

## STUDY ON EFFECTIVENESS OF COMBINED MAINTENANCE IN STRATEGIC ROADS NETWORK IN KATHMANDU VALLEY OF NEPAL

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### **Abstract:**

This study was conducted during the period from January 2019 to July 2019. The questionnaire survey, field observation, in-depth interview, and focus group discussion tools were used in the study. The study found that the mean of regular maintenance work as 3.22 which is slightly higher than fair value. It indicates work carried out is just sufficient as per road engineers. Mean of regular maintenance job worked out 1.90 lies between the good and very good. As per regular road users, overall regular maintenance work carried out thus is found satisfactory. Evaluating the response of both 'regular road users' and 'road engineers', overall regular maintenance works performance is fair only and that should be improved. The overall reactive maintenance response from road engineers is 3.34 slightly more but very near to fair value. It indicates that overall reactive/recurrent maintenance work is found acceptable. The response evaluation regarding reactive maintenance is 2.16 slightly more than poor but less than good as per 'regular road users'. Evaluating both 'Road engineers' and 'Regular Road Users' responses, reactive maintenance work has found fair in condition and thus it needs improvement. Regular maintenance workers training provided by the Division Road Offices once in year is found to be deficient for carrying out effective maintenance activities. 'Length Workers' and their supervisors are looking up for more trainings. The study would like to suggest that the separate and special branch of maintenance division should be established to conduct and regulate the maintenance work. In addition to this, workers should be in sufficient numbers as specified by the Department of Road Norms in rainy as well as in dry season.

**Keywords-** Strategic roads network, regular maintenance, reactive maintenance, strengthened maintenance divisions program, annual road maintenance program

### I. INTRODUCTION

Roadway is one of the major components of the nation, which makes a vital contribution to overall economic and social development in any country. Well- designed and maintained road decreases of vehicle operation cost, road accident rates and constrain of mobility [1]. After the Second World War, transport planning, management and maintenance was based on modernization pattern, and afterward it happened the agenda of industrialized society, set the pace for accelerated investment in road infrastructure development [2].

The Highway Design and Maintenance Standards Model (HDM-III), developed by the World Bank has been used for over two decades to combine technical

and economic appraisals of road investment projects, and to analyze strategies and standards. An international study has been carried out to extend the scope of the HDM-III model, and to provide a harmonized systems approach to road maintenance and management, with adaptable and user-friendly software tools. This has resulted in the development of the Highway Development and Management Tool "HDM-4" [3].

Road accessibility study has shown that currently about 35 percent of people are outside the minimum accessibility (two hours in the Terai and four hour in the hills) from the nearest road head [4]. Despite that Nepal's rural road network grew by an annual of 11 percent, the country's road network and density is the lowest in the region. Nepal has a very low road density of 6.39 Km per 10 Sq. Km. thus indicating poor accessibility to various parts of the country especially in hilly and mountainous region of the country. Even though there has been some progress especially since 1990, the level of progress has been uneven. The connectivity of roads in the mid-western and far-western regions of the country has been far less than in the eastern and central regions [5].

The first long-term planning (twenty-year highway plan) was introduced in late sixties and subsequently nationwide economic and technical feasibility for roads was conducted under the assistance of United Nations Development Program. In the twenty-year highway plan the concept of East West Highway developed in early sixties was integrated with several north-south roads visualized by the Road Transport Organization (RTO). This plan had given thought to some extent towards prevailing regional and geo-political situation. The decade of 1960-1970 witnessed a considerable expansion in road network with significant assistance from bilateral donor and governments like People's Republic of China, India, USA, UK, and the former USSR [6].

With the increase in length of road, Government of Nepal (GON) decided to establish one separate body to construct and maintain the road surface. As a result

government split Public Works Department (PWD) into two separate departments namely Department of Roads (DOR) and Department of Building in 2027 B.S [7].

The increase in the road length was successively planned and implemented through planning in successive national plans since 1951. The Ninth Plan (1997-2002) was committed to complete the road construction and rehabilitation works as well as extends the strategic road network to connect 5 regional headquarters. At that time, DOR felt a separate institution for the efficient maintenance system and the Strengthened Maintenance Division (SMD) was formed. Still overall management of National Highways and Feeder Roads comes within the jurisdiction of the DOR. These roads are collectively called Strategic Roads Network (SRN) roads [8].

The maintenance activities of the strategic roads are carried out through 34 Divisions under the Maintenance Branch. Planned Maintenance activities which have been initiated in support of SMD is use for planning the Year Maintenance program. Each of the Division Prepared the Annual Road Maintenance Plan(ARMP) (which consists of Maintenance in terms of the separate head like Routine/Regular, Recurrent/Reactive, Specific and the Periodic Maintenance), which is integrated to Develop the Integrated Annual Road Maintenance Plan (IARMP) of the Department of Roads [9]. The recurrent road maintenance activities carried out in the Department of Road is predominantly based on the traditional approach where the contractors maintains an existing road based on the indicators such as materials, equipment, and labor whereas routine/regular road maintenance activities carried out through length workers under the supervision of SMD [10].

DOR policy document clearly stated that the meaning of Routine/Regular Maintenance in Nepalese context, that include “Maintenance required continually on every road because of environmental degradation whatever its engineering characteristics or traffic volume.” similarly “recurrent maintenance, required at varying intervals during the year with a frequency that mostly on the volume of traffic using the road” [11].

## II: MATERIALS AND METHODS

### A. Background of Study Area

This study considers the Strategic Road Network (SRN) roads, Kathmandu valley of Nepal. Total numbers of SRN roads in Kathmandu valley is 196

numbers. Out of which 119 km lies in Kathmandu district. Remaining lies in Lalitpur district (53) and Bhaktapur district (24). Strategic Urban Roads (SUR), Feeder Roads National (FRN), Feeder Roads Others (FRO) and National Highway (NH) roads are classified on the basis of DOR, 2013. Among them, only 6 numbers of roads have been considered for the study. All the roads are blacktopped with asphalt concrete wearing course. The elements of these roads are sub-grade; sub-base, base course and asphalt concrete wearing course [12]. Short description of the study area is presented below (Table1, Fig.1).

**Table1: Description of the Strategic Road Network in the study areas**

S. N	Name of Road	Class	Ref No	Length (Km)
1	Gaushala-PuranoBaneshwor	SUR	27SU R012	0.90
2	PuranoBaneshwor-NayaBaneshwor (BICC)	SUR	27SU R012	1.60
3	Saugalchowk-Bholadhoka-Balkumari	SUR	25SU R001	0.96
4	Gwarko-Mangal Bazar-Pulchowk	SUR	25SU R002	0.90
5	Sinamangal-Manohara-Thimi-Sallaghari	FRN	F086	5.00
6	Hanumante Culvert-Sanga	NH	HO3	5.14

[12]

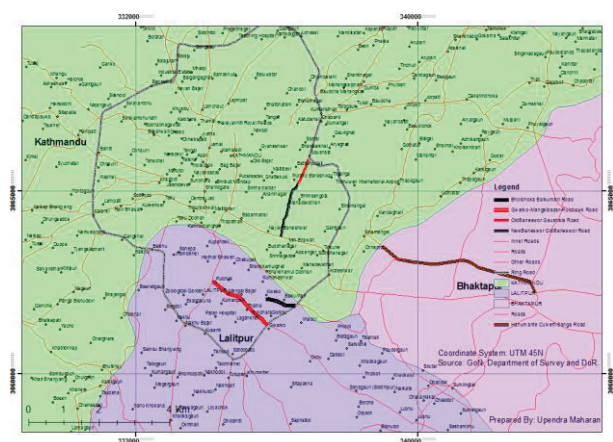


Fig. 1: Map of the Study area

Weighted Mean (WM) Formula used for ranking the values rated by the respondents.

$$W.M. = \frac{N(V.P.) \times 1 + N(P.) \times 2 + N(F.) \times 3 + N(G.) \times 4 + N(V.G.) \times 5}{\text{Total numbers of respondents}}$$

[13]

Where,

N= Number of Respondents, V.P. = Very Poor, P. = Poor, F. = Fair, G. = Good, V.G. = Very Good. The weighted value was fixed from 1 to 5.

### III. RESULTS AND DISCUSSION

#### A. Status of Regular Maintenance

The different conditions of road such as condition of shoulders, grasses cutting, side drain cleaning, culvert cleaning, minor reshaping of drains, bridge cleaning, road sweeping and minor cleaning of slides were studied. Then after activities of regular maintenance with analysis, are presented here.

#### B. Condition of Shoulders

Maintenance of the shoulder comes under the categories of regular or routine maintenance. So the opinion on existing shoulder condition was taken. The figure 2 represents the respondents' answers to the condition of shoulder. The data showed that around 38.88 percent of respondent analyzed the condition of shoulder was fair, 33.33% respondent ranked as good, followed by 16.67 percent with poor condition and very poor and excellent have equal number as 5.56 percent.

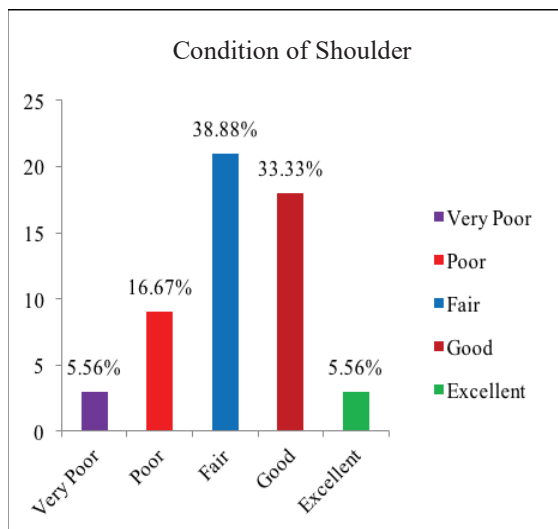


Fig. 2. Condition of shoulder by road related engineers.

The analysis showed that the mean of the answer is 3.17, which is more than the fair value. It

represents the maintenance of the shoulder is satisfactory as per road engineers.

Similarly, same question was asked to the road regular users and the following picture showed that 68.40 % users believed condition of shoulder is good, followed by 24.60% with poor condition, 5.30 % believed very well and only 1.60 % believed very poor condition.

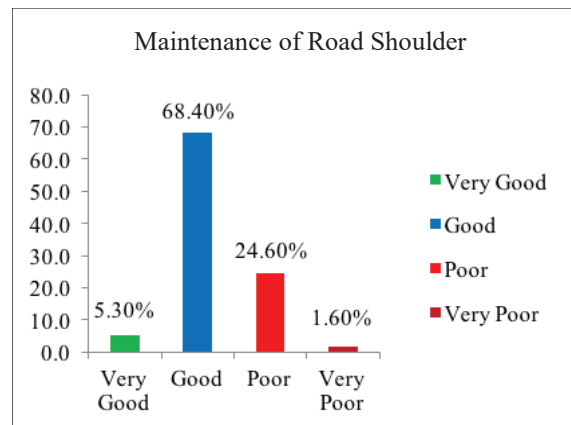


Fig. 3. Maintenance of Road Shoulder by road regular users

The SPSS analysis showed that the mean of the answer is 2.22, which is in-between of fair and poor but near to poor value. It represents the maintenance of the shoulder is unsatisfactory as per road users.

Overall, the maintenance of the shoulder is more than poor and near to fair, so it can be concluded that the maintenance of the shoulder is unsatisfactory.

#### C. Grass Cutting

Grass cutting comes under the categories of regular maintenance. So the opinion on existing grass cutting work was taken. The figure 4 represented the respondents' answers to the condition of grass cutting. The analysis showed that around 37 % respondent analyzed the condition of grass cutting was good, 26 % respondent ranked as fair, followed by 20 % with excellent condition, 13 % with poor grass cutting condition and 4 % with very poor condition.

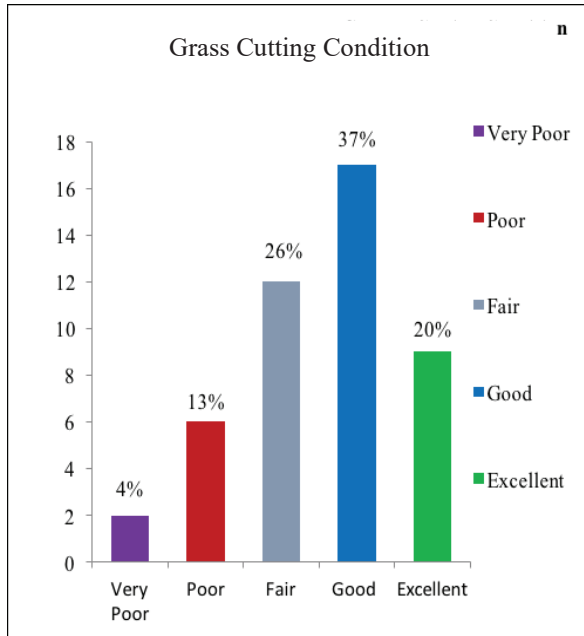


Fig. 4. Condition of Grass cutting by road related engineers

The SPSS analysis showed that the mean of the answer is 3.54, which is more than the fair value and near to good. It represents the cleaning of road side grasses are good as per road Engineers.

Similarly, same question was asked to the road regular users and the following picture showed that 50 percent users believed Cleaning of roadside grasses condition was very good, followed by 39 percent with good condition, 11 percent respondents believed poor and null percent believed very poor condition.

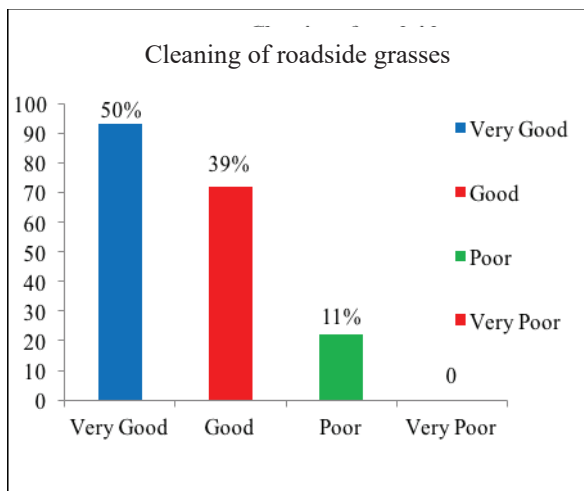


Fig. 5. Response on Cleaning of roadside grasses by road regular users

The analysis showed that the mean of the answer is 1.62, which is in-between of very poor and poor with poor as a nearer value. It represents the

maintenance of the roadside grass cutting is poor as per road users.

Overall, the maintenance of the grass cutting is more than poor and near to fair, so it can be concluded that the maintenance of the grass cutting is satisfactory.

#### D. Side drain and minor slide cleaning

Side drain and cleaning of minor slides comes under the categories of routine maintenance. Therefore, the opinion on side drain and cleaning of minor slides work was taken. The figure 6 represents the respondents' answered to the condition of side drain cleaning and cleaning of minor slides. The data showed that around 35 % respondent analyzed the condition of side drain cleaning was good, 29 % respondent ranked as poor, followed by 25 % with fair condition, 9 % with excellent side drain cleaning condition and 2 % respondent with very poor condition. Similarly, 40 % respondent had analyzed the minor slide cleaning was good, 20 % respondent had ranked the condition as poor as well as fair, 17 % with excellent minor slide cleaning condition and 3 % respondent with very poor condition.

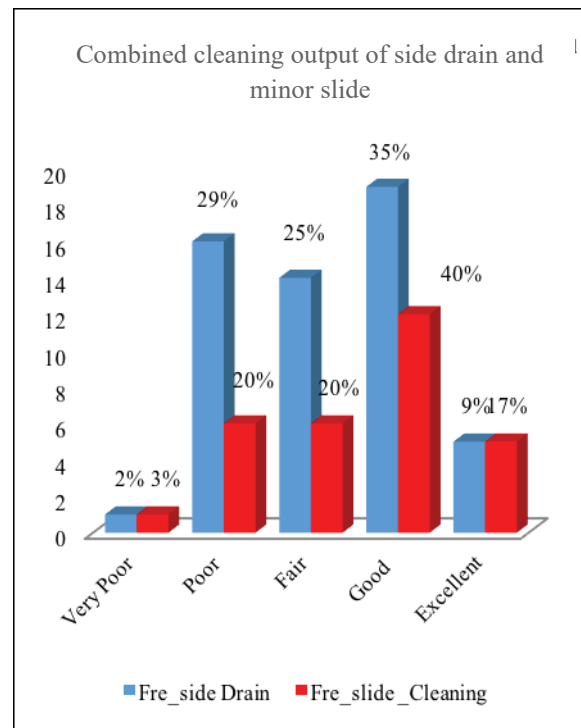


Fig. 6. Condition of combined cleaning output of side drain and minor slide

The analysis of data showed that the mean of the side drain cleaning answer is 3.20, which is more than the fair value and near to fair. It represents the maintenance of the side drain is fair. Similarly,

analysis showed that the mean of the minor slide cleaning work answer is 3.47, which is more than the fair value and near to fair. It represents the minor slide cleaning work is also fair as per road Engineers. Similarly, same question was asked to the road regular users and the following picture showed that about 61.00 % users believed evaluation of traffic sign, drain and small landslide was good, followed by 21.40 % with poor condition, 15.00 % respondents believed very good and 2.60 % believed very poor condition.

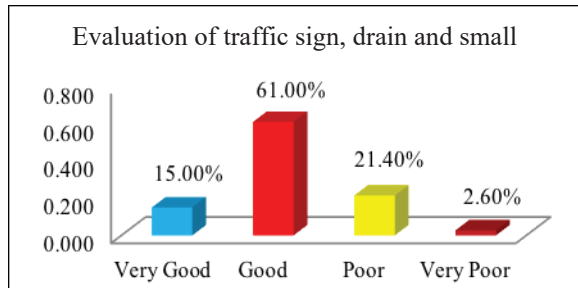


Fig. 7: Response Evaluation of traffic sign, drain and small landslide by road regular users

The analysis of the data showed that the mean of the answer is 2.12, which is in-between of poor and fair with poor as a nearer value. It represents the maintenance of the traffic sign, drain and small landslide is poor as per road users. Overall, the maintenance of the traffic sign, drain and small landslide is in-between poor and fair but near to fair, so it can be concluded that the maintenance of the traffic sign, drain and small landslide satisfactory.

#### E. Culvert and Bridge Cleaning

Culvert and Bridge cleaning comes under the categories of routine maintenance. So the opinion on existing Culvert and Bridge cleaning work was taken. The figure 8 represents the respondent's answers to the condition of Culvert and Bridge cleaning. The data showed that around 45% respondents from bridge cleaning and 36 % respondents from culvert cleaning analyzed the condition is fair, 30 % and 33 % respondent ranked good, followed by 18 % and 14 % with poor, 3 % and 10 % with excellent condition and 3 % and 7 % with very poor condition respectively.

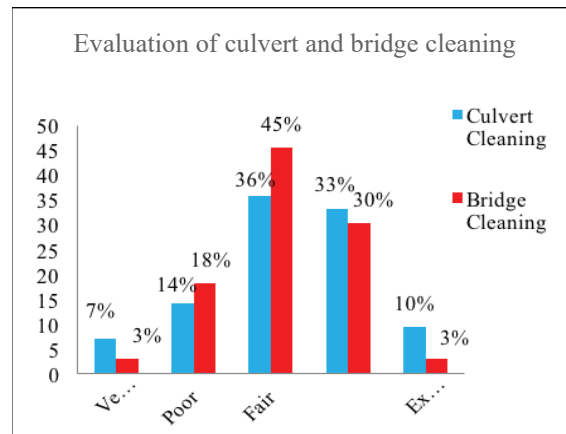


Fig. 8. Condition of Culvert and Bridge cleaning by road related Engineers

The data showed that the mean of the both categories answer is 3.24 and 3.12 for culverts and bridge cleaning respectively, which is more than fair value and near to fair. It represents the cleaning of Culverts and Bridges are fair as per road Engineers.

For the road regular user as the driver, it is difficult to analyze the difference between culvert and bridge so both structures were merged into bridge and a single response was taken. The following picture showed that 58 % believed cleaning of bridge surface condition was very good, followed by 33 % with good condition, 7 % respondents believed poor and 2 percent respondent believed very poor condition.

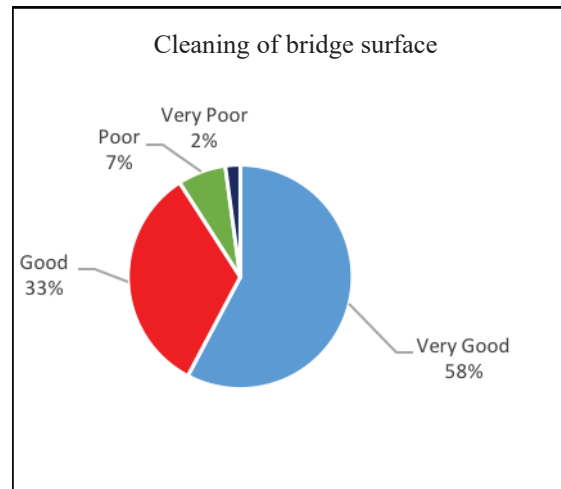


Fig. 9. Response on Cleaning of bridge surface by road regular users.

The analysis of the available data showed that the mean of the answer is 1.53, which is in-between of very poor and poor with poor as a nearer value. It represents the cleaning of bridge surface is poor as per road users.



Overall, the cleaning of the culverts and bridge is near to fair in case of road related engineers whereas in case of road users it is poor, so it can be concluded that the maintenance of the culverts and bridge is unsatisfactory.

#### F. Minor Reshaping of Drains

Minor Reshaping of drains comes under the categories of routine maintenance. Therefore, the opinion on minor reshaping of drains work was taken. The figure 10 represents the respondent's answers to the minor reshaping of drains. The data showed that around 45.10 percent response to fair, 35.30 percent respondent ranked good, followed by 15.70 percent with poor, 3.90 percent with very poor condition and null with excellent condition.

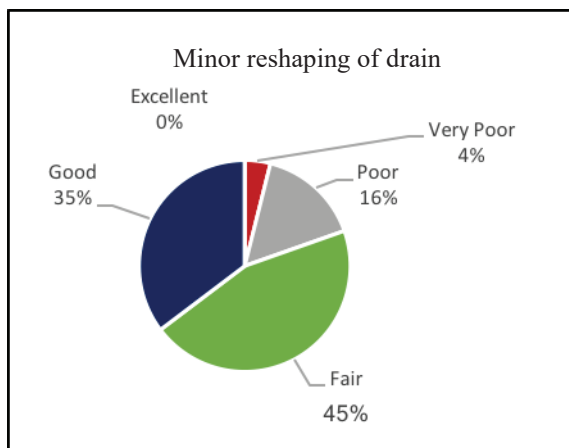


Fig. 10: Response on minor reshaping of drains

The analysis showed that the mean of the minor reshaping of drains answer is 3.12, which is more than the fair value and near to fair. It represents minor reshaping of drains is fair as per road Engineers

Overall, the minor reshaping of drains is in-between good and fair in cases, so it can be concluded that the maintenance minor reshaping of drains is satisfactory.

#### G. Road Sweeping

Road sweeping is an important activity as a road routine maintenance. So, the opinion on road sweeping work was taken. The figure 11 represents the respondent's answered to the condition of road sweeping. The analysis showed that around 33.90 % respondent analyzed the condition of road sweeping was fair, 30.40% respondent ranked as good,

followed by 14.30 % with very poor and poor condition, and 7.10 % with excellent condition.

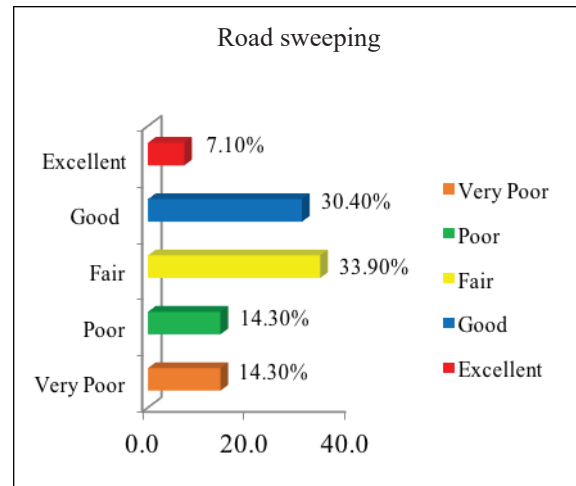


Fig.11. Condition of road sweeping by road related Engineers

The data showed that the mean of the answer is 3.02, which is more than the fair value and very near to fair. It represents the road sweeping work is fair as per road Engineers.

Similarly, same question was asked to the road regular users and the following picture showed that 57 % believed road-sweeping condition was good, followed by 24 % with very good condition, 14 % respondents believed poor and 5 percent believed very poor condition.

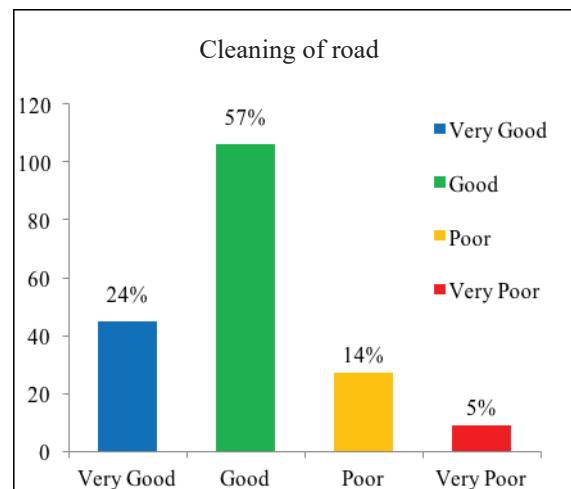


Fig. 12. Response on road cleaning by road regular users

SPSS analysis showed that the mean of the answer is 2.00, which is poor value. It represents the maintenance of the road sweeping is poor as per road users. Overall, the maintenance of the road sweeping is in-between of poor and good, so it can be concluded that the road sweeping is satisfactory.

#### H. Status of Recurrent Maintenance

- *Potholes and patching work*

Pothole and patch repairing are the crucial activity as a road recurrent maintenance. Therefore, the opinion on potholes and patch repairing work was taken. The figure 13 represents the respondent's answers to the pothole and patch repairing. The data showed that around 36% respondent analyzed the condition of road potholes repairing was good, 29 % respondent ranked as fair, followed by 20 % with excellent, 12 % with poor condition, and 3 percent with very poor condition. Similarly data showed that around 46 % respondent analyzed the condition of road patch repairing was good, 23 %t respondent ranked as fair, followed by 15 % with excellent and with poor condition, and only 1 % with very poor condition.

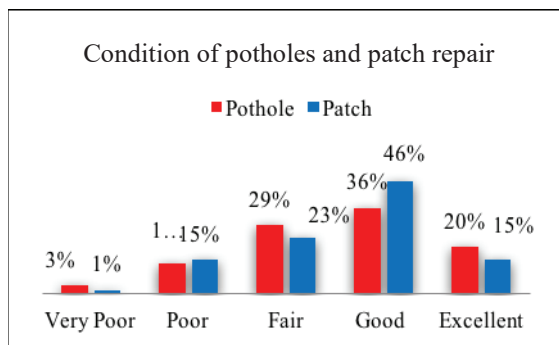


Fig. 13. Condition of potholes and patch repair by road related Engineers

The analysis showed that the mean of the answer is 3.55 and 3.57(almost same), which is lies in between of fair and good and near to good. It represents the pothole and patch repair work is good as per road Engineers.

Similarly, same question was asked to the road regular users and the following picture showed that 52.90 percent users believed pothole-repairing work was good, followed by 24.60 percent with poor condition, 13.40 percent respondents believed very poor and 8.60 percent respondents believed very good road condition. Similarly, 44.90 percent users believed patch-repairing work was good, followed by 24.60 percent it is very good condition, 23.50 percent respondents believed poor and 7.00 percent respondents believed very poor road condition (Fig.14).

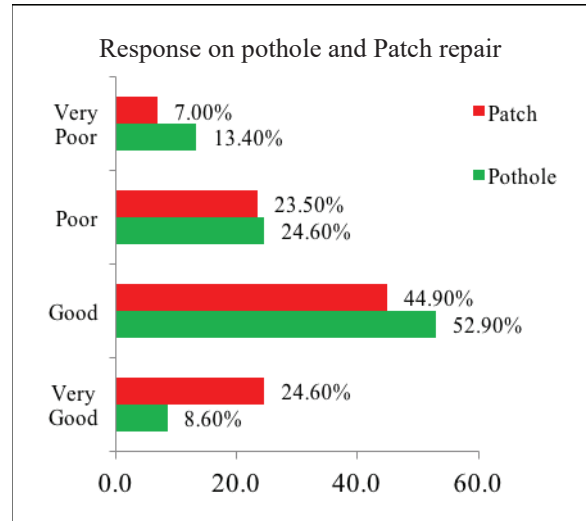


Fig. 14. Response on pothole and patch repair work by road regular users

The SPSS analysis showed that the mean of the answer is 2.43 and 2.13, which is in between good and poor value and near to good. It represents the pothole and patch repair work is satisfactory as per road users.

Overall, the pothole repair work is with fair condition, so it could be concluded that the pothole and patch repair work need to be improved.

- *Edge and shoulder repair work*

Repairing of Edge and Shoulder comes under the categories of recurrent maintenance. Therefore, the opinion on Repairing of Edge and Shoulder work was taken. The figure 15 represents the respondent's answers to the condition Repairing of Edge and Shoulder. The data showed that around 39 percent respondent analyzed the Repairing of Edge and Shoulder was fair, 28 percent respondent ranked as good, followed by 24 percent with poor condition, 7 percent with excellent Repairing of Edge and Shoulder condition and 2 percent respondent with very poor condition.

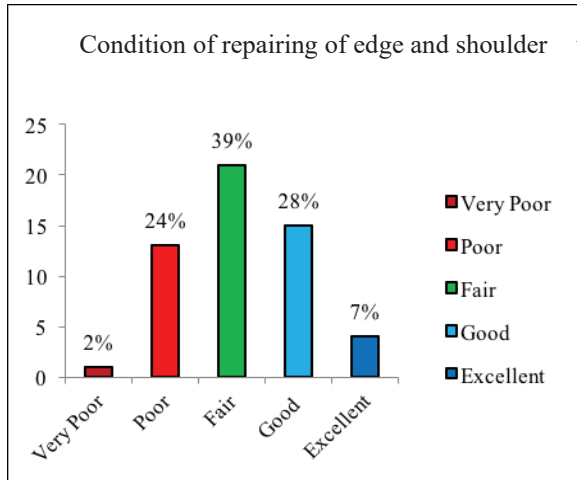


Fig. 15. Condition of Repairing of Edge and Shoulder

The SPSS analysis showed that the mean of the repairing of Edge and shoulder answer is 3.15, which is more than the fair value. It represents the repairing of Edge and shoulder is fair.

Overall, the repairing of Edge and shoulder is in-between good and fair, so it could be concluded that the maintenance of the repairing of edge and shoulder was satisfactory.

- *Sealing Cracks*

Repairing of roads pavement by sealing cracks comes under the categories of recurrent maintenance. The figure 16 represents the respondent's answers to the crack sealing work. The data showed that around 33 percent respondent analyzed the crack sealing work was good, 25 percent respondent ranked as fair, followed by 24 percent with poor condition, 10 percent with very poor sealing cracks and only 8 percent respondent with excellent condition.

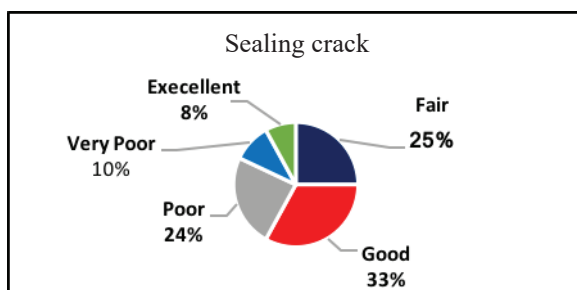


Fig.16: Response on Crack sealing work by road related Engineers

The SPSS analysis showed that the mean of the crack sealing work answer is 3.15, which was more than the fair value and very near to fair. It represented the crack sealing work is fair as per road Engineers.

Similarly, same question was asked to the road regular users and the following picture showed that 86 percent had not seen the crack sealing work while just 14 percent respondents knew about the crack sealing work.

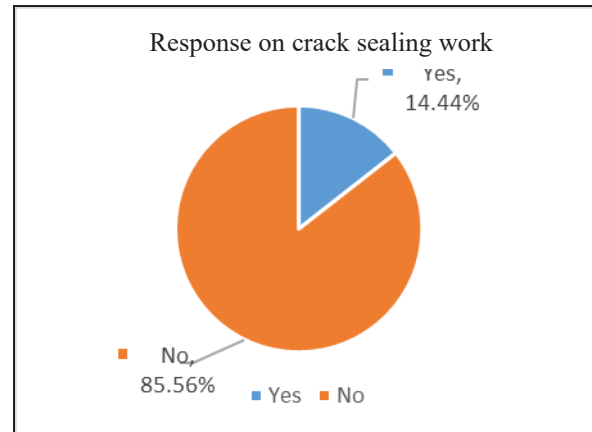


Fig. 17. Response on Crack sealing work by road users

Among the 27 % respondent 77 % respondents believed crack-sealing work was good, followed by 15 % with poor condition and 4 percent respondent believed very poor and very good condition.

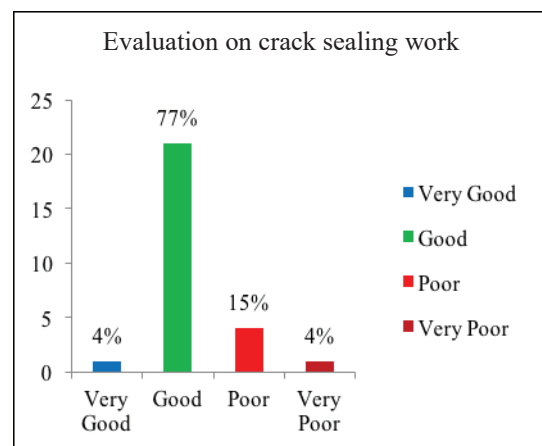


Fig. 18. Evaluation on crack sealing work by road regular users

The SPSS analysis showed that the mean of the answer is 2.19, which is in between good and poor value and near to good. It represents the crack sealing work was satisfactory as per road users. Overall, the crack sealing work was with fair condition, so it could be concluded that the crack sealing work need to be improved.

#### J. Overall response on routine maintenance

- By road related Engineers



Overall response of the routine maintenance work was analyzed. It shows (Fig.19) the respondent's answers to the overall routine maintenance work. The data showed that around 26 respondents answered the overall routine maintenance with 3 to 4 means fair to good, 34 percent answered in-between good and fair so it can be analyzed the overall response was near to fair value.

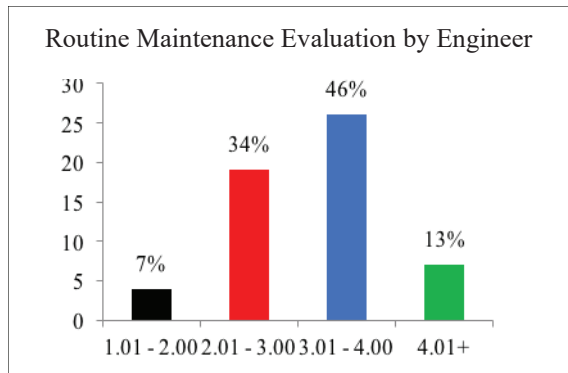


Fig. 19. Overall routine maintenance evaluation by road Engineers

The SPSS analysis of the available data showed that the mean of the overall routine maintenance evaluation was 3.22, which was more than the fair value and very near to fair. It represented the overall routine maintenance evaluation work was fair as per road Engineers.

- By road regular users

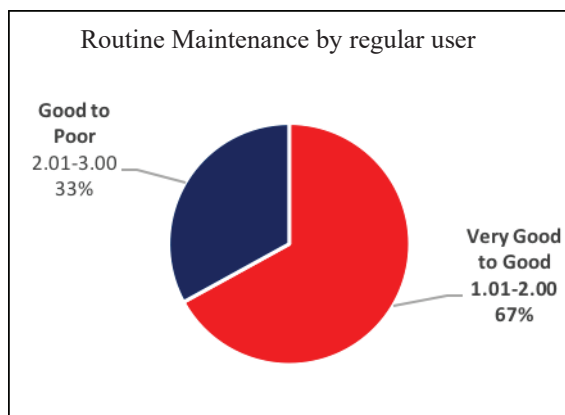


Fig. 20. Overall routine maintenance evaluation by road regular users

Similarly, same question was asked to the road regular users and the following picture showed that 67 % users had answered their overall routine maintenance in between 1 to 2 (Very good to Good), 33 % had answered their overall routine maintenance in between 2 to 3 (Good to Poor). The data showed that the mean of the routine maintenance answer

was 1.90, which was between good and very good. It represented the overall routine maintenance was good as per road regular users.

Overall, the routine maintenance work was with fair condition, so it can be concluded that the overall routine maintenance work needs to be improved.

#### K. Overall response on reactive (recurrent) maintenance

- By road related Engineers

Overall response of the recurrent maintenance work was analyzed. It shows (Fig. 21) the respondent's answers to the overall recurrent maintenance work. The data showed that around 39 percent respondents answered the overall routine maintenance with 3 to 4 means fair to good, 34 percent answered in-between poor and fair, followed by 16 percent in-between good and very good so it can be analyzed the overall response was near to fair value.

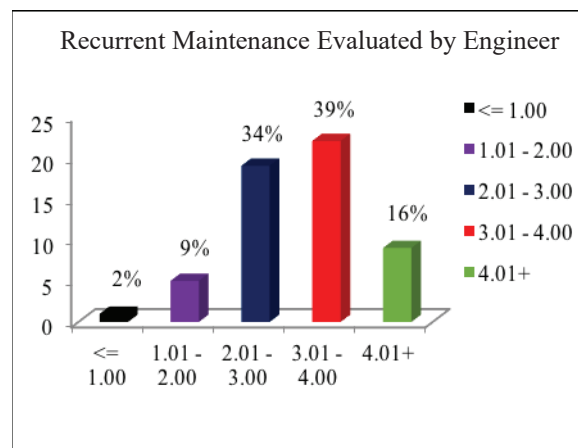


Fig. 21. Overall recurrent maintenance evaluation by road Engineers

The SPSS analysis of the available data showed that the mean of the overall recurrent maintenance evaluation was 3.34, which was more than the fair value and very near to good. It represented the overall recurrent maintenance evaluation work was fair as per road Engineers.

- By road regular users

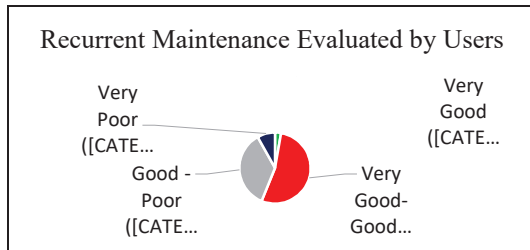


Fig. 22. Recurrent maintenance evaluation by road regular users

Similarly, same question was asked to the road regular users and the following picture showed that 53.50 percent users had answered their overall routine maintenance in between 1 to 2 (Very good to Good), 35.80 percent had answered their overall routine maintenance in between 2 to 3 (Good to Poor).

The SPSS analysis of the available data showed that the mean of the recurrent maintenance answer was 2.16, which were between good and poor. It represented the overall recurrent maintenance was fair as per road regular users. Overall, the recurrent maintenance work was with fair condition, so it could be concluded that the overall recurrent maintenance work need to be improved.

#### IV. CONCLUSIONS

The 'Assessment on effectiveness of combined maintenance in Strategic Road Network (SRN) in Kathmandu valley' has been carried out with investigation and study of all its aspects-both positive and negative. The major findings of the study have been concluded here:

- From the observations, mean of 'regular (routine) maintenance job' is 3.22 slightly more than fair value which indicates, work carried out is just sufficient as per road Engineers.
- Mean of regular maintenance job worked out to be 1.90 lies between the good and very good. As per regular road users, overall regular maintenance work carried out thus is found to be good. Evaluating both 'regular road users' and 'road engineers' responses, overall regular maintenance works performance is fair only and that should be improved.
- The overall reactive maintenance response from road Engineers is 3.34 slightly more but very near to fair value. It indicates that

overall reactive/recurrent maintenance work is found to be at fair state.

- The response evaluation regarding reactive maintenance is 2.16 slightly more than poor but less than good as per 'regular road users'. Evaluating both 'Road Engineers' and 'Regular Road Users' responses, reactive maintenance work is found to be in fair condition and thus needs improvements.
- Regular maintenance workers training provided by the division road offices once in year is found to be deficient for carrying out effective maintenance activities. 'Length Workers' and their Supervisors are looking up for more number of training per year with 'on the job training' module contained in.

#### A. RECOMMENDATION

Division Road Offices has a big workforce to manage for regular constructional activities of road work alongside the 'Regular and Reactive' maintenance activities. A separate and special branch or division with proper study and consideration should be opened up to carry out the maintenance activities for its effectiveness.

- DOR should improve the current maintenance practices and it should require due attention to keep the roads in well-maintained condition.
- Number of workers should be sufficient as specified by the DOR Norms in rainy as well as in dry season.
- More training such as 'on the job training' and more tools should be provided to the supervisor and length for the effectiveness of the routine maintenance work.
- Workers motivation is directly related with the facilities they are getting so to make. It should provide attractive incentives to road workers for the motivation.

#### B. FUTURE RESEARCH WORKS

It has created opportunity to carry out similar research study of other road networks such as Local Road Network (LRN) as well. Future research can be examined the condition of current practice of maintenance in these roads. For the effectiveness of the maintenance activities improvement in the training module currently adopted for 'Length Workers' and 'Supervisors' should be made for

which a study can be conducted to finalize the module and the content.

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