Arts and Social Sciences Journal

Nwoye and Iyiola, Arts Social Sci J 2016, 7:1
http://dx.doi.org/10.4172/2151-6200.1000162

Research Article Open Access

An Assessment of the Carrying Capacity of Lagos Metropolitan Roads: A Case Study of Mile2-Apapa and Lekki-Epe Corridors

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Received date: January 25, 2016; **Accepted date:** February 18, 2016; **Published date:** February 23, 2016

Abstract

Road failure, as one of the major problems of urban transport operations and planning, has become an issue of national concern over the years. This omen has caused severe loss of man-hours, financial resources, loss of lives, transit discomfort, to mention but a few. Thus, this study aimed at exploring and analyzing the carrying capacities of Lagos roads. Its focus was to critically examine pavement classifications, with respect to the design traffic of the corridors chosen as the case study. The study paid attention to the composition of the traffic volumes, existence and effectiveness of load tonnage standards as well as the damage effects of overloading on the life span of the roads. The methodology involved a combination of qualitative and quantitative techniques. The findings revealed that the corridors examined had exceeded their design carrying capacities. However, the composition of the volume of traffic for both corridors was not the same. Lekki-Epe corridor had a very insignificant proportion of high density vehicles (HDV), which are the major cause of road overload and resultant breakdown. On the contrary, Mile2-Apapa corridor had a significantly high proportion of its traffic volume being in the category of the HDVs (20% or 1 in every 5 vehicles being a HDV). The damage effects of overloading on the life span of the roads under review were revealed to be exponential in nature. All of these were seen to be as a result of the lack of implementation of laws and/or legislations on load tonnage standards by government.

Keywords: Road failure; Carrying capacity; Pavement design; High density vehicles (HDV); Load tonnage standard

Introduction

Transport infrastructure is one of the areas of recurrent expenditure for the government of any nation. In sub-Saharan Africa, for every one kilometer of road rehabilitated, an estimated three kilometers of road fall into disrepair, leading to a net deterioration in the total road network [1-8]. The performance of the Nigerian road sector has not been satisfactory despite its enormous potentials for growth and development. Traditionally, the poor transport facilities and infrastructure have severely delayed economic development which weakened transport infrastructure and contributed negatively to attempts to alleviate poverty in the country. Road construction and maintenance in Nigeria is far below the required standard which has made many roads function far below or sometime above their carrying capacity and since road maintenance means the preserving and keeping of road structures as near as possible in their original state. It consists of correcting deficiencies that developed as a result of poor design, age, use and the effects of the elements, and taking steps to prevent or delay the development of other deficiencies. Today, while only few roads in Nigeria carry less than their capacity; many of the busy routes of Lagos are carrying far more than the capacity of such routes. The report pointed out that the problem with roads is that some of the roads were not designed to carry these heavily loaded vehicles (mostly trailers), some roads are designed for 30 tonnes but in Nigeria rather than 30 tonnes you see vehicles carrying 45 to 60 tonnages. Even some carry 90 tonnes. It is so bad, and there is no way the roads can carry such heavy loads. A lot of factors contribute to the problem of road damage thereby leading to concurrent rehabilitation. The Highway Capacity Manual defines capacity as "the maximum sustainable flow rate at which vehicles or persons reasonably can be expected to traverse a point or uniform segment of a lane or roadway during a specified time period under given roadway, geometric, traffic, environmental, and control conditions; usually expressed as vehicles per hour, passenger cars per hour, or persons per hour [9-18]. The idea of carrying capacity in transportation studies is much similar to the foregoing, it is simply the "maximum number of passenger and/or weight of freight that such transport facility (road) can sustain indefinitely given it dimensional etc. qualities. This can be no farther from truth since, transport systems are meant to convey essentially two kinds of things: goods and people, and there certainly is a maximum measure of them that the system can and should carry, if it is not to collapse. Indeed, roads being the oldest and most popular form of transport world-over have had their carrying capacities given greater attention than other modes of transport, as shall be done in this study [19-26].

Aim and Objectives

The aim of this study is to assess the carrying capacity along Lekki-Epe and Apapa road corridors of Lagos State. The specific objectives to achieving the foregoing aim are to:

- Examine the traffic volume on the corridors under review as well as the proportion of high density vehicle (HDV) as a percentage of the total traffic volume thereof,
- Assess the carrying capacities of the roads along the corridors, with respect to the pavement design traffic volume,

- Evaluate the legally permissible load tonnage as well as the damage effect of overloading on the corridors,
- Examine the effectiveness of the regulatory and legislative provisions towards ensuring compliance with road usage, with respect to load tonnage.

Scope of Study

This research is limited to the assessment of the carrying capacity of the corridors examined, with reference to the design traffic vis-à-vis the current traffic volume on the corridors. There were therefore no methodologies relating to civil/structural engineering operations in the research work. However, the forth power model was used to assess the effect of overloading on the life spans of the corridors under review.

Research Hypothesis

This study tested the following hypothesis to check its validity;

H0: Ineffective legislation has no negative impact on the carrying capacities of roads.

H1: Ineffective legislation has a negative impact on the carrying capacities of roads

Theoretical framework of analysis

Concept of Carrying Capacity: The term carrying capacity has different definition but interrelated meaning in various fields of human endeavors. Planners usually define carrying capacity as the ability of the natural or artificial system that can absorb the population growth or physical development without considerable degradation or damage. In transportation geography and road transport planning, the carrying capacity of a road is the maximum potential capacity of a given roadway. It can be expressed in terms of vehicles per hour or per day. There are numerous limitations on road capacity which make it highly unusual for roadways to actually either attain their stated capacities or used beyond it and in some cases there have been efforts to constrain road capacity for the purpose of limiting traffic to reduce congestion or environmental problems. However, the capacity of a road is highly related to the structural design of a roadway or pavements which determine the carriage capacity and aim to protect the subgrade from traffic loads by providing pavement layers which will achieve a chosen level of service, with maintenance and rehabilitation during the analysis period, as cost effectively as possible. The carriage capacity of a road encompasses factors of time, traffic, pavement materials, sub-grade soils, environmental conditions, construction details and economics [27-31].

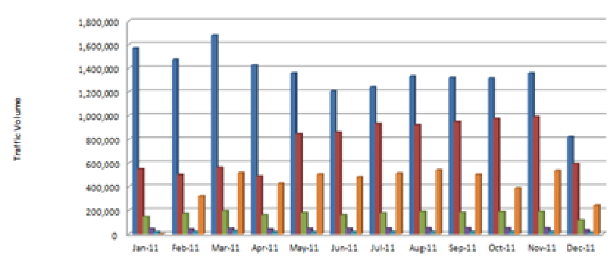
Methodology

Several variables are considered in assessing the carriage capacity of roadways along a corridor. However, a major road misuse that promotes rapid deterioration of the pavement condition is the overloaded vehicles beyond the legal (standard) axle in both proportion and magnitude, as exemplified in Nigeria. Therefore, a combination of primary and secondary data sets was used. Traffic count data was used to calculate average daily traffic for the two corridors and also to determine the volume of traffic on the corridors and the composition of HDV thereof. A pavement classification standard was adopted to benchmark the traffic characteristics of the corridors considered. Interview sessions were conducted for top officials of government agencies on load tonnage standards and the effectiveness of such laws if they are in existence. Questionnaires were used to elicit information on compliance and enforcement of load tonnage standards, if any from road users. Responses from the distributed questionnaire were used to test the research hypothesis. The forth power rule was employed in explaining the damage effect of overloading on the life span of the corridors examined.

Results and Discussions

Traffic volume of the traffic corridors under review

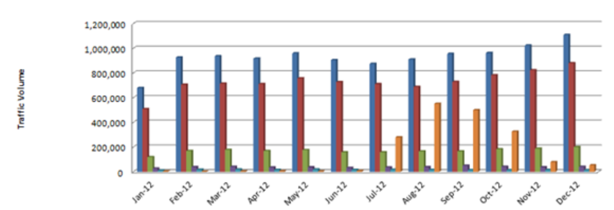
The total number of vehicles on the corridor shows the volume (number terms) of vehicles that pass the road at any given time and the classes of vehicles that use a particular corridor. The volume of traffic is shown on a monthly basis and annual estimation made to ascertain the annual traffic volume along the corridors as shown in the chart below.



	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Car/Sedan	1,569,587	1,475,876	1,682,230	1,426,847	1,359,837	1,207,099	1,244,104	1,333,531	1,322,571	1,316,477	1,359,638	822,290
Van/Small Buses/SUVs	547,566	499,815	560,087	487,822	846,008	859,697	931,387	919,680	948,326	973,736	987,949	593,593
Commercial Buses	146,271	172,447	196,648	161,727	181,112	160,446	177,500	189,783	182,734	188,082	189,887	114,613
Light Truck/Two Axle Buses	44,108	40,021	46,433	39,415	45,147	46,515	48,739	49,233	49,850	49,067	50,353	32,084
Heavy Duty Trucks	18,707	20,920	27,042	17,832	19,064	19,452	19,852	20,306	19,502	21,102	20,439	13,136
Motor bikes	622	318,593	516,856	427,735	504,263	480,365	511,830	539,613	502,867	388,931	534,365	243,120

Figure 1: Traffic volume along Lekki-Epe corridor in 2011.

From the Figure 1 it can be deduced that private cars have the highest volume which accounted for 48.72% in 2011, Van and small buses had 27.67%, Motorcycles accounted for 15.02%, commercial buses had 6.23%, light trucks and two axle buses had 1.64% and the lowest volume went to heavy duty trucks which was 0.72%.



	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
Car/Sedan	679,670	926,908	936,804	917,729	959,611	905,794	875,524	909,823	956,318	962,713	1,023,886	1,109,658
Van/Small Buses/SUVs	508,590	706,043	715,387	710,907	756,888	726,708	710,257	687,297	729,460	782,838	823,824	880,684
Commercial Buses	118,624	168,490	177,534	169,032	176,711	157,522	158,161	164,926	165,763	183,403	187,614	200,700
Light Truck/Two Axle Buses	26,860	38,643	40,549	34,574	36,402	32,650	35,161	38,155	48,896	41,638	36,907	40,109
Heavy Duty Trucks	9,976	17,337	18,715	16,017	18,846	15,820	17,594	16,251	14,454	13,634	15,753	13,669
Motor bikes	4,000	2,415	4,120	5,092	2,880	6,827	279,149	551,811	500,311	325,563	78,513	52,815

Figure 2: Traffic volume along Lekki-Epe corridor in 2012.

From the Figure 2 private cars have the highest volume of traffic along Lekki-Epe traffic corridor in year 2012 with 47.78%, small buses,

Citation: Nwoye CF, Iyiola O (2016) An Assessment of the Carrying Capacity of Lagos Metropolitan Roads: A Case Study of Mile2-Apapa and Lekki-Epe Corridors. Arts Social Sci J 7: 162. doi:10.4172/2151-6200.1000162

Vans and SUVs accounted for 35.84%, Commercial Buses accounted for 8.32%, Light Truck and Two Axle Buses had 1.85%, Heavy Duty Trucks had 0.77% and Motor-Bike had 7.44% of the total volume of traffic along the Lekki-Epe corridor in 2012.

Comparing the traffic information for the two years under review, it becomes empirically logical to conclude that the proportion of HDV as a percentage of the total traffic volume on the Lekki-Epe corridor is approximately 1%.

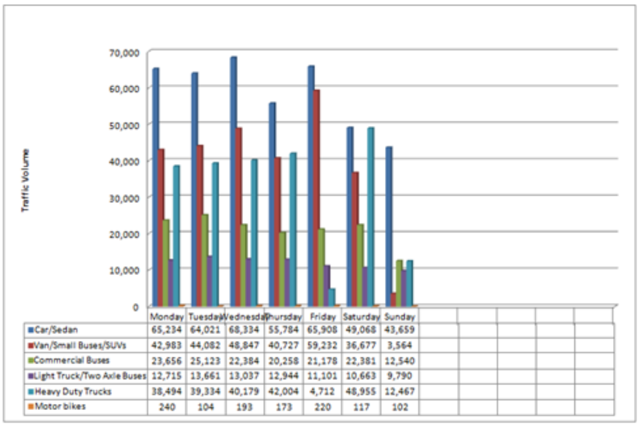


Figure 3: Weekly traffic volume along Mile-2 Apapa corridor.

From the (weekly 16-hours traffic count) Figure 3, private cars had the highest volume of traffic along Mile2 Apapa traffic corridor, with 35.93%, small buses, Vans and SUVs accounted for 24.08%, Commercial Buses accounted for 12.86%, Light Truck and Two Axle Buses had 7.32%, Heavy Duty Trucks had 19.72% and Motor Bike had 0.10% of the total volume of traffic. From this breakdown, it is evident that the proportion of HDV, as a percentage of the total weekly traffic volume on Mile2-Apapa corridor (over a 16-hour period from 6 am to 10 pm) is approximately about 20 %. The implication of this is that, as compared to the case of Lekki-Epe corridor (1% over a 24-hour count), the later is subjected to a higher tonnage stress (1 out of every 5 vehicles being a HDV) and therefore is more susceptible to wear and tear and overall resultant breakdown of the road.

Carrying capacities of the traffic corridors, with respect to design traffic volume

Carrying capacities provide information on what particular weight in load axles, the class of vehicle, the amount of vehicles a given road pavement can carry at an optimal level. This means what the road has been configured to carry without been over stressed or underutilized over its expected useful life. This section provides information on the standard bearing or carrying capacity for the corridors which was gotten from both Lagos State and the Federal Ministry of Works. In order to draw an empirical conclusion on whether or not the carrying capacity of the corridors being examined had been exceeded, with respect to their design traffic, an analysis of the Average Daily Traffic (ADT) for the two corridors was done. This was compared to a traffic and pavement design classification benchmark and was also corroborated by the assertions/representations made by top management personnel of both Lagos State and Federal Ministries of Works respectively. For Lekki-Epe Corridor, The 24-hour count traffic volume for the years 2011 & 2012 were used to determine the ADT. However, for Mile2-Apapa corridor, a weekly, 16-hour self-captured traffic data was used to arrive at the ADT. The results are presented below.

Lekki-Epe Corridor				
Year	**Total annual Traffic Volume (24 hour count)**	**Average Daily Traffic (ADT)**	**Cumulative Average ADT**	**Pavement Classification**
	a	b=a/365		
2011	33,084,482	90,642	78,724	ES3
2012	24,383,907	66,805		
Source: Authors 'calculation from the data from Lagos State Ministries of Transport & Works, 2013.				

Table 1: Determination of Average Daily Traffic for Lekki-Epe Corridor.

Mile2-Apapa Corridor				
Year/days	**Traffic Volume (12 hours count)**	**Total annual Traffic Volume (12 hours count converted to 24 hours) @ 95% Confidence Limit, 5% tolerance**	**Average Daily Traffic (ADT)**	**Pavement Classification**
Monday	183,322	192,970.53	172,457	ES10
Tuesday	186,325	196,131.05		
Wednesday	192,973	203,129.74		
Thursday	171,890	180,936.32		
Friday	162,350	170,894.47		
Saturday	167,860	176,694.74		
Sunday	82,123	86,445.00		
Total	1,146,842	1,207,202		
Source: Authors' calculation, with an adaptation from the Federal Ministry of Works Lagos, 2013, Ministry of Transport and Works, Gaborono Botswana, 2004.				

Table 2: Determination of average daily traffic for Mile2-Apapa corridor.

Juxtaposing Figures 1-3 with Tables 1-3 it could be deduced that although the Lekki-Epe corridor can be said to have exceeded its average daily design traffic, its traffic composition is such that the corridor does not bear heavy vehicular movements as only 1% (1 in every 100 vehicles is a HDV) of the total annual traffic volume is traceable to HDVs. This position is however expected to change over time due to would-be activities at the proposed deep sea port at Lekki and when the Lekki Free Trade Zone becomes operational at full capacity.

Pavement Class (*ES)	Pavement Design Bearing Capacity Million 80kN axles/lane	Volume and Type of Traffic	
		Approximately v.p.d (*ADT)	Description
ES 0.003	<0.003	<3	Very lightly trafficked roads, very few heavy vehicles. These roads could include the transition from gravel to paved roads and may incorporate semi-permanent and/or all-weather surfacing.
ES 0.01	0.003-0.01	3-10	
ES 0.03	0.01-0.03	10-20	
ES 0.1	0.03-0.10	20-75	
ES 0. 3	0.10-0.30	75-220	
ES 1	0.3-1	220-770	Very lightly trafficked roads, mainly cars, light delivery and agricultural vehicles, very few heavy vehicles.
ES 3	0.3-1	>700	medium volume of traffic, and/or many heavy vehicles.
ES 10	1-10	>700	High volume of traffic, and/or many heavy vehicles
ES 30	10-30	>2200	Very high volume of traffic, and/or a high proportion of fully ladden heavy vehicles.
ES 100	30-100	>6500	
*ES=Equivalent Standard; *v.p.d=Vehicle Per Day; *ADT=Average Daily Traffic			

Table 3: Classification of pavements and traffic for structural design purposes.

In the same vein, the Mile2-Apapa corridor can be seen to have clearly exceeded its design traffic carrying capacity. In terms of traffic composition, the corridor can be said to bear a high proportion of HDV as a percentage of the total traffic volume thereof

Legally permissible load tonnage as well as the damage effect of overloading on the corridors

The survival of man in his geographic space is expected to conform to set rules and regulations. These rules and regulations are set by constituted authorizes for the common good of all. In relation to transportation and particularly to sustainable road infrastructure management, such rules and regulations are inevitable.

This section therefore examines the legally permissible load tonnage on the corridors being examined in vis-à-vis the damage effects of not complying with these set rules and regulations

For pavement design, but also to determine the pavement wear effect of different vehicles, the pavement wear effects of different axle loads have to be determined. Generally this is described by a Load Equivalency Factor (LEF), where an axle load is said to be equivalent (producing equal pavement wear) to a number of applications of a reference (standard) axle load.

The most well-known of such a LEF is the so called "fourth power law" which is expressed mathematically as follows.

$$N_{ref}/N_x = (W_x/W_{ref})^4$$

Where,

W_x and W_{ref} are axle loads and N_x and N_{ref} are the corresponding number of load applications.

The fourth power law was found in a road test, carried out in USA between 1958-1960, but it is still relevant in recent times.

The table below shows the mathematical model that can be used to deduce the damage effects on the corridors under review, for every 1 ton increase over the legally permissible tonnage of 40 tons.

Legally permissible load(Tons)	Overload (Tons)	Damage Factor	Damage Effect	% Overload	Road Design Life (Years)	Residual Design Life
A	**b**	**c=b/a**	**d=c⁴**	**e=(b-a)/100**	**f**	**g=f/d**
40	40	1	1	0	30	30
40	41	1.025	1.103813	3	30	27.18
40	42	1.05	1.215506	5	30	24.68
40	43	1.075	1.335469	8	30	22.46
40	44	1.1	1.4641	10	30	20.49
40	45	1.125	1.601807	13	30	18.73
40	50	1.25	2.441406	25	30	12.29
40	55	1.375	3.574463	38	30	8.39
40	60	1.5	5.0625	50	30	5.93
40	65	1.625	6.9729	63	30	4.30
40	70	1.75	9.378906	75	30	3.20

40	75	1.875	12.35962	88	30	2.43
40	80	2	16	100	30	1.88
40	85	2.125	20.39087	113	30	1.47
40	90	2.25	25.62891	125	30	1.17
40	95	2.375	31.81665	138	30	0.94
40	100	2.5	39.0625	150	30	0.77
40	105	2.625	47.48071	163	30	0.63
40	110	2.75	57.19141	175	30	0.52
40	115	2.875	68.32056	188	30	0.44
40	120	3	81	200	30	0.37
Source: Authors' computation, 2013, with an adaptation from a Seminar Report on Maximum Load Limit on national Roads, Cambodia, 2000.						

Table 4: Damage Effects of Overloading on Mile-Apapa and Lekki-Epe Corridors.

From Table 4 above, it can be concluded that overloading of just one (1) ton over the legally permissible threshold can reduce the life span of any corridor by as much as three (3) years in the first year of usage. By extension, if the overload gets to 50% and 100% respectively, the resultant corresponding damage effects, in terms of reduction in the life span of the roads are about 24 and 28 years. No wonder certain roads are seen to deteriorate even in their first year of usage. Although there may be a myriad of factors that underpin rapid rate of road deterioration, overloading couple with dead weight bearing by the roads is about the most significant of them all (Figure 4).

Figure 4: Damages caused by overloaded trucks thereby exerting pressure on the road pavement. This is the major reason for pavement damage along Apapa traffic corridor where about16-25% of the traffic is mainly heavy duty trucks, trailers, oil tankers and container trucks.

Regulatory and legislative provisions towards ensuring compliance with road usage, with respect to carrying capacities

This section provides information on the existing legislative and regulatory policies in ensuring compliance with road usage and carrying capacity on the roads. It will inform what policies are available, levels of awareness of the said policies by major road users and how effective the policies have been overtime. It was gathered from the questionnaire administration and the interview with top management staff of relevant government agencies that, after the abolishment of toll gates in Nigeria in the 1990s, and the attendant destruction of weight bridges at the various toll gates, little or no attention has been paid to road usage in terms of load tonnage till now.

However, the researcher noted that there is a legally permissible load tonnage of 40 tons on all Nigerian Roads. On the one hand, the implementation of this load tonnage threshold has not being enforceable because of the lack of weight bridges or order means of objectively establishing that a road user has violated this set standard.

On the other hand, the overlap in the oversight functions of many government agencies and law enforcement agents also hinder the successful implementation of this rule.

Test of Hypothesis

In this section, the earlier stated hypotheses are tested using the chi-square distribution at 5% level of significance. The method measures the expected frequency and the observed frequency of the collected data, the computation of which is done below. Responses to the question numbered "6" on the questionnaire were used for the hypothesis.

Decision rule

Accept the null hypothesis (H0) if the calculated chi-square value is less than the table value (i.e the critical value) of chi-square.

For easy analysis, the Likert scale of 1-5 used in the questionnaire has been coded as 'YES' and 'NO' responses in testing the hypothesis. Responses of 'AGREE' and 'STRONLY AGREE' have been coded 'YES' as they provide affirmative responses to the question asked and by extension, to the hypothesis.

Responses of DISAGREE, STRONGLY DISAGREE have been coded 'NO' as they provide negative responses to the question asked, and by extension, to the hypothesis.

The 'UNDECIDED' responses are therefore not taken into consideration in the test of hypothesis (Table 5).

H0: Ineffective legislation has no negative impact on the carrying capacities of roads.

H1: Ineffective legislation has a negative impact on the carrying capacities of roads.

Response	Group	Artisans	Govt Workers	Professional Practitioners	Commercial Drivers	Other Road Users	Total
Yes		13	19	13	14	10	65
No		10	31	14	55	21	135
Total		23	50	27	69	31	200

Table 5: Observed distribution.

Degrees of Freedom (v)=(r-1)(k-1)

r =number of rows k=number of columns

Degrees of Freedom (v)=(2-1)(5-1)

Degrees of Freedom=4

Computation of the expected values

Expected value is computed as Column Total × Row Total/Grand Total

Observed Frequency (oi)	Column Total	Row Total	Grand Total	Expected Frequency (ei)	oi-ei	(oi-ei)2	(oi-ei)2/ei	Chi Square Critical Value
13	23	65	200	8.125	4.875	23.76563	2.925	
19	50	65	200	16.25	2.75	7.5625	0.465384615	
13	27	65	200	8.775	4.225	17.85063	2.034259259	
14	69	65	200	22.425	-8.425	70.98063	3.165245262	
10	31	65	200	10.075	-0.075	0.005625	0.000558313	
10	23	135	200	15.525	-5.525	30.52563	1.966223833	
31	50	135	200	33.75	-2.75	7.5625	0.224074074	
14	27	135	200	18.225	-4.225	17.85063	0.979458162	
55	69	135	200	46.575	8.425	70.98062	1.524006978	
21	31	135	200	20.925	0.075	0.005625	0.000268817	13.28448

Table 6: Chi Square Contingency table.

The Table 6 value of chi-square at 5% level of significance of 4 degrees of freedom is 9.49 (2 d.p) while the calculated chi-square is 13.28 (2 d.p).

Since the calculated value of chi-square is greater than its table value, the null hypothesis is rejected and the alternative hypothesis accepted based on the decision rule stated above. It is therefore concluded that ineffective legislation has a negative impact on the carrying capacity of the corridors examined.

This explains, among other things, the reason for the deplorable state of particularly the Mile2-Apapa corridor.

Policy implications of the Research Findings

Having examined some of the findings of the study, the following recommendations are put forward that could possibly help to handle the issue of managing road carriage or bearing capacity along the two traffic corridors examined and elsewhere. They are: Policies and regulations should be made that condition road uses in Lagos state and there is the need to identify a lead agency in government to guide the legislation and enforcement of road usage at all levels in the state. This policy and regulations should be enforced by an enforcement agency which may be existent or a new one.

Assess the problem, policies and institutional settings relating to road traffic carrying capacity and awareness should be created among major traffic users on what classes of vehicle should use designated routes and at what time.

Major traffic corridors should be designed with pavement classes that is fit enough to bear all classes of vehicles and such pavement should be designed in accordance with the prevailing activities that takes place along the traffic route.

Transport planning should be done in a more holistic and comprehensive way that will consider several other factors such as carriage capacity of the pavement which has a link with the emerging population and activities along the corridor. Such planning and policies should also be reviewed as frequently as practicable.

Alternative traffic routes such as rail lines should be provided to support the movement of heavy duty trucks and reduce the demands on roads and as such reduce the effects of stress due to load tonnage on the roads.

There is the need to keep a check on all construction works of the road construction companies and to ensure that the major traffic routes in the state is being constructed to meet the appropriate specifications and carriage or bearing standards of major and highly populated cities.

Conclusion

This study has shown that the issue of road carrying capacity has been given little or no concern in transport planning and management in Lagos state. This has in many ways had great adverse effects on the traffic scenario of many routes in Lagos state generally and on the corridors examined in particular, where all classes of vehicles use all the available lanes with different pavement configurations. At the National level the case is same, where no concern is shown as to what load should be exerted on a given pavement class. This had resulted in additional cost as pointed out that the annual loss due to bad roads is valued at N80 billion, while additional vehicle operating cost resulting from bad roads is valued at N53.8 billion, bringing the total loss per annum to N133.8 billion. The study has concluded that the carrying capacities of the corridors examined had been exceeded and that no knowledge, policies and regulations with respect to load tonnage or bearing capacity of roadways exist in Lagos state. The failure of the state in placing priority on carriage or bearing capacity of its roadway had led to continuous dilapidation of the roads and reduction of their life spans exponentially over time.

References

1. Adebusuyi BS (1994) Financing state government projects through the capital market: problems and prospects. CBN Economic and Financial Review.
2. Adewole AT (2009) Waste management towards sustainable development in Nigeria: A case study of Lagos state. International NGO Journal 4: 173-179.
3. Aina TA, Etta F, Obi C (1994) The search for sustainable urban development in metropolitan Lagos, Nigeria. Third World Plg Rev.
4. Ben-Edigbe J (2010) Assessment of speed-flow-density functions under adverse pavement condition. International Journal of Sustainable Development and Planning 5: 238-252.
5. Burningham S, Stankevich N (2005) Why road maintenance is important and how to get it done. World Bank Transport Note No TRN-4.
6. Adeniji E (2012) FERMA to Engage 10,000 Nigerians for road maintenance-engr. Economic Confidential.
7. Invesys Rail Group (2007) A comparison of the costs of different methods of increasing capacity in rail and road environments. A Transport Capacity Research Paper pp: 1-32.
8. Ukpata J, Etika A (2012) Traffic congestion in major cities of nigeria. International Journal of Engineering and Technology.
9. Hansen M, Glllen D, Dobbins A, Huang Y, Puvathmgal M (1993) Air quality impacts of urban highway capacity expansion: Traffic generation and land use changes. Institute of Transport Studies, University of California.
10. National Mirror Report (2013) Bad roads: Nigerians groan, economy suffers, FG asks for more N1.2trn. Natoinal Mirror.
11. William R, Reilly PE (1992) Operational Aspect of Highway Capacity. In: Traffic Engineering Hanbook (4th Edn.). Institute of Transportation Engineers, Prentice Hall, Englewood Cliffs, New Jersey pp: 117-153.
12. World Bank (2002) An Assessment of the Private Sector in Nigeria. The Bank Group, Washington D.C.
13. Aderamo AJ (2003) A Graph Theoretic Analysis of Intra-Urban Road Network in Ilorin, Nigeria. Research for Development pp: 221-240.
14. Chung S (1988) A conceptual model for regional environmental planning centered on carrying capacity measures. Korean J Region Sci 4: 117-128.
15. De Beer M (1985) Behaviour of cementitious subbase layers in bitumen base road structures. M Eng Thesis, University of Pretoria, Pretoria.
16. De Beer M (1990) Aspects of the design and behaviour of road structures incorporating lightly cementitious layers. Ph.D dissertation, University of Pretoria, Pretoria.
17. De Beer M (1992) Developments in the failure criteria of the South African mechanistic design procedure for asphalt pavements. 7th International conference on asphalt pavements (ISAP), University of Nottingham, Nottingham, UK.
18. De Beer M, Kleyn EG, Savage PF (1989) Advances in pavement evaluation and overlay design with the aid of the dynamic cone penetrometer. 2nd International symposium on pavement evaluation and overlay design, Rio de Janeiro, Brazil.
19. Federal Ministry of Works (1997) Nigeria general specifications. Federal Republic of Nigeria.
20. Godschalk DR, Parker FH (1975) Carrying capacity: A key to environmental planning. J Soil Water Conservation 30: 160-165.
21. Haupt FJ (1980) Moisture conditions associated with pavements in southern Africa. University of Witwatersrand, Johannesburg.
22. Kaplan EL, Meier P (1958) Nonparametric estimation from incomplete observations. Journal of the American Statistical Association 53: 457-481.
23. Hossain M, Iqbal GA (1999) Vehicular headway distribution and free speed characteristics of two-lane two-way highway of Bangladesh. Institution of Engineers 80: 77-80.
24. Howe J (1972) A Review of rural traffic-counting methods in developing countries.
TRL Limited, Crowthorne.

25. Richard A, Kenneth S (1994) The economics of traffic congestion. American Scientist 82: 446-455.
26. Ringert J, Urbanik T (1993) Study of Highway Bottlenecks in Texas. Transportation Research Record 1398, Washington, DC pp: 31-41.
27. Robert C (2003) Road expansion, urban growth, and induced travel: A path analysis. Journal of the American Planning Association 69: 145-163.
28. Robert C, Mark H (2000) Road supply-demand relationships: sorting out casual linkages. Institute of Transportation Studies, University of California.
29. Sarna AC, Jain PK, Chandra G (1989) Capacity of urban roads-A case study of Delhi and Bombay. Indian Roads Congress, New Delhi pp: 1-38.
30. Weinert HH (1980) The natural road construction materials of Africa. Academica, Cape Town.
31. Yoder EJ, Witczak MW (1975) Principles of pavement design. John Wiley, New York.