Tropical Built Environment Journal. Volume 9, No. 3, 400-406, 2023 www.tbejournal.com
ISSN: 1118-1790

IMPLEMENTATION OF INTELLIGENT TRANSPORT SYSTEM FOR HEALTH CARE DELIVERY IN PORT HARCOURT, RIVERS STATE, NIGERIA

Ukeame Emmanuel Ajie[1*] and Esomchukwu Igbokwe[2]

[1]Department of Surveying and Geoinformatics, School of Environmental Sciences, Captain Elechi Amadi Polytechnic, Rumuola, Port Harcourt, Nigeria
[2]Department of Surveying and Geoinformatics, Faculty of Environmental Sciences, Nnamdi Azikiwe University, Awka, Nigeria
*Corresponding Author: ukans4u@gmail.com

Abstract

This research is aimed at implementing an Intelligent Transport System to facilitate quicker response ability and improved health care service delivery in Port Harcourt City. The coordinates of health care facilities in the study area were abstracted using Garmin 78 hand held GPS and overlaid on the road network and transportation infrastructure data using ArcGIS 10.5 software. Database design and creation was achieved using conceptual, logical, and physical modelling. The study deployed the closest facility aspect of intelligent transport system to determine the accessibility of medical facilities during emergencies and the result revealed four closest medical facilities to the incident, including Amadiama Health Centre at 3km, Azubie Health Centre at 3.4km, Garrison Health Centre at 4.1km, and Ozuboko Health Centre at 4.3km. This information can be vital in selecting the most appropriate medical facility for a heart attack emergency, as emergency medical services (EMS) can benefit significantly from it by identifying the most efficient route to the nearest medical facility with specialized cardiac units or emergency departments. The study also carried out a location allocation analysis of health care delivery centres to determine the best locations for health care facilities in the study area. From the study, 14 health care centres were available to serve 134 demand points from the localities. This analysis was structured to determine which health care centre would handle the most demand within a range of 5 km and which locality within the study area would have to travel far distances to access health care services. The study revealed areas that are underserved or have limited access to health care, taking into account travel time, distance, and traffic conditions to ensure that health care facilities are located in areas that are accessible to those who need them the most. The use of the findings of this research was recommended for health care delivery and policy developments.

Keywords: ArcGIS, Emergency Medical Services, GPS, Health Care Service, Intelligent Transport System

Introduction

Intelligent Transport Systems (ITS) is the applications of advanced sensor, computer electronics and communication technologies which, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more

coordinated, and 'smarter' use of transport networks. ITS applications include telematics and all types of communications in vehicles, between vehicles (e.g. vehicle-to-vehicle), and between vehicles and fixed locations (e.g. vehicle-to-infrastructure) (Jonkers and Gorris, 2015).

Mega cities cannot fulfil their vision without providing new solutions for transportation within the cities and so needs Intelligent Transport System (ITS) as a driving force to facilitate its initiatives that will help improve mobility and improve transport infrastructures. ITS is one of the fundamental structures smart cities are using to improve the lives of its citizens and achieving sustainability. It includes tracking high pedestrian areas, traffic patterns, metro stations and coordinating bus times. It also enhances interoperability, general awareness of situations and has capacity to share information swiftly. It also offers a comprehensive approach to risk management, putting emergency procedures and response capabilities in place, identifying dangers, including vandalism or violence, fare evasion, and medical emergencies.

The Nigerian transport system is urgently in need of modern infrastructures such as ITS because it would continue to suffer both in direct and indirect investments opportunities, unless urgent steps are taken by the government to address the status quo. Intelligent Transport System had been identified as a major player in health care delivery for smart cities all over the world (Olujimi, 2009). It enables the implementation of closest facility analysis, as well as location allocation analysis.

Closest facility analysis is a crucial component of an intelligent transport system (ITS) as it helps to optimize route planning and improve operational efficiency. By using Geographic Information Systems (GIS) and other location-based technologies, closest facility analysis enables ITS to determine the most efficient route to reach a destination and identify the closest facility to provide a particular service. Closest facility analysis is particularly important in emergency situations. In emergency response, quick response time is critical in saving lives and minimizing damages. An intelligent transport system that utilizes closest facility analysis can help emergency services respond quickly and efficiently to emergency situations by identifying the closest facilities such as hospitals, fire stations, and police stations to the emergency location.

The closest facility analysis plays a critical role in determining the most efficient route to the nearest medical facility that can provide the necessary medical attention. In particular, emergency medical services (EMS) can benefit from this analysis as it helps them identify the quickest route to the nearest hospital equipped with specialized cardiac units or emergency departments. An intelligent transport system can provide EMS with up-to-date information on traffic conditions, road closures, and other factors that may affect their route. With this knowledge, they can make well-informed decisions and reach the patient in the shortest possible time, which can potentially save the person's life.

Location allocation in an intelligent transport system (ITS) is a technique used to identify the optimal location of facilities (such as health care facilities) to serve a given set of demand points (such as localities) within a transportation network. The aim is to find the best allocation of resources to meet the demand while minimizing the total cost of the service.

The Study Area

Port Harcourt consists mainly of the entire Port Harcourt City Local Government Area and the Obio/Akpor Local Government Area, as well as part of Ikwerre and Eleme Local Government Areas, all of Rivers State. Port

Harcourt is located within latitudes longitude 6° 58′ and 7° 06′ East of the Greenwich Meridian and Latitude 4° 40′00" and 4° 55′ North of the equator. It is bounded by Etche and Ikwerre Local Government Areas, Eleme Local Government Area and the Emohua Local Government Areas in the north, east and west respectively, while in the south it lies along the Bonny River (Ogochukwu, Chukwurah and Success, 2018).

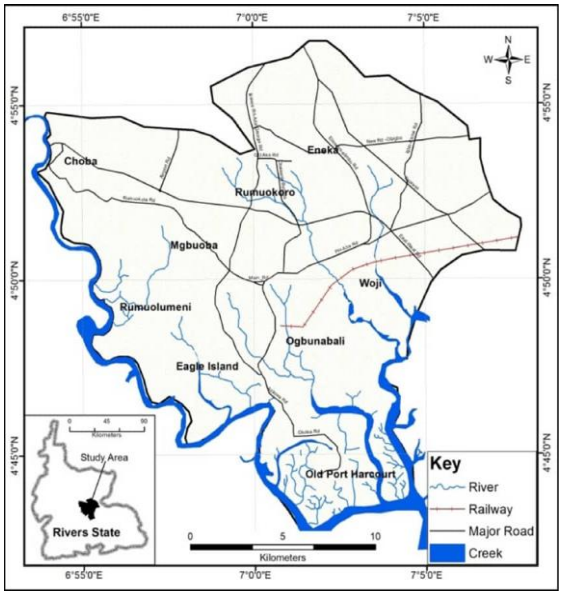


Figure 1: Map of Port Harcourt City

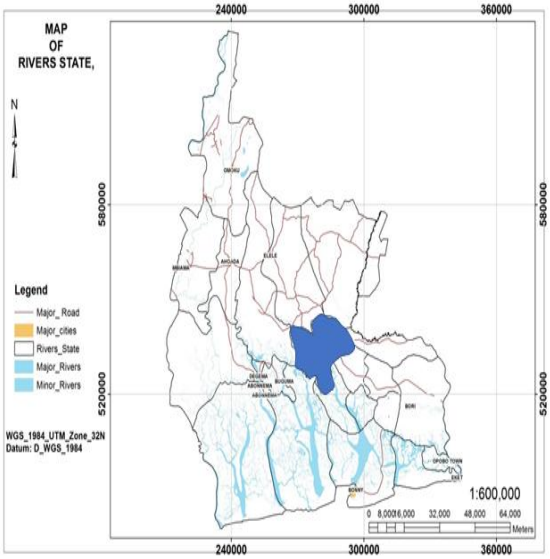


Figure 2: Map of Rivers State Highlighting Port Harcourt City

Port Harcourt consists mainly of the entire Port Harcourt City Local Government Area and the Obio/Akpor Local Government Area, as well as part of Ikwerre and Eleme Local Government Areas, all of Rivers State. Port Harcourt is located within latitudes longitude 6° 58′ and 7° 06′ East of the Greenwich Meridian and Latitude 4° 40′00" and 4° 55′ North of the equator. It is bounded by Etche and Ikwerre Local Government Areas, Eleme Local Government Area and the Emohua Local Government Areas in the north, east and west respectively, while in the south it lies along the Bonny River (Ogochukwu, Chukwurah and Success, 2018).

Materials and Methods

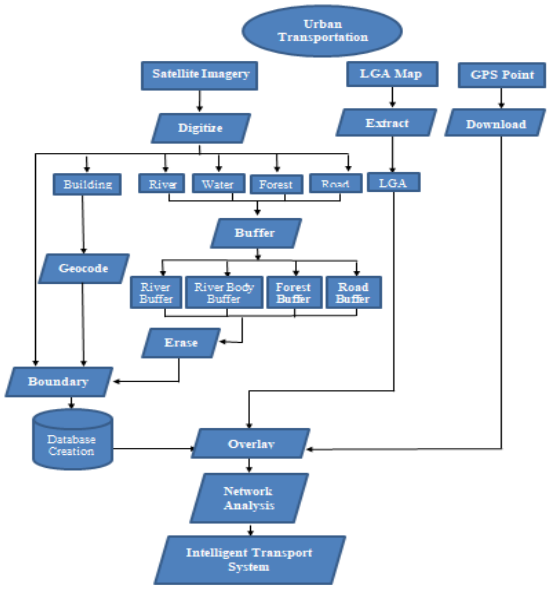


Figure 3: Methodology flow chart

The data requirements for the research include, road network data, digital globe imagery and coordinate points of health facilities. The list and address of the health facilities were received from the Rivers State Ministry of Health. The health facilities were visited and the coordinates of the most central location abstracted. Face to face inquiries of the facilities were also achieved. Coordinates of these facilities were abstracted using Garmin 76 Handheld GPS configure in Universal Traverse Mercator (UTM) System of World Geodetic System of 1984 (WGS-

84) Datum under zone 32N. Plotting was done using ArcGIS 10.5 software.

Database design and creation was achieved with conceptual, logical and physical modelling. The vector conceptual scheme was adopted where point, line and polygon shapes were used to represent entities on scene, while the logical design stage, the relational data model by which data was separated into tables was adopted for each of the entity types. The created database and spatial attributes of features of interest were used to perform an overlay operation, using ArcGIS 10.5 software.

Closest facility and Location allocation analysis were the GIS-based network analysis used to address the two types of scenarios for the study. In achieving the preparation of the network data using ArcGIS 10.5, the acquisition of road network, waterway network and social facilities of the study area were first carried out, followed by conversion of the data into compactable format. The impedance attributes were calculated by determining the length of each line segment in the road network and waterway networks. The derived length in meters is the required cost parameter on which the analysis was dependent on. After creating the network dataset, the network attributes such as speed, travel time, and distance were used to define the assignment of the attributes to the network features such as roads, intersections, and transit stations achieved. The network was verified by running test analysis to ensure that the network is accurate and complete. Errors or issues with the network were refined by adjusting the network attributes or modifying the network features.

Results and Discussion

Closest facility analysis

In the context of heart attack emergencies, this study investigated the utilization of an intelligent transport system's closest medical facility. The result of the study as presented in figure 3 reveals four closest medical facilities to the incident, including Amadiama Health Centre at 3km, Azubie Health Centre at 3.4km, Garrison Health Centre at 4.1km, and Ozuboko Health Centre at 4.3km. This information can be vital in selecting the most appropriate medical facility for a heart attack emergency.

The result of this study highlights the significance of utilising the closest facility analysis feature of an intelligent transport system in the context of heart attack emergencies. By investigating the utilization of this feature, the study revealed that emergency medical services (EMS) can benefit significantly from it by identifying the most efficient route to the nearest medical facility with specialized cardiac units or emergency departments.

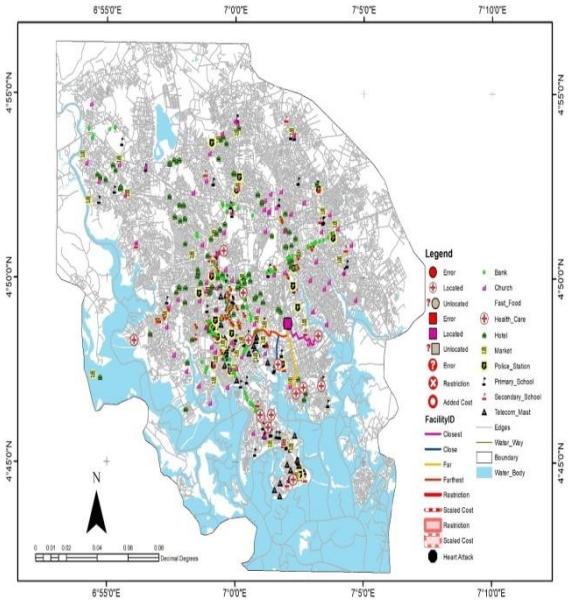


Figure 4: Closest medical facilities to a heart attack incident

One of the essential benefits of using this analysis is that it provides up-to-date information on traffic conditions, road closures, and other factors that may impact the EMS route. With this information, they can make well-informed decisions and reach the patient in the shortest possible time,

which is critical in situations where every second counts.

Overall, the study's findings emphasize the importance of utilizing the closest facility analysis feature of an intelligent transport system in emergency situations, specifically in cases of heart attack. The information provided by this analysis can help EMS to make well-informed decisions and potentially save a person's life by reaching the patient in the shortest possible time.

Location allocation

In this study, location allocation analysis was used to determine the best locations for health care facilities in the study area. The ITS helped identify areas that are underserved or have limited access to health care, taking into account travel time, distance, and traffic conditions to ensure that health care facilities are located in areas that are accessible to those who need them the most.

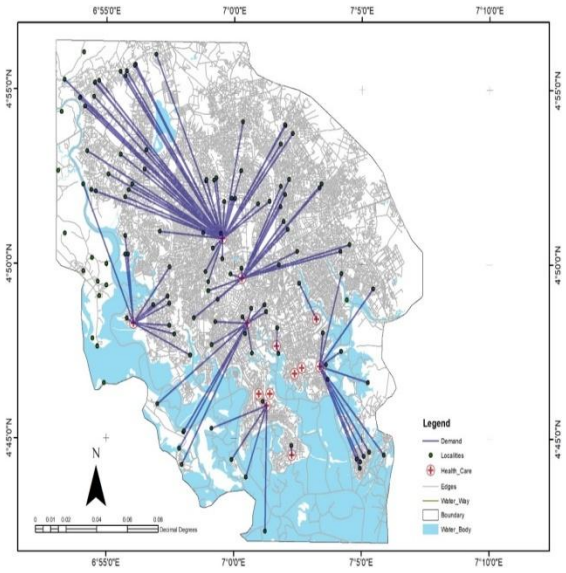


Figure 5: Location allocation analysis

From the study, 14 health care centres were available to serve 134 demand points from the localities. This analysis was structured to determine which health care centre would handle the most demand within a range of 5 km and which locality within the study area would have to travel far distances to access health care services.

Generally, location allocation analysis in an intelligent transport system can help improve access to health care services, reduce travel time and costs for patients, and enhance the overall efficiency of the health care system. The results of this analysis are shown in Figure 5.

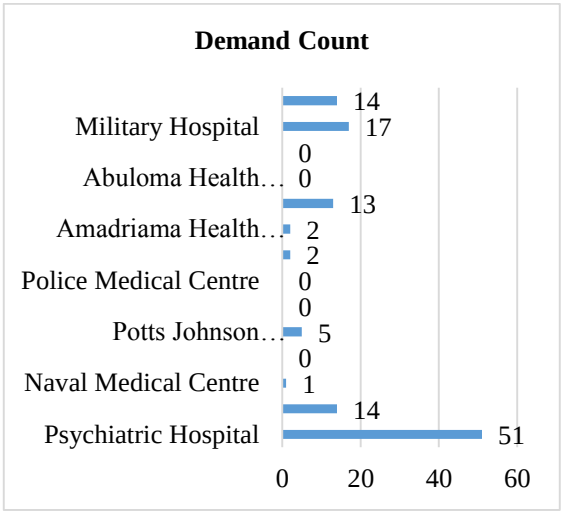


Figure 6: Health care/localities demand count

The results of the location allocation analysis (shown in Figure 5 and 6) provide valuable insights into the distribution of demand for health care services in the study area. Out of the 14 health care centres available to serve 134 demand points from the localities, 5 health care centres had no demands. These centres include Ozuboko Health Centre, Abuloma Health Centre, Police Medical Centre, Sickbay, and Every Woman Health Centre.

However, the Psychiatric Hospital had the highest demand count of 51 within a 5km range, indicating that it is a crucial health care facility in the area. Following closely behind is the Military Hospital with a demand count of 17, while Garrison Health Centre and UOE Medical Centre both have 14 demand counts. Potts Johnson Health Centre has 5 demand counts while Amadiama Health Centre and Azubie Health Centre have 2 demand counts

each. On the other hand, the Naval Medical Center has the least demand count of 1.

In addition, the location allocation analysis also revealed that several localities such as Ahai-Ogbakiri, Ngbagidi, Mbuosi, Okporowo, Oduoha, Rumechie, Rumuokani, Ikukiri, Umuoro, Igbekiri-Isiokpo, Umuigbekwo, and Okpuruta, would have to travel more than 5km to access health care services within the study area. This information can be used to inform decision-making processes for health care resource allocation in the area. By identifying areas with high demand and those with limited access, health care providers can improve service delivery and ensure that their services are accessible to those who need them the most. This can improve the health outcomes of the population and ultimately contribute to the development of a healthier society.

With the help of an ITS, health care facilities can be optimally located to ensure accessibility for those who need them the most while minimizing the total cost of the service. This will lead to improved health care services, increased efficiency, and overall better health outcomes for the population.

Conclusion and Recommendation

Conclusion

The implementation of Intelligent Transport System in health care delivery in Port Harcourt has provided insights for evaluating health care resource allocation decision-making processes in the area. By identifying areas with high demand and those with limited access, health care providers can improve service delivery and ensure that their services are accessible to those who need them the most. This can lead to improved health outcomes for the population and contribute to the development of a healthier society. Using an intelligent transport system, health care facilities can be optimally located to ensure accessibility while minimizing the total cost of the service. This will lead to increased efficiency, better health outcomes, and improved health care services for the population. The results have demonstrated that the intelligent transport system can significantly improve the efficiency and effectiveness of transportation services in the region. It can help to minimize travel distances, reduce travel time, and increase service quality, resulting in cost savings, improved customer satisfaction, and better patient outcomes.

Recommendations

Based on the results of the study, the following recommendations are made:

i. Medical professionals and emergency responders can use the analysis of the closest facility aspect of the intelligent transport system to identify the nearest medical facility with the necessary equipment and expertise to provide effective care to the patient in emergency situations. This can help to save crucial time in getting the patient the care they need, which can ultimately lead to better patient outcomes
ii. The analysis of the distribution of demand for health care services can inform the allocation of resources to health care facilities in the area. The Psychiatric Hospital had the highest demand count of 51 within a 5km range, indicating its significance as a crucial health care facility in the area. The other health care centres with no demands can review their services and explore ways to improve their services to attract more patients.

Reference

Aworemi, J. R. and Ilori, O. M. (2008). An evaluation of the performance of private transport companies in selected Southwestern of Nigeria. *African Journal of Business Management*, 2(8), 131-137.

Jonkers, E. and Gorris, T. (2015). Intelligent transport system and traffic management in urban area. *Civitas*,36.http://civitas.eu/sites/default/files/civ_Polnot6_its_web.pdf%0Ahttps://www.eltis.org/sites/default/files/trainingmaterials/civ_polnot6_its_web.pdf.

Ogochukwu, C. G., Chukwurah, U. C. and Success, C. (2018). Intelligent transport systems (ITS): An approach to traffic congestion challenges in Enugu Metropolis. *Journal of Transportation Systems*, 3(3), 13-19.

Olujimi, J. (2009). Evolving planning strategy for managing urban sprawl in Nigeria. *Journal of human ecology*, 25(3), 201-208.