Development of a route guidance system for Minna Metropolis: With Particular reference to the major roads in Minna.

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Abstract

This research work is aimed at developing a route guidance system for the major roads in Minna metropolis. It focuses on parameters such as; peak congestion periods, travel time, travel speed and delay data on each of the major roads. The results obtained from these studies serve as database for the ArcGIS software, which was then used to analyze the network areas (major roads) to create new possible alternate routes. Random trips through these major roads were generated and analyzed to give directions and generate the optimum route for each trip. The ArcGIS operates based on analysis settings and also given network data. The network data in this research work is the base map of Minna city, while the analysis settings include the impedance and result accumulation. The travel speed is assumed to be constant for each trip, while the varying parameters include the length of the route to be travelled, and the travel time taken to complete each trip. The application of the ArcGIS software has proven to be a very efficient method in providing optimum alternate routes in these locations within the Minna metropolis.

Keywords: Alternate route, ArcGIS, Minna, optimum travel time, traffic

INTRODUCTION

It is no doubt that one of the key advancements of well developed countries is the transportation network and ease of navigation of routes to cater for the movement of the people, goods and services, regardless of the progression in population increase. Nigeria, a country of more than 170 million people and still growing, is the most populated black nation in the world, although with fairly adequate landmass of to accommodate her large population, transportation has become a growing concern over the years, which is primarily due to the large continuous population growth and not enough plyable routes to accommodate these increase in population and economic growth. In many transit- oriented cities around the world, the majority of them depends on public transit system. (PTS) for daily travels (Thomas 2001), hence the need for effective route guidance cannot be over emphasized so as to help vehicles choose faster routes to avoid congestion and also to find the shortest path from source to destination through the use of GPS modules in vehicles, VMS and other relevant ITS methods. To achieve an effective route guidance system, information need to be collected with respect to various roads and routes (Boyce et al 1999), information like: static traffic, road length, speed limit and also by sharing dynamic traffic information, real time traffic movements can also be used in routing for each vehicle. The combination and effective application of all these information stated above will make it possible to mitigate congestion and further reduce the travel time used by the users. Route guidance is a system that integrates many advanced technologies such as communication engineering, information theory and navigation principle (Wu et al 2008), in order to make transportation system reliable and efficient. In the past twenty years, the field of route guidance has grown rapidly. Traffic congestion continues to be a serious problem in modern society and ITS can be a very good way to ease this problem.

Indeed ITS provides various approaches to dealing with traffic congestion on the road networks, studies have shown how traffic advisory information and route guidance could decrease travel time for unfamiliar users (Yang 1999).).

Recently, new advanced systems are capable of incorporating real time congestion delays which allow the users to find the shortest travel time route instead of the standard shortest distance route, and enabling users to adapt to dynamic route instead of the standard shortest distance route, and enabling users to adapt to dynamic traffic conditions. The number of traffic sensors embedded in roadways for the collection of traffic speed, flow and density has significantly increased in the past few years. In particular, major metropolitan areas in many countries have traffic sensors installed in the freeway networks and they continuously monitoring and recording traffic status, which in the long run makes it possible for users to monitor the traffic conditions and select routes based on time traffic condition, navigation systems also have the capability to reroute if a user deviates.

MATERIALS ANDMETHODS

The Base map of Minna was collected from the surveying and geo-informatics department of the Federal University of Technology, Minna, and the major roads that were analyzed using the ArcGIS 10.1 include: Bosso, Dutsen Kura, Kpakungu, Maitumbi, Tunga and Tundun Fulani. Different trips were taken through these roads at almost constant vehicular speed and the results from these trips were compared to the analysis results from the GIS software. Delay studies was also carried out on these roads to ascertain the average delay periods and the average number of cars plying the road that werestoppedattheseperiodsduetotrafficcongestionbycarryingoutthetrafficcount during the morning peak period and also the evening peak period.

The Base Map of Minna

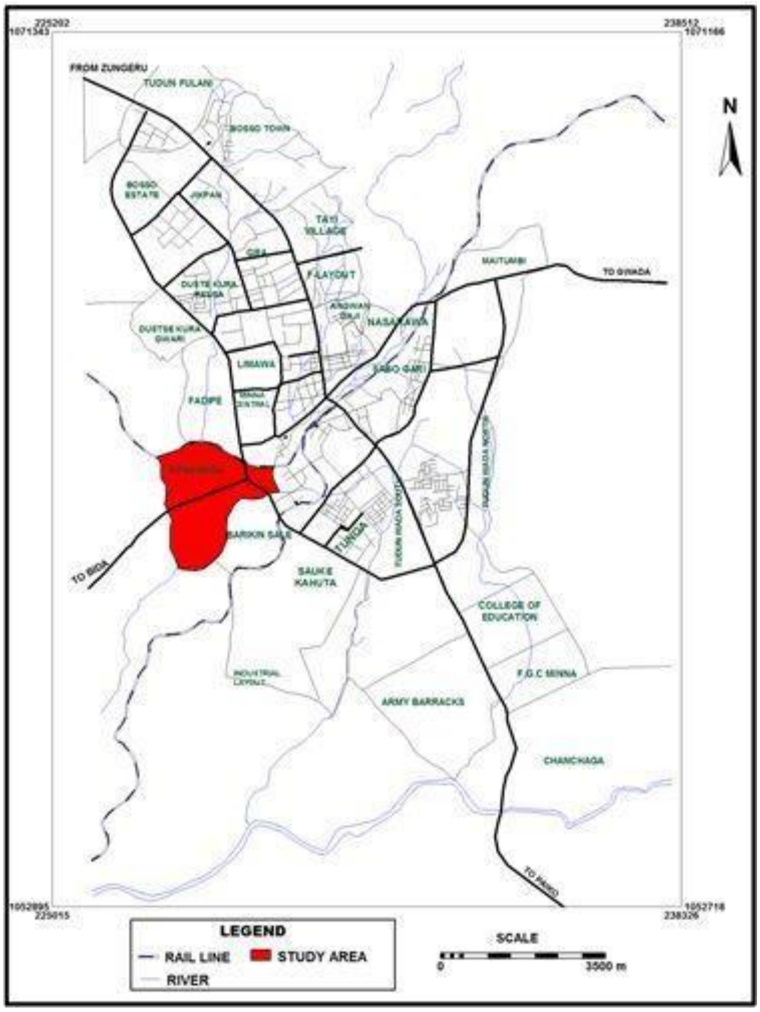


Plate I: The Base Map of Minna showing the major routes in the city.

Trips and Travel time

S/N	Trips	Avg. Car speed (Km/hr)	Travel time (mins)
1	GidanKwano-Bossocampus	60.66	36
2	Police barracks - Shango	66.30	12
3	Dutsen Kura – Tradef fair	78.60	20
4	MusaZago–Statesecretariat	71.60	10
5	Kpakungu – Bosso road	62.30	16
6	Bosso – Tungan goro	54.60	21

7	Westernbypass-Zungeru	60.50	17

Table 1: Showing the time taken to travel the selected routes

Delay studies

Roads	Total delay (sec)	Average delay of stopped vehicles (sec)	Average delay of approach vehicles (sec)
Bosso Tunga	850	75	50
Maitumbi			
Tudunfulani	1200	120	70
Dutsen Kura			
Kpakungu	480	60	45
	300	53	44
	900	90	65
	1150	125	86

Table II: Showing the delay studies done on the major roads

Traffic count

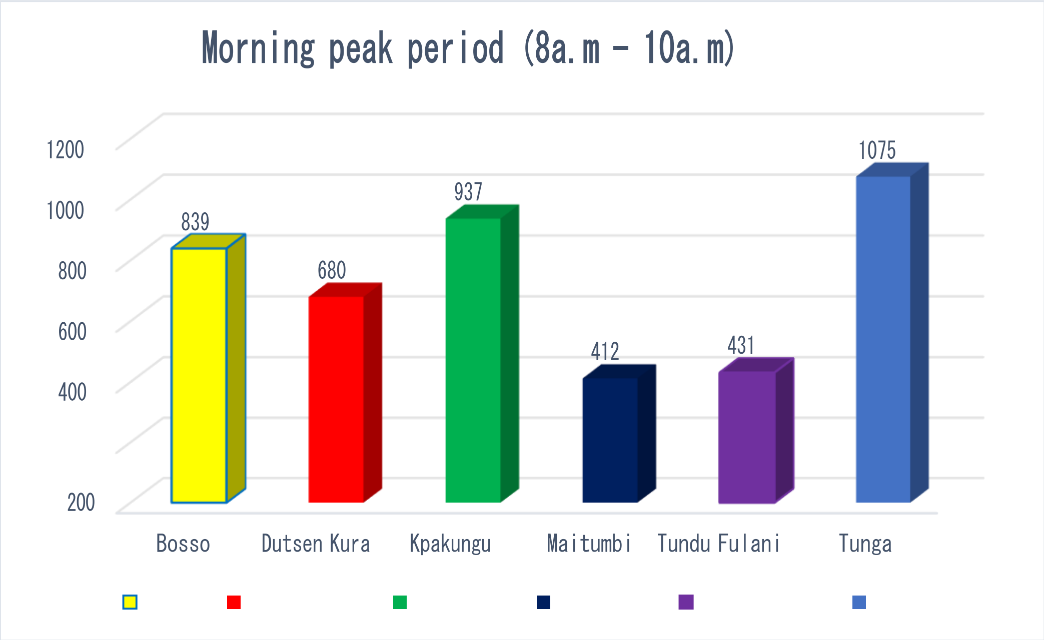


Plate II: Showing the traffic count for morning peak period on the selected roads

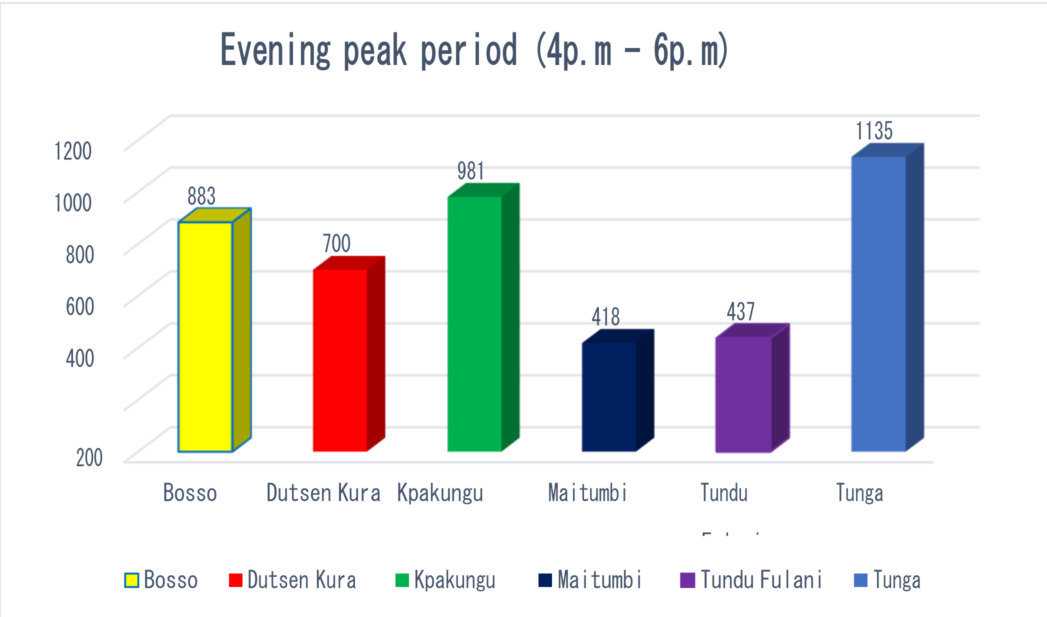


Plate III: Showing the traffic count for evening peak period on the selected roads

Route analysis using the ArcGIS 10.1

The alternate route choices of random selected trips within the Minna city were analyzed using the ArcGIS 10.1, firstly, a network data of the Minna road network was generated, this network data contains the study area, the study area roads and also the study area junctions, after the study area has been generated, the network analyst is used to develop new routes, this analyst has a number of features and functions, but the scope of this project work limits us to the use of only the "new route" feature. Under the new route feature, the network analyst provides alternative routes for each of the random trips generated, each of these trips have different origins and destinations, which is referred to as "stops" in the software, each stop is denoted as "graphic pick 1 or graphic pick 2" depending on the number of stops considered. After the origin and the destination has been picked out, the network analyst is consulted to "solve" for the possible routes, however before consulting the network analyst, it is necessary to edit the route properties which is basically the "analysis settings" and the "accumulations", these route properties will help give directions to the solved route and also choose possible alternate routes. The analysis settings contain impedance settings that determines whether solving for a route which has the shortest possible length from an origin to a destination or solving for a route which takes the shortest time to complete a trip from an origin to the destination. The accumulation setting affects the route analysis in the sense that it activates the minute and length accumulations to enable the network analyst give the directions to each selected route in these parameters i.e. in time and in length, which is the time taken to travel a particular length of a solved route. The route analyst helps choose an optimum route to travel when considering a trip from a particular origin to a destination because most of the alternate routes with longer lengths takes less time to travel and the fastest time taken to travel a particular trips does not always gives the optimum route. Hence, to get the optimum route for a particular trip, the two possible routes have to be compared i.e. considering a route choosing the length impedance and also another route choosing the minute impedance.

RESULTS

I. **Gidan Kwano – Bosso Campus:**

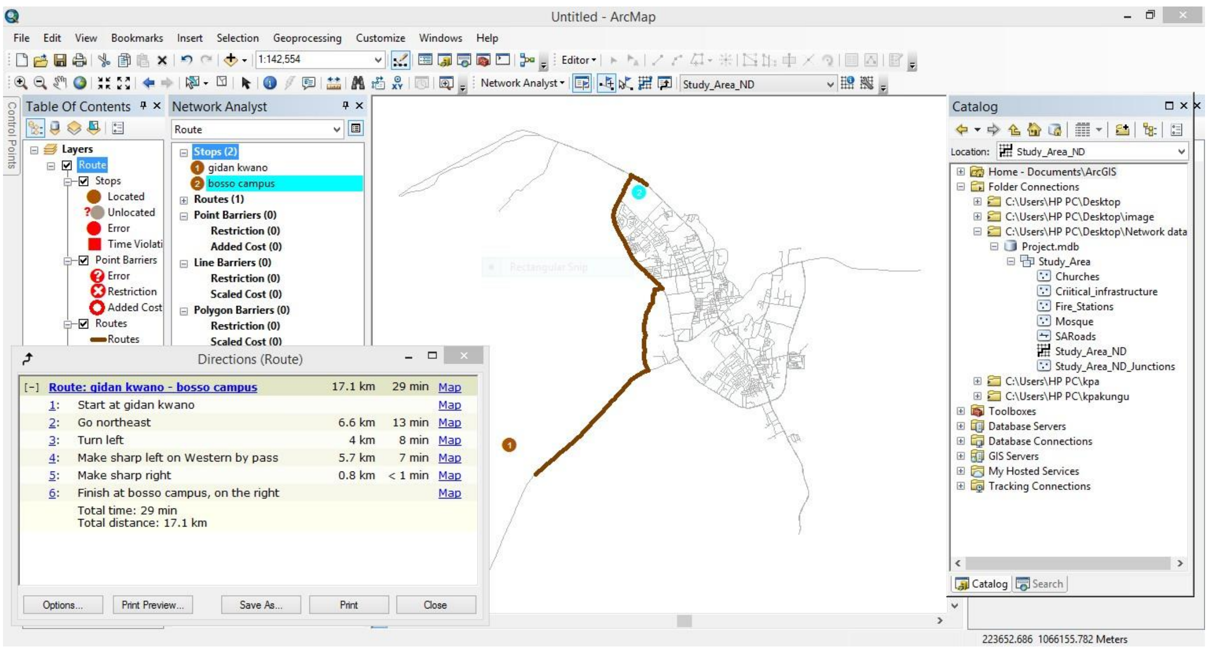


Fig 1: **Length impedance (route 1)**

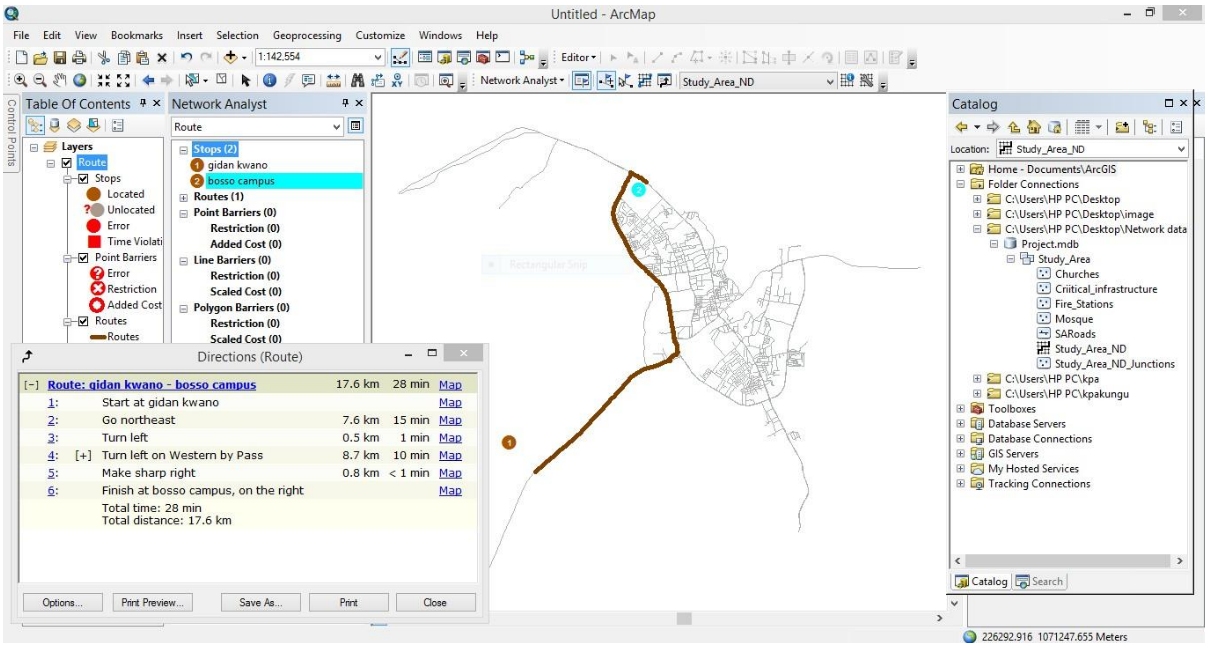


Fig II: **Minutes impedance (route 2)**

Fig I and Fig II show the possible alternate routes considered to travel from Gidan kwano to Bosso campus, however route 2 (Fig II) is preferred to route I because it provides the shortest travel time (28 mins) to travel 17.6 Km.

II. Police Barracks – Shango:

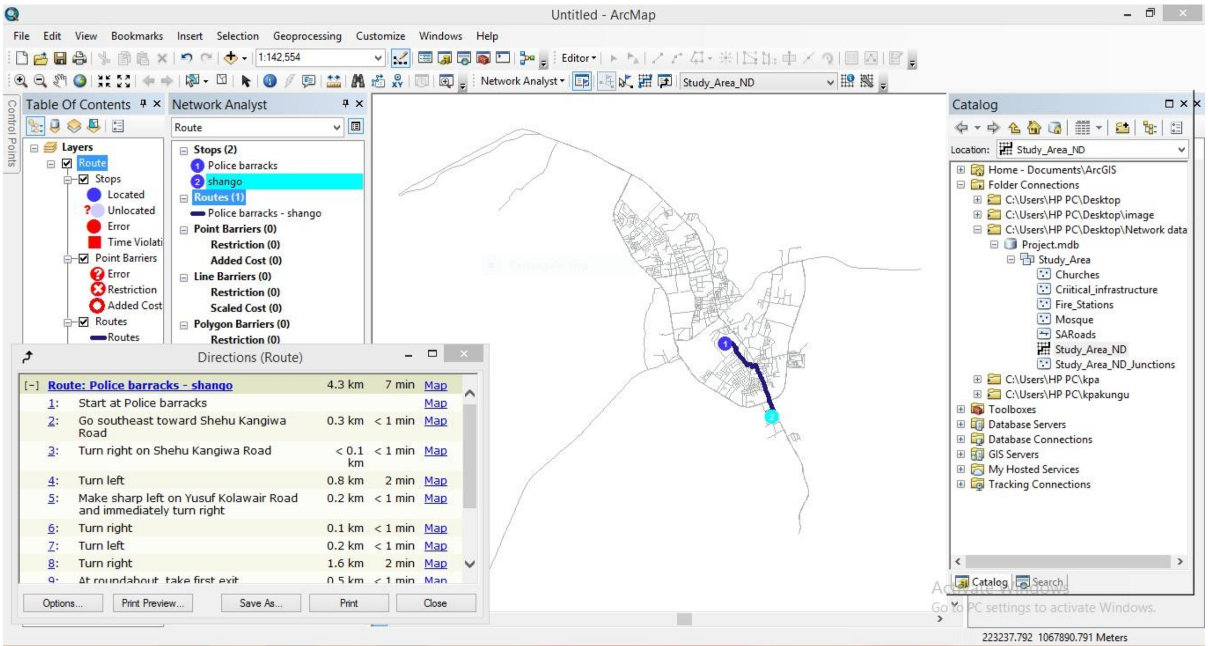
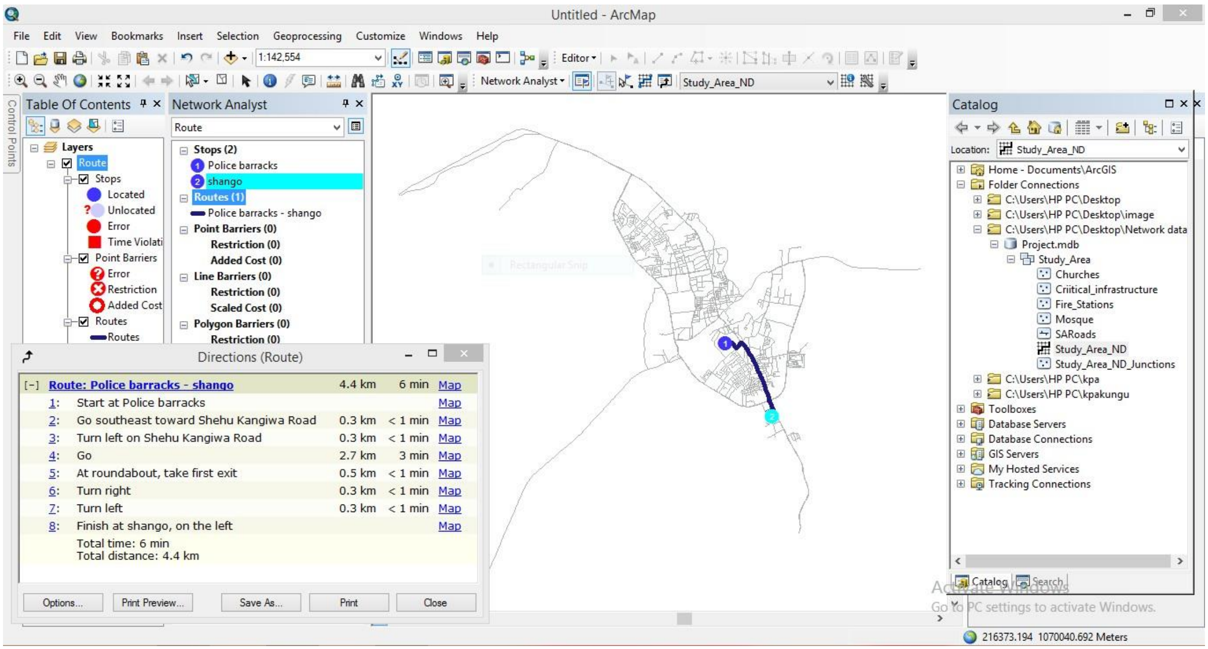


Fig III: **Length impedance (route 1)**



FigIV:**Minutesimpedance(route2)**

ThePoliceBarrackstoShango'salternateroutesconsistofFigIIIandIV,howeverthe optimumrouteispreferablyFigIV,whichisroute2,because itgivestheshortesttravel time to complete the above stated trip.

III. DutsenKura – Tradefair:

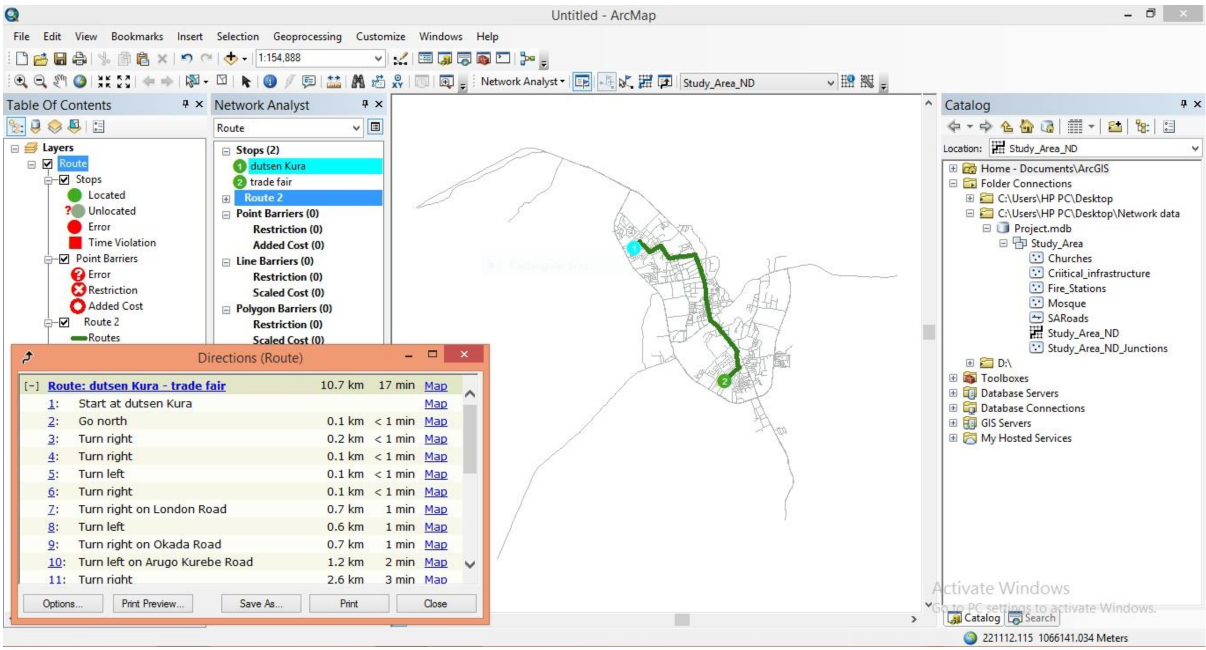


Fig V: **Length impedance (route 1)**

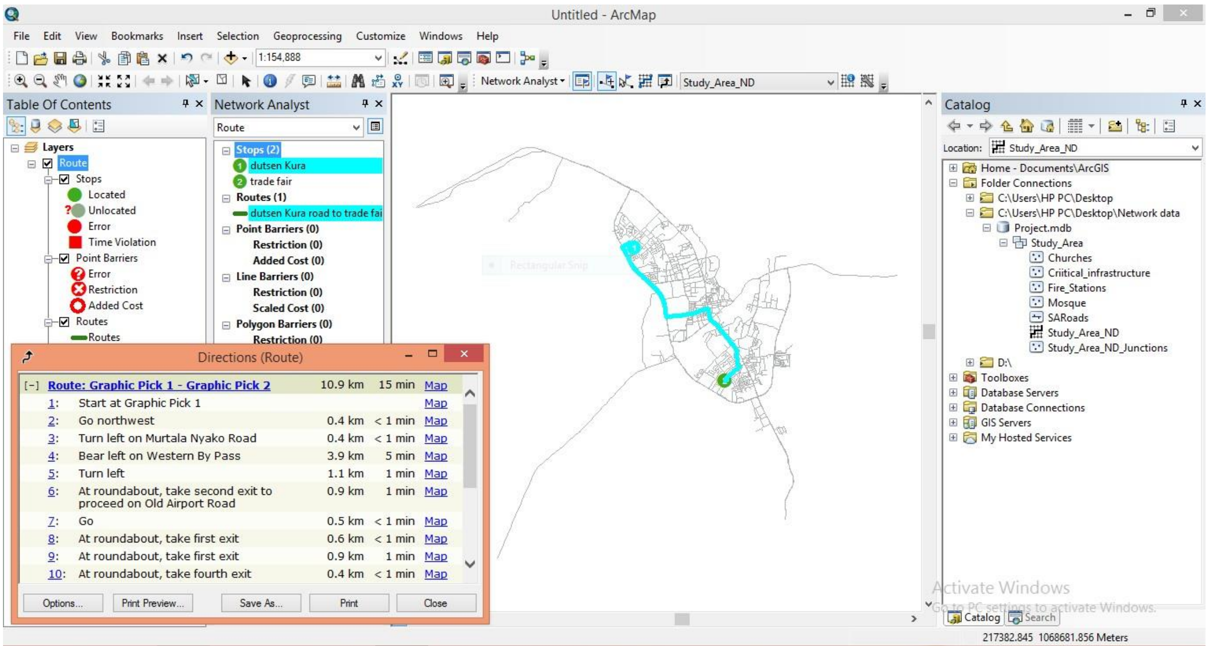


Fig VII: **Minutes impedance (route 2)**

Dutsen Kura to Trade fair has two alternative routes Fig. VI and VII the preferred route to be followed is route 2 (Fig VII). It takes the shortest time (15 mins) to travel 10.9Km, compared to the other analyzed route which takes a longer time to travel the same trip.

IV. Musa Zago – State Secretariat:

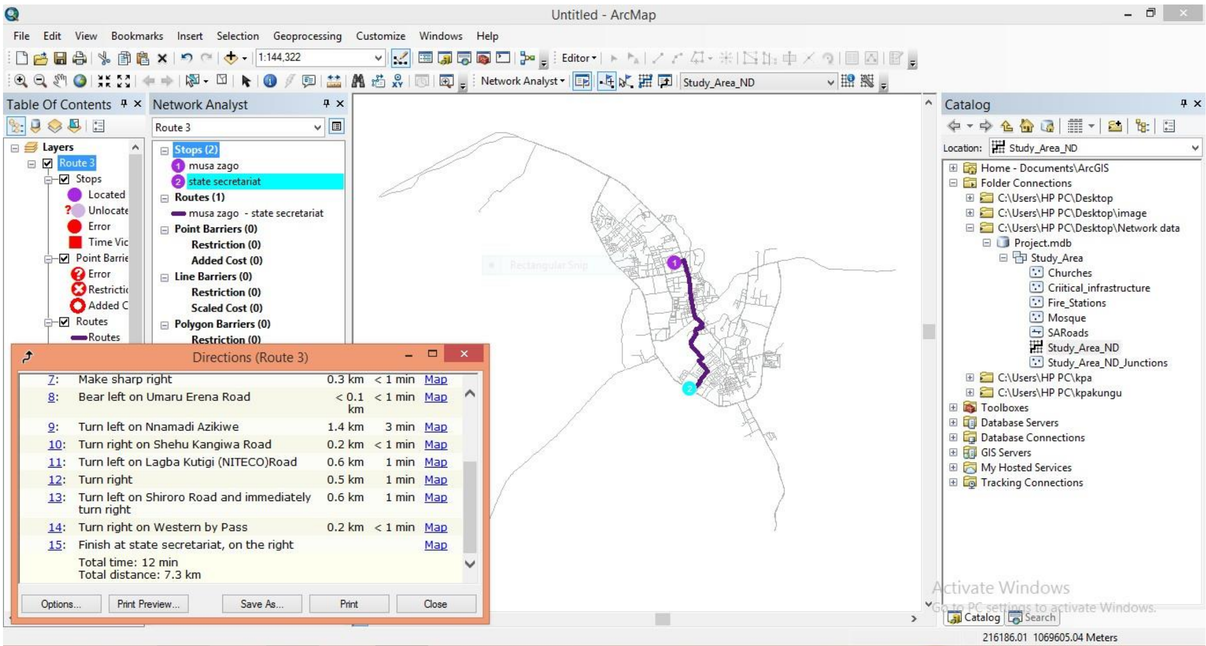


Fig VIII: **Length impedance (route 1)**

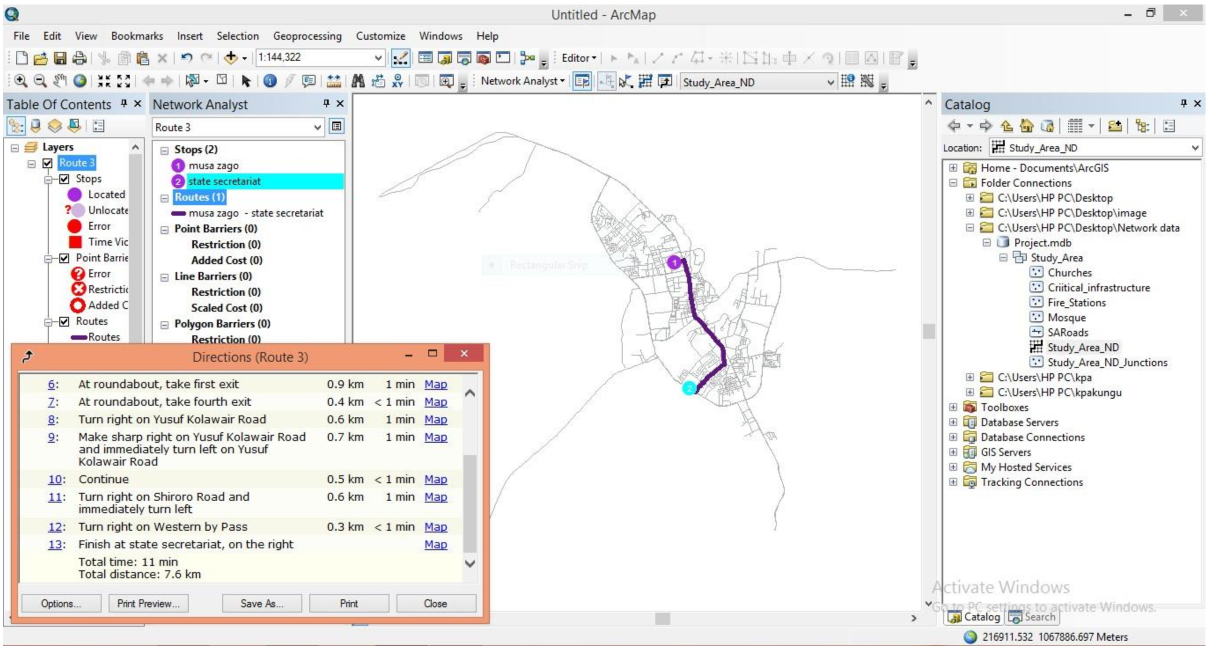


Fig IX: Minutes impedance (route 2)

Fig VIII and fig IX show the possible alternate routes through Musa Zago to State Secretariat, however, the best possible route to be consideredisroute2whichisinfig (IX).

V. Kpakungu – Bosso Road:

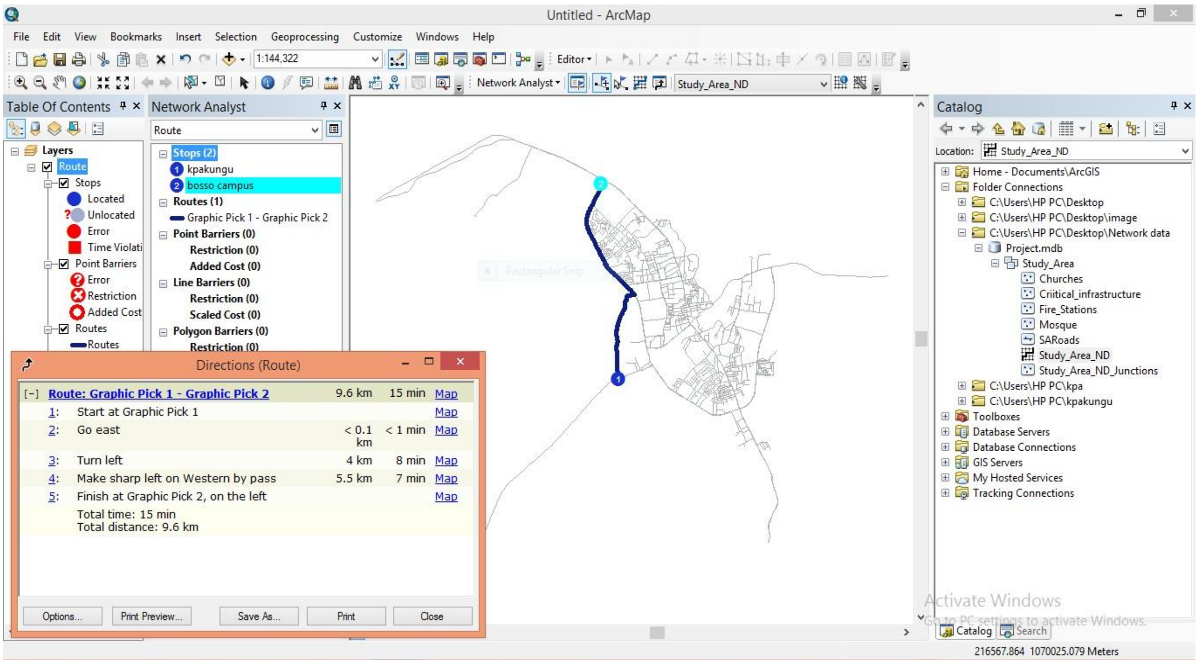


Fig X: **Length impedance (route 1)**

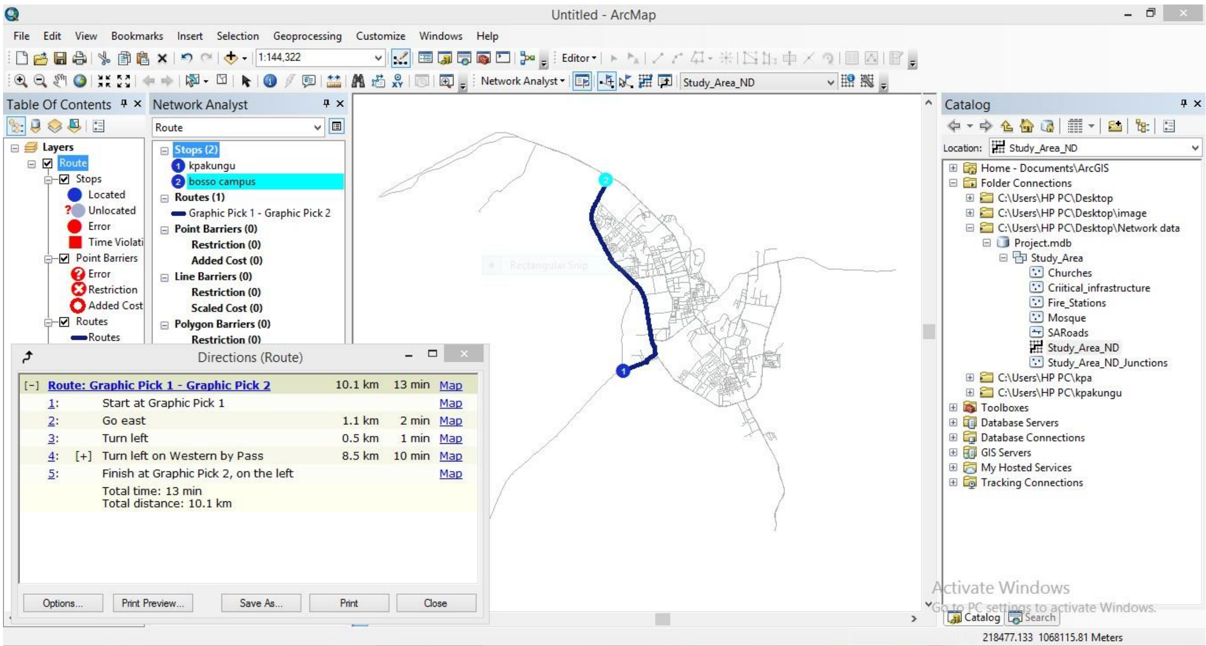


Fig XI: **Minutes impedance (route 2)**

The Kpakungu to Bosso road has two possible alternative routes fig X and fig XI, and the best route to take is route 1 which is fig X.

VI. Bosso – Tungan goro:

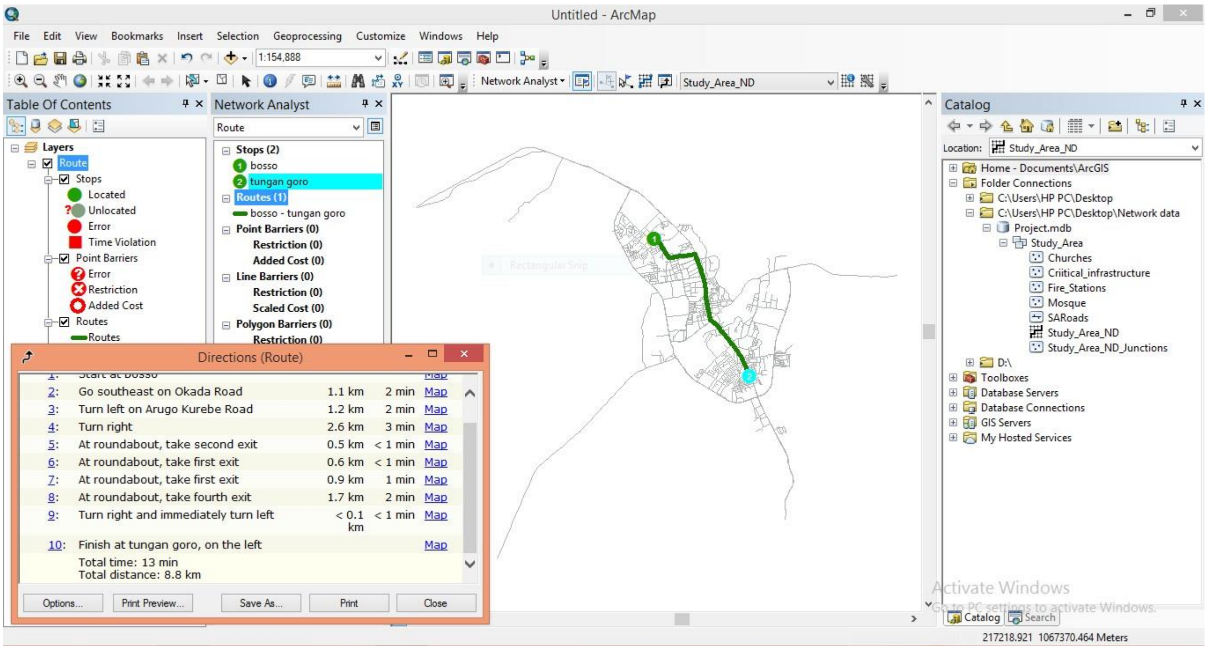


Fig XII: **Length impedance (route 1)**

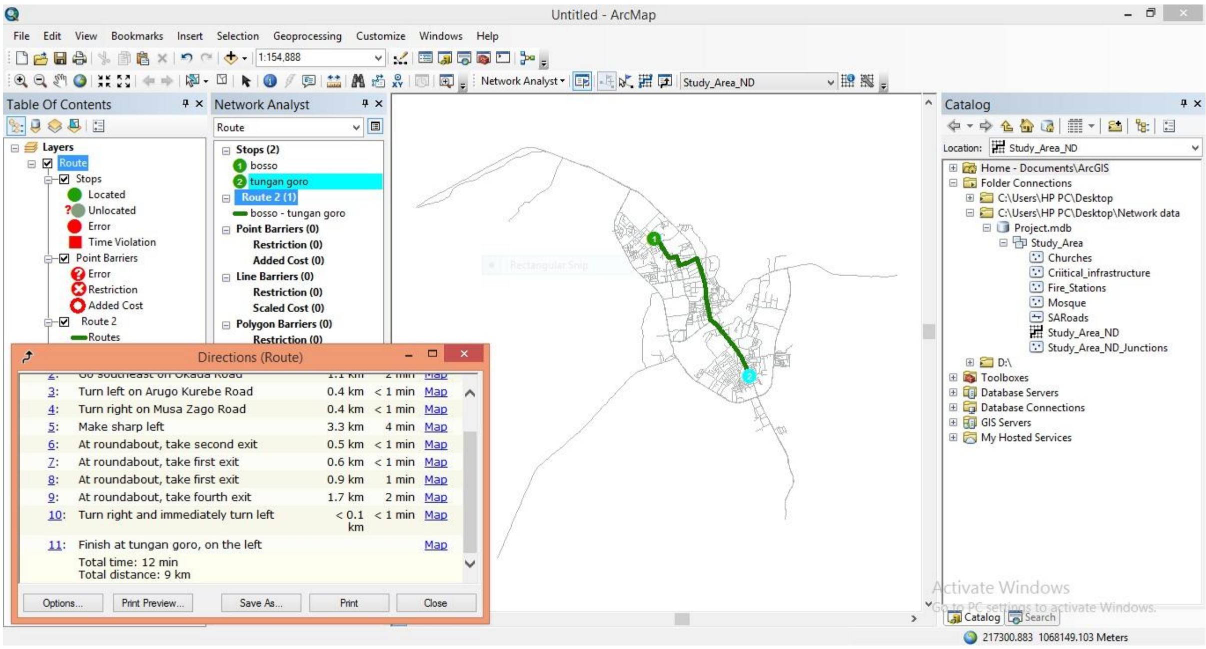
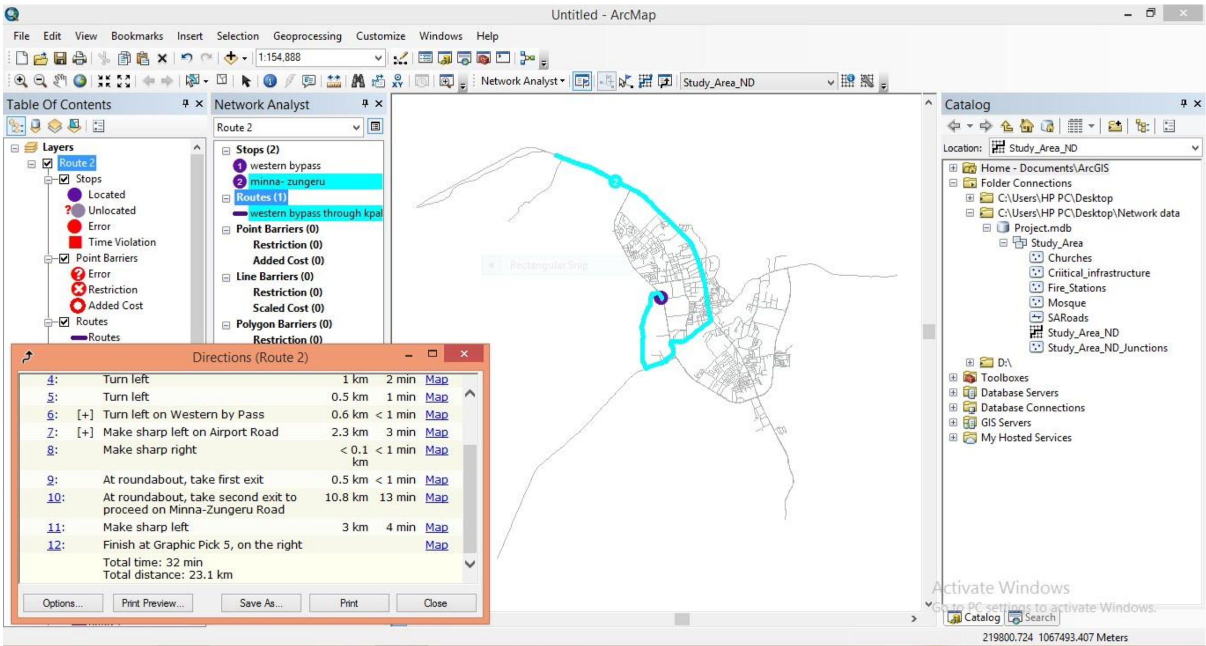


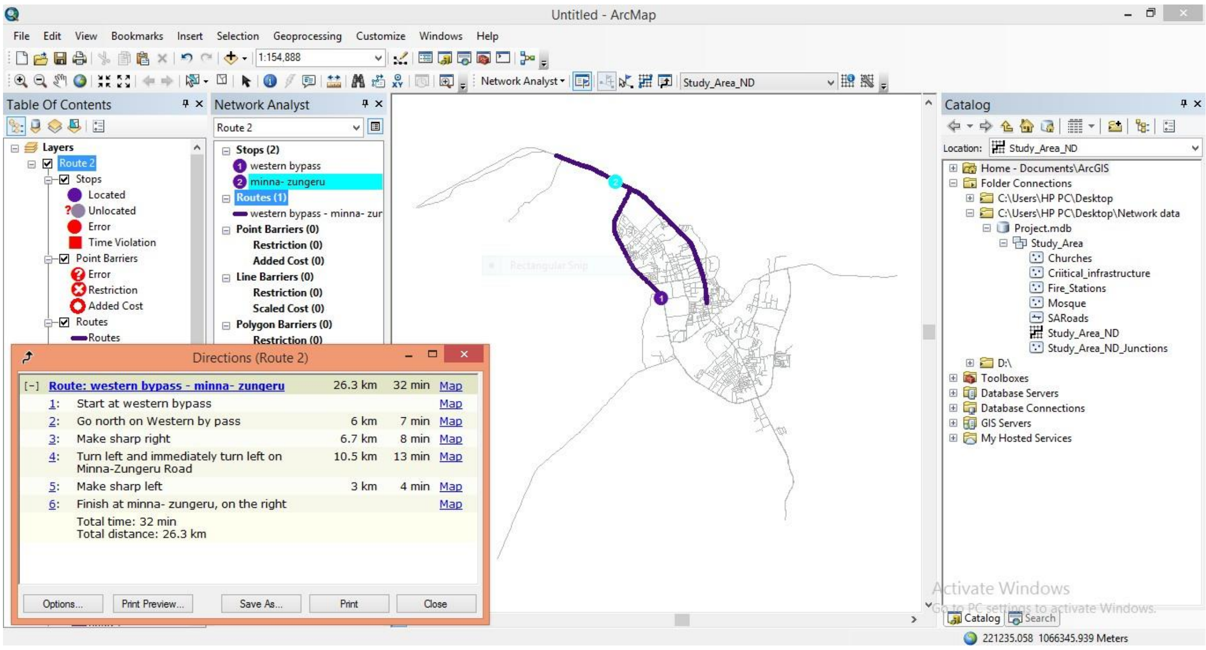
Fig XIII: **Minutes impedance (route 2)**

FigXII and figXIII shows the possible alternative routes considered to travel from Bosso road to Tunga goro, route 2 is preferred, which is figXIII because it gives the shortest travel time to complete the trip.

VII. Western bypass – Minna Zungeru Road:



FigXIV: **Length impedance (route1)**



FigXV: **Minutes impedance (route2)**

This road has two possible alternative routes, out of which the optimum one to consider is the route 2 which lies in figXV, because while these two alternate routes take the same amount of time to complete the trip, the second route covers more distance within the same timeframe.

DISCUSSION

From the analysis of the result, alternate routes are key to solving the problems of traffic congestion. It is also important to note that some trips having shorter road distances take even more time to complete, when compared to trips having longer distances. In essence, alternate routes don't necessarily mean the shorter distance, but the optimum distance. The delay studies gotten through the morning and evening peak period traffic-count made it clear that a good number of the congestion situations that do arise during these trips are basically due to built-up congestion from mostly the starting point of the trip. Using the 'Kpakungu – Bosso' trip as an example, it was shown that the first analysis (route 1) result based on length impedance (shortest distance), which was 9.6Km, was completed under 15mins, which makes the second analysis result (route2) the optimum route to take, because despite the road distance being the longer (10.1Km), the trip was completed in a lesser time (13mins). To know why there is such discrepancy in the results of these trips, the route of the Kpakungu – Bosso trip was carefully studied. The Kpakungu road is about 9m in width, a single lane (dual carriage way), the only connecting road from Gidan Kwano (the main campus of the Federal University of Technology, Minna), with the absence of traffic lights or wardens, the overall condition of this particular road makes it impossible to accommodate the incoming traffic, which in the long run affects the time taken to travel this road. In the route 1 direction details, it was stated that 4Km distance was travelled on the Kpakungu road for a total of 8mins before getting on the western bypass road, while route 2 analysis shows that only 0.5Km was travelled on the Kpakungu road for about 1min, before shortcutting it through an alternate route to link the western bypass. It is key to note that the variation in the outcome of this trip was as a result of how long the Kpakungu road was travelled by one of the routes, resulting into a longer time spent despite the route being the shortest.

CONCLUSION AND RECOMMENDATION

The idea behind creating a route guidance system for Minna metropolis was primarily to solve the congestion problems that grow daily alongside the population and help the road users navigate their daily routes easier, and in the course of this research it was ascertained that creation of new roads and alternate routes is not always the ultimate answer to solving congestion issues, it begs the question of how functional are the existing routes in respect to population growth and increase in traffic. The features of a particular road is not meant to be permanently fixed, the width, number of lanes and carriageways can always be adjusted to suit the change in the real time use of the road. This is the scenario in most part of the Minna metropolis, while the alternation of road features is one of the best ways to solve congestion problems at a lesser cost compared to building new ones, the progression in population and traffic growth in Minna has not been duly accommodated in terms of the existing roads' geometry. Existing roads are not permanent landmarks that should never be changed, they can always be altered to conform to the traffic situations on the road and serve as control measure for congestion.

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