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Effect of Road Network on Maintenance of Commercial Vehicles in the Birim Central Municipality

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Abstract: The study examined the effects and the relationship between the nature of the road network system in the Birim Central Municipality and the routine maintenance schedule by the vehicle manufacturers that are to be observed by vehicle owners and drivers. In addition to that, the study was also meant to find out whether the frequent maintenance as a result of the nature of the road network affects the vehicle owners and drivers income generation. A descriptive survey design was used to analyze the study. The population consisted of vehicle owners, drivers and vehicle mechanics (fitters) totaling hundred (100) randomly selected from the municipality. Questionnaires were designed and used to collect the required data for the study. The data was analyzed using Statistical Package for Social Sciences (SPSS v 16).The study revealed that, the area under-studied had bitumen, gravel and earth roads and most vehicle owners and drivers ply on bitumen because of its accessibility, notwithstanding, they intend to perform more maintenance than those plying on gravel and earth roads which was as a result of poor nature that deters most vehicles. Generally, the nature of gravel and earth roads which are mainly found in rural areas are bad and does not receive regular road maintenance. The results obtained from the analysis indicated clearly that, more than GH¢ 21.00 (61.2%) is spent on weekly maintenance in the area, and this leads to low level of income. Additionally, the results revealed that, the respondents do not refer manufacturer's manuals when performing maintenance on their vehicles as indicated by 96% of them. The road maintenance in the municipality generally is not the best and this makes gravel and earth roads not accessible and motorable and again promotes frequent breakdowns of vehicles.
Based on the findings, recommendations are therefore made for the necessary actions to be taken.

Keywords: Road Network, Schedule Maintenance, Transport, Safety, Profit, Manufacturer's Manual

1. INTRODUCTION

The nature of the road network system in the Birim Central Municipality is a great challenge on the conditions of the vehicles. Transport business has now become a major occupation by the people within the municipality but the nature of road network hinders them from rendering quality services and also prevents them to stick to the maintenance schedule planned for their vehicles within the specified period. Birim Central Municipality is made up of three kinds of roads which comprising bitumen, gravel and earth with which gravel roads form the majority and the bitumen the least. Bitumens are mixture of high-molecular hydrocarbons, methane, naphthene and aromatic series and their oxygen or sulphur derivatives. The major application of bitumen is road construction to ensure rapid movement of goods and services as well as people within the research area. According to [9], asphaltum or tar concrete as artificial material manufactured by compacting a special mixture composed of crushed stone (gravel), sand, mineral powder, bitumen or tar and pitch as a material used in road construction. According to [6], gravel roads can cater heavier traffic and are considered as cheap all-weather roads. The carriageway of this type of road is provided with a camber. These roads are fairly resilient and are suitable to cater for about 100 tonnes of pneumatic tyred vehicles of 60 tonnes of iron tyred traffic per day per lane or average daily traffic between 350-400 vehicles. Earth road is the lowest form of the surface. The nature of these roads in Birim municipality is in a very deplorable state to the extent that, drivers plying on these roads are not able to adhere to the routine maintenance schedule specified by the vehicle manufacturers as a result of constant breakdown of vehicles which needs urgent maintenance response to keep them operating. The bad nature of the roads includes potholes, undulating surfaces and erosion. Adhering to the proper routine vehicle maintenance schedule is important to help keep the vehicle in top running condition and to make profits as far as transport business is concerned [2],[4]. The good nature of road network system is a guarantee to the safe mobility of goods and people from one location to other to enhance business activities. According to [8], high maintenance and operation are important aspect of highway engineering. Involved are the repair and upkeep of surfacing and shoulders, bridges and damaged facilities. Routine vehicle maintenance is the effective way of ensuring that the vehicle is in good condition for day's work. Objectives of maintenance includes; extension of useful life of the vehicles to ensure optimum availability of vehicles for operation to ensure the comfort and safety of personnel's using the vehicles [10].The minimum maintenance to be performed by any vehicle owner or driver is the one stated in the manufacturers maintenance schedule manual. This could be done hourly, weekly, monthly, or yearly, but due to the poor nature of the road network system in the Birim Central Municipality the vehicle owners and drivers perform the maintenance services more often and earlier than stated in the vehicles manual. The routine maintenance to ensure good condition of vehicles covers change of the following; engine oil and filter, tyre and air filter, fuel filter replacement, coolant replacement, transmission service, axle service, battery service, timing belt [3]. No work of this nature has been done to report the effect road network on vehicle maintenance. In view of the above conditions, the present study was undertaken to provide the feedback of the effects that poor nature of the road network has on both commercial vehicles and the rural folks as far as vehicle maintenance is concerned.

2. RESEARCH METHODOLOGY

2.1 Research Design

The study adopted descriptive method to gather the relevant data obtained from the research area. This method was adopted, because the descriptive study seeks to gather information so that a proper presentation and conclusion can be made. This method may be designed to discover whether there is any relationship between two variables [1].

2.2 Study Area

Birim central municipal district is one of the twenty-one-district of the Eastern region of Ghana. The municipal district is located in the southwestern corner of the Eastern Region. The municipal district covers a land size of 1,090 km^2 (420sq mi) and Akim Oda is the capital. The Birim central municipal district is one of the new districts created in 2008 in Ghana. The population settlements of Birim central municipal district is 60,604 per the population and housing census in 2013 [7].

2.3 Population and Sampling Technique

The population in the study refers to the vehicle owners, drivers and mechanics (fitters) and objects that have valuable information to give about the research. The target population for this study was drawn from the Birim Central Municipality consisting of fifty (50) drivers, thirty (30) vehicle owners and twenty (20) vehicle mechanics (fitters). A simple random sampling technique was adopted for data collection in the study.

2.4 Data Collection Instrument

The researcher basically used questionnaires, unstructured interviews, visits and observations to collect the required data study.

2.5 Data Analyses Instrument

The data obtained from the respondents was analysed using the Statistical Package for Social Sciences version (SPSS v 16). This was chosen for easy analysis and a better understanding of the study by interested parties.

3.0 RESULTS AND DISCUSSIONS

Table 1: Types of vehicular roads by occupation χ^2=1.974, p-value=0.373

	Occupation:		
Variables	**Driving**	**Vehicle owner**	**Total**
Bitumen	46	18	64
	76.7%	90.0%	80.0%
Gravel	11	2	13
	18.3%	10.0%	16.2%
Earth	3	0	3
	5.0%	.0%	3.8%
Total	60	20	80
	100.0%	100.0%	100.0%

Presented in Table 1 above shows the type of vehicular roads in the Birim municipality and the results show that more than two-thirds of the respondents (n=64, 80%) reported that they ply on Bitumen roads whereas 13 respondents representing 16.2% reported of Gravel roads while the remaining 3 comprising 3.8% reported of earth. There was no association between the occupation of respondents and the types of vehicular roads in the municipality (χ2=1.974, p-value=0.373).

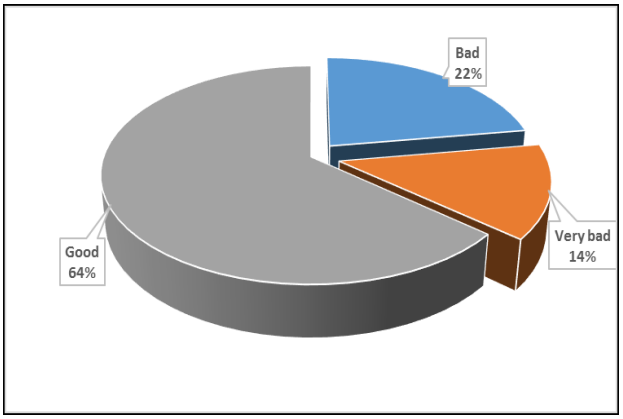

Figure 1: Condition of roads in the Municipality

Table 2: Routine/Periodic maintenance schedule carried out by type of road χ2=6.233, p-value=0.182

	Type of vehicular road			
Variable	**Bitumen**	**Gravel**	**Earth**	**Total**
Daily maintenance	24	2	0	26
	37.5%	15.4%	.0%	32.5%
Weekly maintenance	35	11	3	49
	54.7%	84.6%	100.0%	61.2%
Monthly maintenance	5	0	0	5
	7.8%	.0%	.0%	6.2%
Total	64	13	3	80
	100.0%	100.0%	100.0%	100.0%

Table 2. Is a cross-tabulation of results on the routine/period maintenance schedule carried out by respondents by the type of roads in the municipality? Analysis of the results shows that, more than half of the respondents (n=49, 61.2%) carry out scheduled maintenance weekly, whiles 26 respondents representing 32.5% of the entire respondent population carry out maintenance Daily. The table also shows that majority of the drivers who drive on Bitumen type of road undertake weekly maintenance which represents 35 of the respondents. However, no association was found between responses on the routine/periodic maintenance carried out and they type of road (χ^2 =6.233, p-value=0.182).

Table 3. The nature of the road condition by type of vehicular road χ^2=56.725, p-value<0.001

Condition of Road	Type of vehicular road			
	Bitumen	**Gravel**	**Earth**	**Total**
Bad	11	4	3	18
	17.2%	30.8%	100.0%	22.5%
Very bad	2	9	0	11
	3.1%	69.2%	.0%	13.8%
Good	51	0	0	51
	79.7%	.0%	.0%	63.8%
Total	64	13	3	80
	100.0%	100.0%	100.0%	100.0 %

Table 3 above gives an idea about the condition of vehicular roads in the Birim municipality. The table gives evidence that majority of the roads in the municipality are in good condition as more than half of the respondents (n=51, 63.8%) reported. However, 18 respondents representing 22.5% of the entire population reported that the roads are bad. The results showed a statistically association between the responses of respondents on the condition of roads and the type of vehicular roads in the municipality (χ^2=56.725, p-value<0.001).

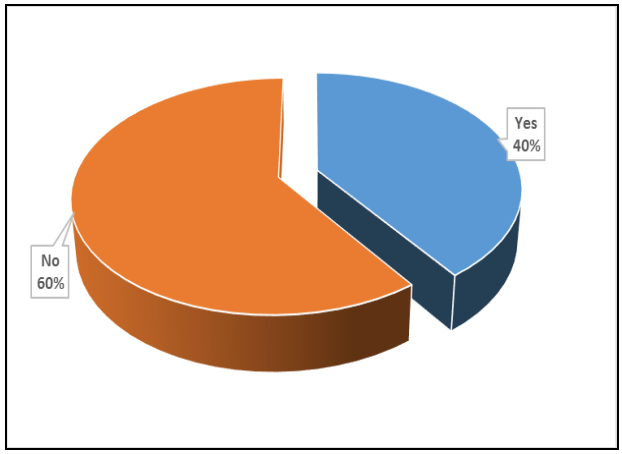

Figure.2. Does the road you ply receive regular road maintenance?

Respondents were asked to indicate whether roads in the municipality receive regular maintenance. Figure.2 shows that 60% of the respondents responded 'No' whereas the remaining 40% responded 'Yes'. Those who answered 'Yes' admitted that the maintenance carried out on the road is only patching of potholes as indicated in the Table 4.

Table 4. Type of road maintenance

Responses	Frequency	Percentage
Patching of potholes	32	100.0
Total	100	100.0

Table 5. Influence of bad nature of road on vehicle maintenance

Responses	**Frequency**	**Percent**
It promotes regular vehicle maintenance	28	100.0
Total	100	100.0

Respondents were asked to indicate the nature of the road in the Birim Municipality. From the responses, all those who responded 'Bad' and 'Very Bad' were asked to indicate whether the 'Bad' nature of the road influences or contributes to vehicle maintenance. The responses being shown in Table 5 shows that all the respondents reported that the 'Bad' nature of the road is a major cause of regular vehicle maintenance.

Table 6. The road condition and cost on maintenance schedule

The nature of the road condition	cost on maintenance schedule			
	Daily maintenance	**Weekly maintenance**	**Monthly maintenance**	**Total**
Bad	1	15	2	18
	3.3%	34.1%	33.3%	22.5%
Very bad	4	7	0	11
	13.3%	15.9%	.0%	13.8%
Good	25	22	4	51
	83.3%	50.0%	66.7%	63.8%
Total	30	44	6	80
	37.5%	55.0%	7.5%	100.0 %

(χ^2=11.934, p-value<.05)Pearson's R = -.303, p<.05

Table 6 shows the relationship between road condition and the cost maintenance carried out. The responses shows that, majority of the respondents (n=44, 55%) reported that, it is expensive to carry out weekly maintenance. Also 30 respondents representing 37.5% of the entire population reported, it is expensive to carry out daily maintenance. However, analysis of the results found a statistically significant association between the nature of roads and cost of maintenance schedule (χ2=11.934, p-value<.05).A statistically significant but week negative Pearson's correlation was found between the variables (Pearson's R = -.303, p<.05) 1 tailed. This suggests that there is a negative linear relationship

between the nature of road and the cost of maintenance schedule where the road gets bad. There is an increase in weekly maintenance schedules which has been found to be expensive. Also the relationship was found to be significant which indicates that the linear relationship is strong.

Table 7. The cost of maintenance every week by routine/periodic maintenance schedule to be carried out

	The cost of maintenance every week			
	GH¢ 5.00-10.00	**GH¢ 11.00-20.00**	**> GH¢ 21.00**	**Total**
Daily maintenance	2	6	18	26
	16.7%	24.0%	41.9%	32.5 %
Weekly maintenance	9	17	23	49
	75.0%	68.0%	53.5%	61.2 %
Monthly maintenance	1	2	2	5
	8.3%	8.0%	4.7%	6.2%
Total	12	25	43	80
	15.0%	31.3%	53.7%	100.0 %

(χ^2=4.002, p-value=.406), Pearson's R = -.207, p=.065

Table 7 is a cross-tabulated results showing the cost of maintenance by the routine/periodic maintenance schedule carried out. Reading horizontally, out of the 80 respondents majority (n=49, 61.2%) carry out weekly maintenance whiles incurring more than GH¢21.00 as the cost of vehicle maintenance every week. Further the 26 respondents representing 32.5% maintain their vehicles daily and out of this, majority (n=18, 41.9%) also incur more than GH¢21.00 as cost of maintenance every week. However, at a (χ^2=4.002, p-value=.406) the results showed no association between the cost of maintenance and the period maintenance schedule carried out by respondents. Again there was a negative correlation between the variables in that a reduction in the routine/periodic maintenance carried out the higher the cost of maintenance and the more maintenance works carried out in the week the slower the cost of maintenance.

Table 8. Cost of maintenance every week by age of vehicle under maintenance.

	Age of vehicle under maintenance			
	1-5 years	**6-10 years**	**11-15 years**	**Total**
GH¢ 5.00-10.00	7	4	1	12
	14.0%	15.4%	25.0%	15.0%
GH¢11.00-20.0	19	5	1	25
	38.0%	19.2%	25.0%	31.2%
> GH¢ 21.00	24	17	2	43
	48.0%	65.4%	50.0%	53.8%
Total	50	26	4	80
	62.5%	32.5%	5.0%	100%

The cost of maintenance per week spent with respect to the age of the vehicle is presented in the Table 8. From the table, it was discovered that more than half of the respondents representing 53.8% spends more than GH¢ 21.00 and 25 out of them also representing 31.2% spends between GH¢ 11.00-20.00 on maintenance every week irrespective of the age of the vehicle whereas 15% of the respondents spend between GH¢ 5.00-10.00.Moreover, vehicles ageing between 6-10 years spend more than GH¢ 21.00 as reported by 65.4% of the respondents as against 48% of vehicles within the ages of 1-5 years as the least.

Table 9. Usage of manufacturer's manual during vehicle maintenance (χ^2=2.778, p-value=0.249)

	Usage of manual for vehicle maintenance		
Variable	**Yes**	**No**	**Total**
Driving	4	56	60
	100.0%	58.3%	60.0%
Vehicle mechanic (fitting)	0	20	20
	.0%	20.8%	20.0%
Vehicle owner	0	20	20
	.0%	20.8%	20.0%
Total	4	96	100
	4.0%	96.0%	100.0%

Table 9 shows the usage of manufacturer's manual during vehicle maintenance. Outcome of the analysis shows that 96% of the respondents do not refer to the manufacturer's manual when carrying out vehicle maintenance. However, 4% of the respondents responded 'Yes'. No association was found between the use of manufacturer's manual during vehicle maintenance and the occupation of respondents (χ2=2.778, p-value=0.24.

3.1 DISCUSSIONS

3.1.1 Types of roads in the municipality and how they influence vehicle maintenance

As more people are into transport business in the Birim Municipality, there must be motorable or accessible roads for plying on them. The municipality is made up of three different kinds of vehicular roads. These include bitumen, gravel and earth. However, individual road type must be able to serve its intended function in the municipality. The initial findings of the study shows that a significant number of respondents 80% ply on bitumen road as against 16.2% who ply on gravel road, only 3.8% of the respondents ply on the earth road. It is a fact that these three types of vehicular roads exist in the municipality to facilitate the free movement of both goods and services and people from different locations to another. From the findings it appears that the majority of both drivers and vehicle owners prefer plying on bitumen road to any type of road. The reason is that bitumen roads are accessible and motorable. The results obtained indicated that, (64%) depicts the condition of the road is good as stated by the majority because they ply on only bitumen road. This response is in

line with [9] that bitumen as a mixture is a durable material for road construction. (25%) of the respondents disagreed to the majority's decision that the road condition generally is good, because they ply on gravel and earth roads which are normally found in the remote areas of the municipality. With regards to the number of days plying on the road in a week and occupation (drivers and vehicle owner), the researcher decided to find out how many days do the respondents use their vehicles on the road because the frequent usage of vehicle on a particular road has a great influence on the rate at which vehicle maintenance is done. Again, the results also indicated that, the respondents perform weekly vehicle maintenance irrespective of the road type as depicted by 61.2% of the analysis from the data received. Daily maintenance is the second to weekly vehicle maintenance and the monthly vehicle maintenance is the least of them as they stand at 32.5% and 6.2% respectively. Vehicles that plied on bitumen type of road undergo more weekly vehicle maintenance, this was because most vehicles plied on bitumen road in the municipality. This study therefore suggests that, those that plied on gravel (84.6%) and earth (100 %) roads carry out weekly vehicle maintenance on their vehicles more than that of bitumen (54 .7%) road type. This is as a result of the poor nature of the road network system in certain part of the municipality.

3.1.2 The effects of the nature of road network in the area on vehicle conditions

The results from the analysis of this section of the study revealed that, the majority of the respondents (79.7%) said that the nature of the road network is fairly good. With regards to both gravel and earth roads it was realized that the nature of the road network system is bad as shown by the analysis of 69.2% and 100% respectively. This indicates that the rural areas of the study area which have most of their roads being gravel and earth are not accessible and motorable and even some of the bitumen road is not in good condition. The respondents who said the nature of road networks are bad, also indicated that, it has a great influence on their vehicle maintenance. The respondents were again made to indicate whether the road they ply receives regular road maintenance and more than half of them (60%) said 'No' to that effect but the rest of the respondents (40%) responded 'Yes'. This portrays that, the road maintenance culture in the municipality is generally poor and its affects the road accessibility. Results shown in (Table 7) indicated that, weekly maintenance (55%) was found to be the expensive maintenance schedule irrespective of the nature of the road condition followed by daily maintenance. In the study area, the results shows that, most vehicles ply on bitumen road (which is fairly good) and as a result have more maintenance schedule (63.8%) as compared to other nature of the road conditions. The results again indicated that, drivers and vehicle owners spends more than GH¢ 21.00 to maintain their vehicles as reported by 53.5% of the respondents with respect to weekly maintenance. With the cost of maintenance every week, the respondents spends more on weekly maintenance schedule (61.2%), next is the daily maintenance schedule as indicated by 32.5% of the respondents. Concerning the age of vehicle and maintenance cost, the researcher realized that the respondents incur more than GH¢ 21.00 representing 53.8% and 31.2% of them spend between GH¢ 11.00-20.00 whereby 15% of the respondents pay between GH¢ 5.00-10.00 to keep their vehicles in good conditions regardless of the age. Meanwhile, the respondents spend more (> GH¢ 21.00) on vehicles falling between the age bracket of 6-10 years as indicated by 65.4% of them but they spend less in maintaining those in 1-5 years.

3.1.3 The usage of vehicle manufacturer's manuals for vehicle maintenance

The researcher sought to enquire whether the respondents perform their vehicle maintenance under the guidance of the manufacturer's manuals and the study clearly showed that, they do not consult the manufacturer's manuals when carrying out the maintenance on their vehicles. The results revealed that, (96%) of the respondents said 'No' and the remaining of the respondents (4%) answered 'Yes'. Without consultation of vehicle maintenance manuals, it makes it difficult for one to know the kind of maintenance to be carried out and when to do so. [2],[3] Reported that, the best source of information about scheduled maintenance is from the vehicle manufacturers. He again describes manuals as books provided by vehicle manufacturers to users in which rules and regulations which will help in the safe and effective use of their equipment (vehicles) are clearly written. Once the respondents do not refer to manuals, to know the required scheduled maintenance to be performed as stated by manufacturers, it is evidence that the proper vehicle maintenance may not be carried out.

4.0 CONCLUSION

The study has shown that the three kinds of vehicular roads (bitumen, gravel and earth) in the municipality, bitumen is more motorable than the rest but the nature of these roads system is bad and discourages free movement vehicles especially gravel and earth as the majority of road network linking the various rural areas. Owing to this, drivers who ply on these roads (gravel and earth) incur high maintenance cost as a result of frequent breakdown. From the research, it was also found that drivers and vehicle owners perform weekly maintenance more than any other maintenance and also discovered from the poor nature of the road network. The bad nature of the road can be checked by ensuring regular and proper road maintenance such as patching of potholes, grass cutting along the roads, reshaping etc. to make it more accessible but the study indicated that the roads do not receive regular and proper maintenance as they should and the only maintenance carried out is patching of potholes which is not even as regular to keep the road halfway maintained in shape for easy accessibility. Drivers and vehicle owners pay more to maintain their vehicles as the study indicated and it found to be the reason for income reduction as far as transport business in the area is concerned and if they continue to spend more on maintenance can discourage them from performing the regular routine maintenance of their vehicles. Furthermore, they pay more once again to maintain their vehicles as they are getting older within the age range of 6-10 years. Drivers, vehicle owners as well as vehicle mechanics do not refer the manufacturers' manuals which contain the key instructions for maintaining the vehicles.

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