Maintenance Financing and Its Impact on Road Performance: A Case Study of Mugling-Narayanghat-Lothar Section, Nepal

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Abstract

Nepal's Strategic Road Network (SRN) forms the backbone of national connectivity and economic integration. By February 2024, Nepal's national road network come to 34,257 km, including 18,421 km of blacktopped roads, 7,697 km of gravel roads, and 8,139 km of earthen roads. The maintenance of roads continues to suffer from chronic underfunding and weak institutional management. This study aims to evaluate the allocation and sufficiency of funds for SRN maintenance, identify shortcomings, and suggest improvements focusing on the Mugling–Narayanghat–Lothar corridor under the Bharatpur Division Road Office. A mixed-method approach was employed, integrating secondary data from the Roads Board Nepal (RBN), Department of Roads (DoR), and Division Road Offices with Key Informant Interviews (KII) and Focus Group Discussions (FGD) involving engineers, financial officers, and experts. The findings reveal a significant fund deficit, with a shortfall of NRs. 77.73 billion (70.53%) in Strategic Road Network maintenance funding by FY 18/19, and a 51.59% deficit in the Mugling-Narayanghat-Lothar section between FY 13/14 and 17/18. The major challenges include insufficient budget allocation by the Ministry of Finance, improper distribution of revenue collected from road users, and the lack of a performance-based fund disbursement mechanism by the Road Board Nepal. The study recommends revising ARMP based on proper assessments and allocating funds equitably based on user charge contributions. Despite significant revenue generation from fuel levies and vehicle registration fees, only a small portion was allocated to RBN. Key challenges include limited budget allocation, incomplete transfer of road user revenues, manpower shortages, and reliance on traditional maintenance practices. The study recommends ensuring all revenues transfer to RBN, adopting the PBMC approach, integrating maintenance into life cycle cost planning, and establishing a research and development.

Keywords: *Fund Deficit, Maintenance Financing, Road Performance, Road User Revenues.*

Introduction

Road transport plays a dominant role in enhancing socio-economic activities and strengthening national integrity. The function of the Strategic Road Network (SRN) is to provide linkage and connectivity throughout the country. As reported, Nepal's national highway network plays a crucial role in the country's infrastructure and socio-economic development. By February 2024, Nepal's national road network totaled 34,257 km, including 18,421 km of blacktopped roads, 7,697 km of gravel roads, and 8,139 km of earthen roads (Economic Survey, 2023-24, MOF).

Major routes like the Pushpalal Highway and Kaligandaki Corridor experienced the longest closures, intensifying socio-economic impacts, including supply chain delays and hampered emergency responses. For instance, in 2024 alone, severe floods and landslides resulted in 814 highway closures across 41 national highways throughout the country. The BP Highway, a vital connection between Kathmandu and eastern Nepal, has been severely affected by flood-related hazards, leading to significant closures and extensive damage(Bist et al., 2025).

Failure to carry out road maintenance works at the right place and time can lead to serious consequences. One of the main causes of this problem is institutional issues, such as a weak institutional framework, lack of human resources and proper responsibilities, inefficient management structures, and an inadequate financing system (Heggie & Vickers, 1998). One important approach is the concept of commercialization, which involves operating road infrastructure on a fee-for-service basis and managing it with principles similar to those used in business. This approach aims to enhance accountability, sustainability, and efficiency in road service delivery (Gwilliam & Shalizi, 1999). Road maintenance interventions help to slow down the rate of deterioration, preventing complete failure of the pavement before it reaches the end of its design life (FHWA,1983).

Road deterioration is caused by the effects of the physical environment, traffic, material properties, quality of road construction, design standards, and the age of the pavement. (TRRL, 1993). Road

maintenance activities are categorized according to the frequency of operation (TRRL, 1981). Road maintenance involves minor activities undertaken on a routine basis and major activities undertaken on a periodic basis to eliminate pavement defects (Paterson, 1987).

Road management involves both technical and administrative efforts to keep roads in a condition. However, in many cases, public agencies that have the responsibility for maintaining road networks often lack a clear understanding of the road's actual asset value. As a result, road agencies tend to operate as a government unit, including planning, contracting, supervision, and maintenance. This approach often leads to inefficiencies, such as excessive staffing, weak oversight, and limited accountability. These structural issues not only hinder performance but also reduce the incentive for delivering quality maintenance services (Robinson et. al,1998). In Mozambique, Balcerac De Richecour & Heggie (1994) studied and found that direct disbursement of funds to road agencies was effective, conforming to strong control mechanisms and promoting the efficient use of public resources.

The government resources are often limited and insufficient to meet all the infrastructure development needs, particularly in the transport sector, where project typically requires substantial capital investments. An emerging approach may be road user charges, parking fees, to collect private investment in road maintenance. This funding model represents an original and potentially attractive proposal. While increasing the difficulty in relying solely on traditional public financing methods, the development of highway infrastructure through Public-Private Partnership (PPP) models is gaining prominence as a viable alternative(Obeng & Tuffour, 2020).

The study recommends developing road cut-slope design guidelines tailored to Nepal's geology and climate, using rigorous geotechnical or numerical methods. The guidelines must remain simple, user-friendly, and account for infiltration and groundwater despite limited investigation capability. This study also explains spoil-disposal practices and specifies stabilization measures where land acquisition is restricted. Comprehensive training for engineers, contractors, and workers nationwide is essential for effective implementation(Robson et al., 2025).

Landslide hazard mapping is essential in delineating landslide-prone areas and optimizing low-cost mitigation measures in mountainous regions. The analysis shows that geomorphological and human factors significantly influence slope-failure probability. A five-class hazard map helped identify key causative factors and relate them to failure mechanisms. Bioengineering measures such as vegetation and small civil structures are recommended as cost-effective solutions for shallow failures in Nepal. A mitigation map with fourteen classes of required stabilization measures was developed(Dahal & Dahal, 2017) .

The primary objective of this study is to evaluate the adequacy of funding allocated for the maintenance of the Strategic Road Network, identify existing gaps and limitations in current financing practices, and formulate evidence-based recommendations for improvement.

Road Maintenance Funding Mechanism

Various mechanisms for funding road maintenance are discussed in the following ways.

A. **The Budget Approach:** This involves road maintenance funding through government tax policies. It is applied from the view that road infrastructure assets are publicly-owned and should be funded through general taxation. It is commonly applied in developed countries, especially in Europe. Most Asian countries are however moving away from this system to other funding sources due to the following reasons as different sectors compete for limited Government budget, Tax payers are unwilling to tolerate continual increases in tax rates, Maintenance spending is usually deferred because the road deterioration process is not very visible in the short term and Increased road spending, which has made it impossible for road funds to be fully financed from government budgets (Heggie & Vickers, 1998).

B. **International Private Finance:** The introduction of private finance into infrastructure projects is seen as a new way to ease rising fiscal constraints for infrastructure investment. The modalities of its implementation vary depending on the functions given to the private sector, such as designing, constructing, operating, managing, financing, and maintaining the ownership of the asset. Many different terms are used for private financed road projects. These include the concept of build, own, operate and

transfer (BOOT) or build operate and transfer (BOT) in which the private sector finances, designs, builds, maintains and operates a facility for a fixed term before transferring it to the owner.

C. **Private-Public Partnerships (PPP):** With the PPP, the Government introduces the private sector investor into road maintenance by putting their own capital at risk. This is because of private sector management efficiencies which are not fully replicated in the public sector. The private sector is contracted to deliver road maintenance according to the form of specified output.

D. **International Financing Institutions:** This relates to funding from multilateral and bilateral financing institutions referred to as donor agencies. This process is normally arranged through a formal agreement between the host government, aid donors and officials of the road sector. The donors may be interested in a particular area of the country, a particular road or wish to give general institutional support for maintenance or planning. Robinson et al, (1998), indicated that donor support for road maintenance funding had been dwindling in most developing countries over the years.

E. **Tariff Setting for Road User Charges (RUC):** A fair and equitable RUC is based on charging individual vehicles for the actual cost of the road use. The tariff is set by the standard market model of demand and supply.

F. **Funding Mechanism in Nepal**: For the Nepalese context, Road Board Nepal (RBN) is an autonomous organization established under the Road Board Act 2002. RBN is dedicated to providing sustainable funds for the planned maintenance of roads. RBN collects road user fees and manages the road fund by prioritizing need-based allocations to road agencies for maintenance. RBN could receive funds mainly from only three sources, which are road user charges, fuel levy on diesel and petrol used by vehicles, and vehicle registration fees(Road Board Nepal, 2079/80).The annual budget is managed by the fuel levy and the vehicle registration fee, reflected in the government's red book. The road user fee is generally collected by the private contractor on the highest evaluated bidding basis. This tax collection from six roads was stopped a few years back from the Covid-19 pandemic, and now these roads are in the upgradation stage. It is planned to establish after the upgradation has been completed.

Funding Challenges and Maintenance Practices in Nepal's Road Sector

In Nepal, road maintenance funding and practice have long been molded by the Department of Roads (DoR), primarily through the Strengthened Maintenance Divisions Program (SMDP) introduced in the 1990s, which institutionalized routine, recurrent, periodic, and emergency maintenance supported by the Annual Road Maintenance Plan (ARMP). Despite these planned mechanisms, maintenance has faced chronic underfunding, with the Priority Investment Plan (2007–2016) estimating a need of Rs. 31.2 billion for maintenance. To address inefficiencies, Performance-Based Maintenance Contracts (PBMC) were introduced in 2003 with donor support, aiming to link payments to service quality. Although PBMCs offered up to 54% cost savings compared to SMDP, their impact was limited by weak contractor performance, poor enforcement, backlog maintenance, and overloaded traffic. Consequently, road conditions frequently failed to meet performance standards, indicating the need for stronger institutional capacity, realistic contracts, and sustainable funding (Mulmi, 2016).

Balancing SMDP and PBMC Approaches for Cost-Quality Road Maintenance

A balanced maintenance practice that combines the strengths of both the Strengthened Maintenance Division Program (SMDP) and the Performance-Based Maintenance Contracting (PBMC) approach is considered appropriate for optimizing cost and quality. To achieve this, SMDP should be upgraded to align with PBMC standards, particularly by enhancing the capacity of length workers to carry out routine maintenance, pavement repairs, and intervention-based works at the required performance level. A one-year contract mechanism is suggested, covering the regular cyclic activities before and after the monsoon season, and payments should be made on an item-rate basis but linked to PBMC-level performance standards. Instead of directly adopting a four-year PBMC contract, which carries higher risks of disputes and claims, it is recommended to introduce the PBMC model gradually, beginning with one-year contracts and progressively extending to multi-year agreements(Dawadi et al., 2022).

Materials and Methods

This study was conducted for the detailed investigation of the fund provision system in road maintenance of SRN. Data collection was carried out, which consists of both primary and secondary data related to the funds flow for maintenance of SRN and for the Mugling-Narayanghat-Lothar Road from the RBN, DoR Maintenance Branch, and DRO Bharatpur. Analysis of the collected data is required to find the result. Quantitative analysis of data is performed with simple arithmetic calculations.

Study Area

The study area covers all the SRNs of Nepal for an overview of the fund provision system and its sufficiency as per the requirements for maintenance needs. Mugling-Narayanghat and Narayanghat-Lothar road corridors under the Bharatpur Divisional Road Office were studied in detail according to the budget compliance of road maintenance needs. The Mugling–Narayanghat–Lothar corridor is a critical segment of the East-West Highway and a gateway linking Kathmandu with southern Nepal, India, and major trade routes. The area was selected due to high traffic volumes and freight movements, significant hazard exposure, heavy reliance on SRN for national connectivity, and documented maintenance challenges.

Data Collection

The data collection method for this research is considered a mixed approach. Primary data collection, KII (Key Informant Interview), and FGD (Focus Group Discussion) were used as qualitative methods to collect expert insight from stakeholders. The responses were then quantified through ranking and frequency analysis for comparative evaluation. The secondary data collection from the government website and official records was considered a quantitative method.

Primary Data

The primary data for the study were taken from the KII (key informant Interview) and FGD (focus group discussion). The KII were taken with the officials of RBN, officials of DoR, officials of Division Road Offices and Transportation Experts who are directly involved in road maintenance, and FGD were done at the office of RBN, DoR, DRO Bharatpur, and Kathmandu.

Secondary Data

The secondary data were collected from official records, annual reports, and websites of Road Board Nepal, the Department of Road, and the Division Road Office Bharatpur. The secondary data sources are presented in Table 1.

Table 1 Secondary Data Used from Various Available Sources

SD from	Types of data	Data used for
Roads Board Nepal	a. Integrated Action Plan (IAP) b. Integrated Annual Road Maintenance Plans (IARMPs) c. Road Toll tax rate and tax collection d. Budget disbursement and expenditure by RAs	a. Analysis of the road maintenance fund of SRN b. Finding the Funding gap of SRN.
Department of Roads (DoR)	a. Road infrastructure and maintenance data	a. Analysis of the road maintenance fund of SRN
Division Road Office (DRO), Bharatpur and Kathmandu	a. ARMPs b. Annual plan and progress report c. Financial data from the account section	b. Finding the Funding gap of the Mugling-Narayanghat-Lothar road corridor.

Methods of Data Collection

Key Informant Interviews

KII were conducted with selected respondents. The researcher used two types of interviews, personal interviews and telephone interviews. Personal Interview was a method of data collection which involves presentation of oral-verbal stimuli and reply in terms of oral–verbal responses (Kothari, 2004). By the KII method, altogether nine officials and experts of the transport sector responded to the subject matter and presented in Table 2.

Table 2 Respondents for KII

Respondents From	Respondents Designation	No of Respondents
RBN	Technical Director, Senior Engineer, Account Officer	4
DOR/DROs	Senior Divisional Engineers and Account Officer	3
Consulting Engineers	Transportation Experts	2
Total		9

Focus Group Discussions

Four focus group discussions were conducted to the officials of RBN, DoR, DRO Bharatpur, and DRO Kathmandu for the road maintenance fund, its sufficiency, problems for implementation, and ways to solve the problems. There were 24 participants in four FGDs, where participants were the Technical Director, Engineers, financial officers of RBN, Senior Divisional Engineer (SDE), Engineers, Sub-Engineers, and Accountants of DoR/DRO Bharatpur and Kathmandu. FGDs were carried out to gather stakeholders' information, opinions, and thoughts.

Data Analysis

The secondary data collected was utilized to determine the budget deficiency and funding gap for the maintenance of SRN with the help of simple arithmetic calculations in Microsoft Excel, whereas KII was performed with nine professionals of RBN, DoR, DROs, and transportation experts. A total of nine stakeholders were interviewed, and based on the frequency of the factors, the common factors that repeated frequently by the key informants were noted and ranked with the weightage gained for the existing problems and solutions for the maintenance of SRN. The frequency factors are also determined by simple arithmetic calculations with the help of Microsoft Excel.

Results and Discussion

Analysis of the Fund Flow for the Maintenance of SRN

A detailed analysis of the IARMP (Integrated Annual Road Maintenance Plan) of the last ten years (2009/10-2018/19) was done to determine the condition of fund flow for the maintenance of the SRN of Nepal. The status of yearly fund flow to all the DROs throughout the country from RBN, according to the planned maintenance strategy for the maintenance of SRN, including bridge maintenance, was determined. The total need versus allocated and the fund gap are shown in Table 3.

Table 3Annual Maintenance Needs and Allocated Fund of SRN

Fiscal Year	Road under maintenance km	Total Divisional Need Identified in all SRN, Rs. '000	Total Disbursement of Budget Rs '000	Annual Budget Deficit in all SRN, Rs. '000	Annual Budget Deficit in all SRN %
2009/10	4,586.00	5,282,426.00	1,878,000.00	3,404,426.00	64.45
2010/11	5,909.00	7,051,275.00	2,411,989.00	4,639,286.00	65.79
2011/12	6,574.00	7,992,385.00	2,610,000.00	5,382,385.00	67.34
2012/13	7,758.00	8,300,049.00	2,712,987.00	5,587,062.00	67.31
2013/14	8,194.00	7,760,928.00	3,638,660.00	4,122,268.00	53.12
2014/15	8,909.00	10,398,509.00	3,697,546.00	6,700,963.00	64.44

2015/16	9,100.00	12,134,696.00	3,713,000.00	8,421,696.00	69.40
2016/17	9,423.00	16,776,693.00	3,714,633.50	13,062,059.50	77.86
2017/18	11,317.41	16,186,286.00	3,098,840.00	13,087,446.00	80.86
2018/19	13,447.62	18,317,329.00	4,995,559.00	13,321,770.00	72.73
Total		110,200,576.00	32,471,214.50	77,729,361.50	70.53

(Source: Road Board Nepal, 2018)

The study determined that the total deficit budget till FY2018/19 for road maintenance was NRs. 77,729,361,500 (Rupees Seventy-Seven Billion Seven Hundred Twenty-Nine Million Three Hundred Sixty-One Thousand and Five Hundred Only). The annual maintenance fund for maintenance of SRN was in deficit from a minimum of 53.12% to a maximum of 80.86%. The average annual budget deficiency is NRs. 7,772,936,150.00 (Rupees Seven Billion Seven Hundred Seventy-Two Million Nine Hundred Thirty-Six Thousand and One Hundred Fifty Only). The total average percentage of per year deficit budget for road maintenance is 70.53%. This condition of the fund gap is shown in a bar chart in Figure 1.

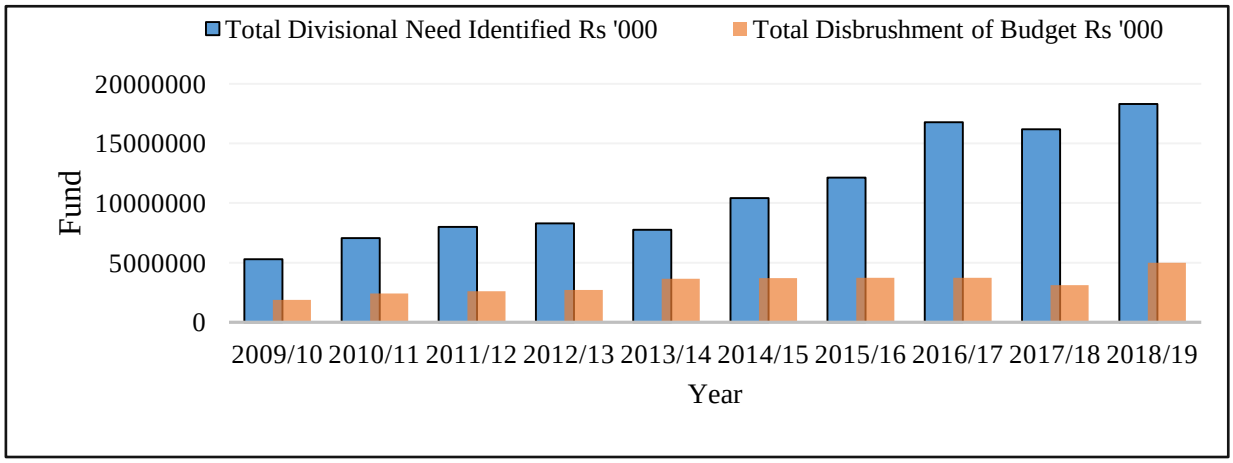
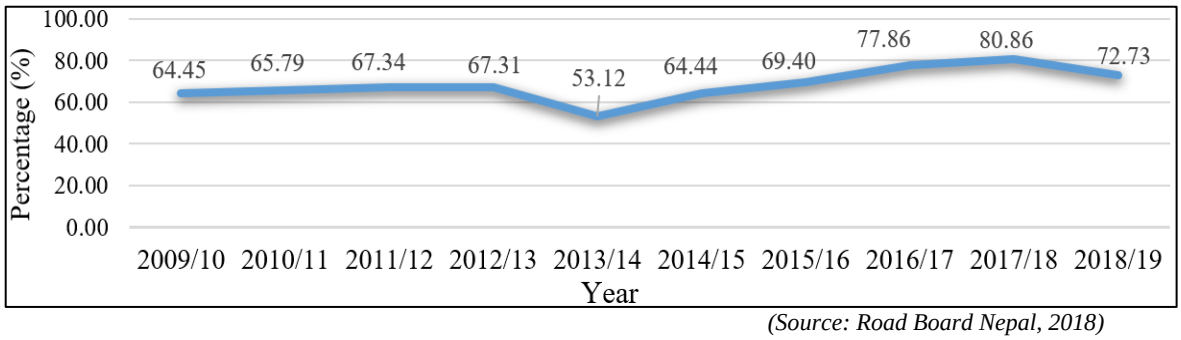


Figure 1: Annual Maintenance Needs and Allocated Fund (Source: Road Board Nepal, 2018)

As shown in Figure 1. the needs of yearly road maintenance budget increase at a very high rate, and the provision of maintenance funds at a lower rate than the need. This fund deficiency was calculated as a percentage, and the percentage gap is shown in Figure 2. This shows the budget flow is imbalanced and irregular, and insufficient. The lowest value of the budget deficit is 53.12% and the highest deficit is 80.86%.



(Source: Road Board Nepal, 2018)

Figure 2: Annual Maintenance Fund Deficit

In FY 2009/10, the maintenance fund deficiency was 64.45%, increasing to 67.34% by 2011/12. From FY 2012/13, the gap slightly decreased, reaching 53.12% in FY 2013/14 with a fund provision of NRs. 3.64 billion. However, in FY 2014/15, despite an increase in maintenance funds to NRs. 3.70 billion, the gap widened to 64.44% due to higher maintenance needs. The gap continued to rise up to a peak of

80.86% in FY 2017/18, after that slightly dropping to 72.73% in FY 2018/19. The average fund gap was 68.33%. Although the maintenance funds increased annually, the need for maintenance increases at a higher rate.

The total revenue generated by the Department of Transport Management (DoTM) and Nepal Oil Corporation(NOC), which can be allocated for road maintenance in that period, to the optimal amount of NRs. 115,016,309,980.00, but the total allocation from the Government was only NRs. 28,838,205,000.00, and unallocated revenue is NRs. 86,178,104,980.00. If allocated to the optimal level, there will be a surplus amount of NRs. 8,448,743,480.00 after utilization of the overall road maintenance of SRN. The details of the revenue generated, budget allocated to RBN, and unallocated revenue are shown in Table 4.

Table 4: Revenue Generation and Allocation by Government of Nepal

F.Y.	DoTM NRs. '000	NOC NRs '000	Total NRs. '000	Allocated to RBN NRs. '000	Allocated %
2003/04	149526.04	199138.72	348664.76	220000.00	63.10
04/05	151909.12	225825.79	377734.91	362800.00	96.05
05/06	168070.53	227451.00	395521.53	330000.00	83.43
06/07	250507.01	247029.02	497536.02	390000.00	78.39
07/08	444147.98	499514.00	943661.98	760000.00	80.54
08/09	688439.21	741108.02	1429547.22	664500.00	46.48
09/10	1458640.92	926556.00	2385196.92	1314500.00	55.11
10/11	4612145.47	1758821.36	6370966.83	2518000.00	39.52
11/12	5089462.29	2097860.20	7187322.49	2768000.00	38.51
12/13	6668249.05	2332714.90	9000963.95	2573700.00	28.59
13/14	7625457.83	2616719.40	10242177.23	4000000.00	39.05
14/15	11036814.48	2991057.74	14027872.22	4238646.00	30.22
15/16	12512837.00	2467697.94	14980534.94	4374154.00	29.20
16/17	17328609.00	29500000.00	46828609.00	4323905.00	9.23
Total	68184815.90	46831494.08	115016309.98	28838205.00	

(Source: Road Board Nepal, 2019)

The above Table 4 shows that the revenue generation is increasing rapidly but the allocation of revenue to road maintenance is decreasing at a rapid rate. The allocation percentage of FY 2016/2017 was only 9.23%. In 2019, estimated annual needs were about USD 495 million, yet allocations covered only a fraction, with RBN recording a significant gap. By 2020–2021, COVID-19 further constrained revenues, reducing toll income from USD 2.4 million in 2019–2020 to just USD 0.03 million in 2022–2023, cutting an important additional source. In 2021–2022, allocations improved slightly, with RBN receiving approximately NPR 6.9 billion (USD 58.3 million), but this still met less than 15% of the needs. For 2022–2023, total allocations reached USD 89.9 million (including World Bank funds), covering only 18% of the USD 495 million required. Within this, the national highway network received approximately USD 72 million (60% of its needs), while provincial and local roads received just USD 17.5 million, which is barely 5% of their needs. Overall, Nepal faces a persistent annual funding deficit of more than USD 400 million, demonstrating a widening gap between identified needs and actual financing (Cartier Van Dissel & Anyala, 2024).

Assessment of Maintenance Fund for Mugling-Narayanghat-Lothar Road

The study of maintenance budget allocated and expenditure record received from the account section of DRO Bharatpur and RBN of the last five years (2013/14 to 2017/18), study of ARMP, and yearly progress report determined that the annual maintenance fund flow condition and gap of the resources of Mugling-Narayanghat and Lothar-Narayanghat roads. The maintenance fund analysis for the Mugling–Narayanghat–Lothar Road in combine from FY 2013/14 to 2017/18 reveals a significant budget gap. Overall, over a five-year period, the total budget needed was NPR 679.57 million, while only NPR 272.80 million was allocated, resulting in a gap of NPR 406.76 million or 59.85%. The highest annual gap occurred in FY 2014/15 with 70.88%, followed by FY 2016/17 with 73.59%, and FY 2017/18 with

84.90% as shown in Figure 3. These figures highlight a consistent underfunding trend, severely impacting maintenance efforts. While some years show full funding for specific road sections, the overall pattern reflects inadequate financial support, leading to compromised road quality and sustainability.

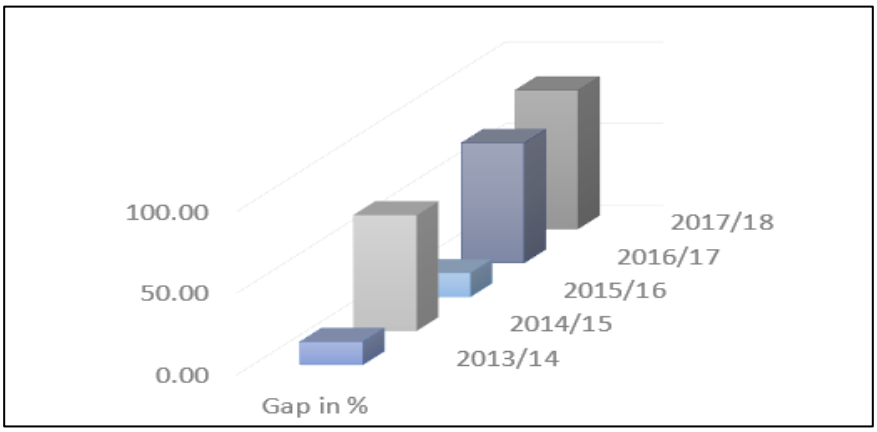


Figure 3 Fund Gap in Mugling-Narayanghat-Lothar Road

The fund gap percentage varied from 14.10% minimum to 84.90% and the average deficit of funds was 51.59%. The annual road maintenance fund flow in the Mugling-Narayanghat-Lothar Road was irregular, insufficient, and with a highly swinging pattern. This shows that the assessment of the need for a budget by the Government sector was not practical and was not justifiable.

Response Analysis from the KII Perspective

KII was carried out with the stakeholders of RBN, DoR, DROs, transportation experts, and the findings were ranked and presented in Table 5. A total of nine stakeholders were interviewed, and based on the frequency of the factors, here are the common factors that are existing problems and solutions for the maintenance of SRN. The ranking of the problems and corresponding responses are presented in Table 5 and Figure 4, respectively.

Table 5: Ranking of the Existing Problems in Road Maintenance as per KII

Problems Faced by the Organization for Road Maintenance	Rank
1. The government focuses on new road construction rather than road maintenance	2
2. Existing road maintenance budget and work done follow the traditional system	6
3. Insufficient budget provided by the Ministry of Finance (MoF) for road maintenance.	1
4. Maintenance works are not a priority for Road Agencies (RAs)	5
5. Backlog maintenance increases yearly	4
6. Revenue obtained from the fuel tax and vehicle registration charges is not fully allocated to the RBN.	1
7. Manpower for the monitoring and supervision is insufficient	3
8. Immature contractors and technical manpower involved in specialized maintenance works	8
9. Maintenance contractors have not seriously implemented the road maintenance works	7
10. Others	9

Key Informant Interviews (KII) revealed major issues in SRN road maintenance and management. A full 100% of respondents indicated that the budget provided by the Ministry of Finance is insufficient, and fuel tax and vehicle registration revenues are not fully transferred to RBN accounts. 88.88% noted the government's focus on new road construction over maintenance. Insufficient manpower for monitoring was highlighted by 77.78%, and 66.66% mentioned increasing backlog maintenance due to a lack of periodic funding. Other issues included low maintenance priority (55.56%), reliance on

traditional practices (44.44%), weak contractor performance (33.33%), and inexperienced technical personnel (22.22%). The output of the responses from KII is shown in Figure 4.

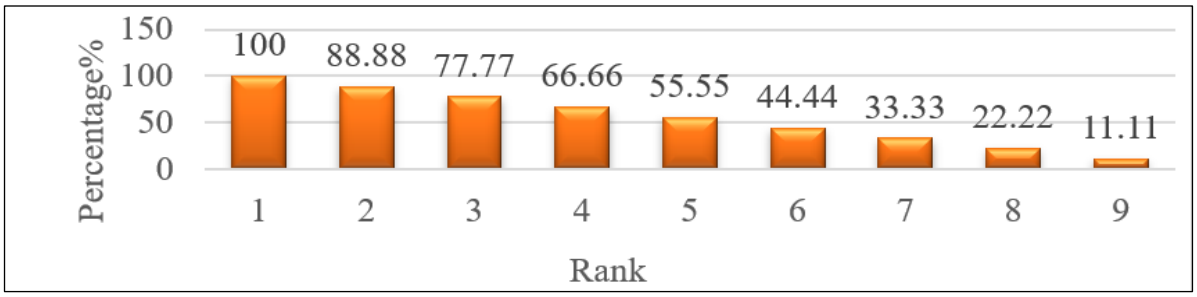


Figure 4 Response from the KII

Response Analysis from FGD Perspective

The Focus Group Discussion reveals numerous challenges in maintaining the road network effectively. The Government focuses on new road construction, but the budget is insufficient, and the traditional methods of construction are recorded as major issues. Roads continue to deteriorate due to the lack of funds, causing difficulties for road users, as potholes are increasing rapidly. Backlog maintenance is growing each year, and revenue from fuel tax and vehicle registration is not fully transferred to RBN. Additionally, there is insufficient manpower for proper monitoring and supervision, and road maintenance works are often categorized as minor works, resulting in less attention.

As a solution, several measures are recommended. Collected revenue should be sufficiently allocated to RBN for road maintenance; sufficient budgets, along with enough human resources, are essential for ensuring quality work. Expanding toll roads with an automated electronic toll collection system can help strengthen the user-pay system. Scientific approaches should be applied to manage fuel tax revenues, and the Government must provide collected funds to RBN according to the RBN Act. Maintenance should shift to a Performance-Based Maintenance Contract (PBMC) system with necessary improvements from the previous one, while trained manpower and experienced contractors are crucial for effective supervision and implementation.

Similarly, a major problem is a lack of a sufficient maintenance budget, leading to delays and neglect in works by the Department of Roads (DoR). There is a large backlog in periodic maintenance, and often, adequate design standards are not followed. The shortage of maintenance engineers has overloaded existing staff. Additionally, the Ministry of Finance (MoF) is not providing adequate revenue to the Road Board Nepal (RBN). Routine maintenance is hampered by inefficient length workers, unprofessional contractors, and delays that disrupt the maintenance cycle. To address the above-identified problems, several solutions are proposed. The Ministry of Finance should allocate sufficient revenue to RBN, and adequate manpower must be ensured for maintaining quality. Regular road maintenance training should be provided to technical personnel, and a Research and Development (R&D) branch should be established. Road Agencies (RAs) must be more actively involved, the maintenance division should be strengthened, and scientific methods should be adopted for tolling systems. Furthermore, although road maintenance requires specialized skills, inexperienced contractors are involved due to the Public Procurement Act (PPA) and Regulation (PPR), often compromising the quality of work.

Possible solutions to the problems include recognizing the maintenance budget as a major investment and integrating it as a key part of the entire asset management cycle. Maintenance works should be prioritized carefully to ensure optimum use of available funds. Specialized and fully mechanized techniques must be used to enhance the quality and efficiency of maintenance activities. Additionally, budget estimation should be incorporated during the design phase as part of the lifecycle cost planning.

The organization is facing several critical problems affecting its road maintenance efforts. Government funding prioritizes new road construction over maintenance, leading to increased potholes and higher repair costs. A shortage of maintenance budgets further hampers effective management. Small, time-consuming maintenance works are often neglected, and there is a growing backlog of periodic maintenance tasks. The lack of maintenance engineers results in overburdened existing staff, reducing efficiency. Additionally, the Ministry of Finance is not providing adequate collected revenue to the Road Board Nepal, worsening financial constraints and making it difficult to maintain road quality and safety standards.

The MOF should provide sufficient dedicated revenue to the RBN and ensure a timely budget flow for maintenance activities. Adequate manpower must be dedicated to improving the quality of maintenance works, supported by regular road maintenance training for technical personnel. Additionally, developing an efficient automated electronic toll collection system and managing backlog maintenance timely and properly are crucial steps forward. The problems with funding in road maintenance in SRN are obtained from the KII and FGD are approximately similar. Therefore, it shows that the results from the KII and FGD help to validate the findings from the secondary data analysis. From the combination of the KII and FGD performed in the office of the Road Board Nepal, DoR, and DROs to find out the problems in funding and implementation of road maintenance, the major problems found are summarized in Table 6.

Table 6 Road Maintenance Related Problems

S.N.	Identified Problems
1	Insufficient budget provided by the MoF for road maintenance.
2	Revenue obtained from the fuel tax and vehicle registration charges is not fully allocated to RBN.
3	The government focuses on the new road construction rather than road maintenance
4	Manpower for the monitoring and supervision is insufficient
5	Backlog maintenance increases yearly
6	Maintenance works are not a priority for RAs
7	Existing road maintenance budget and work done follow the traditional system
8	Most of the contractors in road maintenance are not seriously involved in the maintenance works
9	Immature contractors and technical manpower involved in specialized maintenance works
10	Potholes number, size are an increasing rate, and therefore, road users face problems
11	Maintenance of roads is a specialized work, but it involves a new contractor
12	The maintenance budget is not taken as a major investment.
13	Negligence in road maintenance due to small but time-consuming work.

(KII & FGD, 2019)

The possible solutions for the problems of road maintenance as suggested from KII and FGD, are summarized in Table 7.

Table 7 Possible Solution for Road Maintenance Problem

S.N.	Solution for Road Maintenance Problems
1	Revenue obtained from the fuel tax and vehicle registration charges should be fully transfer to RBN account and implement it on road maintenance.
2	Maintenance system should be transformed to a Performance-Based Maintenance Contract (PBMC) with modification of the previous weaknesses.
3	Government must focus in the road maintenance than road construction by the policy and funding level
4	Manpower for the monitoring and supervision should be sufficient with properly trained and experienced.
5	Sufficient budget management, timely planning and implementation for backlog maintenance is essential
6	Maintenance works must be in a priority of RAs
7	Existing road maintenance budget and working methodology should be scientific, innovative and fully mechanized.
8	Immature contractors and technical manpower should be properly guided for the specialized maintenance works

9	Increase in toll roads with an upgraded to an automated electronic tolling facility.
10	Other sources of revenue should be expedited for road maintenance.
11	Fund allocation from RBN should be based on the commercialization value of the road, as high value should be given to roads of high-volume traffic flow.
12	Estimation and planning of maintenance at the time of design period of road for construction/upgrading the part of the lifecycle cost
13	Establishment of the Research and Development (R and D) branch for an effective road maintenance.

(KII & FGD, 2019)

Conclusion

The analysis of maintenance financing for Nepal's Strategic Road Network (SRN) shows a persistent and significant funding gap. Over the past ten years (FY 2009/10–2018/19), RBN's allocations based on the IARMP covered only a small portion of actual need, resulting in an average deficit of 70.53%. The consistency of this gap indicates long-standing issues in the assessment and financing of maintenance needs, reflected in growing backlog maintenance. Despite high revenue generation from fuel levies and vehicle registration fees, only a limited share is transferred to RBN. As a result, maintenance financing is not aligned with a true user-pay system. The case study of the Mugling–Narayanghat–Lothar section further illustrates the problem: irregular, insufficient, and fluctuating budget allocations, failing to meet maintenance needs despite high traffic volumes and correspondingly high fuel consumption. Institutional challenges such as insufficient budget transfer from the MoF, incomplete allocation of road user revenues, and inadequate qualified manpower further constrain effective maintenance. These issues collectively weaken the ability of RBN and DoR to deliver planned, timely, and quality maintenance across the SRN.

Recommendation

Based on the findings, it is recommended that maintenance financing for Nepal's Strategic Road Network be aligned with the IARMP to ensure adequate and planned funding for routine, recurrent, periodic, and backlog maintenance. Priority corridors such as the Mugling–Narayanghat–Lothar section require focused investment, as persistent underfunding accelerates pavement deterioration and increases long-term lifecycle costs. Adopting a user-pay and business-oriented management approach, supported by lifecycle-based budgeting and timely interventions, can improve the sustainability and reliability of road services. Furthermore, maintenance budget allocation should be linked to measurable indicators, including fuel consumption as a proxy for traffic volume, road condition parameters such as IRI, and the strategic importance of each road section, enabling transparent and equitable fund distribution. Strengthening institutional capacity, particularly through enhanced monitoring, supervision, manpower, and the establishment of a research and development unit within the Road Board Nepal, is essential. Additionally, the adoption of standard maintenance practices, especially the PBMC approach, must be supported by ensuring that fuel levy and vehicle registration revenues dedicated to maintenance are transferred adequately to the Road Board Nepal.

Conflict of Interest

Authors declare no conflict of interest.

References

Bist, T. C., Tiwari, H., & Negi, C. S. (2025). National highway disruptions and their effects: A case study of the 2024 monsoon season in Nepal. *Journal of UTEC Engineering Management, 3*(1), 37–52. https://doi.org/10.3126/juem.v3i1.84816

Cartier Van Dissel, S., & Anyala, M. (2024). *Road maintenance financing and cost recovery options: The future of road user revenues in developing Asia and the Pacific* (SDWP No. 100). Asian Development Bank.

Dahal, B. K., & Dahal, R. K. (2017). Landslide hazard map: Tool for optimization of low-cost mitigation. *Geoenvironmental Disasters, 4*(1), Article 7. https://doi.org/10.1186/s40677-017-0071-3

Dawadi, A., Shrestha, S. K., & Giri, O. P. (2022). Road maintenance practices in Nepal: A case study of the Malekhu–Mugling road section. *Advances in Engineering and Technology: An International Journal, 2*(1), 59–67. https://doi.org/10.3126/aet.v2i01.50444

Department of Roads. (2017). *Integrated annual road maintenance plan (IARMP) 2017/2018*. Government of Nepal, Ministry of Physical Infrastructure and Transport.

Department of Roads. (2021). *Road statistics 2020/21*. Government of Nepal, Ministry of Physical Infrastructure and Transport.

Federal Highway Administration. (1983). *Pavement management system: Pavement deterioration and optimal maintenance*. U.S. Department of Transportation.

Gwilliam, K., & Shalizi, Z. (1999). Road funds, user charges, and taxes. *World Bank Research Observer, 14*(2), 159–185.

Heggie, I. G., & Vickers, P. (1998). *Commercial management and financing of roads* (World Bank Technical Paper No. 409). World Bank.

Kothari, C. R. (2004). *Research methodology: Methods and techniques* (2nd ed.). New Age International.

Ministry of Finance. (2024). *Economic survey 2080/81*. Government of Nepal.

Mulmi, A. D. (2016). Assessment of performance-based road maintenance practices in Nepal. *Open Journal of Civil Engineering, 6*(2), 225–241. https://doi.org/10.4236/ojce.2016.62021

Obeng, D. A., & Tuffour, Y. A. (2020). Prospects of alternative funding sourcing for the maintenance of road networks in developing countries. *Transportation Research Interdisciplinary Perspectives, 8*, Article 100225. https://doi.org/10.1016/j.trip.2020.100225

Paterson, W. D. O. (1987). *Road deterioration and maintenance effects*. Johns Hopkins University Press.

Richecour, A. B., & Heggie, I. G. (1994). *Review of African road funds: What works and why* (SSATP Working Paper No. 14). World Bank.

Robinson, R., Danielson, U., & Snaith, M. (1998). *Road maintenance management: Concepts and systems*. Macmillan Press.

Robson, E. B., Dahal, B. K., & Toll, D. G. (2025). A participatory approach to determine the use of road cut slope design guidelines in Nepal to lessen landslides. *Natural Hazards and Earth System Sciences, 25*(3), 949–973. https://doi.org/10.5194/nhess-25-949-2025

Road Board Nepal. (2012–2017). *Business plan of Roads Board Nepal*. Kathmandu, Nepal.

Road Board Nepal. (2023). *Annual progress report 2079/80*. https://rbn.gov.np

Transport and Road Research Laboratory. (1981). *Maintenance management for district engineers* (Road Note No. 1). Overseas Unit.

Transport and Road Research Laboratory. (1993). *A guide to the structural design of bitumen-surfaced roads in tropical and subtropical countries* (Road Note No. 31). Overseas Unit.