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### ASSESSMENTS OF FAILURE PATTERN ON SOME SELECTED SECTIONS OF UNILORIN CAMPUS ROAD

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#### ARTICLE INFO

#### ABSTRACT

*Keywords:*

*Failure Pattern,  
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This study assesses the various types of failure pattern on some selected sections of Unilorin Campus Road which was achieved through identifying different types of failure pattern, establishing surface rating and user's based rating score of the selected road network. Two appropriate methods were used i.e. subjective and objective assessments. The above mentioned methods were used to come up with the available set objectives. Having collect and analyzed the relevant data's, it was concluded that the prevalent failures observed on this facility are cracking, pothole and raveling. The average weighted value of the failure type are cracking with the highest value of 4.548, followed by pothole which has the value of 4.48 and lastly raveling which possessed the lowest value of 0.0690. It was also concluded that value of surface rating and user's based rating score are 2.5 and 4.34 respectively.

#### 1.0 Introduction

Deterioration of a pavement system is becoming a serious problem for most roads under full operational condition in developing countries like Nigeria. Road failure is however common in many developing countries and keeping these road systems in good condition is the most cost-effective (Tarawneh and Mohmd, 2013). According to Abdulkareem and Adeoti(2004) structural failure of a highway pavement in Nigeria are caused due to the following factors; action of weather and rain, unstable ground conditions and poor drainage, poor construction materials and methods, inadequate maintenance among others.

Okido (2012) found out that failure observed on Nigerian highways are caused as a result of the factors like poor design and construction, use of poor quality material in construction works, poor workmanship and poor supervision. He also suggests the following factors will contribute to the failure of road systems such as local standard of practice, poor laboratory insitu tests on soil sample e.t.c.

To develop economy of a country, transportation systems are very essential and also play a special role in enhancing parameters that lead to significant improvement in a nation's economy.

Generally, prioritization of highway sections for maintenance operations in Nigeria have been based on experienced and judgment of highway engineers and maintenance personnel. However, due to the randomness and complex interactions of the factors involved in pavement deterioration mechanisms, this approach is inefficient, prone to errors and may lead to improper scheduled maintenance activities. Initial assessment of the physical pavement condition can be carried out through a visual assessment on the flexible surface condition.

Consequently, with the increase in traffic usage and awareness of pavement management system however this menace can be addressed by designing a proper method of assessing the pavement failure through the effective development of inventory of the conditions of road networks within Unilorin Campus as perceived subjectively by the regular/captive road users. The inventory so developed will assist in the identification of failure patterns and the deserving preventive maintenance measures. User's based rating score using subjective assessments and surface rating index from objective assessments would help in predicting the current condition of the road system. According to DOT, 2003 the rating scale is between 0.0-4.0. As the type, amount and severity of the different types of defects increases, the surface rating decreases. Therefore, the newly constructed road has an approximate value of 4.0 as surface rating index. Meanwhile, the prevalent occurrence of failure observed on this facility gave rise to this effort and possible measures which will be adopted could lead to a better results.

However, the aim of this study is to assess the failure pattern of some selected sections of Unilorin campus road and following objectives were drawn;

- (i) Identification of various types of pavement failure on flexible pavements with a particular reference of Unilorin Road network.

- (ii) Establishment of surface rating and user's based rating score of the selected road network.

#### **MATERIALS AND METHODS**

In this study, two methods were used to assess the performance of a road networks within Unilorin campus. The length of the selected road section is 2.75Km. The methods are; subjective assessment and objective assessment. Subjective assessment is one in which structured questionnaires containing relevant information on road performance are distributed to the road users while objective assessment entails proper visual condition survey to the entire study area. Different types of failure pattern were observed during the survey. These types of failure were analyzed thoroughly and critical occurrences of the defects were considered. Having conducted the survey, total weighted failure using appropriate equations were established. The results obtained were then compared with DOT Distress Identification Manual, 2003 for the purpose of generating the current surface rating of the road network. The tools used for the collection of the relevant data are; measuring tape, ruler, digital camera, record sheets, paint and brush.

#### **Description of the Study Area**

The University of Ilorin is located in Ilorin which is between Latitude  $8^{\circ} 25' 00''$  N and  $8^{\circ} 32' 00''$  N and longitude  $4^{\circ} 30' 41''$  E. The town is by its geographical location usually referred to as the gateway city between the northern and the southwest parts of Nigeria. The town is also centrally located to a number of very important places in Nigeria. Unilorin campus road started from the main gate to the university central area with a distance of about 6km and approximate width of 7.5m. Figures 2.1, 2.2 and 2.3 represent the various pattern of the failure observed on this road network.



Figure 2.1: Chainaging at 25m intervals



Figure 2.2: Cracking and potholes



Figure 2.3: Cracking, potholes and raveling

### Data Collection

University of Ilorin campus road is one of the major arterial that connects very important places within the university premises like Senior and Junior Staff quarters, Staff Schools, Central

Mosque, Church, and general area of the University. Being the major route, the facility continue to experience frequent surface defects which affect the general performance of the road and motorists.

Based on this problems, two methods were used to come up with a better solution, collection of relevant data and appropriate measures was also adopt to tackle the prevalent menace. The methods are; subjective and objective assessments.

**Subjective Assessments**

In this method, the desired data were collected after distributing 120 well-structured questionnaire to the road users in their respective locations such as faculties, departmental units among others. Meanwhile, 105 questionnaires were returned and sample size was establish to be 100 using simple statistical analysis.

**Objective Assessments**

Visual condition surveys were carried out in collecting relevant data using objective assessments method. In order to avoid unnecessary mistakes and to understand the present condition of the study area, 100m tape was used to measure the total distance of the route of study. After the above mentioned exercise, then the inventories of the road (i.e

types of road failure) were taken using relevant engineering tools. The data collected were then analyzed to predict appropriate maintenance measures.

**Empirical Equations used in Objective assessments**

The following equations are used to calculate the overall surface rating of bituminous pavements;

$$\text{percentage of cracks (\%)} = \frac{\text{length of cracks observed}}{\text{length of the section being surveyed}} \times 100 \text{ -----}$$

(2.1)

$$\text{percentage of Raveling (\%)} = \frac{\text{length of raveling observed}}{\text{length of the section being surveyed}} \times 100 \text{ -----}$$

(2.2)

$$\text{percentage of pothole (\%)} = \frac{\text{number of potholes}}{2} \times 100 \text{ (not to exceed 100\%)} \text{ --- (2.3)}$$

However, Table 1 and 2, clearly describe the weighting factor and surface rating of a bituminous pavement using the standard of DOT Distress Identification Manual, 2003.

Table 1: Bituminous Pavement Weighting Factors

Failure Type	Weighting factor
Cracking (alligator and block)	0.25
Rutting	0.15
Raveling	0.02
Patching/pothole	0.04

Source: Adapted DOT Distress Identification Manual, 2003

Table 2: Surface Rating of Bituminous Pavements

Total	weighted	Surface Rating (SR)		
Percent				
0		4.0	19-20	1.7
1		3.8	21	1.6
2		3.6	22-23	1.5
3		3.4	24	1.4
4		3.2	25-26	1.3
5		3.0	27	1.2
6		2.9	28-29	1.1
7		2.8	30-33	1.0
8		2.7	34-40	0.9
9		2.6	41-47	0.8
10		2.5	48-54	0.7
11		2.4	55-61	0.6
12		2.3	62-68	0.5
13		2.2	69-75	0.4
14		2.1	76-82	0.3
15		2.0	83-89	0.2
16-17		1.9	90-96	0.1
18		1.8	97-100	0.0

Source: Adapted DOT Distress Identification Manual, 2003

**RESULTS AND DISCUSSION**

**Pavement Condition Survey (From Unilorin Main Gate to Former Secondary School Road)**

Table 3 shows in details the present condition of the study area. The prevalent failure types

and their magnitude in terms of size and number are clearly presented using objective assessments.

Table 3: Results of the Pavement Condition Survey (Unilorin Campus Road)

Chainage (m)	Pothole(n o)	Cracking(m)	Raveling(m)				
0+000-	-	-	-	0+225			
0+025				0+225-	-	20.00	-
0+025-	-	20.43	-	0+250			
0+050				0+250-	-	24.71	-
0+050-	-	20.01	10.00	0+275			
0+075				0+275-	-	15.44	10.09
0+075-	-	15.03	5.00	0+300			
0+100				0+300-	-	25.18	8.07
0+100-	-	25.13	5.03	0+325			
0+125				0+325-	6	24.91	15.03
0+125-	-	25.42	-	0+350			
0+150				0+350-	3	15.03	-
0+150-	-	20.03	5.04	0+375			
0+175				0+375-	3	25.15	5.43
0+175-	3	15.01	-	0+400			
0+200				0+400-	2	20.04	7.25
0+200-	4	20.22	-	0+425			
				0+425-	1	24.54	6.17
				0+450			

0+450-	2	25.32	3.45	1+050-	9	24.53	-
0+475				1+075			
0+475-	-	24.63	-	1+075-	3	20.00	-
0+500				1+100			
0+500-	2	25.04	2.44	1+100-	7	15.00	-
0+525				1+125			
0+525-	-	24.82	-	1+125-	3	10.05	-
0+550				1+150			
0+550-	-	15.23	-	1+150-	3	10.07	-
0+575				1+175			
0+575-	3	24.52	-	1+175-	2	5.14	-
0+600				1+200			
0+600-	-	25.01	-	1+200-	2	5.35	-
0+625				1+225			
0+625-	2	25.33	-	1+225-	6	10.00	-
0+650				1+250			
0+650-	-	25.21	-	1+250-	2	5.02	-
0+675				1+275			
0+675-	1	15.00	-	1+275-	1	-	5.11
0+700				1+300			
0+700-	3	24.81	-	1+300-	10	15.00	-
0+725				1+325			
0+725-	2	20.01	5.01	1+325-	7	15.36	-
0+750				1+350			
0+750-	3	20.34	-	1+350-	-	20.19	-
0+775				1+375			
0+775-	4	24.61	-	1+375-	3	5.08	3.23
0+800				1+400			
0+800-	4	25.08	-	1+400-	-	5.00	8.07
0+825				1+425			
0+825-	1	20.00	-	1+425-	-	-	3.00
0+850				1+450			
0+850-	2	20.41	-	1+450-	1	3.03	-
0+875				1+475			
0+875-	6	24.50	-	1+475-	4	10.04	-
0+900				1+500			
0+900-	1	20.07	-	1+500-	-	-	3.02
0+925				1+525			
0+925-	5	10.11	-	1+525-	3	3.14	2.06
0+950				1+550			
0+950-	2	20.04	-	1+550-	-	10.00	-
0+975				1+575			
0+975-	1	15.03	-	1+575-	1	5.09	-
1+000				1+600			
1+000-	2	20.05	-	1+600-	3	-	-
1+025				1+625			
1+025-	3	20.41	-	1+625-	-	20.00	-
1+050				1+650			

1+650-	-	-	-	1+925	-	-	-
1+675	-	-	-	1+925-	-	5.11	-
1+675-	-	-	-	1+950	-	-	-
1+700	-	-	-	1+950-	-	-	-
1+700-	-	-	3.05	1+975	-	-	-
1+725	-	-	-	1+975-	-	2.34	-
1+725-	-	-	2.03	2+000	-	-	-
1+750	-	-	-	2+000-	-	-	-
1+750-	-	-	-	2+025	-	-	-
1+775	-	-	-	2+025-	-	10.00	-
1+775-	-	-	-	2+050	-	-	-
1+800	-	-	-	2+050-	-	5.36	-
1+800-	-	10.00	-	2+075	-	-	-
1+825	-	-	-	2+075-	-	10.04	-
1+825-	-	5.03	-	2+100	-	-	-
1+850	-	-	-	2+100-	-	-	-
1+850-	-	5.06	2.03	2+125	-	-	-
1+875	-	-	-	2+125-	-	5.09	3.01
1+875-	-	5.11	-	2+150	-	-	-
1+900	-	-	-	2+150-	-	15.05	-
1+900-	-	2.45	-	2+175	-	-	-

**Analysis of Results using Objective Assessments Method**

Table 4: Calculation of Weighted Failure (Cracking)

Chainage (m)	Cracking (m)	Percentage of crack (%)	Weighted Failure= (% of crack× 0.25)
0+100-0+125	25.13	0.91	0.228
0+125-0+150	25.42	0.92	0.230
0+250-0+275	24.71	0.90	0.225
0+300-0+325	25.18	0.92	0.230
0+325-0+350	24.91	0.91	0.228
0+375-0+400	25.14	0.91	0.228
0+425-0+450	24.54	0.89	0.223
0+450-0+475	25.32	0.92	0.230
0+475-0+500	24.63	0.90	0.225
0+500-0+525	25.04	0.91	0.228
0+525-0+550	25.82	0.94	0.235
0+575-0+600	24.52	0.89	0.223
0+600-0+625	25.01	0.91	0.228
0+625-0+650	25.33	0.92	0.230
0+650-0+675	25.21	0.92	0.230
0+700-0+725	24.85	0.90	0.225
0+775-0+800	24.61	0.89	0.223
0+800-0+825	25.08	0.91	0.228
0+875-0+900	24.55	0.89	0.223
1+050-1+075	24.92	0.91	0.228

Table 5: Calculation of Weighted Failure (Pothole)

Chainage (m)	Pothole (no)	Percentage of pothole (%)	Weighted Failure= (% of pothole x 0.04)
0+325-0+350	6	12	0.48
0+875-0+900	6	12	0.48
0+925-0+950	5	10	0.40
1+050-1+075	9	18	0.72
1+100-1+125	7	14	0.56
1+225-1+250	6	12	0.48
1+300-1+325	10	20	0.80
1+325-1+350	7	14	0.56

Table 6: Calculation of Weighted Failure (Raveling)

Chainage(m)	Raveling (m)	Percentage of Raveling (%)	Weighted Failure= (% of raveling x 0.02)
0+50-0+075	10.00	0.36	0.0072
0+075-0+100	5.00	0.18	0.0036
0+100-0+125	5.03	0.18	0.0036
0+150-0+175	5.04	0.18	0.0036
0+275-0+300	10.09	0.37	0.0074
0+300-0+325	8.07	0.29	0.0058
0+325-0+350	15.03	0.55	0.0110
0+375-0+400	5.43	0.20	0.0040
0+400-0+425	7.25	0.26	0.0052
0+425-0+450	6.17	0.22	0.0044
0+725-0+750	5.01	0.18	0.0036
1+275-1+300	5.11	0.18	0.0036
1+400-1+425	8.07	0.29	0.0058

Table 3.5: Summary of Weighted Failure obtained from Unilorin Campus Road

Failure Type	Weighted Failure
Cracking	4.548
Pothole	4.480
Raveling	0.069
Total Weighted Failure	9.097

#### Analysis of Results obtained From Administered Questionnaire

The following charts i.e. Figure 1-13 are the analysis of the results obtained from established

questionnaire that are distributed to the road users.



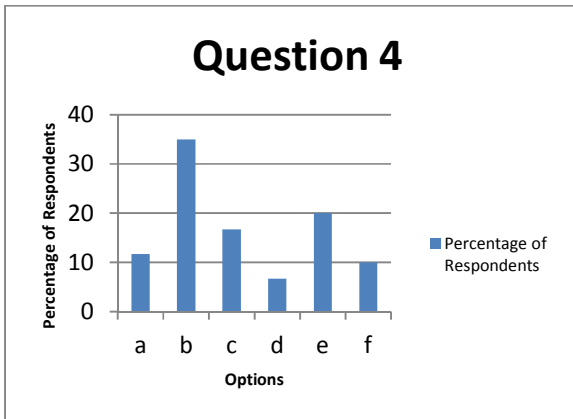


Figure 1: Percentage of Respondents versus Options (Q4)

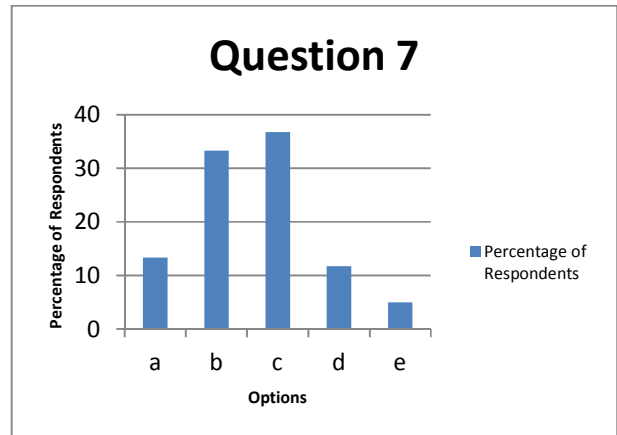


Figure 4: Percentage of Respondents versus Options (Q7)

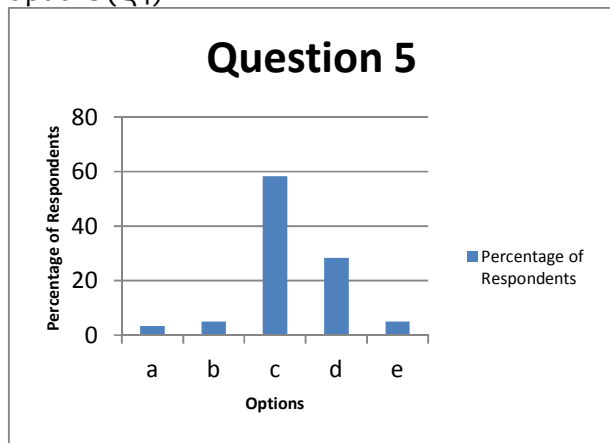


Figure 2: Percentage of Respondents versus Options (Q5)

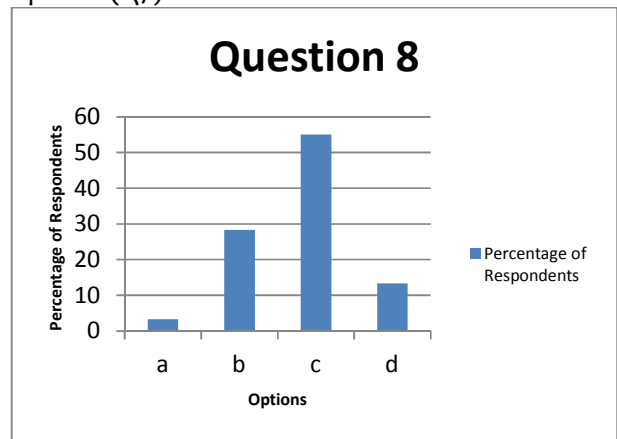


Figure 5: Percentage of Respondents versus Options (Q8)

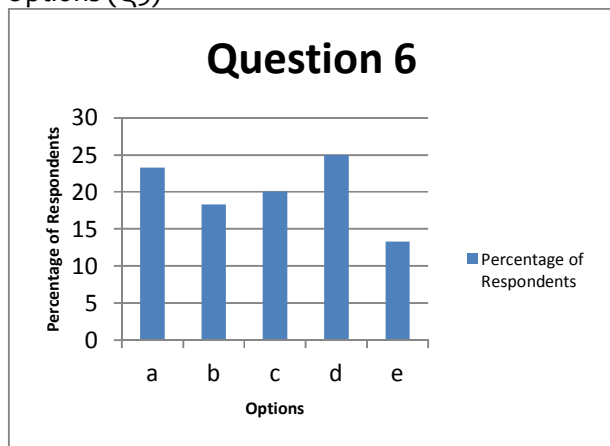


Figure 3: Percentage of Respondents versus Options (Q6)

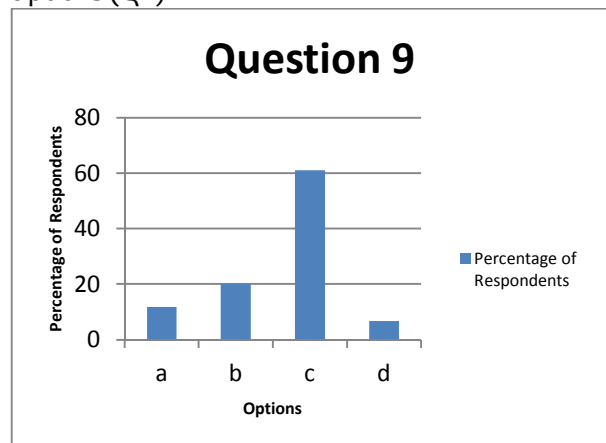


Figure 6: Percentage of Respondents versus Options (Q9)

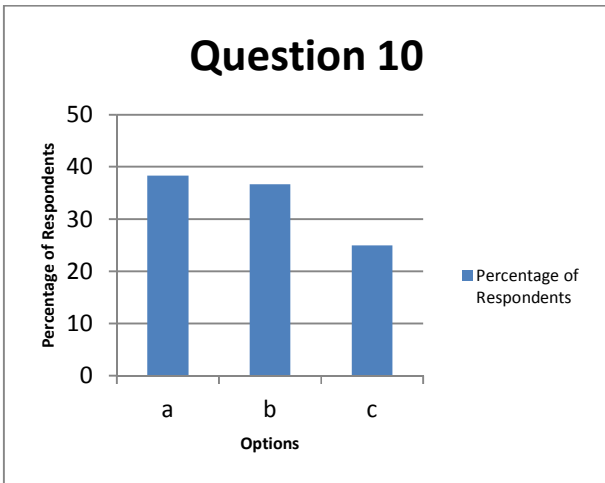


Figure 7: Percentage of Respondents versus Options (Q10)

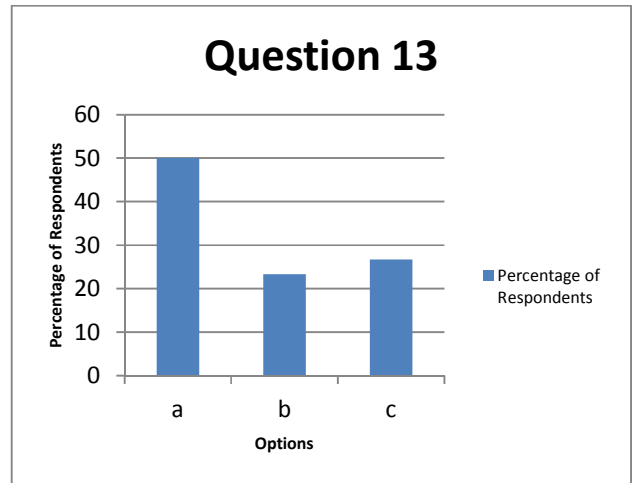


Figure 10: Percentage of Respondents versus Options (Q13)

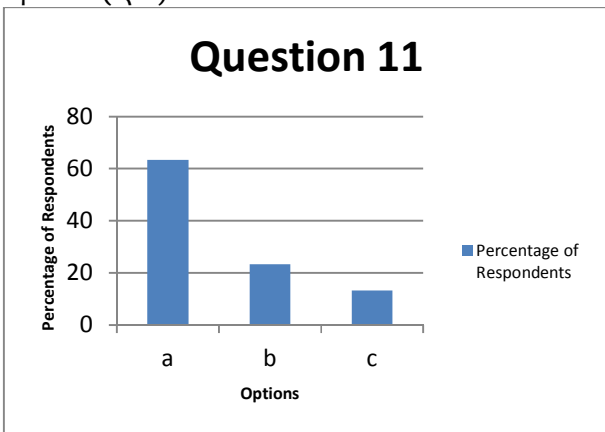


Figure 8: Percentage of Respondents versus Options (Q11)

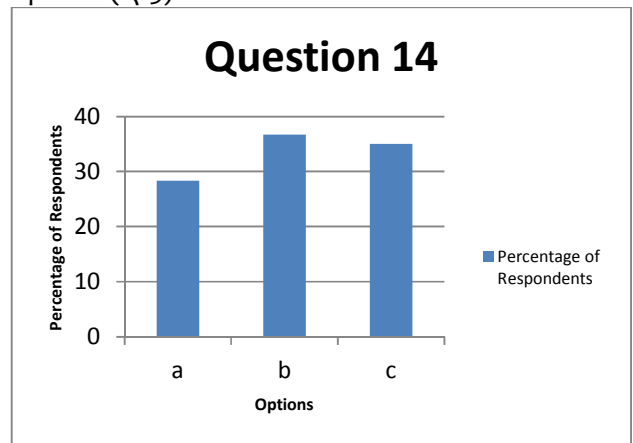


Figure 11: Percentage of Respondents versus Options (Q14)

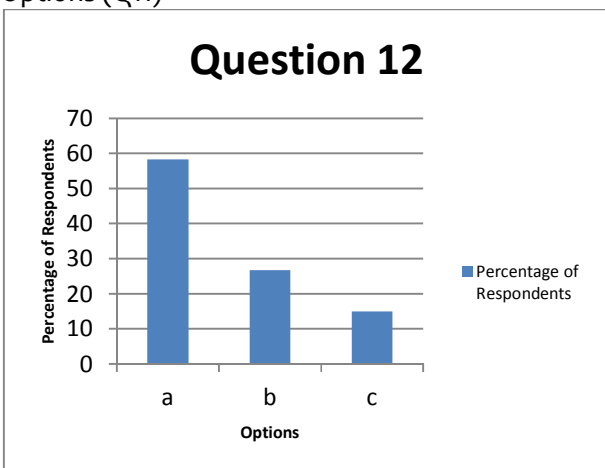


Figure 9: Percentage of Respondents versus Options (Q12)

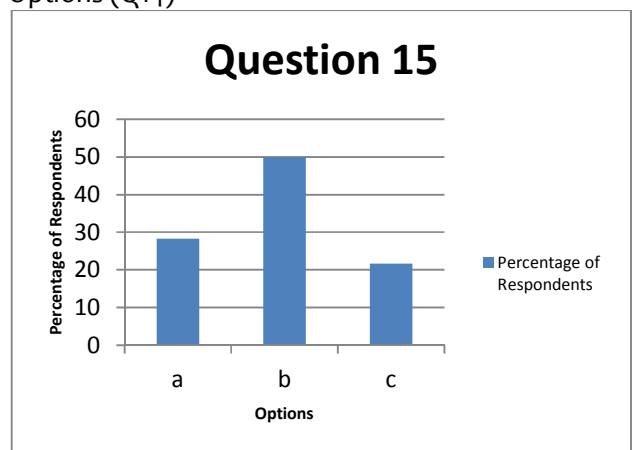


Figure 12: Percentage of Respondents versus Options (Q15)

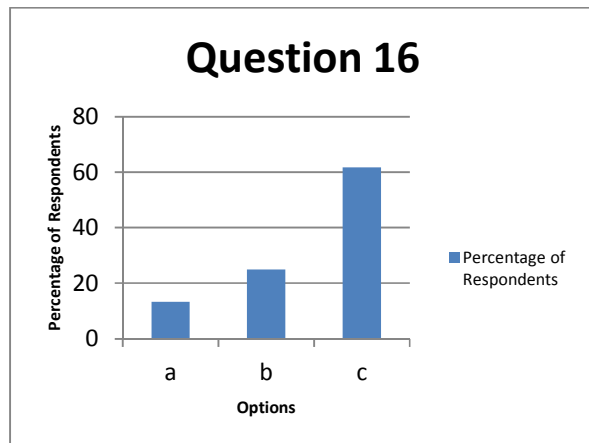


Figure 13: Percentage of Respondents versus Options (Q16)

**Determination of User’s Based Rating Score**

According to Hick’s et al., 2011 user’s rating score of a given road system could be established using factors like performance evaluation, constructability and maintenance, Performance Evaluation Attributes Rating Factor

25 %	Failures observed	0.25
61 %	Causes of failure	0.61
50 %	Failure before end of the expected design life	0.50

Constructability and Maintenance Attributes

63.3 %	Experience of maintenance team in work accuracy	0.63
36.7 %	Design and construction accordant with standard	0.37
50 %	Quality of maintenance work executed	0.50

Road User Satisfaction Attributes

58 %	Present condition of the road network	0.58
55 %	Riding quality of the road	0.55
35 %	Changes on the road with regards to its performance	0.35

4.34

and road user satisfaction. The above mentioned attributes were analyzed thoroughly using relevant information from administered questionnaire.

**DISCUSSION**

**Objective Assessments Method**

After conducting the visual condition survey, the prevalent defects observed are cracking, pothole and raveling. The critical values among the defects were analyzed thoroughly in order to establish the current rating of the road surface. Weighted failure of each defect were calculated and the results are; cracking=4.548, pothole=4.48 and raveling=0.069. Having obtained the results, total weighted failure was also computed by summing the above results i.e. 9.097. The obtainable results were then

compared with DOT Distress Identification manual, 2003 and approximate surface rating of the road system was established as 2.5.

**Subjective Assessments Method**

With regards to subjective assessments, 4.34 were obtained as the overall rating score of this particular road section. Having compared the value with DOT Distress Identification manual, 2003 clearly shows that the condition of the road system is still fair and consequently the expected treatment measures required is localized repair or rehabilitation with thin overlay using appropriate asphaltic material.

### CONCLUSIONS AND RECOMMENDATIONS

After thorough analysis of the results obtained, the following conclusions and recommendations were drawn;

- (i) Three types of failure pattern were found to be frequent on this selected portion of road system. Among the three types, cracking was the prevalent in terms of occurrence followed by potholes and lastly raveling. It was concluded that the value of weighted failure obtained for the respective defects are cracking 4.548, pothole 4.48 and raveling 0.069.
- (ii) It was also concluded that 2.5 and 4.34 were obtained as the respective surface rating and user's based rating score of this facility. Using this value, maintenance agencies can decide on prioritizing the treatment measures.

- (iii) Having obtained the rating scores, careful comparison with DOT Distress Identification Manual, 2003 was done in order to establish suitable treatment measures. It was concluded that total rehabilitation of the affected area should be encourage using an appropriate asphaltic material.
- (iv) It is recommended that the rating indices which were developed using two appropriate methods should serve as a guide to any maintenance and other relevant agencies in finding out suitable treatment to these defects.
- (v) It is also recommended to implore more sophisticated equipments and methods. This effort will help in covering larger distance route and consequently more realistic results could be obtained.

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**Questionnaire**

Acceptable?	5	Very Good
Yes	4	Good
No	3	Fair
Undecided	2	Poor
	1	Very Poor
	0	

Section Identification \_\_\_\_\_ Rating \_\_\_\_\_  
 Rater \_\_\_\_\_ Date \_\_\_\_\_ Time \_\_\_\_\_ Vehicle \_\_\_\_\_

Fig.1.0 Present Serviceability Rating (Source: AASHTO, on a scale of 0-5)

Table 1.0 Present Serviceability Rating

Rating	Condition of the Road
1	Very poor
2	Poor
3	Fair
4	Good
5	Very good



Figure 3.0: Pothole



Figure 4.0: Raveling



Figure 5.0: Transverse Cracking

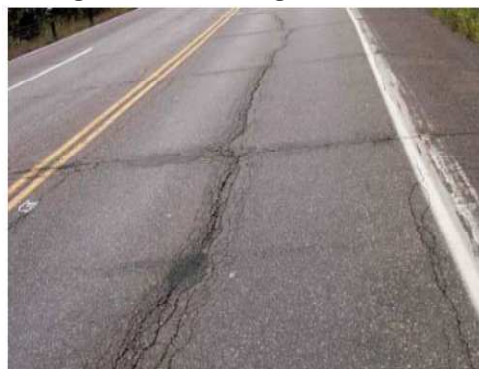


Figure 6.0: Longitudinal Cracking



Figure 7.0: Alligator cracking



Figure 8.0: Rutting

Note: Please kindly refer to the Table & figures above while attempting the following questions.

- (1) Sex
  - (a) Male (b) Female
- (2) Marital Status
  - (a) Married (b) Single
- (3) Occupation
  - (a) Student (b) Civil Servant (c) self employed (d) unemployed
- (4) What changes do you observed on this road network (i.e. from university Gate to Former Unilorin Secondary School Road) in terms of performance?
  - (a) Comfortable (b) convenient (c) uncomfortable (d) inconvenient (e) fair (f) poor riding quality
- (5) What is the present condition of road network from University Gate to Former Unilorin Secondary School Road?
  - (a) Very poor (b) Poor (c) Fair (d) Good (e) Very Good
- (6) What are the failures observed on this particular road network?
  - (a) Transverse Cracking and Potholes (b) Longitudinal Cracking, Potholes and Raveling (c) Alligator Cracking, Potholes and Rutting (d) Cracking (alligator, longitudinal & transverse), Potholes, and Raveling (e) Potholes, raveling and alligator cracking
- (7) State the frequent failures observed from the options given in question 6 above?
  - i. (a)
  - ii. (b)
  - iii. (c)
  - iv. (d)
- (8) How can you rate the riding quality of these road networks?
  - (a) 1 (b) 2 (c) 3 (d) 4 (e) 5
- (9) What are the possible causes of this Failure?
  - (a) Climatic Factors (b) In Proper Design Method used (c) Poor Workmanship and Incompetent Supervision (d) Excessive Traffic Loads
- (10) Is this particular route of concern in capable of serving the user completely?
  - (a) Yes (b) No (c) undecided
- (11) Does the experience of road maintenance team play an important role in work accuracy?
  - (a) Yes (b) No (c) undecided
- (12) Are the maintenance activities for Paved Roads depend upon Failure type?
  - (a) Yes (b) No (c) undecided
- (13) Is this particular road networks failed before end of its design life (life span)?
  - (a) Yes (b) No (c) undecided
- (14) Are the design and construction methods used in these road networks accordant with the standard provided?
  - (a) Yes (b) No (c) undecided
- (15) What is your opinion in the level of maintenance works in these routes with standards?
  - (a) Acceptable (b) Not acceptable (c) undecided
- (16) As a road user, what can you suggest in terms of maintenance aspect to be more suitable in addressing this problem?
  - (a) Restructuring pavement maintenance team (b) More funds to be allocated to the maintenance unit (c) Adopting and explore proper method of maintenance