The Social Sciences 2 (2): 167-174, 2007

Appropriate Traffic Congestion Mitigation Strategies for an Unplanned Urban City

Ogundipe, Olumide Moses
Department of Civil Engineering, University of Ado-Ekiti, Nigeria

Abstract: This research reviews the types and causes of traffic congestion in relation to high volumes of vehicles on the roadway with particular reference to an unplanned city, Ado-Ekiti, Ekiti State, Nigeria. It examines the recurring and non-recurring congestion caused respectively by high volume of vehicles on the roadway during the same time periods and at critical locations and temporary disruption of transportation system like traffic incidents, poor weather etc. Also, the impacts that congestion delays have on the users are examined. The research then enumerates the measures that can be adopted to mitigate congestion in such traffic situations: these measures can be broadly classified into the supply initiatives like improvement of urban road network, coordination of traffic movements and the demand initiatives like road pricing, parking restrictions and entirely movements' reversals.

Key words: Traffic, congestion, impacts, delay, transportation

INTRODUCTION

Traffic congestion has been identified as being able to account for incremental costs resulting from interference among road users (TDM Encyclopedia, 2004). These impacts are most significant under urban-peak conditions when traffic volumes approach a road capacity. Road traffic congestion is a significant and growing problem in many parts of the world. Moreover congestion continues to increase despite, the conventional approach of building new roads because of a variety of reasons-political, financial and environmental reasons. In fact, building new roads can actually compound congestion, in some cases, by inducing greater demands for vehicle travel that quickly eat up the additional capacity (Sheldon and Wayne, 1995). Propensity to travel is higher because owners of vehicle make more convenient journeys. It is even more domineering in traditional Nigerian cities and towns where planning is not adequate. The traditional hinterland in such cities as Lagos, Ibadan, Ilorin, Ado-Ekiti, etc experience this problem, because their organic structure does not encourage effective urban traffic movement.

Traffic congestion has become a severe scourge in large cities in both the industrialized and developing countries (Bulletin FAL, 2001), Nigeria inclusive and Ado-Ekiti in particular is not left out. Increasing demand for urban transport and transit has led to longer travel times and greater incidence of accidents, environmental problems and deterioration of the quality of life than is considered acceptable for citizens. Congestion has also been observed to decrease productivity through lost time and causes stress and put additional wear on our vehicles, all of which have a negative impact on our pocket books (TMG, 2003). Congestion reduces mobility and increases driver stress, vehicle costs and pollution, hence the need to device means of controlling congestion. Urban settlements in the developed settlements are better planned than what obtains in the developing ones. Yet reports of incidences of traffic congestion abound on daily basis. Then it is obvious that likely worse situations may occur in the unplanned cities of Africa.

Congestion arises out of the conjunction of two factors. The first is that every process has a finite capacity. The second is that every process has a stochastic character; there is some degree of randomness in both the demands placed on a process to service those demands (Marvin, 1975). Whenever the total input rate is greater than the output link capacity, congestion occurs. When the network becomes congested, the queue lengths may become very large in a short time, resulting in buffer overflows and cell loss. Congestion control is therefore necessary to ensure that users get the negotiated Quality of Service (QoS) (ATM, 2005).

Congestion used to mean it took longer time to get to/from research in the rush hour, but congestion now affects more trips, more hours of the day and more transportation systems. This study reviews literature on the types of congestion, causes and impacts/costs of congestion, ways of measuring congestion and the measures of controlling congestion in an unplanned urban city.

The study area: Ekiti-state was created from old Ondo-State on 1st October 1996 and Ado-Ekiti emerged as the state capital. Before then, she had existed as a local government headquarters. This development attracted more people, establishments, hotels, recreational facilities, etc, thus she grew to become the most populated town in the state. Consequently the number of vehicles on the roads increased owing to the acquired political and administrative status of the town. Ado-Ekiti covers approximately 262 square km, having north-south length of 16 km and an east-west stretch of 20 km. The structure of Ado-Ekiti does not conform with the three types of urban structure formulated by some researchers; the concentric zone model developed by Burgess that land use is arranged around a single center called Urban Business District (CBD), the sector model by Hoyt described the urban expansion as axial growth pushing out from the center along transportation lines and the multiple model by Harris and Hommer explained that land use of a city is built around several business district rather than a single nucleus (Aderamo, 2004).

TYPES OF CONGESTION

Many types of congestion occur in transportation systems, but it is especially important to distinguish two major categories (Marvin, 1979);

- Load-independent congestion
- Load-dependent congestion

Load-independent congestion: This occurs when system performance is degraded by the interactions of system components, even if the system is not utilized (Marvin, 1979). For example, vehicles moving along guide way can experience congestion even if there are no passengers or cargo on the vehicles. In this case the demand that causes congestion is that of the system components such as vehicles rather than passengers or cargo. There are a number of specific types of congestion in this category, two of which are vehicle-facility congestion and vehicle-schedule congestion.

Vehicle-facility congestion: Every facility, whether guideway or terminal exhibits congestion effects. A terminal has a service rate at which it can handle arriving or departing vehicles. A guideway has a service rate at which vehicles move over facility. The mechanism controlling congestion on guide ways is the head spacing-speed distribution. As the volume of vehicles scheduled or otherwise attempting to move through a guideway approaches capacity, vehicle interactions cause speed reductions and thus delays (congestion).

In this case $\lambda = q$, the actual frequency (flow rate) of vehicles, while $\mu = q_c$, the flow capacity of the facility. Vehicle-facility congestion can occur whether the vehicles are empty or full; the demand is not load but vehicles. This is mostly prevalent in Ado-Ekiti where the performance on most of the roads is a function of the system components such as types of vehicle, intersections, alignment (horizontal and vertical), etc.

Vehicle-schedule congestion: This type of congestion arises when the number of scheduled trips is large relative to the number that can be produced by the available fleet. Here, the service rate is a function of the number of round trips per vehicle per time period. The demand is the number of round trips required to meet the schedule $\lambda = Q$, where Q is the scheduled frequency.

Load-dependent congestion: This occurs when system performance is degraded by the volume of flow of loads (Passengers or cargo). If the flow volume of passengers or cargo is zero, no degradation occurs. Also, in this category, a number of specific types of congestion occur, two are listed below (Marvin, 1979).

Load-vehicle congestion: This arises when a stream of vehicles move over a route past a terminal at which loads is waiting to board. The waiting time experienced by a passenger (or cargo load) at the terminal has two components: Waiting time until the first vehicle arrives (after arrival of the passenger at the terminal) and the additional time (if any) until a vehicle with an empty space arrives.

In this case, if q the frequency at which vehicles move past the terminal and each vehicle has a payload capacity w, then the number of seats (or tons) available per unit of time is wq and the service rate is μ.

$$\mu = wq \qquad (1) \quad \text{(Marvin model)}$$

Marvin (1979) Suggested that the model is crude, a more realistic one would model the arrival of batches of seats of size w at a rate q. The arrival rate l is the number of passengers (or tons) at the terminal ready to board (per unit time). That is delay time reflects the probability of finding a seat. In the case of a grain slipper waiting for an empty railcar to be available to him for loading by the rail carrier, the delay may be due to competing demands for the available vehicle capacity.

Table 1: Peak hourly flow for certain areas in ado-ekiti before and after it became capital of ekiti-state

S/No.	Roadways	Peak hourly flow (V.P.H) (before)	Peak hourly flow (V.P.H) (after)	% increase in phf (%)
1	Post office-Oja-Oba	879	1,048	42.0
2	Fajuyi-Texaco filling station	765	1,333	74.2
3	Old garage-Poly Junction	578	1,620	180.3
4	Mathew street	245	580	177.6
5	Post office-Okoli Road	710	1,092	53.8
6	Ejigbo-Ajilosun	398	720	

Source: (Oluwadare and Akinfe, 2000)

Load-schedule congestion: A key element of a schedule is the time allowed, for each detailed element of a vehicle's movement. For example, the time allowed for loading and unloading cargo or passengers at each step. Congestion occurs when the actual volumes to be loaded require more time originally scheduled. In this case the service rate is the quantity of passengers or cargo that can be loaded per unit time and the arrival rate is the actual volume requiring loading.

Recurring congestion: This is the delay that occurs in the same place at the same time on daily basis (USDT-FHA, 2005). Recurring is the predictable delay caused by high volume vehicles too much for the available capacity to handle using the roadway during the same daily time periods (e.g., peak commute periods, holiday periods, or special events) and at critical locations (intersections, interchanges, major long-term construction areas, or toll plaza areas) (Sheldon and Wayne, 1995; USDT-FHA, 2005).

The reasons for increase in driving are varied and complex, as enumerated by USDT-FHA (2005) include among others, growth in motor vehicle ownership and affordability of use, growth in commuting to research alone, lack of transit availability because of urban sprawl and changing patterns of land use.

Many of the enumerated causes of recurring congestion apply to situation in Ado-Ekiti, an unplanned urban city that suddenly put on the garment of a larger political or urban settlement. The status of Ado-Ekiti as state capital takes toll on the transportation system and the traffic situation in particular; the dilemma of poor road network coupled with meager resources has made traffic condition terrible in the state capital. As revealed by Table 1, there has been a tremendous increase in the peak hour traffic flow. The percentage increase range from 42-180.3%, hence the existing facilities could not efficiently and effectively cope with the sudden surge in vehicles on the roads. Aluko (2004) Observed that the short distance intersections along the major route in the town results in congestion.

Street trading and road businesses also result in traffic congestion. In Ado-Ekiti, some markets are located close to the highways, examples are the Oja-Oba market that is normally observed on daily basis and Bisi Egbeyemi market located behind the post-office used every 5 days. Because of the closeness of these markets to the highway, street trading and road businesses take place, consequently the traffic flows are obstructed leading to congestion. Indiscriminate parking of vehicles along the roadsides also results in congestion as it reduces the road width. Aluko (2004) Observed in his study that the causes of delay in Ado-Ekiti metropolis include passenger services (commercial vehicles), intersection inadequacies, bad road and pedestrian interference.

Nonrecurring congestion: This is the delay attributed to temporary disruptions of the transportation system by spontaneous unplanned occurrences like traffic accidents and incidents, research zones, poor weather, emergency maintenance and special events (Sheldon and Wayne, 1995; Jeff, 2004). As reported by USDT-FHA (2005) these external events can have a major effect on traffic flow. When these events occur, their main impact is to steal physical capacity from the roadway. Events also may cause changes in traffic demand by causing travelers to rethink their trips. This type of congestion occurs in a typical unplanned urban city like Ado-Ekiti.

IMPACTS/COSTS OF CONGESTION

Congestion affects the research trips and the personal trips. It affects the movement of people and the flow of goods to the market. To the travelers including truckers (both long haul and local pickup and delivery), household and business service providers (such as plumbers, computer technicians, police and ambulances services) and personal travel (such as commuters, vacationers and shoppers), congestion means lost time, missed opportunities, frustration and waste of personal resources. To the employer, congestion means lost of worker productivity, delivery delays and increased costs. Speed, reliability and the cost of urban and intercity freight movements are increasingly affected by congestion (Sheldon and Wayne, 1995; USDT-FHA, 2005). The congestion costs to freight interests are significant. Congestion is growing on many key freight segments of the transportation system and congestion can drastically reduce the productivity of the overall freight network. The delay caused by congestion could vastly increase the costs of those freight movements that are today managed to exacting schedules (USDT-FHA, 2005).

Congestion causes more fuel to be used and more emissions to be produced. The extra time spent in congestion causes service providers to make fewer calls per day, leading to higher prices for consumers, this is particularly important for emergency medical, fire and police services which may be unnecessarily delayed from attending to medical, crime and disaster situations (USDT-FHA, 2005). Companies with production schedules timed to take advantage of trucks delivery components to an assembly line as they are needed must instead plan for items to arrive early. This consumes space and inventory, expending resources that could otherwise be spent on productive activities. For trucking as congestion spreads into the midday period, which is the peak travel periods for trucks, more direct costs will be incurred and reliability-for trucks, the ability to hit delivery windows predictably will decrease and will add even more costs as firms struggle to optimize delivery schedule. This is especially a problem for trucks who must meet just-in- time delivery schedules set by shippers, manufacturers and retailers.

MEASURING CONGESTION

Traffic congestion is considered as one the main urban transportation problems (in this case, urban includes suburbs and even small resort communities during tourist season or other major events) (TDM, Encyclopedia, 2004). Congestion can be measured in various ways, including roadway Level of Service (LOS), Average traffic speed and Average Congestion Delay compared with free flowing traffic (Todd, 2004).

Various indices are used to quantify, monetize (measure in monetary units and evaluate congestion), as enumerated in Table 2.

One of the key principles that the Federal Highway Administration (FHWA) has promoted is that the metrics used to track congestion should be based on travel time experienced by the users of the highway system. While the transportation profession has used many other types of metrics to measure congestion, travel time is a more measure of how congestion affects users (USDT-FHA, 2005). Travel time is understood by a wide variety of audiences-both technical and non-technical-as away to describe the performance of the highway system. Travel time reliability is a growing problem as the variation in travel time from day to day is a significant characteristics of the congestion problem. In a typical unplanned urban city like Ado-Ekiti, congestion can be best measured using travel time, which is the time required by the vehicles to traverse measured course, because the equipment required are readily available. The measured course may contain intersections and other features that hamper/hinder the free flow of traffic.

Table 3 and 4 show the relationships between traffic speed, volume and density for a highway and how these factors relate to level of service ratings. Traffic speed and flow on urban streets are determined primarily by intersection capacity, which is affected by traffic volumes on cross streets and left turn signal phases.

Table 2: Congestion indicators

Indicator	Description
Roadway Level of Service (LOS)	Intensity of congestion delays on a particular roadway or at an intersection rated from A (congested) to F (extremely congested)
Travel time rate	The ratio of peak period to free-flow travel times, considering only reoccurring delays(normal congestion delays)
Travel time index	The ratio of peak period to free-flow times, considering both reoccurring and incident delays(e.g., traffic crashes)
Percent travel time in congestion	Portion of the peak period vehicle or person travel that occurs under congested conditions
Congested road miles	Portion of the roadway miles that are congested during peak periods
Congested time	Estimate of how long congested rush hour
Congested lane miles	The number of peak-period lane miles that have congested travel
Annual hours of delay	Hours of extra time due to congestion
Annual delay per capital	Hours of extra travel time divided by the number of peak period road users
Annual delay per road users	Hours of extra travel time divided by the number of peak period road users
Excess fuel consumption	Total additional fuel consumption due to congestion
Fuel per capita	Additional fuel consumption divided area population
Annual congestion costs	Hours of extra time travel multiplied time a travel time value, plus the value of additional fuel consumption. This is monetized congestion cost.
Congestion cost per capita	Additional travel time costs divided by area population
Average traffic speed	Average speed of vehicle trips for an area and time(e.g., peak period)
Average commute travel time	Average commute trip time
Average per capita travel time	Average total time devoted to travel

Source: (TDM Encyclopedia, 2004)

Table 3: Highway speed, flow and density

LOS	Speed range (mph)	Flow range (veh/hour/lane)	Density range (veh/mile)
A	Over 60	Under 700	Under 12
B	57-60	700-1,100	12-20
C	54-57	1,100-1,550	20-30
D	46-54	1,550-1850	30-42
E	30-46	1850-2000-	42-67
F	Under 30	Unstable	67-maximun

Source: (Homburger *et al*., 1992)

Table 4: Maximum traffic volumes (passenger cars per hour per lane)

	LOS A	LOS B	LOS C	LOS D	LOS E
4-lane freeway	700	1,100	1,550	1,850	2,000
2-lane highway	210	375	600	900	1,400
4-lane highway	720	1,200	1,650	1,940	2,200

Source: (TDM Encyclopedia, 2004)

Table 3 shows the speed, flow and density of traffic under each Level of Service (LOS) rating, a standard measure of traffic congestion while Table 4 shows maximum traffic volume per lane for various types of roadways.

MEASURES OF CONTROLLING CONGESTION

A multidisciplinary approach is required in order to keep the negative effects of congestion under control and to ensure standards of living remain sustainable (Bulletin FAL, 2001). Transportation engineers and planners have developed a variety of strategies to deal with congestion. These measures are broadly classified into supply and demand initiatives (Bulletin FAL, 2001).

Demand initiatives: Action in respect of demand signifies modifying transportation habits. These sorts of measures promote behaviour that is more in keeping with high volumes of traffic and safe travel. The aim is to improve the behaviour of vehicles and pedestrians, change the types of vehicle circulating at peak times, with preference given to large capacity vehicles and also to shift some trips to times when there is less traffic. In other words the goal is to rearrange trips rather than to eliminate them, since that would mean forgoing the benefit such trips represent to those wishing to undertake them (Bulletin FAL, 2001). Congestion is to a large extent due to the intensive use of motor vehicles, particularly in commuting. Traffic hold-ups could be alleviated if significant numbers of motorists who travel in high volume areas or periods could be persuaded to use public transport or change the time of their journey. Several options are set out below.

Road safety education: It is vital that drivers and pedestrians improve their behaviour. Traffic regulations set out rights and constraints as to the use of streets, thereby improving flows and preventing accidents. Undisciplined driving coupled with a lack of respect for others reduces the road network's capacity to a fraction of its potential. Attempts to gain a few seconds at the risk of disobeying the traffic rules governing intersections and streets cause serious disruption to other road users, leading to greater congestion and an increased likelihood of accidents. Pedestrians must also respect the rules of road, crossing streets only at authorized times and places. Therefore, it is enormously important to educate the entire community about traffic regulations, a process which should start from childhood (Bulletin FAL, 2001). This will go a long way in improving the transportation system of the state.

Parking restrictions: Parking is a vital element of any road transport system. By restricting parking in congested areas, it is possible to increase the space available to traffic and to discourage certain car trips, thereby easing congestion. Some of the measures available are; parking bans in specific places at specific times, especially along roads with high traffic volumes. Setting of limits on parking space or time. Imposition of a charge for parking or provision of the space that reflects the costs of parking borne community. Provision of park and ride facilities, which enable journeys to be made using a combination of automobiles and public transport.

Road pricing: Road pricing involves charging users a fee, either for traveling in or entering congested roadway or areas. Only users who are prepared to pay will be able to take to the road, with all others forced to either use alternative modes of transport or undertake the car journey in periods when there is no charge. One interesting feature is that, in principle the use of public roads is regulated by a market instrument and not by government imposed regulations. Before road pricing is implemented, answers need to be found to aspects such as impact or areas not subject to charges, the intended purpose of revenue raised and possible adverse effects on residents and activities in the charging area.

Staggering of trips: This entails establishing different starting and finishing times for various activities such as research, commerce, schools, universities, etc. Traffic volumes are characterized by distinct peak periods during which a large number of journeys are concentrated. Many activities start up in the early part of the day, so numerous journeys to places of research and study take virtually the same time. A similar pattern occurs in the afternoon when research and business activities come to an end. As a result it would be beneficial to be able to stagger trips over a long period of time. During reorganization, care should be taken not to interfere with normal business operations. In cities like Ado-Ekiti, staggering of trips is infeasible as most trips take place in the peak period and government may not have the power to influence such trips.

Restrictions of vehicle use (carless days): This involves banning a portion of vehicles from being on the roads from Monday to Friday, in places and at times prone to congestion. Restricting a large number of vehicles from circulating at the same time, though not impinging on the right to purchase them is one way to lessen congestion. The measures may be applied to all cars in turn over the course of the week, in accordance with the final digit of the number plate. In addition, trucks and other cargo laden vehicles would normally be banned from circulating in the central city at peak periods. Buses should be exempted, since they create least congestion per passenger transported and represent an important alternative for people forced to keep their own car at home. Restriction could be via surcharge on the annual motor vehicle license. This will be effective, if those that will keep their vehicles at home can make their trips conveniently and comfortably.

Flextime: This means that employees are allowed some flexibility in their daily research schedules. For example rather than all employees working 8:00 to 4:30 am, some might research 7:30 to 4:00 am and others 9:00 to 5:30 am. The shifts travel from peak to off-peak periods, which can reduce traffic congestion directly; and can assist commuters in matching transit and rideshare schedules, allowing mode shifts. This depends greatly on the influence of government on peoples' trips.

Access management: This is a term used by transportation professionals for coordination between roadway design and land use to improve transportation. It involves changing land use planning and roadway design practices to limit the number of driveways and intersections on arterials and highways, constructing medians to control turning movements, encouraging clustered development and creating more pedestrian oriented street designs. This reduces friction along the roadway, which tends to increase traffic speeds, reduce congestion delays and reduce crashes.

Speed reductions: Reducing traffic speeds to 55 mph or less on congested roads can often increase traffic flow and reduce conflicts and driver's stress. This may be achieved by reducing posted speed limits, improving enforcement of existing limits, or implementing road design features that discourage excessive speeds.

Traffic calming and roundabouts: Traffic calming includes a variety of roadway design features that reduce vehicle travel speeds and volumes. Traffic calming results in smoother traffic, more optimal speeds and causing overall reductions in congested delays. In particular, modern roundabouts are alternatives to stop signs and traffic signals at small and medium size intersections that can reduce stopping requirements and avoid traffic platoons.

Supply initiatives: The supply of transport services consists of a range of means of providing transit, which can be categorized as follows: Urban road infrastructure or network; means of transport or vehicles; and the way in which both are managed.

Improving any component of supply normally increases passenger-bearing capacity and reduces congestion. A number of solutions are outlined below which reflect this principle.

The urban road network: Infrastructure is comprised of avenues, streets and intersections. In unplanned cities like Ado-Ekiti, the road system is often poorly designed and maintained and this state of affairs would need to be improved before extensions to reduce congestion could be envisaged. Substandard design or condition of the road system causes congestion. Instances abound of unmarked traffic lanes, unexpected changes in the number of such lanes, bus stops located next to intersections and other shortcomings that hamper the flow of traffic and comprise security. The poor condition of road surfaces and in particular potholes, restricts the capacity of the roads. Habitality should combine the ease of movement and one way to do this is to assign special functions to different streets; some may be designed and used for long journeys and high volumes, others for local service and accessibility, with the remainder performing mixed roles. Besides, large investments in wider roads typically fail to deliver the expected results, as new motorists join the traffic volumes, a phenomenon evident in cities where motorway networks have been built.

Intersections: Crossroads can lead to substantial, improvements in traffic flows. As a general rule, road capacity is determined by intersections. Since they are where two or more roads meet, they must allow vehicle flows that cross each other's path to continue their journey. It is important to design intersection with care, since they are normally where bottlenecks occur. The paths to be taken should be clear, as should waiting areas for vehicles continuing on or turning. Similarly needs for pedestrian must be catered for. Intersections may be unsignalized (only where there are lower traffic volumes), feature right of way signs (with priority determined by give, way and stop, signs), or operate with traffic lights. The choice of control system depends on the range of factors, such as traffic volumes, visibility, hold-ups or accidents.

Coordination of traffic lights: Traffic lights are appropriate at many intersections. Where many lights are located at close intervals, coordination is one of the most effective means of increasing the speed of traffic flows and achieving savings in term of travel times, fuel, pollution and accidents. Coordination involves establishing cycles, allocating times and providing phases in a road or network in such a way that vehicles can travel at a specified speed, thereby keeping the disruption caused red lights to minimum. Some ways of coordinating traffic lights are: Coordination using fixed, that is pre-set, plans, which can be changed manually. Though this approach is not obsolete, the results achievable are limited in scope. Centralized flexible coordination, which allows for phasing changes as and when, required; the system is administered from a central computer and is responsive to changes in actual volumes at each intersection. In this way, it is possible to make very fine adjustments in areas of high traffic density. Combined system, such as providing flow dynamic control in city center, fixed plans in some remote arterials and even autonomous in functional terms.

Giving priority to public transport: One practical method of increasing passenger-bearing capacity is to place greater reliance on vehicles that transport more passengers than car. This means fewer vehicles on the road, leading to more efficient use of scarce respect (Bulletin FAL, 2001). Giving priority to public transport is justified on two counts: first, public transport causes congestion per passenger transported and secondly, it is a regulatory step that corrects the distortion resulting from private motor vehicles not paying for the costs of congestion they cause. Apart from granting buses certain advantages in phasing traffic lights, the main preference is to reserve lanes solely for their use. That enables buses to speed up, while eliminating friction with other vehicles, which in certain circumstances step up their speed, as has been borne out on quite a few occasions. This has been adopted in some cities in Nigeria e.g. Abuja. Some options are listed below:

Bus only lanes: Lanes set aside solely for buses, normally signposted by markings. They are cheap to implement but their effectiveness, except in the case of reverse flow depends on motorist's acceptance, which is not always forthcoming.

Segregated bus lanes: Similar to bus only lanes, but are physically separated from other lanes, so as to prevent encroachment.

Exclusive bus roadways: Here, the entire width of a street is given over to public transport. Except in the case of new roads, this solution should be implemented only at peak time.

Variable direction roads: These are roads where the direction in which traffic moves changes during the day, in accordance with traffic volumes, with a view to improving flows. Hence, at peak times, the direction of traffic in a One Way Street can be reversed or street can be reversed or street can be converted to the benefit of the more dense streams. This traffic management system yields significant time savings in many cases. Changing direction according to time of day requires good information and signposting in order to prevent confusion and accidents. This can be adopted in an unplanned urban city like Ado-Ekiti.

Technologies to improve transportation operations: A wide variety of technologies have been devised to control congestion. Some are listed below.

Intelligent Transportation Systems (ITS): These include the application of a wide range of new technologies, including driver information, vehicle control and tracking systems, transit improvements and electronic charging. These can provide a variety of transportation improvement including driver convenience, reduced congestion, increased safety, more competitive transit and support for pricing incentives. ITS of cameras and computers help motorists to stay clear of congestion before they start their journeys (Bassma, 2003).

Incident detection and management: A significant of traffic congestion results from some sort of traffic incident, such as a disabled vehicle, a crash or dangerous driving. Many urban regions have coordinated programs that prevent identity and respond to such events quickly and efficiently. These may include centralized traffic management centers, video traffic surveillance, emergency response teams and special resources for dealing with specific problems, such as cranes and even helicopters to move disabled vehicles.

Ramp metering: Transportation operators employ information to decide how to use transportation devices like ramp meters. Ramp meters control the number of vehicles that can enter a highway ramp. This tends to maintain smoother traffic flow on highways.

Motorist information systems: Motorists information can include changeable message signs, radio reports and internet information about traffic conditions. These can reduce motorists stress by letting them anticipate conditions.

CONCLUSION

Traffic congestion causes delay, which ultimately impact on movement and standard of living in urban centers. It is enormously important that the causes of congestion are identified and the ways of mitigating them need to be addressed. Success against congestion requires not only attacking it on multiple fronts but also requires cooperation among transportation agencies such as Federal Road Safety Corps (FRSC) etc, businesses and the public. Since we are all affected by congestion, it is important that we all research together to address the congestion problems.

Both technical analyses and anecdotal information from the public are useful in identifying where they will be and what causes them. In this paper the causes identified include facility stress, street trading and road businesses, pedestrian interference, inadequacy in operations at intersections were found to be prevalent in Ado-Ekiti. Working together at the federal, state and local levels can operate as an integral and essential part of delivery transportation services and reducing congestion. Indeed and in particular Ado-Ekiti situation in mind, a number of mitigation measures were identified. The transportation community can accelerate the solution to congestion by being more aggressive in championing the need for transportation systems management and operations, more aggressive in showing the benefits of management and operations and more aggressive in the deployment and use of traffic engineering, transportation management and traveler information tools.

Traffic congestion, although cannot be totally eradicated can be reduced to barest minimum by employing the control measures earlier stated in this report. It is therefore necessary that transportation engineers and other stakeholders like Town Planners do proper planning of the transportation system of a city in order to avoid congestion.

REFERENCES

Aderamo, A.J., 2004. Lecture note on Urban and Regional Transportation Planning.

Aluko, O.O., 2004. Travel time and Delay Study of Ado-Ekiti M.Sc Thesis submitted to Civil Engineering Department, University of Ibadan.

ATM Congestion Control, 2005. Fang lu, http//www.cse.ohio-state.edu/~jain/cis788-95/ftp/atm-cong/index.html March.

Bassma, A.l. Jandaly, 2003. Gulf News Online.

Bulletin, FAL, 2001. Measures for controlling Traffic Congestion, Facilitation of Trade and Transport in Latin America and the Caribbean.

Homburger, Kell and Perkins, 1992. Fundamentals of Traffic Engineering, (13th Edn.), Institute of Transportation Studies, UBC (Berkeley; http//www.its.berkeley.edu/).

Jeff Paniati, 2004. Operational Solutions to Traffic Congestion, Public Roads, Vol. 68.

Marvin, L. Manheim, 1979. Fundamentals of transportation systems analysis Volume 1, Basic Concepts, Massachusetts Institute of Technology.

Oluwadare, B. and A. Akinfe, 2000. Street Trading and Traffic Flow in Nigerian cities, Ado-Ekiti as a case study B.Eng thesis submitted to Civil Engineering Department, University of Ado-Ekiti, Nigeria.

Sheldon, G., Strickland and Wayne Berma, 1995. Congestion Control and Demand Management, Public Roads Online, pp: 58- 3.

TDM Encyclopedia, 2004. Congestion Reduction Strategies, Victoria Transport Policy Institute.

Transport Management Group, 2003. A Better Way to Work.

Todd Litman, 2004. Congestion Costs, Transportation Cost and Benefit Analysis; Techniques, Estimates and Implications, Victoria Transport Policy. Institute (www.vtip.org/tca).

United States Department of Transportation-Federal Highway Administration, 2005. Traffic Congestion and Reliability: Linking Solutions to Problems, Final Report.