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RESEARCH ARTICLE

ROAD SEGMENTATION IN APAPA LOCAL GOVERNMENT AREA OF LAGOS STATE WITH REGARD TO THE SEA PORT CONGESTION

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ABSTRACT

This study investigated road segmentation and its effect on road traffic congestion in Apapa (LGA) of Lagos state, Nigeria. The aim is to carry out spatial data structures of dynamic road segmentation of APAPA LGA showing the road segment (spatial data) and its topological information.. Survey research design was used to gather data through primary and secondary sources. The data collected were analyzed using ArcGIS 10.2 software to develop geospatial database for road congestion management and control. The results showed that road traffic congestion has negative effect on firms' performance in Apapa seaport and its environs. This paper concluded that economic activities within Apapa LGA have been negatively affected by road traffic congestion. It was recommended that firms can actually move to a more comfortable zone to reduce stakeholders such as customers' and employees' stress of entry and exit in that location and increase business owners 'chances of expanding their businesses.

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INTRODUCTION

Spatial data are data that are geographically referenced and interconnected. The need to place information pertaining to the physical environment and the socio-economy in a geographical context pervades all human activities. This has made modern society become increasingly dependent on geographic data that is accurately and reliably spatially referenced. Dynamic segmentation is the process of computing the map locations of linearly referenced data (for example, attributes stored in a table) at run time so they can be displayed on a map, queried, and analyzed using a GIS. The dynamic segmentation process enables multiple sets of attributes to be associated with any portion of a line feature without segmenting the underlying feature. In the transportation field, examples of such linearly referenced data might include accident sites, road quality, and traffic volume (Von Holdt, 2004). Environmental System Research Institute (ESRI) defines as "a process of transforming linearly referenced data (commonly called events) stored in a table into a feature that can be displayed on a map." This is accomplished by referencing non-spatial tabular data (events) to spatial linear features (routes) in ArcGIS.

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A route is a special polyline feature on which events can be located. The special nature of routes is that their location is defined in terms of XY coordinates as well as a measure value (m-value). The difference between a normal polyline and a route is shown in figure 1 below.

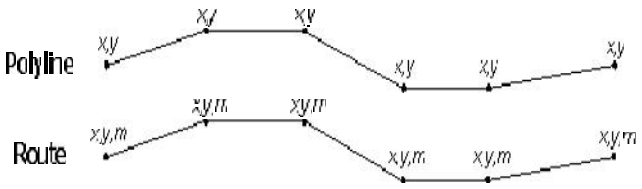

Figure 1. Polyline and route features; source (Von Holdt, 2004)

The dynamic segmentation functionality in ArcGIS was developed by the ESRI to offer linear infrastructure managers an improved method of spatial data analysis and display. This report investigates the implementation of dynamic segmentation using typical road management data. Dynamic segmentation is investigated in the Apapa LGA of Lagos State, Nigeria to gain an understanding of the how it works and what the implications of its implementation are. The findings of this study will show that the implementation of dynamic segmentation can considerably improve the spatial analysis and display of road management data.

However, the level of compatibility between the network referencing system and the route development process in ArcGIS can influence the manpower effort to implement dynamic segmentation in Apapa LGA considerably. In this work, spatial data or roads segmentation were evaluated by acquiring the following topological information. Such includes spatial data such as; Serial number of roads, Date of observation, Road names, Road ID, Number of segments for the entire roads, Each segment ID, Coordinates of each segment (Northern(m) and Eastern(m)), Date of observation, Starting and ending time of observation, Volume of vehicles/lane (To and Fro), Each segment travel time (hr, min or sec), Causes of congestion and the coordinate of the point, Nature of segment, Adjoining land use (left and right) , Nature of crime, Coordinate of crime location, Local inhabitants, Noticeable crime time, Name of nearest police station, coordinate of the nearest police station etc. Non-spatial (attribute) data which includes; Habit of inhabitants, Average income of inhabitants, Poverty level in area, Youth concentration in the area, Inhabitants' general mode of transportation etc; were also acquired and analyzed. Linear reference is a method for dynamic segmentation, which stores the geographic position by measuring the relative position of linear features, that is, locating the event along the line by distance, was not also left out. Moreover, it is important to know that dynamic segmentation is developed on linear reference. If use two data structures: route dataset and event table dataset. In real life, many geographic positions are recorded as the events of features along the line. For example, we tell you that an accident happened in 500m west to the No. 32 corner. Sometimes, over-accurate figures are useless for us in our daily life. However, the relative positions points or lines can help us get the information we want at ease. Linear reference can associate each part of the linear feature to different attribute values under the conditions of not splitting the linear feature into sections. The thought of linear reference can be applied in linear data collection like roads, railways, rivers, etc., public transportation system management, road quality management as well as communication and distribution networks (such as power grids, telephone lines, TV cables, water supply and drainage pipes, etc.).

Some basic concepts which are necessary in dynamic segmentation include:

- **Route:** Route is a linear feature (such as the road, street, river, pipe, etc.) that is characterized of ID and measure system, and it has a position ID and a measure value (generally used M to describe it like mileage).
- **Measure Value (M):** Measure Value is a coordinate system that is independent of the other feature classes. The unit between the Measure value and other features isn't necessary to be the same.
- **Route ID field:** Is a field in the rout dataset, storing the route ID. The Route dataset, the event table and the spatial data contain this field.
- **Route Dataset:** Stores the location of events, that is a route dataset is a vector dataset.
- **Route Position:** Route position describes a "point" in the route or a "section" along the route. A point in the route position is described by a Measure value, and a line in the route position is described by two Measure values: Start Measure and End Measure.
- **Event:** When the route positions and their associated attributes store in one table, a route event will be organized, which is called event for short. There are two kinds of route positions, so they are corresponding to two types of route event table: point event table and line event table.

Aim: The aim is to carry out spatial data structures of dynamic road segmentation of APAPA LGA showing the road segment (spatial data) and its topological information.

Objectives

The aim can be achieved through the following objectives:

- To acquire the positional data of each segmentation;
- To determine the volume of traffic of the study area;
- To determine the topological features of each segmentation of the road;
- To determine crime spot, potholes, congestion spot, accident scene and police post in the study area.

MATERIALS AND METHODS

Digitizing of the Base Map: The selected roads within APAPA Local Government were obtained from a street map of APAPA Local Government Area. The selected roads were digitized to obtain the spatial information required for the road segmentation. The roads of interest were digitized in ArcGIS 9.3 software. It was created as a separate shapefile and added as a layer within the GIS.

The following are the roads selected within the local government.

- Liverpool Road
- Oduduwa Road
- Apapa Road
- Marina Road
- Point Road
- Park Lane
- Wharf Road
- Apapa Oworonshoki Express
- Burma Road
- Creek Road
- Ware House Road

Segmentation of the Selected Roads: The selected roads were transversed with personal transport and segment of roads was done base on junctions as well as bus stops. The spatial information of these points i.e. the X, Y coordinate were acquired with hand held GPS and they form the nodes of the required road segmentation. The coordinates of these points were imported into ARCGIS 10.2 software and exported as shapefile with the name nodes. The nodes fell on the digitized selected roads and were connected together with a separate shapefile feature called segments overlaid on the selected roads. The above operations resulted to the development of an arc-node topology defined by the nodes and the segments. The roads were divided into 44 segments.

Nature of each segment: Information describing the nature of each individual segment include the presence of crime scene, congestion points, presence of pot holes and the segment general structural condition. The general structural condition of the road was noted and the location of pot holes, congestion point as well as crime scenes was taken with hand held GPS.

These coordinates were also imported into the GIS environment.

Attribute information of the roads and the segment: Other attribute information noted here include the number of lanes of the roads, the mode of transportation, the local inhabitants of each segment, the land use to the left and right sides of the segments, the travel time of the segment and the traffic condition of the roads.

The Database of the attribute information: The entire attribute information acquired for all the roads and the segments were presented in the GIS database environment. The entire work is saved in a CD drive so that the database of information can be assessed. Figure 2 below shows some part of the database of the attribute data.

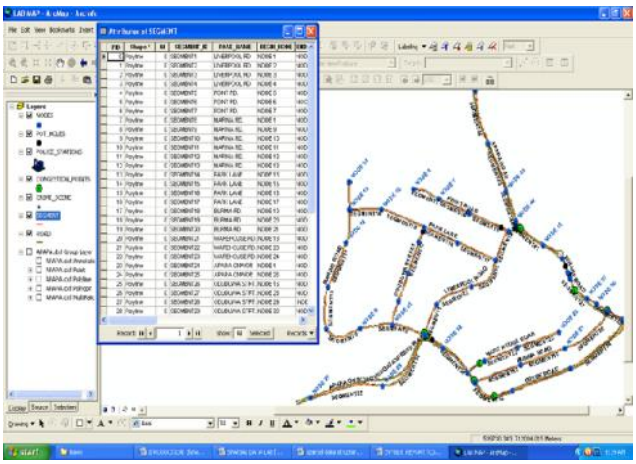

Figure 2: showing some part of the database of the attribute data

RESULT AND ANALYSIS

Database of Road Segmentation: The information acquired from the field describing the road network as well as the segments i.e. the attribute information, are built in a database developed in a GIS platform using ArcGIS 10.8 software. This database contains information such as name of road, segment ID, nature of roads, nature of segments, presence of pot hole, presence of crime scenes, presence of congestion, causes of congestion, local inhabitants of segment, length of segments, adjoining land use (to the left and right), mode of transportation along the segment, the traffic condition of the roads and the number of lanes of the road. These large amount of attribute information for all the segment were spatially reference with respect to the positions of all the segments and this is the basis of every GIS operation; providing an environment for relating the spatial locations of features with the attribute information describing the spatial feature (which in this case the roads and the road segments represents the spatial feature)

Presentation of the Road Segmentation: The visual representations of the spatial features describing the dynamic road segmentation i.e. the roads, the road segments, the nodes, crime scenes, police station, congestion point, pothole location and the land use are presented pictorially as maps in three(3) category as:

- Map showing the selected road network in Apapa Local Government Area.
- Map showing the conditions of the selected road network in Apapa Local government Area.
- Map showing the segmentation of the segmentation of roads into arcs and nodes within Apapa Local Government Area.

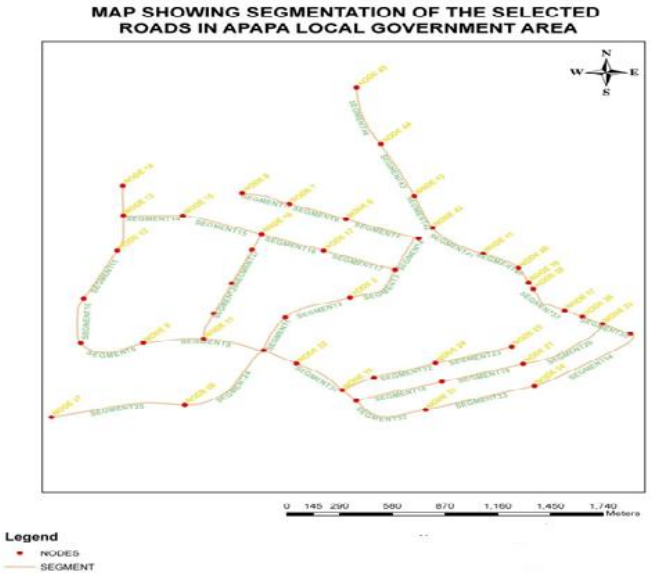

Figure A:

Table A: coordinates of the nodes

NODE_ID	EASTING9(m)	NORTHING(m)
NODE 1	539854	711785
NODE 2	539972	712057
NODE 3	540328	712219
NODE 4	540576	712449
NODE 5	540706	712707
NODE 6	540306	712866
NODE 7	539995	712991
NODE 8	539735	713080
NODE 9	539191	711845
NODE 10	538848	711843
NODE 11	538864	712211
NODE 12	539048	712607
NODE 13	539081	712897
NODE 14	539079	713144
NODE 15	539410	712895
NODE 16	539842	712744
NODE 17	540183	712607
NODE 18	540285	711458
NODE 19	540362	711369
NODE 20	540833	711527
NODE 21	541280	711672
NODE 22	541716	712004
NODE 23	540460	711560
NODE 24	540798	711679
NODE 25	541217	711814
NODE 26	539419	711336
NODE 27	538686	711234
NODE 28	539789	712613
NODE 29	539678	712337
NODE 30	539579	712089
NODE 31	539523	711879
NODE 32	540033	711676
NODE 33	540745	711296
NODE 34	541342	711493
NODE 35	541869	711920
NODE 36	541606	712062
NODE 37	541508	712113
NODE 38	541336	712290
NODE 39	541309	712344
NODE 40	541254	712463
NODE 41	541060	712583
NODE 42	540782	712795
NODE 43	540681	713058
NODE 44	540498	713484
NODE 45	540364	713951

TABLE B: CONGESTION POINTS CAUSES OF CONGESTION AND THEIR COORDINATES

CONGESTION	CAUSE_OF_C	ORTHING(m)	EASTING(m)
LIVERPOOL BUS STOP/LIVERPOOL ROAD	T-JUNCTION	711783	539865
LIVERPOOL BUS STOP/MARINA ROAD	T-JUNCTION	711807	539843
NEAR FCMB,GTB,NIGER BISCUIT	TRAILERS PARK	711242	540557
ROUND ABOUT TO WHARF ROAD	T-JUNCTION	711912	541888
ROUND ABOUT FROM CORMMERCIAL ROAD	ROUND ABOUT	712179	541379
T- JUNCTIONS FROM WHARF RD TO APAPA RD	ROUND ABOUT	712732	540826
CREEK ROAD JUNCTION TO BURMA RD	T- JUNCTIONS	711385	540351
FIRST ROUND ABOUT FROM CREEK ROAD JUNCTION	ROUND ABOUT	711533	540412
BURMA/WHARF ROAD T-JUNCTION	T-JUNCTION	712000	541713

FIGURE C: BAD ROAD CONDITION AT THE BRIDGE DIVERSION ALONG CREEK ROAD

FIGURE D: TRAFFIC AT LIVERPOOL ROUND ABOUT/BUS-STOP

FIGURE E: NOTABLE CRIME SCENE AT LIVERPOOL BUSSTOP/UNDER BRIDGE

APPENDIX F: TRAFFIC NEAR INDUSTRIAL PART OF CREEK ROAD AFTER BURMA ROAD

APPENDIX G: HIGH TRAFFIC AT T- JUNCTIONS FROM WHARF RD TO APAPA ROAD

Table C. Other Attribute Information about Road

Segment_id	R0ad_name	Begin_node	End_node	Nature_seg	Lnd_use_ri	Lnd_use_le	Seg_tra_ti	Tribe_of_l	Presence_o	Causes_of_	Mode_of_tr	Segment_le
Segment1	Liverpool rd	Node 1	Node 2	Intersection	Residential	Residential	00:00:31	Mixed tribe	Yes	Round about	Taxi,okad and private	300.78500000000
Segment2	Liverpool rd	Node 2	Node 3	Intersection	Residential	Residential	00:00:37	Mixed tribe	Nil	Nil	Taxi,okad and private	396.14100000000
Segment3	Liverpool rd	Node 3	Node 4	Intersection	Residential	Residential	00:00:30	Mixed tribe	Nil	Nil	Taxi,okad and private	369.30500000000
Segment4	Liverpool rd	Node 4	Node 5	Intersection	Residential	Residential	00:00:29	Mixed tribe	Nil	Nil	Taxi,okad and private	306.37400000000
Segment5	Point rd.	Node 5	Node 6	Intersection	Residential/commercial	Residential/public	00:00:31	Mixed tribe	Nil	Nil	Taxi,okad tri-cycle and private	431.88200000000
Segment6	Point rd.	Node 6	Noce 7	Intersection	Residential	Residential	00:00:28	Mixed tribe	Nil	Nil	Taxi,okad tri-cycle and private	334.77900000000
Segment7	Point rd.	Node 7	Node 8	Intersection	Residential	Residential	00:00:20	Mixed tribe	Nil	Nil	Taxi,okad tri-cycle and private	278.36100000000
Segment8	Marina rd.	Node 1	Node 9	Intersection	Residential/commercial	Residential	00:00:48	Mixed tribe	Nil	Nil	Danfo,taxi,tri-cycle and private	682.11000000000
Segment9	Marina rd.	Node 9	Node 10	Intersection	Residential/commercial	Residential/commercial	00:00:34	Mixed tribe	Nil	Nil	Danfo,taxi,tri-cycle and private	387.23000000000
Segment10	Marina rd.	Node 10	Node 11	Intersection	Residential	Residential	00:00:32	Mixed tribe	Nil	Nil	Danfo,taxi,tri-cycle and private	377.53500000000
Segment11	Marina rd.	Node 11	Node 12	Intersection	Commercial	Residential	00:00:40	Mixed tribe	Nil	Nil	Danfo,taxi,tri-cycle and private	436.48000000000
Segment12	Marina rd.	Node 12	Node 13	Intersection	Residential	Residential	00:00:23	Mixed tribe	Nil	Niil	Danfo,taxi,tri-cycle and private	295.48200000000
Segment13	Marina rd.	Node 13	Node 14	Intersection	Residential/commercial	Residentiall	00:00:55	Mixed tribe	Yes	Market	Danfo,taxi,tri-cycle and private	246.46900000000
Segment14	Park lane	Node 13	Node 15	Intersection	Residential/commercial	Residential	00:00:30	Mixed tribe	Nil	Nil	Taxi,tri-cycle and private	328.68600000000
Segment15	Park lane	Node 15	Node 16	Intersection	Residential	Residential	00:00:44	Mixed tribe	Nil	Nil	Taxi,tri-cycle and private	458.88900000000
Segment16	Park lane	Node 16	Node 17	Intersection	Residential/commercial	Residential,commercial and recreational	00:00:31	Mixed tribe	Nil	Nil	Taxi,tri-cycle and private	364.21200000000
Segment17	Park lane	Node 17	Node 18	Intersection	Residential	Residential/commercial	00:00:39	Mixed tribe	Nil	Nil	Taxi,tri-cycle and private	427.67300000000
Segment18	Burma rd.	Node 19	Node 20	Intersection	Industrial	Industrial	00:00:43	Nil	Nil	Nil	Taxi and private	496.94700000000
Segment19	Burma rd.	Node 20	Node 21	Intersection	Industrial	Industrial/commercial	00:00:40	Nil	Nil	Nil	Taxi and private	469.22200000000
Segment20	Burma rd.	Node 21	Node 22	Intersection	Industrial	Industrial	00:00:39	Nil	Nil	Nil	Taxi and private	570.06000000000
Segment21	Warehouse rd.	Node 18	Node 23	Intersection	Industrial/commercial	Industrial	00:00:58	Nil	Yes	Round about	Danfo,taxi and private	199.73900000000
Segment22	Warehouse rd.	Node 23	Node 24	Intersection	Industrial/commercial	Industrial	00:00:36	Nil	Nil	Nil	Danfo,taxi and private	359.38900000000
Segment23	Warehouse rd.	Node 24	Node 25	Intersection	Industrial	Indutrial/commecial	00:00:23	Nil	Nil	Nil	Danfo,taxi and private	441.52300000000
Segment24	Apapa onworoshonki express	Node 1	Node 26	Intersection	Public	Public	00:00:49	Nil	Nil	Nil	Danfo,private and okada	662.49000000000
Segment25	Apapa onworoshonki express	Node 26	Node 27	Intersection	Public	Public	00:01:00	Nil	Nil	Nil	Danfo,private and okada	750.26900000000
Segment26	Oduduwa strt.	Node 16	Node 28	Intersection	Residential/commercial	Residential/commercial	00:00:19	Mixed tribe	Nil	Nil	Danfo,taxi,private and okada	140.77400000000
Segment27	Oduduwa strt.	Node 28	Node 29	Intersection	Residential	Residential	00:00:28	Mixed tribe	Nil	Nil	Danfo,taxi,private and okada	297.16900000000
Segment28	Oduduwa strt.	Node 29	Node 30	Intersection	Residential	Residential	00.00:24	Mixed tribe	Nil	Nil	Danfo,taxi,private and okada	267.25000000000
Segment29	Oduduwa strt.	Node 30	Node 31	Intersection	Residential	Residential	00:00:19	Mixed tribe	Nil	Nil	Danfo,taxi,private and okada	220.31700000000
Segment30	Creek rd.	Node 1	Node 32	Intersection	Residential/commer	Residential	00:00:15	Mixed tribe	Yes	Round about	Danfo,taxi and private	210.33500000000
Segment31	Creek rd.	Node 32	Node 18	Intersection	Commercial/industrial	Commercial/industrial	00:00:32	Nil	Nil	Nil	Danfo,taxi and private	336.32700000000
Segment32	Creek rd.	Node 18	Node 33	Intersection	Commercial/industrial	Commercial/industrial	00:01:12	Nil	Yes	Trailer park	Danfo,taxi and private	563.58300000000
Segment34	Creek rd.	Node 34	Node 35	Intersection	Commercial/industrial	Commercial/industrial	00:00:57	Nil	Yes	Round about	Danfo,taxi and private	717.54100000000
Segment35	Wharf road	Node 35	Node 36	Intersection	Commercial	Commercial	00.00.47	Nil	Yes	T-junction	Danfo,taxi and private	299.41500000000
Segment36	Wharf road	Node 36	Node 37	Intersection	Commercial	Commertial	00:00:21	Nil	Nil	Nil	Danfo,taxi and private	110.20800000000
Segment37	Wharf road	Node 37	Node 38	Intersection	Industrial	Residential/commertial	00:01:00	Mixed tribe	Nil	Nil	Danfo,taxi and private	263.53500000000
Segment38	Wharf road	Node 38	Node 39	Intersection	Industrial	Residential/commercial	00:00:23	Mixed tribe	Nil	Nil	Danfo,taxi and private	60.85530000000
Segment39	Wharf road	Node 39	Node 40	Intersection	Industrial	Residential/commercial	00:00:56	Mixed tribe	Nil	Nil	Danfo,taxi and private	131.16900000000
Segment40	Apapa rd	Node 40	Node 41	Intersection	Industrial	Residential	00:02:00	Mixed tribe	Nil	Nil	Danfo,taxi and private	233.65200000000
Segment41	Apapa rd	Node 41	Node 42	Intersection	Industrial	Residential	00:05:02	Mixed tribe	Yes	Round about/t-junction	Danfo,taxi and private	357.36400000000
Segment42	Apapa rd	Node 42	Node 43	Intersection	Commercial/industrial	Residential	00:06:23	Mixed tribe	Yes	About/t-junction	Danfo,taxi and private	282.62700000000
Segment43	Apapa rd	Node 43	Node 44	Intersection	Residential	Commercial	00:05:02	Mixed tribe	Nil	Nil	Danfo,taxi and private	464.78500000000
Segment44	Apapa rd	Node 44	Node 45	Intersection	Reidential/commercial	Commercial	00:05:02	Mixed tribe	Nil	Nil	Danfo,taxi and private	494.74800000000
Segment33	Creek rd.	Node 33	Node 34	Intersection	Industrial	Commercial/industrial		Nil	Nil	Nil	Danfo,taxi and private	628.16700000000

CONCLUSION AND RECOMMENDATION

Dynamic road segmentation provides a platform for planning and controlling changes on road network. Since the roads are broken down into segments temporal changes of the road structure as well as the traffic conditions of the roads can be analyzed and suitable decisions as well as policies for proper road maintenance can be easily taken and the policies implemented with respect to the segmentation of the roads.

The findings from the study confirmed the relationship between road traffic congestion in the operating business environment and firms' performance. This finding contradicts the position of Taylor (2002) which admitted that traffic congestion is an evidence of social and economic vitality of firms. It was concluded that road traffic congestion has reduced the sales rate and profitability of the firms in the CBD and that most of the stakeholders would not mind business relocation. It should be noted that this might not be the case in some other CBDs where road network are well designed and road users are disciplined.

The following recommendations were put forward:

- There is need for Apapa road network system to be maintained adequately.
- Road users attitudinal change campaign should be embarked upon immediately.
- People should endeavor to use public transport or small-size vehicles and create parking lots for vehicles.
- Alternative means of road transportation should be created within the port area
- Any business that cannot cope can relocate to a comfort zone in the face of difficulty in gaining entry or exit. This is more so where the raw materials are not tied to that particular environment.

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