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Intersection Improvement at Kelambakkam along Rajiv Gandhi Salai in Chennai

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Abstract

With the high growth of city traffic, the conflict between travel demand and supply has increased and the vehicular flow becomes congested. Traffic congestion can be characterized by the decline in speed, the increase in travel timeand by the long queue on the road. Congestion happens when the volume exceeds the road capacity. Road intersection is not sustainable if its capacity exceeds the volume, but this condition exists only in certain intersections and it has dominated over entire city. Rajiv Gandhi Salai is an Expressway and Kelambakkam-Vandalur Road in South Chennai seems to be talk of the City. The volume of traffic on the IT Expressway corridor is more than three lakhs passenger car equivalence (PCE) on weekdays. This paper discusses more about how to manage the traffic volume at Kelambakkam intersection. To improve the traffic flow at the Kelambakkam intersection along Rajiv Gandhi Salai of South Chennai, traffic survey is conducted which include road inventory and volume count along the various arms towards the intersection. Volume accumulation curves are developed and peak volume and peak of peak time is obtained. From the analysis it is found that the peak volume is of 10719 PCE during 18.30 to 19.30 hours at this intersection. Volume to capacity ratio is found greater than one which makes high level of congestion and poor level of service. To manage this Transport System Management concepts are suggested in various scenarios which may reduce the volume lesser than the capacity.

Keywords: Traffic Congestion, Demand Management, Traffic Survey, Transport System Management, Passenger car equivalence.

INTRODUCTION

Traffic can be defined as the vehicular flow, the link between road users and the infrastructure and understanding, creating an optimal traffic network with efficient movement of traffic. With the high growth of city traffic, the conflict between travel demand and supply has increased and the vehicular flow becomes congested. Traffic congestion can be characterized by the decline in speed, the increase in travel timeand by the long queue on the road. Congestion happens when the volume exceeds the road capacity. Road intersection is

not sustainable if its capacity exceeds the volume, but this condition exists only in certain intersections and it has dominated over entire city. Rajiv Gandhi Road is an IT Expressway and Kelambakkam-Vandalur Road in South Chennai seems to be talkof the City. The volume of traffic on the IT Expressway corridor is more than three lakhs passenger car equivalence (PCE) on weekdays. This paper discusses more about how to manage the traffic volume at Kelambakkam intersection.

Road is a long narrow strip with a smooth and paved surface for motorized vehicular movement between two or more points. An intersection is a road junction where two or more roads either meetor cross. An intersection must be maintained with care to augment safety in movement. Intersections are important locations on road. They regulate the speed, safety, cost and efficiency of a road. The turning movements of vehicles reduce safety and efficiency, making left turns never makes much trouble but right turn is most important in intersection development and operation which will reduce congestion on the road. The most used methods include improvising signal timing, improving sight distance, making driver's awareness that they are nearing an intersection and improving bicycle or pedestrian facilities at the intersection. Objective of this study is to collect traffic volume at study area, to assess volume to capacity ratio and to suggest traffic flow improvement measures.

REVIEW OF LITERATURE

Velmurugan S et al (2005) said that the traffic was growing at rapid rate in urban areas of India and the management of traffic operations on the limited road network of the cities had become a gigantic task to the concerned authorities. Despite the concerted efforts of concerned authorities aimed at augmenting road infrastructure, traffic congestion was continuing to increase leading to environmental degradation. A major study was commissioned by the Government of India to quantify urban travel by road and associated air pollutants coming from automobile exhausts in eight cities namely, Delhi, Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Kanpur and Agra. The objective was to make an assessment of total number of vehicles and develop database and techniques to estimate road traffic and pollution loads in each city. They described operating characteristics of traffic, quantification of traffic and air pollution loads on major road network of Chennai city. Manuj Darbari et al (2008) discussed the application of Petrinet as the workflow tool to model urban Traffic system. Their work was divided into phase: the first phase deals with orthogonal extension of Petrinet to enhance the permutation of control and traffic flow simulation. The second phase discussed application of continuous pertinent with intelligent agents to the model the UTS in continuous format with single central control agent. Bhargavi PS and N. Kannaiya Raja (2011) identified and analyzed the reasons for road traffic accidents in Tamilnadu. They investigated the different causes of accidents occurred in past years in Tamilnadu. Tamilnadu was reported in one of the accident prone zone in India with having highest rate of road accidents. They investigated why Tamilnadu reported in top number of accidents and what were the reasons for occurring accidents and how could resistance the accidents.

Amudapuram Mohan Rao and Kalaga Ramachandra Rao (2012) said that traffic congestion had been one of major issues that most metropolises were facing. It was believed that identification of congestion was the first

step for selecting appropriate mitigation measures. Congestion - both in perception and in reality - impacts the movement of people. Traffic congestion wastes time, energy and causes pollution. There were broadly two factors, which effect the congestion; (a) micro-level factors (b) macro-level factors that relate to overall demand for road use. Congestion was 'triggered' at the 'micro' level, and 'driven' at the 'macro' level. The micro level factors were, many people want to move at the same time, too many vehicles on limited road space. On the other side, macro level factors are land-use patterns, car ownership trends, regional economic dynamics, etc. They gave an overview and present the possible ways to identify and measure metrics for urban arterial congestion. A systematic review was carried out, based on measurement metrics such as speed, travel time/delay and volume and level of service. Liu Bo and Zhang Fusheng (2013) developed a new wireless traffic signal control system. Several kinds of wireless communication were compared and choose the most of them determine the most suitable for application in traffic controller technology in them. In the design of network nodes, CC2530 wireless MCU was used as a kernel part of the network node in hardware design, the application program based on Z-Stack protocols.

Absar Alam M and Faisal Ahmed (2013) said that traffic congestion was a public policy issue and solicits a policy response which could strike a balance between urbanization and urban mobility. In the case of India, several policy initiatives had been undertaken but had not yielded desired outcomes. This is primarily because the focus had only been on public transport improvement measures, while traffic demand management measures had largely been neglected. They studied the traffic scenario in selected Asian cities and the policy measures undertaken by their respective governments. It revisited relevant policies in India and assessed the gaps that determine the desired impact of such policies on reducing traffic congestion. It also suggested the policy measures to overcome these gaps and the way ahead.

Nikita A Haribhakta et al (2015) said that an increased population growth rate leads to traffic congestions. This had been a serious problem faced by all areas worldwide, affecting environmental, economic and ecological sectors. Conventional traffic system could not evaluate gigantic traffic concentration in very effective modus, also it was time consuming system where waiting time was identical for unlike masses. SWARM was based on adaptive, collective, decentralized, co-ordination, self-organization properties. It was a system in which all nodes or members of system interact with each other to bring about particular task in an intelligent, efficient and in decentralized fashion. It might need not to be centralized. It is non-hackable system. Swarm was preeminent option to handle tasks which are intricate adequate to perform congestion avoidance, traffic flow improvement. Swarm technology was used in the field of robotic, computer science and telecommunication. Theyic signal with the help of distributed, adaptive, self-organization, multi-agent approach such that each signal would interact with one another. They concentrated on different Biological algorithms which were used for implementation of the system.

Sampathkumar V et al (2015) said that the Sterling road was one of the major intersections in Chennai metropolitan area which need attention to decongest. It was supported only by roadways. The increase in traffic volume with lack of road geometry resulted in congestion. The Sterling road had Information Technology companies with lakhs of employees travelling along the road. This intersection had roads along North to South

and East to West which connect to the major regions. It struggled with more volume than the capacity which leads delay and queuing of vehicles. The static delay here increases journey time. Transport system management was suggested by avoiding right turn movements and diverting the vehicles would decrease the volume. As a long term measure, a grade separator was suggested as per standards along North- South direction would have better control on volume and sustain in the coming years.

AnastasiosKallianiotis and DimitriosKaliampakos (2016) said that as the need for the construction of underground spaces is growing, the need to integrate human behavior analysis into their design studies was obvious. In order to make this happen, the current belief that subterranean structures were unsafe needs to be altered. Increasing the safety of these spaces was the key factor that would achieve the most comfortable and effective utilization by the public. They evaluated underground spaces as regards to their evacuation effectiveness and to compare them with similar above-ground buildings. To accomplish this, on one hand the factors that affect the evacuation effectiveness had been defined and on the other hand a tailor cut evaluation system had been developed. Among the factors influencing the evacuation effectiveness, the location of the exit doors/routes was of primary importance. Therefore, the evacuation evaluation methodology was based on the location of the exit doors design. The developed software, apart from checking the compliance of a given underground space with the evacuation regulations regarding the exit door location, assessed and evaluates all possible combinations of exit doors location based on the evaluation system developed. The grading for each combination resulted from the value of the variables that affect the evacuation procedures, according to the evaluation function developed. The evaluation system developed could give the evacuation safety profile of any space, helping a lot not only to check the safety of a given space, but also to design safer structures as well. The results of the comparative study of various areas proved that underground structures were quite safe in reference to evacuation procedures even in case where only two exits were available.

Gayathri R and A. Amudha (2016) used the solar energy in powering density based traffic control system with remote over ride facilities. Since solar energy was one of the major renewable sources and was non-polluted an attempt was made to utilize this energy in the traffic control system. A photovoltaic system was utilized for powering the system continuously. During normal time the signal timing changed automatically on sensing the traffic density at the junction by IR interruption method. But in the event of any emergency vehicle like ambulance, fire brigade etc. requiring priority were built in with Radio Frequency (RF) remote control unit to over ride the set timing by providing instantaneous green signal in the desired direction by blocking the other lanes by red signal. Higher traffic density at one side of the junction demands longer green time as compared to specific allotted time. The proposed traffic control system using a micro controller of 8051 family duly interfaced with photo sensors, changes the junction timing automatically to accommodate movement of vehicles smoothly to avoid unnecessary waiting time at the junction. The density of the vehicles was measured in three zones i.e., low traffic zone, medium traffic zone and high traffic zone based on which timings were allotted accordingly. The over ride feature in this unit is activated by an on board RF transmitter operated from the emergency vehicle which in turn provides a high priority for all emergency vehicles.

Geethu Lala et al (2016) said that the spectacular increase of number of motor vehicles on the road was mainly attributed ingeneration of traffic problems like accidents, congestions, delays etc., especially in the urban premises of developing countries. They examined the traffic problems and sustainable improvement of road intersection at Ettumanoor, India. The spacial and temporal constitutions of the vehicle as well as pedestrian traffic at the intersections were examined and the characteristics of the junction indoctrinating the delay problems were identified. Data regarding the traffic volume, land use and pedestrian movement activities were collected through direct field surveys. Analysis of the collected data revealed that the improper planning of the junctions, lack of traffic signals and unauthorized parking were the major factors contributing to the traffic congestions. Various remedial measures were also proposed, focusing on junction improvement, alternative operation plan and junction signalization.

Vaishali Mahavar and Dr-Jayesh Juremalani (2018) said that road infrastructure had seen consistent improvement in the last years. Connectivity had improved and road transportation had become a focus of rapid development. Roads were providing better access to services, ease of transportation and freedom of movement to people. But in metropolitan cities traffic congestion is increasing rapidly, it results in chronic situation in dense downtown areas. Traffic signals played a significant role in the urban transportation system. They control the movement of traffic on urban streets by determining the appropriate signal timing settings. Adaptive traffic signal controllers as the principle part of intelligent transportation systems had a primary role to effectively reduce traffic congestion by making a real time adaptation in response to the changing traffic network dynamics. Many methods used for traffic signal timing optimization under different criteria's. Here different methods were proposed by reviewing different research papers for traffic signal control, which gave best adaptability & optimization ideas in traffic signal control.

Vinidha Roc A et al (2018) said that traffic signals were the most efficient way of controlling traffic in a busy junction. But, it could be seen that these signals fail to control the traffic effectively when a particular lane had got more traffic than the other lanes. The idea behind this project is to implement a system which would easily control the traffic and help for the emergency vehicles to reach at their destination easily and quickly. In this project, a system of cameras was used to regulate traffic. They obtain information in their respective places and coordinate with other cameras in the system to change traffic signals and suggest green signal for that route to avoid maximum traffic. Emergency vehicle could be detected with the help of sound sensors placed in the junction, which coordinate with the microcontroller and makes the particular lane free. Zinabu Hailu (2018) said that the availability of highway transportation had provided several advantages that contribute to a high standard of living. Several problems related to the highway mode of transportation exist. These problems include highway-related crashes, parking difficulties, congestion and delay. To reduce the negative impact of highways, it was necessary to adequately collect information that describes the extent of the problems and identifies their locations. Such information was collected by conducting traffic surveys and studies. Using the information from traffic determination of un-signalized intersection's modification analysis was performed and it was used to improve level of service and to determine traffic volume as well as reserved capacity of the road to reduce traffic congestion as well as traffic delay that increase by maneuverability occur over the road stream.

Priyadharshini K and S.K.Manikandan (2019) changed the timing delay between the traffic light systems automatically according to the number vehicles passing through the lane. Traffic congestion was a severe problem in most of the cities. Fixed time based system was used in traffic signaling system which might provide incompetent if one lane was operational than the others. . It would diminish productivity of the individuals and a lot of work hour was wasted in this system Sometimes higher traffic congestion at one side of the lane needed longer green signal as compared to fixed time based systems, as a result propose here a mechanism in which the time period of green signal and red signal was assigned based on the density of the traffic present at that time. To optimize this problem we had to design an automatic traffic control system. This could be achieved by using proximity Infrared sensors. Once the density was calculated, the luminous period of green signal was assigned with the help of the microcontroller. The sensors which were placed on each sides of the road at a particular distance which would detect the numbers of the vehicle passing that lane and sent the information to the microcontroller based on the information it would decide which lane was to be free or when to revolutionize over the signal lights. In further, had to elaborate the procedure of this structure.

Putting European transport on track for the future' (2021) said that mobility and transport matters. From daily commuting to work, visiting family and friends, tourism, to the proper functioning of global supply chains for the goods in the shops and for industrial production, mobility was an enabler of economic and social life. Free movement of people and goods across its internal borders was a fundamental freedom of the European Union (EU) and its single market. Travelling in the EU has led to greater cohesion and a strengthened European identity. As the second-largest area of expenditure for European households, the transport sector contributed 5% to European GDP and employs 10 million workers. Mobility brings many benefits for its users, it is not without costs for our society. These include greenhouse gas emissions, air, noise and water pollution, but also accidents and road crashes, congestion, and biodiversity loss – all of which affect our health and wellbeing. Past efforts and policy measures have not yet sufficiently addressed these costs. The transport sector's greenhouse gas emissions have increased over time and represent now as much as a quarter of the EU's total.

STUDY AREA

Intersection is as a place where two or more roads meet each other. This area is meant for the vehicles to turn to various directions to reach their destination. The study of intersections is very important to the traffic engineers in urban scenario. The study intersection at Kelambakkam is a T (3 road) intersection from where Sholinganallur is towards North, Vandalur towards West and Kelambakkam, Thiruporur towards South. The location of Kelambakkam in Chennai and the study intersection at Kelambakkam is shown in Figure 1and 2.

Kelambakkam is a large residential neighborhood of South Chennai, Tamil Nadu, India. It is a place of its economy grows with the State Industries Promotion Corporation of Tamil Nadu (SIPCOT) IT Parkin neighboring Siruseri, Chennai's dedicated technology office space. Kelambakkam is a suburban located in the South-East of Chennai city along Rajiv Gandhi Road formerly Old Mahabalipuram Road (OMR) and Kelambakkam intersection is about five kilometer from Siruseri IT Park and 12 km from Sholinganallur intersection. It is

another important junction after Sholinganalur, which connects at Vandalur along GST road in West and near Kovalam along ECR road in East. Kelambakkam is considered as the Southern

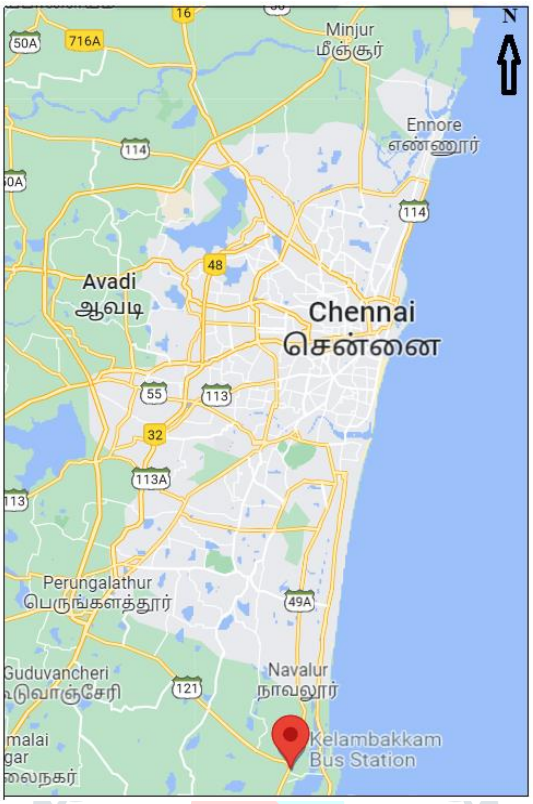

Figure 1 Location of Kelambakkam in Chennai

Figure 2 Study intersection at Kelambakkam in Chennai

gateway to Chennai City. The subsequent uplift of colleges, hospital, research centers and offices around Kelambakkam proved fortunate to this location, as many of the workers in these offices often made Kelambakkam as their home. The Chettinad Hospital and Research Institute is located about 100 meters from this intersection. This area is easily accessible by Metropolitan Transport Corporationbuses and has a moderate size bus terminus near Kelambakkam market. The Congested flow at Kelambakkam intersection is shown in the Figure 3.

Figure 3 Congested flow at Kelambakkam intersection

DATA COLLECTION

Data collection is one of the important functions is to organize and implement various services and studies aimed at collection of data pertaining to traffic characteristics. Such study include origin and destination survey, volume count, speed and delay, travel time, accident statistics, parking characteristics, pedestrian behavior and use of streets, capacity studies, economic loss caused by inferior traffic facilities. Here in this study volume count and road inventory survey have been carried out. Inventory or geometric survey and traffic volume count survey is done at the study intersection. Geometric Survey is used to find the length and breadth of road and the dimensions of other components such as divider, foot path, bus stops, pedestrian path and parking space. At Kelambakkam intersection the vehicles moving in different directions are occupying same space at the same time moreover 1800 pedestrians per hour alsoseek same space for their manoveries crossing. Width of Rajiv Gandhi Road (North-South) is 16.3m, road towards West is with 13.3m wide and the output of inventory survey is shown in Figure 4.

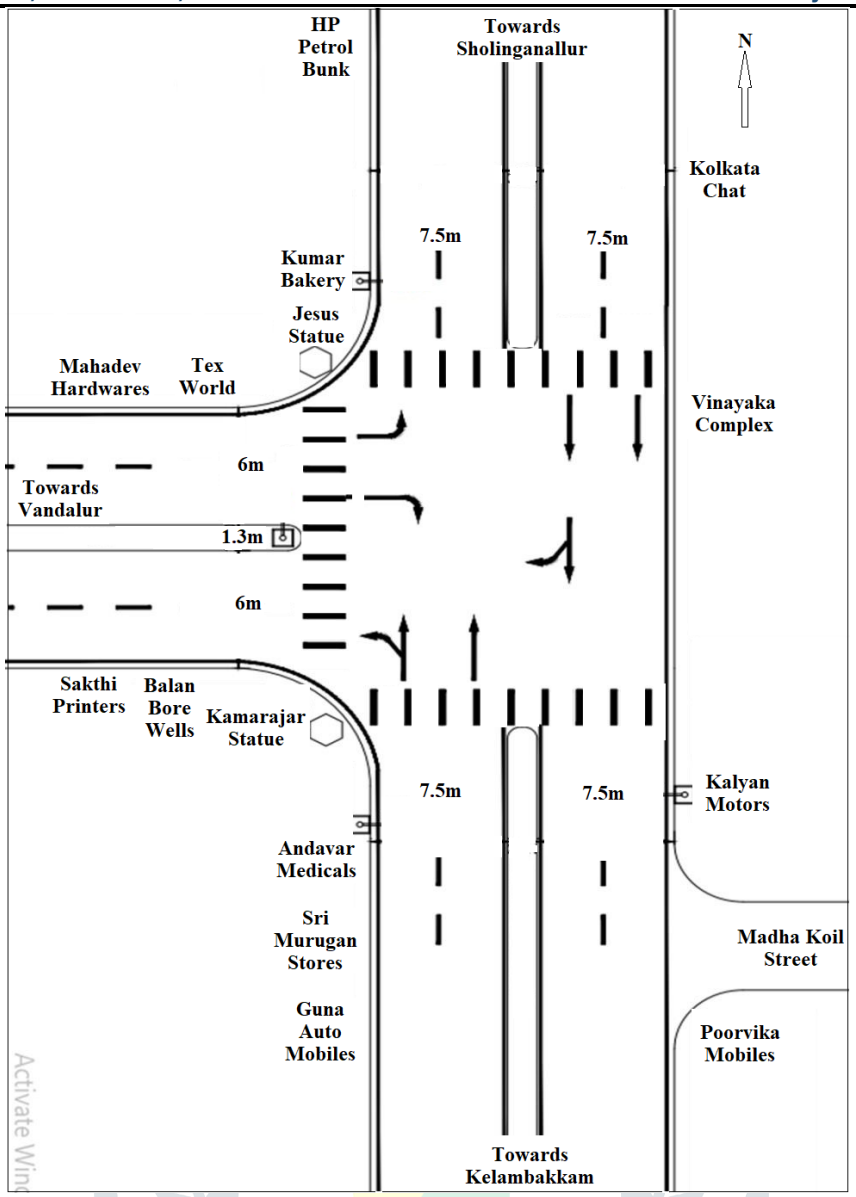

Figure 4 Road inventory at Kelambakkam Intersection in Chennai

Volume count survey (Traffic Census) is also carried out to assess the traffic characteristics. It helps in traffic regulation and management, which tends to a safe and efficient vehicular movement. Different types of vehicles offer different degrees of interference to other traffic and are necessary to bring all types to a common unit called as passenger car equivalence (PCE). Traffic volume count survey is done manually on standard sheet in which the volume is being counted and written with time duration at 30 minutes interval time between 8 and 21 hours. Volume count survey is done at all directions. The direction of vehicular movement, number of two wheelers, autos, cars, buses and trucks is counted and written on the data sheet. Peak time, peak volume and peak of peak are identified. The flow volume is expressed as PCE as shown in Table 1. Volume accumulation curve showed in Figure 5 from which the peak of peak volume (10719 PCE) is obtained between 18.30 and 19.30 hours. The volume from each arm is dissipated in PCE at Peak hour (18.30-19.30hrs) at Kelambakkam intersection and is shown in Figure 6.

Table 1 Traffic flow at Kelambakkam intersection

Hour	Two wheeler	Car / Three Wheeler	Bus /Truck	Volume In PCE
7.00 -7.30	2267	828	278	2796
7.30-8.00	2541	1074	313	3284
8.00-8.30	2833	1293	328	3694
8.30-9.00	3119	1541	365	4196
9.00-9.30	3468	1665	389	4566
9.30-10.00	3462	1744	372	4591
10.00-10.30	3247	1628	367	4353
10.30-11.00	3151	1385	326	3939
15.00-15.30	2890	1429	369	3981
15.30-16.00	3146	1570	417	4394
16.00-16.30	3179	1594	434	4486
16.30-17.00	3245	1727	461	4733
17.00-17.30	3539	1815	478	5019
17.30-18.00	3639	1864	503	5193
18.00-18.30	3555	1882	533	5259
18.30-19.00	3626	1970	512	5319
19.00-19.30	3796	2008	498	5400
19.30-20.00	3084	1794	474	4758
20.00-20.30	2734	1653	383	4169
20.30-21.00	2378	961	341	3173

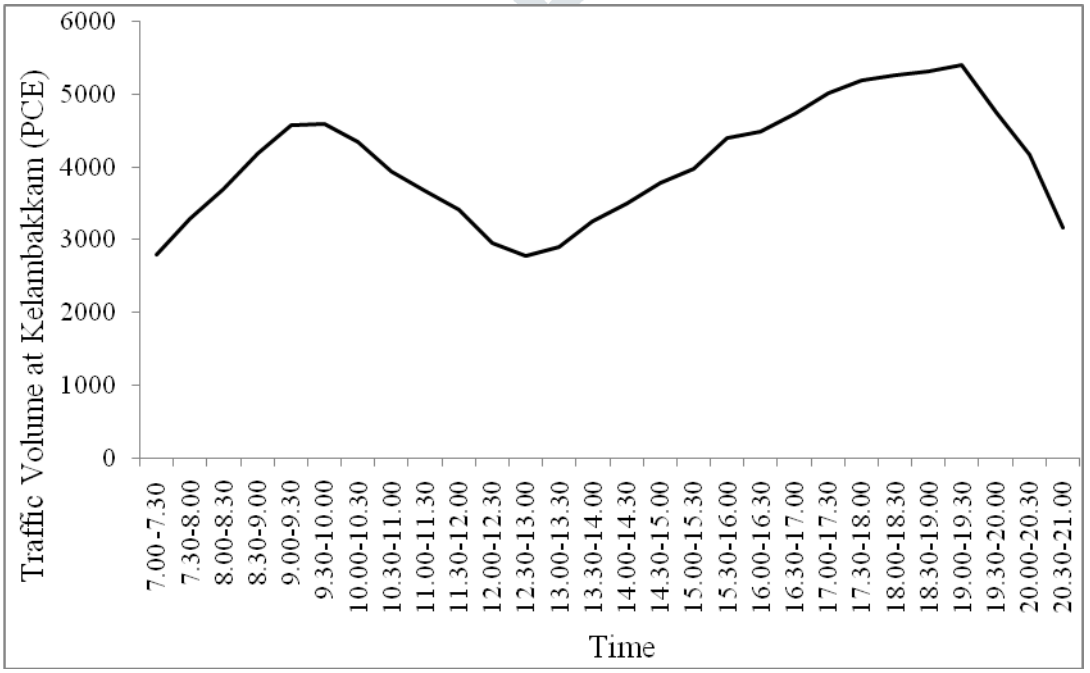

Figure 5 Volume Accumulation at Kelambakkam intersection between 7 and 21 hrs in PCE

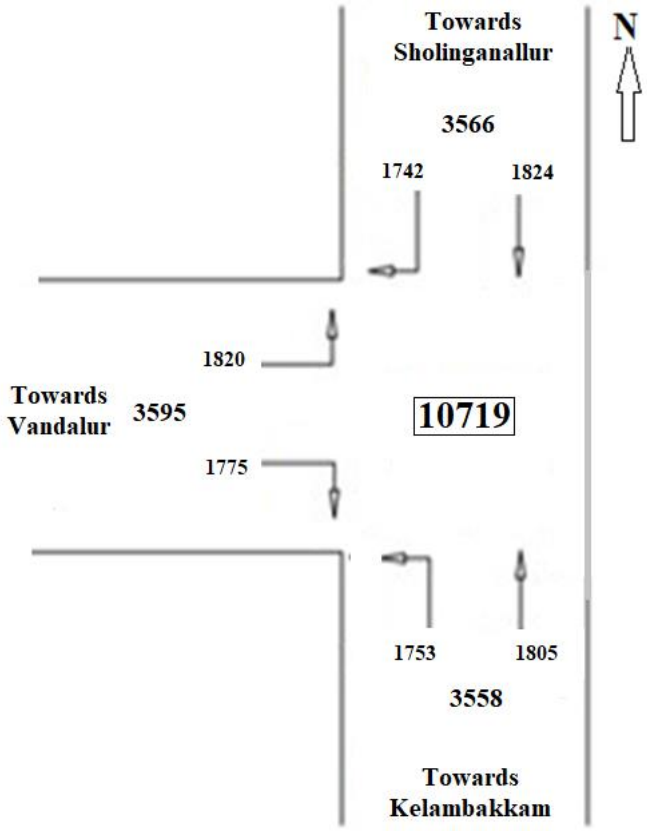

Figure 6 Traffic flow from various directions in peak hour (18.30-19.30 hrs) at Kelambakkam intersection.

TRAFFIC ANALYSIS

Peak hour, V/C ratio and Mode of share have been found from the analysis. The ratio of the service volume (10719 PCE) to capacity (9200 PCE) at the peak of peak time between 18.30 to 19.30 hrs is 1.17. The present volume is forecasted at an annual rise of 7.5% as per IRC and seems to be 14315 PCE in 2026 and the V/C will be of 1.56 which implies the need for present improvement measures. The calculation of V/C for the coming years is shown in the Table 2. In the peak hour (18.30-19.30) model share of vehicle is assessed and shown in the Figure 7 which shows that the share of two wheeler is dominating upto 60%, cars share of 32% and just 8% of commercial vehicles.

Table 4.2 Forecasted Volume of Capacity ration at Study Intersection

Year	Volume (V) in PCE	Capacity (C) in PCE	V/C
2022	10719	9200	1.17
2023	11523	9200	1.25
2024	12387	9200	1.35
2025	13316	9200	1.45
2026	14315	9200	1.56

(For capacity refer Table 21.19, Practical capacities of two-way roads, p535, Chapter 21, Section 11, Highway

capacity, Book "Traffic engineering and transportation planning" by L.R.Kadiyali, Khanna publishers, 8th Edition 2013, ISBN 81-7409-220-X).

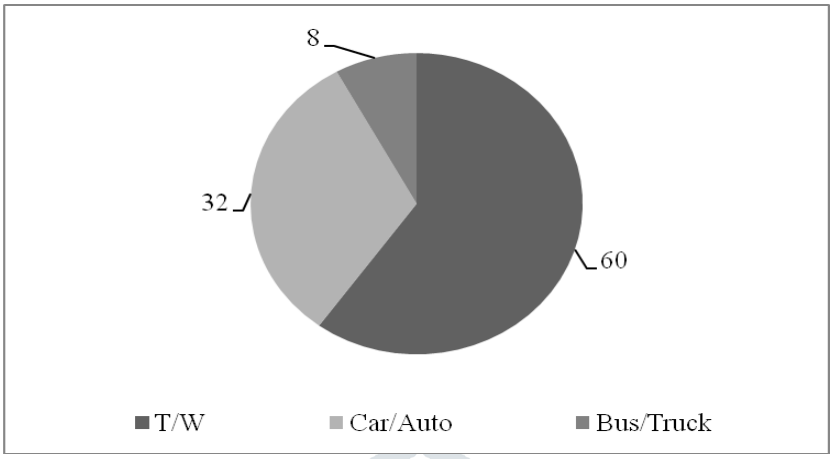

Figure 7 Model split of vehicle at Kelambakkam Intersection between 18.30-19.30 hrs

TRAFFIC FLOW MANAGEMENT

As the traffic on the existing road system in cities grows, congestion becomes a serious problem. Medium and long term solutions such as widening of roads, providing elevated flyovers, constructing by passes and urban expressways are not economical. Short term may be the simple and inexpensive solution which can tide over the crisis for coming few years.

Prohibition of right turning may be by introducing a T turn which is diversion of the right turning traffic to an alternative intersection further along the road where there is more capacity for dealing with a right-turn. It is often useful for dealing with a difficult right turn for a minor road into a major road. The right turn gets shifted to a minor-minor junction. G turn which is diversion of the right-turning traffic to the left before the junction. It is useful for a right-turn from a major road, since it is converted to a left turn from major road and a straight movement at the study junction and a Q turn which is a diversion of the right turning traffic beyond the junction. Since only left turns are involved in it is considered as the least obstructive.

Short term measures have been proposed. As a primary management proposal diverting the traffic flow from South to West near Kamarajar statue and permitting it as a left turn before 120m from the study intersection in South which is of 3.7m wide road to connect Kelambakkam-Vandalur road will evict 1753 PCE and the peak volume at intersection will become 8966 PCE (10719-1753) and the V/C also comes down to 0.97 (8966/9200). The proposed route diversion is shown in Figure 8. As a secondary management proposal diverting the traffic flow from North to West near Jesus statue and permitting it as a right turn before 85m from the study intersection in North which is of 4.20m wide road to connect Kelambakkam-Vandalur road will evict 1742 PCE and the peak volume at intersection will become 8977 PCE (10719-1742) and the V/C also comes down to 0.97 (8977/9200). The proposed route diversion is shown in Figure 9. The combined effect of primary and secondary proposals will evict 3495 PCE and the peak volume at intersection will become 7224 PCE (10719-3495) and the V/C also comes down to 0.78 (7224/9200) which will well improve the flow at the study intersection.

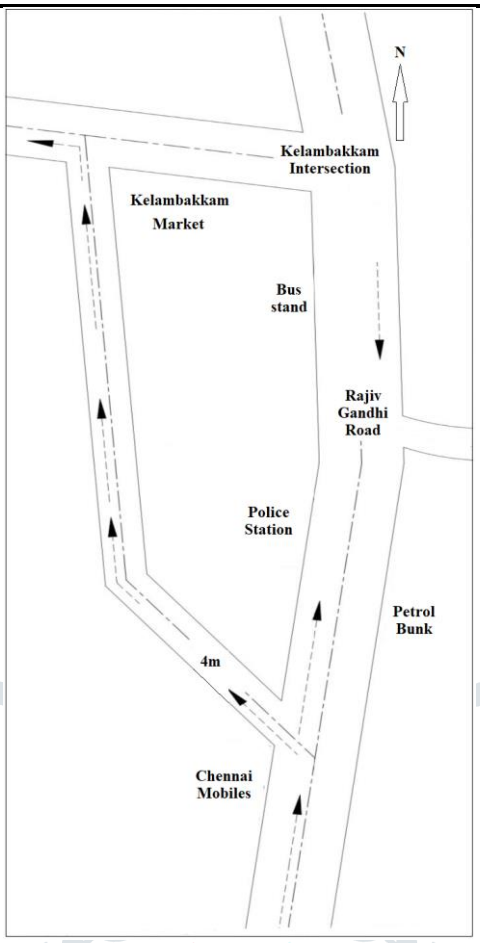

Figure 8 Proposed flow near Kamarajar statue at Kelambakkam intersection

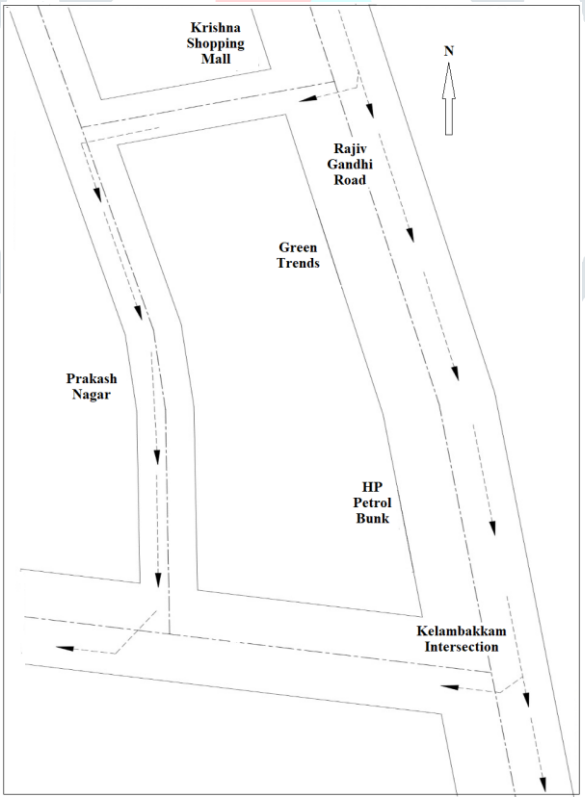

Figure 9 Proposed flow near Jesus statue at Kelambakkam intersection

CONCLUSION

Traffic congestion can be characterized by the decline in speed, the increase in travel timeand by the long queue on the road. Congestion happens when the volume exceeds the road capacity. Road intersection is not sustainable if

its capacity exceeds the volume. The turning movements of vehicles reduce safety and efficiency. The study intersection at Kelambakkam is a T (3 road) intersection from where Sholinganallur is towards North, Vandalur towards West and Kelambakkam, Thiruporur towards South. Kelambakkam is a large residential neighborhood of South Chennai. It is a suburban located in the South-East of Chennai city along Rajiv Gandhi Road. At Kelambakkam intersection the vehicles moving in different directions are occupying same space at the same time moreover 1800 pedestrians per hour alsoseek same space for their manoveries crossing. Inventory or geometric survey and traffic volume count survey is done at the study intersection.

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Short term measures have been proposed. As a primary management proposal diverting the traffic flow from South to West near Kamarajar statue and permitting it as a leftturn before 120m from the study intersection in South which is of 3.7m wide road to connect Kelambakkam-Vandalur road will evict 1753 PCE and the peak volume at intersection will become 8966 PCE (10719-1753) and the V/C also comes down to 0.97 and as a secondary management proposal diverting the traffic flow from North to West near Jesus statue and permitting it as a right turn before 85m from the study intersection in North which is of 4.20m wide road to connect Kelambakkam-Vandalur road will evict 1742 PCE and the peak volume at intersection will become 8977 PCE (10719-1742) and the V/C also comes down to 0.97.

The combined effect of primary and secondary proposals will evict 3495 PCE and the peak volume at intersection will become 7224 PCE (10719-3495) and the V/C also comes down to 0.78 which will well improve the flow at the study intersection.

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