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Assessment of Road Conditions Using Road Lab Pro and Daily Road Voyager

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Abstract:-This work described and analyzed the roughness of the surveyed road using two applications-Road Lab Pro and Daily Road Voyager. These phone applications are entirely different in work and function based on their configuration to enable the user carry out specific task in checkmating the road abnormalities.

A qualitative approach was used in the data collection and analysis using two applications (RoadLab Pro and Daily Road Voyager) to estimates the roughness based on kinematic and GPS sensors in the smartphone, records the path taken and bumps encountered, and allows entering tags. The result of the study was based on the survey carried out significant on proximity in measured data with total survey length and average speed was observed that total pavement deterioration on some sections of the road was not sensed by the RoadLab Pro application; this may be a failure which smart phone applications reliant on accelerometers as primary roughness sensors may not detect.

Keywords:- *Pavement Roughness, Roadlab Pro, Daily Road Voyager, Road Asset Management System, Road Condition Monitoring.*

I. INTRODUCTION

Road condition monitoring is a road quality assessment method which plays an important role in infrastructure management and helps in allocation of road maintenance resources, its primary objective is to detect distress on the road surface by measuring surface abnormalities. Essentially, it provides an indication of the level of serviceability of any road network; an indicator of the comfort expected by commuters, presence of hazards along route, possible wear and tear on vehicles plying the route and so on. Hence, data collected through road condition assessments forms a major component of any effective Road Asset Management System (RAMS) and basis for road maintenance(Ekpenyong et al., 2021)

According to ASTM International, E867-06 (2012) standard, pavement roughness is defined as "the deviation of a surface from a true planar surface with characteristic dimensions that affect the vehicle dynamics and ride quality" (ASTM International, 2012). In essence, pavement roughness is a quantitative representation of distress in pavement and major parameter for pavement surface (ASTM International, 2012).

Pavement Roughness is measured using the International Road Roughness Index (IRI), irrespective of the technology employed. IRI is described as "a mathematical representation of the accumulated suspension stroke of a vehicle, divided by the distance travelled by the vehicle during a test". The units are millimeter/meter (mm/m). In developing countries, challenges exist in the collection of road roughness data for entire road networks. The prohibitive cost associated with data collection from the manual approach to the cost of acquiring state of the art systems, the cost of maintaining such equipment, its level of expertise needed and difficulty of regular network scale deployment have rendered most data collection approach unsustainable for developing countries. Alternatively, smartphone-based road condition monitoring systems fill the gap between sophisticated systems and the subjective ratings by experienced crews. Recent advances in computing and sensor technology indicates ubiquitous and pervasive computing applications for intelligent infrastructure systems thereby justifying the use of this technology as it falls within the accuracy limit of an IQL-3/4 device of ± 20%. For instance, Roadlab Pro smartphone application collected IRI was correlated with laser measurement system, result shows the possibility to reach greater than 0.85(Ekpenyong et al., 2021).

This research is done mainly to ascertain the road conditions of various routes using phone aided applications-**RoadLab Pro** and **Road Voyager.**

II. STUDY AREA

The study location is within Kano metropolis, Nigeria. It is situated between latitudes 11'25' N to 12°47' N and longitude 08°22' E to 8°39' E east and 472m above sea level with Open Street Map ID Node: 2990890859. The study area consists of BUK old site road network and the main road connecting BUK new site and BUK old site.

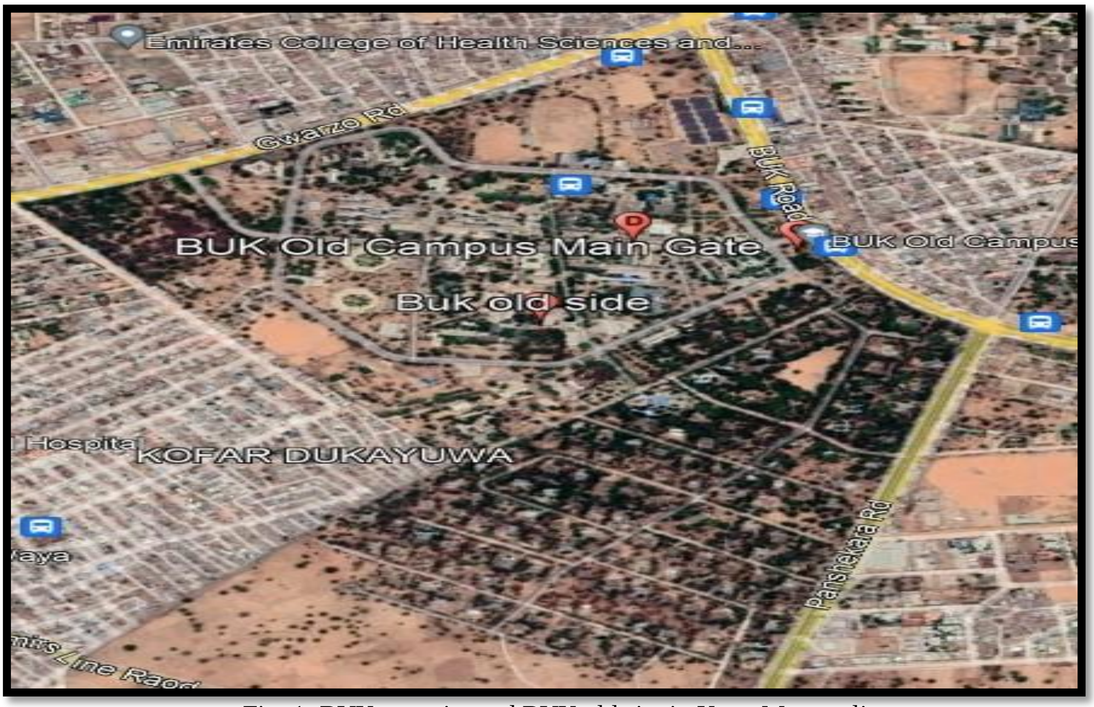

Fig. 1: BUK new site and BUK old site in Kano Metropolis

III. RESEARCH METHOD

Two (2) android phones running the RoadLab Pro version 2.0.145 and Daily Road Voyager. The smartphone (with Installed RoadLab Pro Mobile App) application is used to estimates the roughness based on kinematic and GPS sensors in the smartphone, records the path taken and bumps encountered, and allows entering tags.

The RoadLab Pro is a free smartphone-based road condition monitoring and mapping application designed by the World Bank. The application algorithm taps into the smart phone's gyroscope, accelerometer and GPS data in order to automatically evaluate pavement roughness. It classifies the IRI values measured into four different categories as described in the figure below; The application collects GPS coordinates of road section, geo record location of large bumps, pictures and anomalous observation which can be tagged indicating associated road risk.

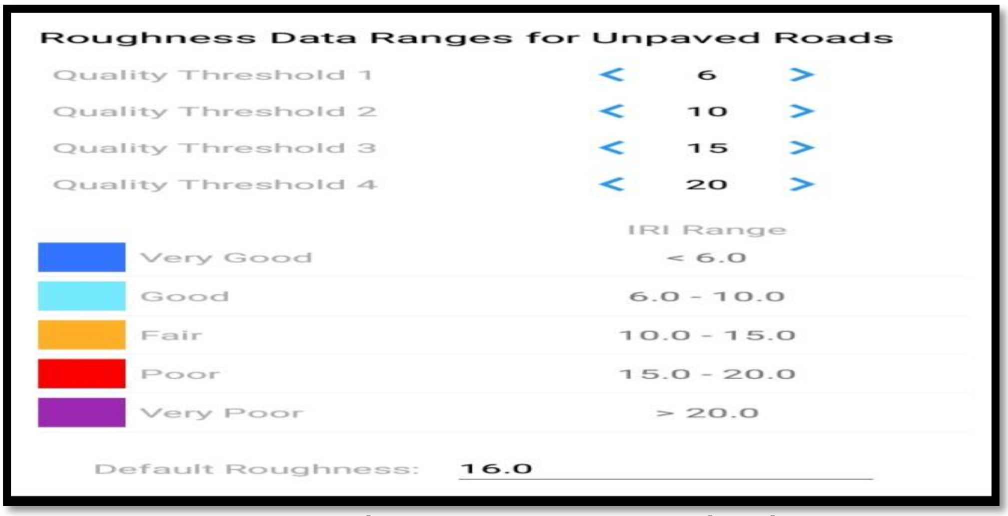

Fig. 2: Roughness Data Ranges For Unpaved Roads

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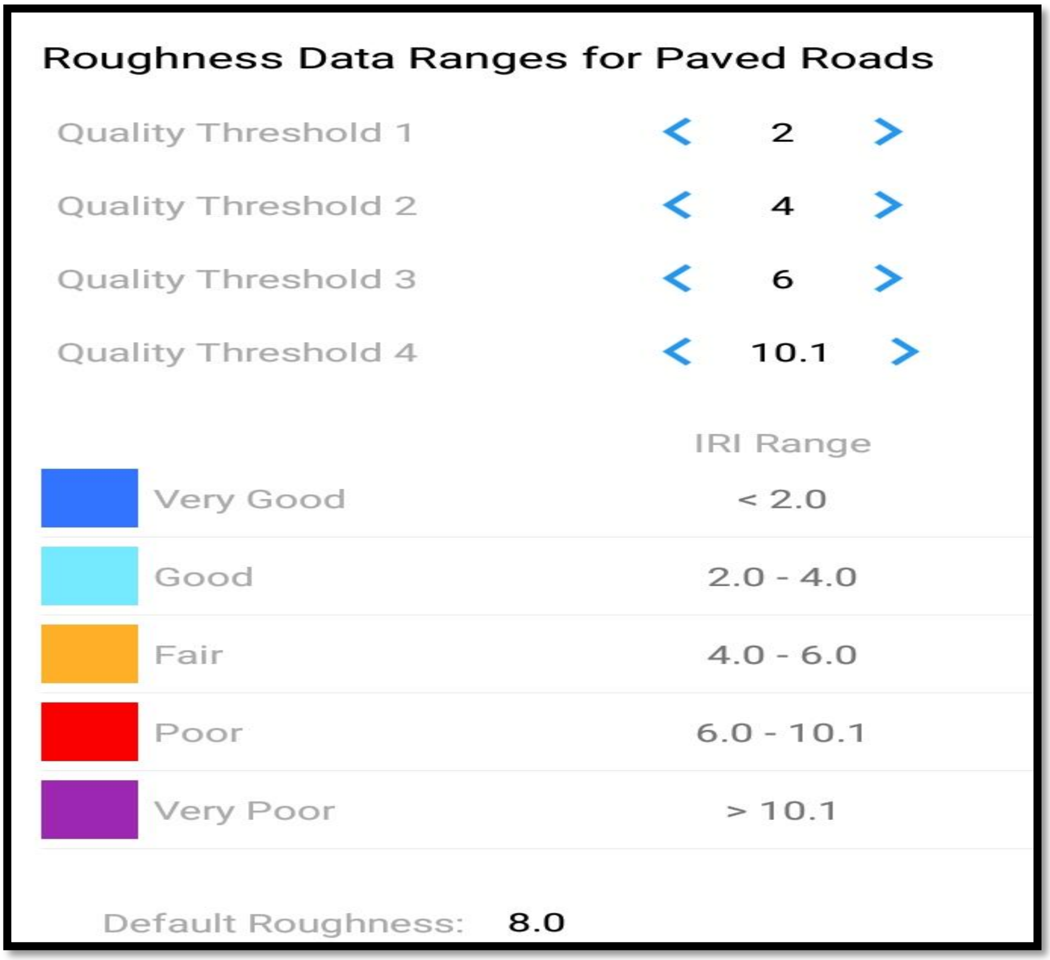

Fig. 3: Roughness Data Ranges ForPaved Roads

RoadLab Pro equally incorporates a flexible system for managing, editing, and exporting data. Furthermore, data measured can be visualized directly in QGIS or Google Earth using Keyhole Markup Language (KML) files. The operational speed for RoadLab Pro is within 15km/h – 100km/h.(Ekpenyong et al., 2021). The web platform allows data to be exported as Keyhole Markup Language (KML), Comma Separated Variables (CSV) and text files for each route assessed allowing for further analysis.

And the other smartphone (with Installed Daily Road Voyager Mobile App) application is allowing for continuous video recording from vehicle, essentially, the application acts as a video black box, dash cam, or auto VDR, recording everything but only keeping what the user is really interested in. the user is usually the driver of the car, who can now quickly and safely capture video sequence of important road condition and events.

These devices are securely mounted on the windshield of a Honda CRV Vehicle in vertical (RoadLab pro) and horizontal (Daily Road Voyager) mode in a well oriented position with the X, Y and Z axes aligned. The applications are allowed to collect data on the selected routes.

For this study; the roughness measurement and other parameters such as time stamp, road ID, Latitude, Longitude, Distance surveyed (m), Speed (km/h), and altitude (m), are collected in both directions along Bayero University, Kano (BUK Old Site) road network. The Road lab Pro and Daily Road Voyager employed simultaneously recording the data required.

IV. RESEARCH RESULTS AND DISCUSSION

A. BUK New Site Main to BUK Old Site Old Gate

The road is dual carriageway and comprises of asphalt paved on both the carriageway. The total surveyed length of the route is approximately 6.5km with an average speed of 42km/h from the data collected from the road lap pro, the average IRI of the road is 3.0; classified as good. From visual observation some sections of the road were identified with block crack, potholes, ravelling and rutting.

Fig. 4: BUK New Site Main to BUK Old Site Old Gate

B. *BUK old Site Ring Road*

The road is dual carriageway and comprises of asphalt paved on both the carriageway. The total surveyed length of the route is approximately 2.5km on both directions with an average speed of 47 km/h and average IRI with roughness of 3.94; classified as fair. From visual observation, some sections of the road were identified with block crack, potholes, ravelling and rutting.

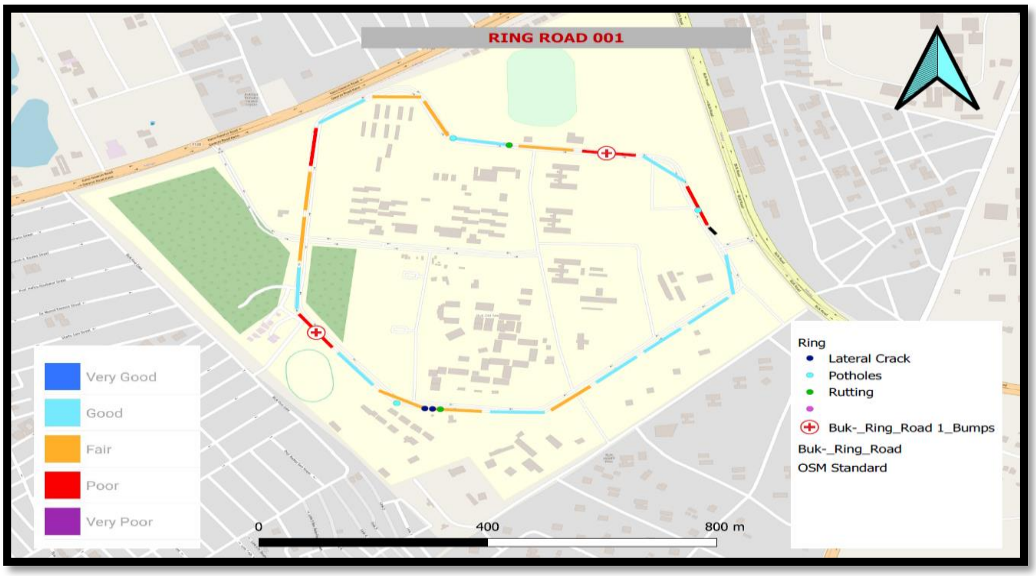

Fig. 5: BUK old Site Ring Road

C. *Umaru Shehu Street*

The road is asphaltic paved single carriageway. The total surveyed length of the route is approximately 0.75 km with an average speed of 38 km/h and average IRI with roughness of 3.64; classified as good. From visual observation, some sections of the road were identified with delamination and rutting.

Fig. 6: UmaruShehu Street

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D. Ogun Street

The road is asphaltic paved single carriageway. The total surveyed length of the route is approximately 0.75 km with an average speed of 38 km/h and average IRI with roughness of 3.64; classified as good. From visual observation, this routesome sections of the road were identified with deterioration and potholes.

Fig. 7: Ogun Street

E. OchapaOnazi Street

The road is dual carriageway and comprises of asphalt paved on both the carriageway. The total surveyed length of the route is approximately 0.75 km on both clockwise and anticlockwise direction with an average speed of 42 km/h and average IRI with roughness of 3.41; classified as good. From visual observation, the route is identified with polished aggregate and rutting on several sections.

Fig. 8: OchapaOnazi Street

F. Mallam Dando Street

The road is asphaltic paved single carriageway. The total surveyed length of the route is approximately 0.3 km with an average speed of 25 km/h and average IRI with roughness of 4.93; classified as fair. From visual observation, this route was identified with raveling and bleeding on some section.

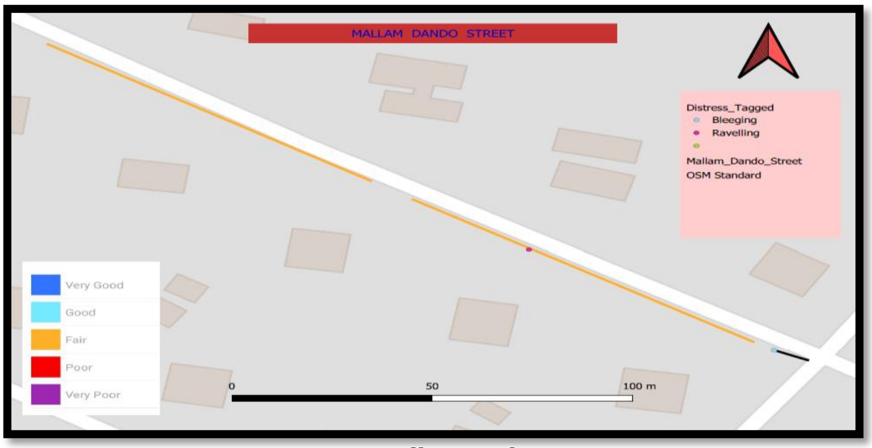

Fig. 9: MallamDando Street

G. Kusugu Crescent

The road is asphaltic paved single carriageway. The total surveyed length of the route is approximately 0.5 km with an average speed of 28 km/h and average IRI with roughness of 5.86; classified as fair. From visual observation, this route was identified with delamination and fatigue crack.

Fig. 10: Kusugu Crescent

H. Clinic Street

The road is asphaltic paved single carriageway. The total surveyed length of the route is approximately 0.75 km with an average speed of 30 km/h and average IRI with roughness of 7.85; classified as poor. From visual observation, this route was identified with highest number of distresses such potholes, cracks, bumps and raveling.

Fig. 11: Clinic Street

I. Junior Staff Quarters Street

The road is asphaltic paved single carriageway. The total surveyed length of the route is approximately 0.5 km with an average speed of 38 km/h and average IRI with roughness of 3.41; classified as good. From visual observation, this route was identified with several distress such as potholes, rutting and slippage crack.

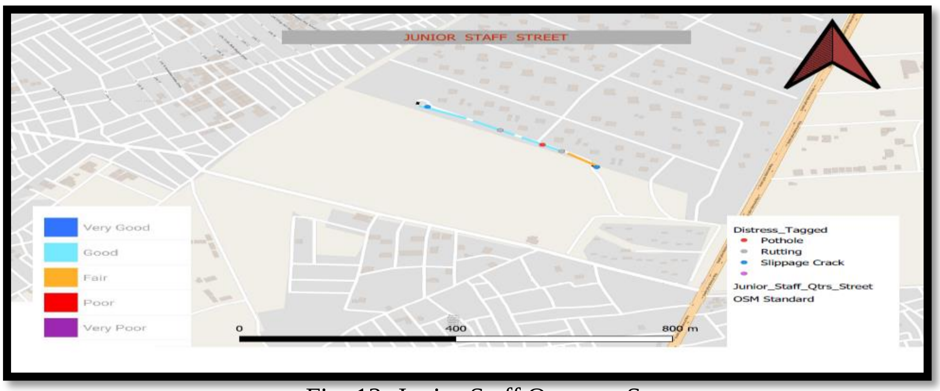

Fig. 12: Junior Staff Quarters Street

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J. ASUU Secretariat Street

The road is asphaltic paved single carriageway. The total surveyed length of the route is approximately 0.13 km with an average speed of 26 km/h and average IRI with roughness of 4.78; classified as fair. From visual observation, this route is found to be fair with a little area noticed with bleeding.

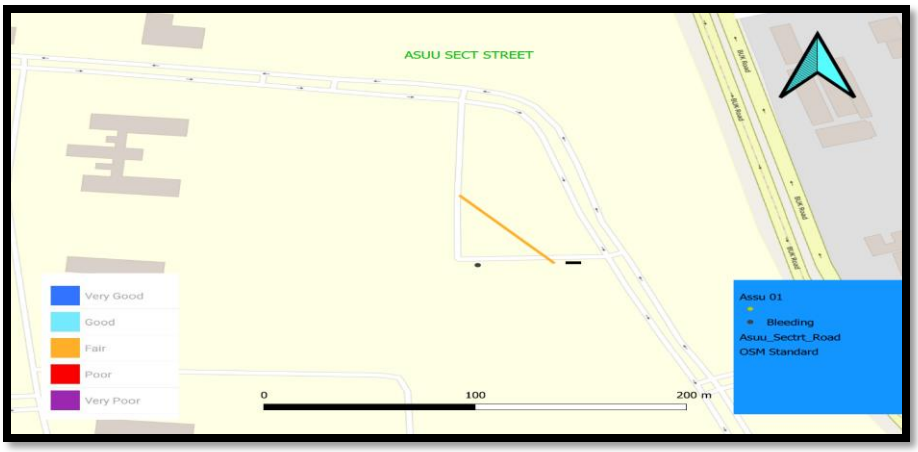

Fig. 13: ASUU Secretariat Street

K. Abdullahi Dan buran Jada Street

The road is asphaltic paved single carriageway. The total surveyed length of the route is approximately 0.36 km with an average speed of 38 km/h and average IRI with roughness of 3.16; classified as good. From visual observation, the route has distresses such as bleeding, potholes and rutting.

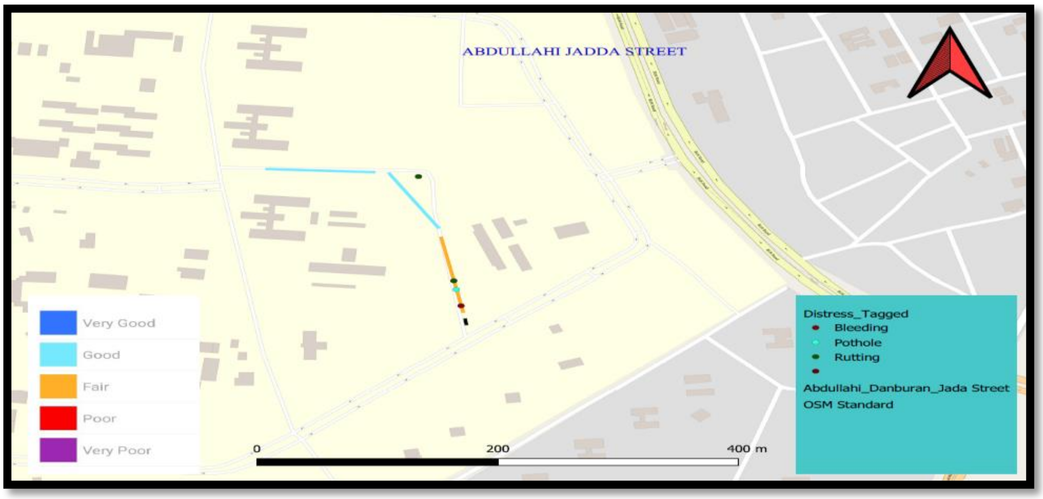

Fig. 14: Abdullahi Dan buran Jada Street *Anna Street*

L. Anna Street

The road is asphaltic paved single carriageway with a section under construction at the time of a survey. The total surveyed length of the route is approximately 0.6 km with an average speed of 25 km/h and average IRI with roughness of 4.96; classified as fair. From visual observation, the route was identified with many distresses such as edge cracks, potholes and raveling at some portion.

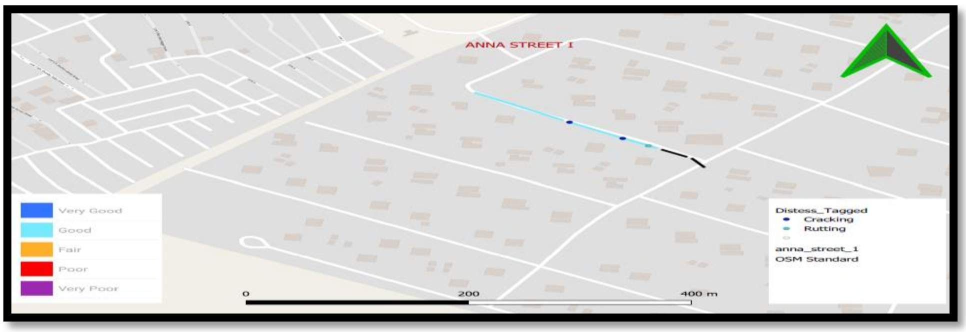

Fig. 15: Anna Street

M. Main Quarters Road

The road is asphaltic paved single carriageway. The total surveyed length of the route is approximately 1.2 km with an average speed of 48 km/h and average IRI with roughness of 3.9; classified as good. From visual observation, the route is identified with delamination, fatigue cracks and potholes in some sections.

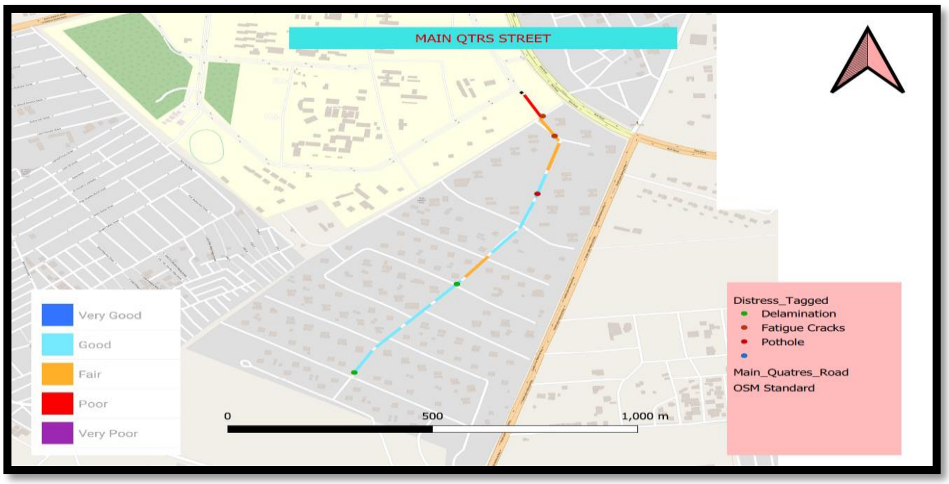

Fig. 16: Main Quarters Road

V. CONCLUSION

In this study, the roughness, surveyed length and vehicle speed measurement using RoadLab Pro application and important road conditions and events were captured using daily road voyager application along selected routes were conducted.

Result show significant proximity in measured data for total surveyed length and average speed. It was observed that total pavement deterioration on some sections of the road was not sensed by the RoadLab Pro application; this may due to smart phone applications reliant on accelerometers as primary roughness sensors. Improvement and further design of applications to sense road conditions at all speed need to be done for its advancement.

Results also indicate that BUK old site road network is in a good state as the IRI value ranges between 2.0 to 4 except clinic road which is in a poor state with IRI of 7.85.

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