

ASSESSMENTS OF THE GRAVEL ROAD DETERIORATION HAVING LACK OF MAINTENANCE: CASE STUDY IN JIMMA ZONE

Tarekegn Reta Mesfin* and Eba Kitata Kenea

Received: August 27, 2021; Revised: July 27, 2022; Accepted: September 27, 2022

Abstract

Gravel roads deterioration with absence of maintenance is one of the serious issue and common problem in the world. It's majorly affected by deterioration which manifests as removing from gravel road materials with the major factors such as traffic volume and environmental conditions. Jimma zone might have been a standout amongst those ranges influenced toward the issue for gravel road having lack of maintenances. In order to achieve the objective of this study, the researchers were used questionnaire survey method. The existing road sections having lack of maintenance on a given time have been identified. Then the representative road (Sarbo-Busa, Saka-Ushane and Buxure-Sanxama) and questionnaire surveys samples have been selected by non-probabilistic purposive and systematic sampling respectively. The questionnaire's survey was focused on identifying the causes of absence of maintenance and pre-conditions considered. questionnaire survey was analyzed by RII. The absence of maintenance was occurred due to lack of budget fund, poor management, lack of skilled manpower, lack of good material quality, lack of regular inspections, poor working environments. The pre-conditions considered while maintaining the gravel roads are: Cost of maintenance, class as the road, maintenance schedule, skilled manpower, topography, number of road users, traffic volume, and economic standards of the society and location of the road from the center. In Jimma zone the deterioration of gravel roads have been increasing with the absence of maintenance time.

Keywords: Gravel road, Deterioration, Maintenance delays, Surface materials

Introduction

Roads are a critical asset and should be properly maintained no matter of their magnificence or function to decorate their sustainability and overall performance. Globally, gravel road comprises the more proportion of the period of public roads in rural areas across the developing countries. (Petts *et al.*, 2005). It accounts for nearly sixty percent of the principal road network. Gravel road would vital importance in various parts, furthermore

incredulous relating to that of transportation. For huge numbers of roads creating universal locations, over seventy-five percent of those road system comprises of gravel type of roadway which covers more of the world's road. (Rajkamal *et al.*, 2014).

Out of the total road network in Ethiopia, gravel road shares 82% of all road networks (ERA, 2011). The total length of the road in Ethiopia is 56,100 kilometers that include both gravel and

Lecturer, Department of civil engineering, College of engineering, Assosa University www.asu.edu.et, Assosa, 5220, Ethiopia,
E-mail: tare.b.ayana@gmail.com; tulugada@gmail.com

* Corresponding Author

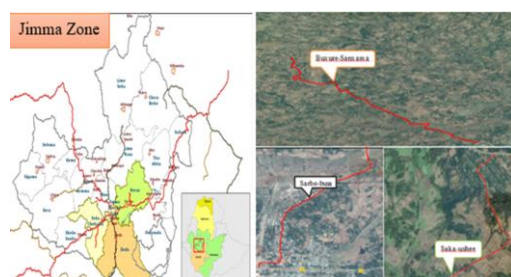


Figure 1. Map of the study area and selected gravel road sampled

asphalt road asset, ERA had 24,550 kilometers as a federal and the regional road authorities had 31,550 kilometers. (ERA, 2011). Gravel road may be aggregate surfaced road, sometimes should have alluded to be taken as unpaved road (ERA, 2016).

Gravel is utilized for surfacing provincial road what's more settled on from regular aggregates (Songco, 2002). It became no longer best carry traffic's masses but also be proof against shear deformation and wear i.e. they have got enough class and sturdiness. The road deterioration manner begins immediately after starting to traffic. Because of the motion of site traffics and climatic adjustments over a period of time, the problems with gravel are numerous like gravel loss, safety chance, soreness and nuisance, air pollutants, and inaccessibility of roads at some point of rainy season (Assosiations, 2014).

Traffic volumes for diverse ecological part needed the elementary variables on upgrading gravel misfortune accuse. Gravel passing rates from claiming roughly 25-30mm thickness as quite a while as stated by one hundred motors steady with day will be predicted, relying on precipitation and materials properties mainly plasticity (Chamoro *et al.*, 2009). This procedure begins off advanced exceptionally gradually in place that it has the capacity with presently not a chance to be important, and about whether it quickens at snappier costs as postpone maintenance has been proceeded. Those assessment from claiming distresses through this approach, contending that the impacts accepted didn't outfitted with an exact estimation of the states of the whole way surface (Rivera *et al.*, 2015).

Materials and Methods

Study area

This study was conducted at Jimma zone, which is found at the southwestern part of Ethiopia. Which is located 335km at road southwest of Addis Ababa. Its geographical coordinates are between 7°13'-8°56'N latitude and 35°49'-38°38'E

longitude. The topographic feature's elevations vary from 1000m to 3360m above sea level. Jimma town is found in an area of average altitude, of about 5400 ft. (1780 m) above sea level. It lies in the climatic zone of locally known as woyinadega. (Lata, 2009)

The study was conducted on the three selected gravel roads (Sarbo-Busa, Saka-Ushane and Buxure-Sanxama) found in Jimma zone wereda. The general characteristics of those three selected roads were discussed in the following paragraph. The road Sarbo-Busa has found in Karsa wereda and located 42km by road northeast of Jimma city. The road Saka-Ushane was found in Saka Chekorsa wereda and located 34km by road South West of Jimma city. The road Buxure-Sanxama has found in Mana wereda and located 22km by road northeast of Jimma city. The altitude of this wereda ranges from 2250 to 3010 meters above sea level. Shown in Figure 1. (Lata, 2009)

Sample size and selections

The objective of sampling turned into to provide a practical approach of permitting the facts collection and processing components of studies to be executed whilst ensuring that the pattern affords a very good illustration of the population, which is the sample turned into representative (Liu, 2007). Due to the fact that, the whole facts approximately the populace, sampling strategies has been used for this research. Non-probability purposive sampling has been used to select population of gravel road.

Data collections

For this study, questionnaire survey was the main method of data collection. The studies questionnaire contained twenty-four questions related with the reasons and absence of maintenance that have been identified thru literature review and dialogue with some events worried in Jimma zone road authority. The questionnaire turned into developed in order to compare the cause's absence of maintenance on the gravel road deteriorations.

Sampling Procedures and Analysis

The researcher targeted on the road geometric standard DC2 (collectors and feeder). In Ethiopia, the majority of the road network is gravel road and also in that of the targeted area. According to Jimma zone road authority, the majority of gravel road population was DC2. In this study, the gravel road samples were taken from the road networks of interest area, which were identified by gathering information from zonal road authority. The selected samples were characterized by maintenance times that was already absented for one-year, two years, and three years.

Table 1. Questionnaires distributed and response rate.

Respondents	Questionnaires Distributed		Questionnaires Returned		Response rate in (%)
	Number	Percent (%)	Number	Percent (%)	
1.Clients	21	63.63	18	54.54	85.71
2.Consultants	12	36.36	11	33.33	91.66
Total	33	100	29	87.87	87.87

Questionnaire surveys procedures

The sample required for the questionnaire survey was fixed by using systematic sampling. The most common form of systematic sampling is an equal probability method where every Kth case in the population frame is selected for inclusion in the sample. Once the population frame is randomized, the next step is to decide on the sampling interval. The confidence level set in determining the sample size is 95% confidence level of the target population. The response is taken to be within positive or negative 5% (+ or -5%) of the population. The sample size for the population was calculated using the formula below (Huntington, 2005).

$$n = \frac{Z^2 pqN}{e^2(N-1) + Z^2 pq} \quad (1)$$

Where;

N – Size of the population

P – Sample proportion

n – Size of the sample

q – 1-P

e – Accepted error (e=0.05, this is because the estimate should be within 5% of the true value)

Z – The value of the standard deviation at a given confidence level.

Questioner survey analysis.

The questionnaire were categorized into two main components. The first one was the questions related to the pre-considerations while maintaining the gravel roads which include thirteen questions and the second one was focused on the causes of absence of maintenance that contains ten questions. Totally twenty-three questions that were related to gravel road maintenance conditions in Jimma zone were prepared and provided for the respondents.

The significances and their related percentage values were defined as: Not Significant (N.S.) with 0% of absence contributing factors; Slightly Significant (S.S.) with <35% of absence contributing factors; Moderately Significant (M.S.) with 35-60% of absence contributing factors; Very Significant (V.S.) with 60-75% of absence contributing factors; Extremely Significant (E.S.) >75% absence contributing factors. The collected data were analyzed through the statistical techniques

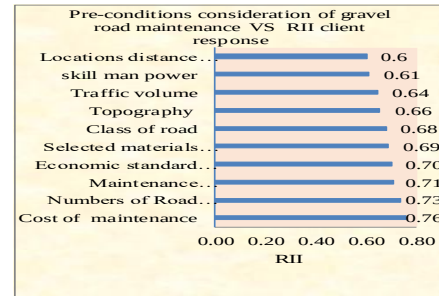


Figure 2. pre-conditions considerations whilst maintenance absence client prospective

and indices. Equation 2 was used for calculating the RII (Relative Importance Index) which is required to analyze the issue of the causes gravel road's absence of maintenance in study area.

$$RII = \frac{\sum W}{A * N} \quad (2)$$

Where,

W= Weighting given to each cause by respondent and its value ranges from 1 to 5, where '1' is N.S. and '5' is E.S.,

A = Highest weight i.e. '5' in this case,

N= Total number of respondents identified Causes are classified into five groups depending upon their RII. It is very difficult to suggest the possible measures to each and every absence of maintenance, because of the occurrence of lies in the questionnaire. So attempts are made to suggest the possible measures for those causes, which are E.S. and pertain to maximum contribution as an absence maintenance factor.

Results and Discussions

The response rate is shown in Table 1.

Pre-Conditions considerations whilst maintenances (client prospective)

The respondent's evaluation shows that approximately the pre-attention for the duration of gravel avenue preservation have been explained and mentioned as of on Figure 2. In line with the results obtained from evaluation based on RII, 75.6% of the

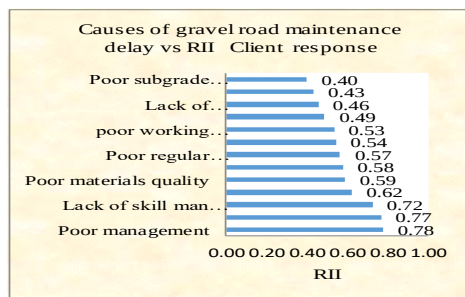


Figure 3. Causes of maintenances absence client prospective

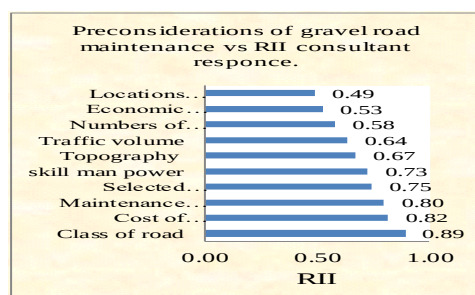


Figure 4. Shows the pre-condition consideration while maintains consultant prospective

respondents feel that the fee of gravel road may be determined as pre-conditions concerns whilst keeping the gravel avenue. 73.3% of the respondent feel that the quantity of road users can be apprehended because the pre-conditions even as preserving. 70% of respondents feel that the financial widespread of the society can be determine as pre-situations preservation. 68.9% of respondents feel that selected materials used for any gravel road can be recognized the pre-situations maintenance.

Causes of the gravel road deteriorations with maintenances absence client prospective.

The effects of the respondents' evaluations based at the questionnaire end result of the reasons of absence of maintenances at the gravel road deteriorations have been defined & discussed inside the Figure 3. The result shows that 77.8% of the respondent feel that bad road maintenance control machine may be understood because the first and main causes of gravel avenue loss of maintenance's. 76.7% of respondent feels that loss of price range fund needed for gravel avenue preservation may be discerned as the second one causes of gravel avenue loss of maintenance. 72.2% respondent feel that absence of skilled/professional manpower can be understood the reasons of gravel road loss of maintenances. 57.6% respondent feels that poor

regular inspection may additionally determine because the reasons of gravel road absence of maintenance. 54.4% of respondent's experience that awful climatic situations may be understood as the reasons of gravel road absence of maintenance. 53.3% respondent experience that respondent feel that poor working environment in the organizations may understand as the causes of gravel road absence of maintenance.

Pre-condition considerations whilst maintenance (Consultant prospective)

Respondent's opinion on the pre-conditions consideration while maintaining the gravel road were explained based on the obtained results. According to that 89.1% respondent feels that class of the road may be discerned as the first pre-condition consideration during gravel road maintenance. 81.8% respondents feel that the cost of maintenances may understand as the second pre-condition consideration during gravel road maintenance. 80% respondents feel maintenance schedule may discern as the pre-condition consideration while gravel road maintenance. 74.5% respondent feel that selected materials haul distance may be understood as the pre-condition consideration during gravel road maintenance. 72.7% of respondents feel that the absence of skilled manpowered may discern as the pre-condition consideration during gravel road maintenance. Show in Figure 4.

Causes of absence of maintenance consultant prospective

Respondent's opinion on the causes of absence of maintenance on the gravel road deteriorations were explained. According to that 92.7% of respondents feel that absence of budget fund for gravel road maintenance system may be understood as the first and causes of gravel road absence of maintenance's. 85.5% of respondent feel poor materials quality may be discerned as the causes of gravel road absence of maintenance. 81.8% respondent feel that absence of poor management may discern as the causes of gravel road absence of maintenance. 80.0% of respondent feel that absence of skilled manpowered may understand the causes of absence of maintenance's. 78.2% of respondents feel that poor regular inspections may be understood as the causes of absence of maintenance. 76.4% respondent feel that poor working environment in the organizations administered the gravel road may discern as the causes absence of maintenance. 72.7% respondent feels that absence of equipment is also the causes of gravel road absence of maintenance. 69.1% respondents feel that poor sub-grade materials may be discerned as the causes of gravel road

Table 2. Ranking causes of absence and gravel road maintenance pre-considerations. (Client and consultants prospective)

Pre-conditions considerations while maintaining gravel road and Cause of		Number of responded out of 18 respondents (client) RII value	Rank	Number of responded out of 18 respondents (consultants) RII value	Rank	Average RII	Rank Based on RII Average
No.	Pre-conditions considerations while maintaining gravel road						
1	Cost of Maintenance	0.756	1	0.818	2	0.787	1
2	Class of road	0.678	6	0.891	1	0.784	2
3	Maintenance schedule	0.711	3	0.800	3	0.756	3
4	Selected materials haul distance	0.689	5	0.745	4	0.717	4
5	skill manpower	0.611	9	0.727	5	0.669	5
6	Topography	0.656	7	0.673	6	0.664	6
7	No of road users	0.733	2	0.582	8	0.658	7
8	Traffic Volume	0.644	8	0.636	7	0.640	8
9	Economics standard of the society	0.700	4	0.527	9	0.614	9
10	Locations distances consideration	0.600	10	0.491	10	0.545	10

Major cause of maintenances delays							
1	Lack of budget fund	0.767	2	0.927	1	0.847	1
2	Poor management	0.778	1	0.818	3	0.798	2
3	Lack of skill manpower	0.722	3	0.800	4	0.761	3
4	Poor materials quality	0.589	5	0.855	2	0.722	4
5	Lack of equipment	0.622	4	0.727	7	0.675	5
6	Poor regular inspections activity	0.567	7	0.782	5	0.674	6
7	Poor working environment in the organizations	0.533	9	0.764	6	0.648	7
8	Poor climatic conditions	0.544	8	0.618	11	0.581	8
9	Lack awareness	0.489	10	0.636	10	0.563	9
10	Lack of maintenances standard manuals	0.456	11	0.655	9	0.555	10
11	Poor subgrade material conditions	0.400	13	0.691	8	0.545	11
12	Topography	0.578	6	0.509	13	0.543	12
13	Lack of commitment by the government	0.433	12	0.545	12	0.489	13

absence of maintenances. 65.5% respondent feel that absence of maintenance standard manuals effects the gravel road maintenance in the organizations may be discerned as the causes of gravel road absence of maintenance. Show in Figure 5. and Table 2.

Causes of absence of maintenance

The following discussions are based on the results obtained from the average RII. The respondents gave a number of opinion on the causes of absence of maintenance in gravel road deteriorations. Accordingly, 84.7% of respondents feel that lack of budget fund required for maintenance of gravel roads may discern as the first causes of gravel road absence of maintenance. 79.8% of respondent feel that poor management system in the organizations administered the road may discern as the second causes of gravel road absence of maintenance. 76.1% respondent feel that absence of skilled manpower the causes of gravel road maintenance. 72.2% of respondents feel that lack poor material quality may discern as the causes of gravel road absence of maintenance. 67.5% of respondents feel that absence of material equipment (machine, survey equipment) may be understood as

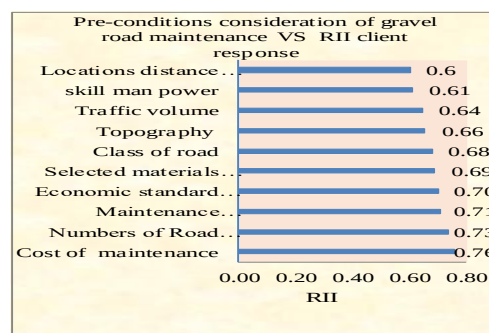


Figure 5. Shows causes of gravel road maintenances absence consultants prospective

the causes of gravel road absence of maintenance. 67.4% respondent feel that poor regular inspections of the gravel road administered body e.g. Jimma zone and wereda road authority may discern as the causes gravel road absence of maintenance. 54.5% of respondent feels poor sub-grade materials may discern as the causes of absence. 54.3% of respondent of the respondent feel that topography of the gravel road located may discern as the causes of

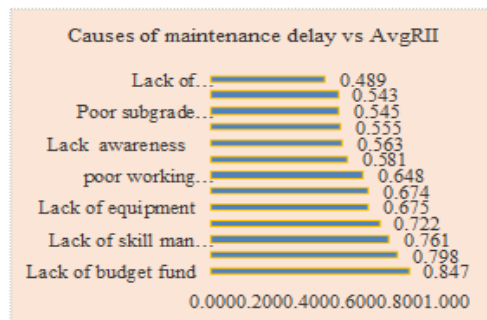


Figure 6. Causes gravel road absence of maintenance both client and consultants perspective

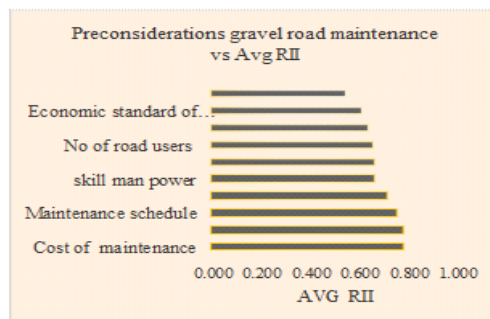


Figure 7. Graphical presentation on pre-conditions maintenance consideration

gravel road absence of maintenance. 48.9% feels that absence of commitment by the government to maintenance may be distinguished as the causes of absence of maintenances. Graphically both clients and consultant's perspective were shown in Figure 6.

Pre-conditions considerations whilst gravel road maintenance

The clients and consultant opinion on the contribution towards the pre-conditions consideration while maintenances gravel based on the average RII values were detailed in the following paragraph. According to that, 78.7% of all respondents feel that cost of gravel road maintenance may discern as the first pre-conditions consideration. 78.4% of respondent feel that class of the gravel road standards may understand as the pre-conditions consideration. 75.6% of respondent feel that maintenance schedule may discern as the pre-conditions consideration while prioritizing gravel road maintenance. 71.7% of the respondent feel that selected materials haul distance the gravel road needs maintenances may distinguish as the pre-conditions consideration while prioritizing gravel road maintenance. Why because most of the gravel

road budget was gathered from the road users. 54.5% of the respondents feel that location of the road existed may discern as the pre-conditions consideration. Graphically both clients and consultants perspective were shown in Figure 7.

Conclusions

The major causes of gravel road with absence of maintenances have obtained from questionnaire responses, estimated from the average relative important index (RII) of respondents (clients and consultants) opinions. Globally, rural roads may make up over eighty percent of the road network length but are given lower priority in the allocation of funding because of their much lower traffic volumes. It was revealed that absence of gravel road maintenance's budget fund may be identified as the primary causes of the gravel road absence of maintenances.

For most developing and emerging economies countries, the road maintenance challenge is dominated by the poor road maintenance management system. In Jimma zone poor management system was the main causes of gravel road absence of maintenance. Poor management in the organization of road and transport office was completely taken as the causes of absence of maintenance since it affects the serviceability of road infrastructure. Another challenge related to that of absence of maintenance for gravel road was lack of skilled manpower during maintenance's data gathering and analysis. Poor climatic conditions (difficulty) also cause absence of maintenance, because the majority of Jimma climatic condition was wet which was difficult for maintaining gravel road regularly. Due to lack of awareness on negative impact of absence of maintenance on overall performance, absence of maintenance for that road have been occurred through this study area. It was identified that absence of gravel road maintenance's standard manuals may discern as the causes of absences of timely maintenance. Existence of poor sub-grade materials was another cause of gravel road maintenance's absences. Timely maintaining of the gravel road was not possible due to the observed topographic conditions of the study area. Inadequate government's commitments towards gravel road maintenances gives the way to the causes of gravel road maintenance's absences. Solving all those raised issues can result in timely maintenance of gravel road to reduce absence of gravel road maintenance.

Acknowledgments

We would like to express our gratitude to Assosa University for parrrainage us.

References

- Assosiations, WR. (2014). The importance of road maintenance, France. <http://www.piarc.org/>
- Chamoro, A., Desolminihac, H., Salgado, M., and Barrera, E. (2009). Development and validation of methode to evaluate unpaved road condition with objectives Transport research board., 3-9.
- ERA. (2011). Design manual of low volume road. Road maintenance booklet Part A. Addis Ababa.
- ERA. (2016). Introduction to low volume road design. Addis Ababa.
- Huntington, G. (2005). Gravel roads asset management. Transportation Research Circular E-C078: Roadway Preservation. 214-228. <https://onlinepubs.trb.org/onlinepubs/circulars/ec078.pdf>
- Lata, D. (2009). UN-OCHA.
- Liu, A. and Fellows, R. (2007). Research Methods for construction. 3rd ed. Blackwell Publishing Limited, Hoboken.
- Petts, R., Cook, J., Dzung, B., and Kackada, H. (2005). Editor providing low-cost, sustainable Access through Infrastructure Works suitable for Small and Medium enterprises. Annual Conference Proceeding, Development studies Association, Vietnam: Intech-TRL.
- Rajkamal, K., Dinesh Reddy, T., Rohiz, D.Venkahia.C., and Prasad, R.K. (2014). Performance Evaluation of gravel road sections sealed with surface dressing. Transport research procedea., 81-89.
- Rivera, F., Chamorro, A., Lucero, R., and Aravena, C. (2015). Development of condition indicator for managing sealed rural road networks. Transport research board.
- Songco, Jocelyn A. (2002). Do Rural Infrastructure Investments Benefit the Poor? Evaluating Linkages-A Global View, A Focus on Vietnam. Policy Research Working. World Bank. Washington DC, 2796p.