15,393,920**
2	A02	6.10	-	1,355,231	1,820,714	9,071,026	**12,246,971**
3	A03	8.74	-	970,878	483,413	3,745,840	**5,200,131**
4	A04	6.11	10,121	1,234,149	5,721,935	8,404,563	**15,370,767**
5	A05	1.80	-	399,904	511,740	1,524,530	**2,436,174**

Total maintenance cost of each type of all road was presented graphically in fig 2 the data for this graphs was taken from table 5. Graph shows that among the total maintenance cost of each road periodic maintenance cost was higher than other type of maintenance works. Graphs also shows that that total estimated maintenance cost of all five roads is 50,647,962 out of which Naudanda-SarangkotRoad RoadRoad (A_{05}), have lowest cost NRs. 2,436,174 which is about 4.81% of total maintenance cost. Whereas Birethanti-Syaulibazar-Chane Road (A_{01}) has maximum maintenance cost of NRs. 15,393,920 which covers about 30.39% of total maintenance cost.Dhikurpokhari-Dharapani-Bhadaure road (A_{04}) required NRs. 15,370,767 about 30.34% of total budget. Similarly Naudanda-Serachaur-Saureni-Karkitahara road (A_{03}) requires NRs. 5,200,131 which is about 10.26% of total maintenancecost. Whereas, total estimated maintenance cost of Kande–Bhadaure road (A_{02}) have NRs. 12,246,971 which covers about 24.18 % of total maintenance budget. Finally Table 6 was developed for road selection.
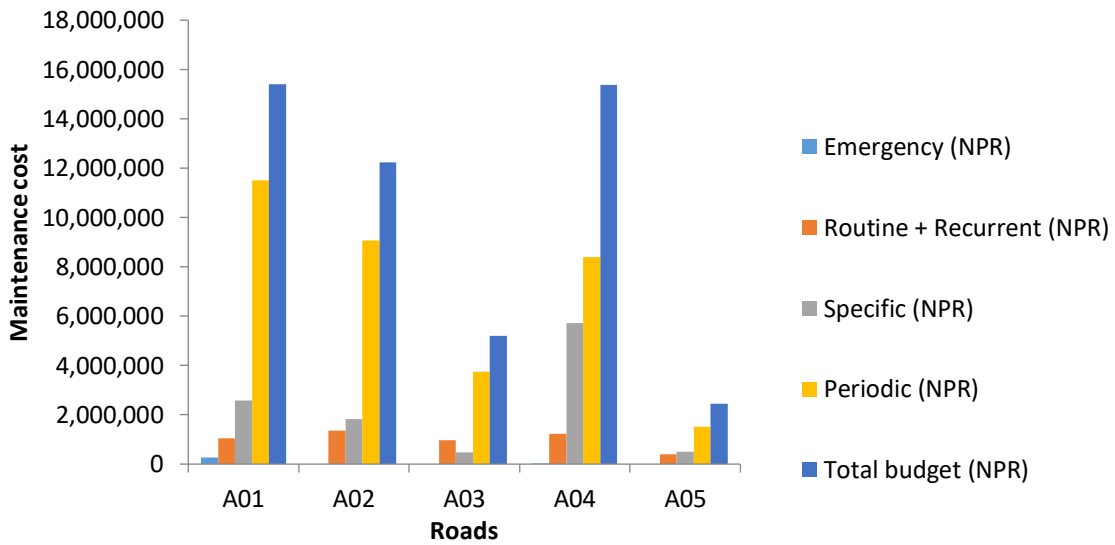

Figure 2. Total cost of maintenance

.**Table 6. Table for selection of road with priorities for maintenance**

S N	Code	Total Maintenance Cost (NPR)	Surface Type	Vehicle per Day	Road users Population No's	Ratio of Annul Maintenance Cost/Annual Vehicle	Remarks
	Total	50,647,962					Priority
1	A01	**15,393,920**	Gravel +earthen	218	4257	193.46	2nd
2	A02	**12,246,971**	Gravel	45	7617	745.62	3rd
3	A03	**5,200,131**	Earthen+ gravel	5	4219	2849.38	5th
4	A04	**15,370,767**	Gravel +earthen	24	7617	1754.65	4th
5	A05	**2,436,174**	Blacktopped	634	4430	10.52	1st

From the above Table 6 Naundanda-Sarangkot Road (A05) get the first priority of maintenance works considering the above mentioned factor i.e. road maintenance cost, road type, road users and traffic volume similarly others road alsogets the their priority based on theabove mentioned factors.

B. BudgetAllocation for Road Maintenance

Total budget for works (Pujitgat) of this municipality is 179 million out of which 160.5 million for road sector which about 89.66% of total budget. The allocated budget was sum of the budget by central government provincial government and local government under different condition. The total budget allocated for rural road sector only by Rural municipality in the Nepalese Fiscal Year 2076/2077 is about 39 million out of which budget allocation for maintenance purpose of road is only 0.65 million which is about only 1.66 % of total budget(9).From Figure3 it is clear that rural municipality gives less priority for road maintenance. Most of the budget allocated in road upgrading and track opening rather than maintenance.
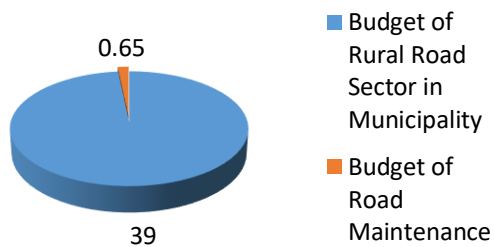

Figure 1 Budget Allocation for Upgrading and Maintenance by Rural Municipality

IV. CONCLUSION

This research is conducted to assess the condition, budget requirement, selection of road with priorities for maintenance, to find the gap between allocated budget and required budget for road maintenance of selected road in Annapurna Rural Municipality of Kaski District Nepal. The following conclusion is drawn from this research:

1. The existence of biggestgap between budget required and budget allocated for maintenance of rural roadin rural municipality

2. The priority of road selection plays a major role in determining which road will maintain.

3. The entire road network required periodic routine and specific maintenance budget for smooth flow of traffic in all weather in rural area. Among them Naudada-Sarangkot road (A_{05}) should get first priority for maintenance work.

In conclusion it is recommended to allocate the sufficient budget for maintenance as per requirement and prioritization.

ACKNOWLEDGEMENT

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