

A Review Paper on Travel Time and Congestion Analysis

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Abstract: The vehicular citizenry in Ahmedabad is around 25201084 (2018) so it is very necessary to negotiate its alacrity and infirmity effects like as air and noise pollution & Other Environment Effects, traffic congestion, time loss, and so on. S.G Highway has 44.5 km long stretch of Ahmedabad, an oldest and most important link. For declamation the traffic congestion, classified volume count survey of 3 days (by Video Graphic method), travel time and delay survey (by Moving Observer Method), Origin–Destination Survey (by License plate matching method) for 3 days, and for speed-flow-density relationship Spot speed study at S.G. Highway will Be carry out and examine. From the calculated data, graph of flow v/s density, speed v/s density and speed v/s flow relationship will Be evolve with the R² value of each relationship. This examine will prove that the travel time taken by vehicle to reach the destination is usually higher than the travel time in free flow condition. From all examine data, alternate invigorating measures will prospect. Based on those alternative invigorating measures best alternative will choose and validated in the VISSIM simulation Model and design in AutoCAD for better illustration of issue.

Keywords – Travel Time, Congestion, VISSIM, AutoCAD, Simulation Model, Traffic, S.G. Highway.

I. INTRODUCTION

During the Past two decades there is the expeditious growth in the urbanization in India. Due to the urbanization the demand of transportation facilities which are the basic requirement of our country's urban population is rising enormously. The growth of the urban population is upsurge because of the more people are entrained to gain employment for living better quality of life that is also one reason behind boosting the urbanization.

As the urbanization increases the per capita income will also magnify that's why people will utilize their own vehicle to travel from origin to destination. In fact, the growth rate of the country's economic development hoist too fast and sometimes much faster than infrastructure development causing limited road space to deal with personalized vehicles so this reason leads to the increasing road capacity also increasing congestion and delay that is major reason behind the accidents. It has been concluded that traffic accidents are among the primary cause of accidental deaths in Indian cities.

The best strategy to meet the growing urban travel demand in a sustainable manner is to convince people with reasoning to shift from personalized vehicles to public transportation. This is because public transportation occupies less road space, consumes less fuel and emits fewer pollutants as compared to any other motorized modes of travel

The expeditious growth of registered vehicles is enormously increasing year by year in India. It is seen from table 1 with annual growth rate of 9.95% the year 2010 to 2016 the overall growth of vehicle are almost 2.23 times.

Table: 1 Number of Registered Vehicle in India

| Year | Buses | Taxis | Light Motor Vehicles | Goods Vehicles | Two Wheelers | Cars | Jeeps | Miscellaneous | Grand Total |
|------|---------|---------|----------------------|----------------|--------------|----------|---------|---------------|-------------|
| 2010 | 176642 | 3615086 | 3615086 | 6431926 | 91597791 | 13749406 | 1760428 | 7552876 | 127745972 |
| 2011 | 1238245 | 1789417 | 4016888 | 7064495 | 101864582 | 15467473 | 1974253 | 8045441 | 141865607 |
| 2012 | 1296764 | 2011022 | 4242968 | 7658391 | 115419175 | 17569546 | 1987098 | 8866332 | 159490578 |
| 2013 | 1418763 | 2416453 | 4718672 | 8596762 | 132550294 | 20503389 | 2132893 | 9768046 | 182445229 |
| 2014 | 1468010 | 2109348 | 4638377 | 8697541 | 139409778 | 21671515 | 2216888 | 9778764 | 190703971 |
| 2015 | 1527396 | 2256619 | 5028312 | 9344464 | 154297746 | 23807986 | 2546731 | 10474886 | 210023289 |
| 2016 | 1384740 | 2341375 | 6392010 | 10516156 | 168975300 | 25634824 | 2265488 | 12048062 | 230030598 |

- a) Include multi axled/Articulated Vehicles/Trucks and Lorries of light motor vehicles.
- b) Includes Omni buses/Tractors/Trailors/Others.

Source: Transport Research Wing, Ministry of Surface Transport

Table 2 shows the registered vehicles in Surat with growth rate and composition from 2014 to 2019.

Table: 2 Ahmedabad City Vehicle Data

| Sr..Num | Year | Transport Vehicle | Non transport Vehicle | Total |
|---------|-----------|-------------------|-----------------------|----------|
| 1 | 2014-2015 | 2156394 | 16564173 | 18720567 |
| 2 | 2015-2016 | 2292095 | 18069201 | 20361296 |
| 3 | 2016-2017 | 2421032 | 19615507 | 22036539 |
| 4 | 2017-2018 | 2566058 | 21254759 | 23820816 |
| 5 | 2018-2019 | 2680808 | 22520277 | 25201084 |

Source: Regional Transportation Office, Ahmedabad (2019)

I.I Congestion

There is not an precise definition of traffic congestion. One of the main causes for this shortage of clearance is that congestion is both:

- A physical phenomenon bond with manner in which vehicle fetter each other's progression as claim for limited road space consuming full capacity.
- A relative phenomenon relates with the user anticipation as well as road system performance.

Both functional and user aspect are important for acknowledge of congestion and its impact, congestion is a situation in which demand for road space surpass supply. It is the reaction of vehicles occurring on each other, due to the speed flow relationship, in conditions where the use of a transport system approaches capacity. Congestion is a relative phenomenon that is connected to the difference between the roadway system performance that users anticipate and in which way the system actually carry out. Urban traffic congestion has to be understood in the broad ambience of city dynamics and collection of things. Traffic congestion in urban areas, sometimes is the outcome of successful urban economic development, employment housing & cultural; policies that make people want to live and work aggressively close to each other and attract firms to benefit from the yield in abundance can be derived. There are indices that, not even they captivated by the prospect, urban road users are prepared to live with crowded roads so long.

Cities provide ingress to a wide range of activities, people, services, goods, markets, opportunities, ideas and networks. Sometimes congestion can simulate travel speed but in some eventuality such as dense urban cores, congestion may both be accustomed and, to some degree, confirm. In such type of cases, cities have come to confirm a degree of congestion and continue to get along comparatively well as long as overall practicable in high. It is difficult to see how congestion should be annihilate in urban areas because there is no such expression that urban road user anticipate to travel in congestion-free condition at peak hours. Cities aren't anxious against congestion at specific location like obstacle and cost-effective measures. However, in the remote future what matters most for policy is how congestion can be managed so that favorable output can earn.

I.I.I Causes of Congestion

The imminent causes of congestion are countless, e.g. too many vehicles for a given road's design or intersection capacity, dynamic changes in roadway capacity caused by lane switching and car-following demeanor. They are also inevitably linked to other ambiguous factors such as land-use patterns, employment patterns, income levels, car ownership trends, infrastructure investment, regional economic dynamics, etc. Generally, however, it identifies two principal, broad classification of causal factors; micro-level factors (e.g. those that relate to traffic "on the road") and macro-level factors that relate to overall demand for road use. In this ambience, congestion is "triggered" at the "micro" level (e.g. on the road), and "driven" at the "macro" level by factors that contribute to the contingency of congestion and its rigorousness.

I.I.II Effects of increased congestion

Effect of increased congestion whether it is defined physically or relatively it is classified by:

- Sluggish speeds
- protracted journey times
- escalation queuing at junctions or obstacle
- escalation stopping and starting time
- high time spent stationary
- Less expected journey times

I.II Traffic Count

It is fundamental to know the magnitude of traffic data required or to be collected, which will then determine its quality and type of vehicle classification to be followed. Traffic counting falls in two main classification, which are manual counts and automatic counts. There is no difference between the two methods; however, an appropriate method of traffic counting is a function of the level of traffic flow and the required data quality. This difference can be diminish from the discussions of the respective methods below.

I.II.I Counting Using Video Camera

Video image processing system utilizes machine vision technology to detect vehicles and abduction details about individual vehicles when required. A video processing system usually monitors multiple lanes simultaneously (see figure 1), and therefore it requires a high level of computing power. generally, the operator can communal set the desiderated traffic detection points anywhere within the systems view area. Algorithms are used to excerpt data required for the detection of the raw data feeds. Due to the complicity of the images, it is not recommended that they should be carried outdoors as this can give poor results. In absence of algorithms, manual count also can be accomplished in a dictate format of CVC.

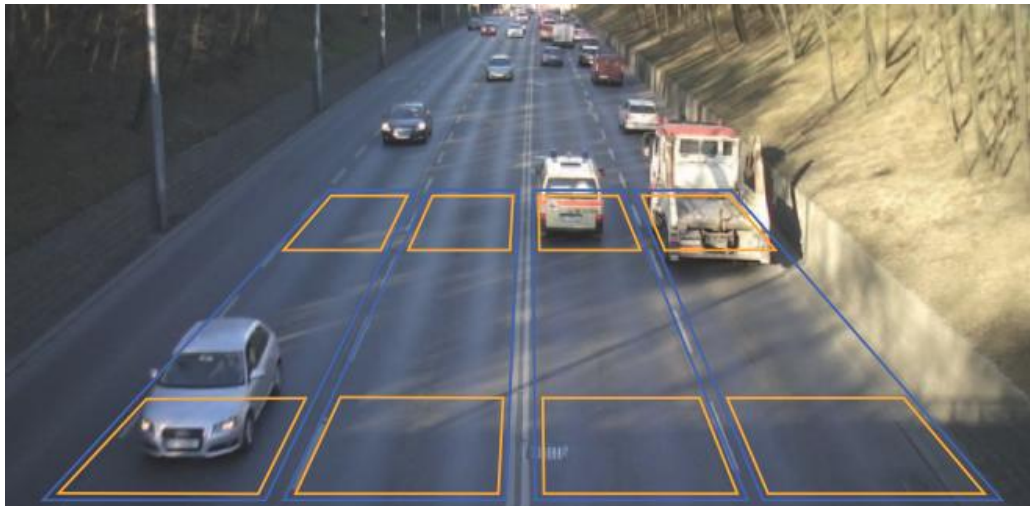


Figure 1 Video camera method

Source: <https://www.google.co.in/>

I.III Travel Time Study and Delay Studies

Travel time is an important study in traffic control and highway improvements. It has observed that the importance of travel time and delay and since travel time studies is widely used to document congestion and to quantify the actual impact of highway improvements. Determining the amount of time required to travel from one point to another on a given route requires a travel time study. Different information may also be collected on the locations, duration and causes of delays in conducting study. This study is known as a travel time and delay study. Data obtained from travel time and delay studies give a good indication of the level of service on the study section. These data also gives brief information for identifying problem locations, which may require special attention in order to improve the overall flow of traffic in the route. (Iaem C. Mauricio, OCTOBER, 2003).

Delay is defined as an extra time spent by drivers against their expectation (not under control of driver). Delay can have many forms depending on different locations. A study made to provide information concerning the amount, cause, location, duration and frequency of delay as well as travel time and similar value. The time lost by moving vehicles due to traffic friction and traffic control device is called delay, which is not under control of driver.

I.III.I Method for obtaining travel time and delay study

Moving-vehicle method: In this method, the observer moves in the traffic stream and makes a round trip on a test section. The enumerator starts at section, drives the car in a particular direction say eastward to another section, turns the vehicle around drives in the opposite direction say westward toward the previous section again. Let, the time in minutes it takes to travel east (from A-A to B-B) is t_a , the time in minutes it takes to travel west (from B-B to A-A) is t_w , the number of vehicles traveling east in the opposite lane while the test car is traveling west be m_a , the number of vehicles that overtake the test car while it is traveling west be m_o , and the number of vehicles that the test car passes while it is traveling west from be m_p .

The volume (q_w) in the westbound direction can then be obtained from the equation (1) and the average travel time in the westbound direction is obtained from equation (2) below.

$$q_w = (m_a + m_o - m_p) / (t_a + t_w) \dots\dots\dots (1)$$

$$tw (Avg) = t_w - [(m_o - m_p) / q_w] \dots\dots\dots (2)$$

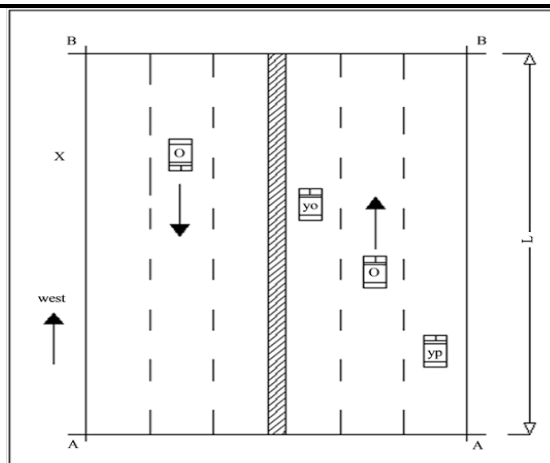


Fig. 2 Moving Observer Method

I.IV Origin - Destination Survey

Origin - Destination Survey is carried out to find different output like Vehicle flows on links, Junction movements, Passenger flows, Traffic variability, Peak-hour factors, Average Annual Daily Traffic etc. It has mainly two method (1) Manual Counts (2) Automatic Counts.

Here, Survey is carried out by using Registered license plate method from video graphic data

I.IV.I Method for obtaining origin - Destination Survey

License Plate Method: when the amount of turning off and on the route is not great and only over all speed value are to be secured, the license-plate method of speed study may be satisfactorily employed. Investigator stationed at control point along the route enters, on a time control basis, the license-plate numbers of passing vehicles. These are compared from point to point along the route, and the difference in time values, through use of synchronized watches, is computed. This method requires careful and time-consuming office work and does not show locations, causes, frequency, or duration of delay. Four basic methods of collecting and processing license plates normally considered are:

1. **Manual:** collecting license plates via pen and paper or audio tape recorders and manually entering license plates and arrival times into a computer.
2. **Portable Computer:** collecting license plates in the field using portable computers that automatically provide an arrival time stamp.
3. **Video with Manual Transcription:** collecting license plates in the field using video cameras or camcorders and manually transcribing license plates using human observers.
4. **Video with Character Recognition:** collecting license plates in the field using video, and then automatically transcribing license plates and arrival times into a computer using computerized license plate character recognition.

I.V Fundamental Relationships

Here, Fundamental parameters are Speed, Flow, Density and relationship as equation (3) and the diagram generated are shown from Figure 10 the relationship between Speed-Flow, Speed-Density and Flow-Density are the fundamental diagram of traffic flow.

$$q = k v \dots\dots\dots (3)$$

Where, q = flow, k = Density, v = Average Speed

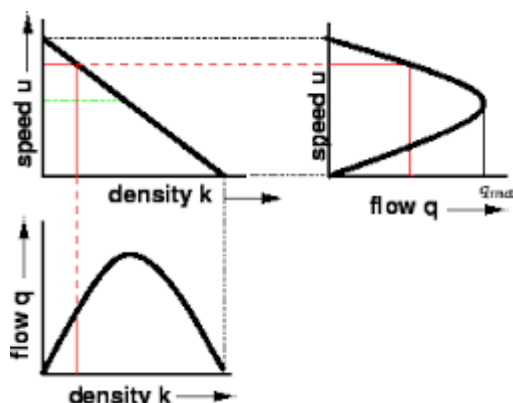


Figure 3 Speed-flow-density diagram

Source: Nptel Chapter 2, Fundamental relation of traffic flow by Dr. Tom V. Mathew.

II LITERATURE REVIEW

1. Rao Amudapuram Mohan, Rao Kalaga Ramchandra, “Measuring Urban Traffic Congestion – A Review”, (International Journal for Traffic and Transport Engineering, 2(4); 286-305), August 2012.

In this research paper, researcher tried to give an overview and present the possible ways to identify and measure metrics for urban arterial congestion. Researcher reviewed distinct aspects like definition; measurement criteria followed by different countries or organizations. There are two principle categories of causes of congestion, and they are micro- level and macro level. Researcher discussed the existing practices carried out in countries like United States of America, South Korea, Japan and India. In India Roy et al. (2011) discussed a novel and interesting way to detect the congestion on the urban arterials in India. They suggest using a Wi-Fi signal emitting device and a receiver across the road to identify the congestion on other hand Dewan and Ahmad (2007) conducted a survey for carpooling in Delhi and willingness of commuters for car pooling and they observed that car-pooling is one of the solutions to reduce the traffic congestion in Delhi. Also the researchers define general definition of congestion implies that it can be measured in various ways like Average Speed, Flow/Density, Delay And Travel Time Variability, Volume, Level Of Service, Demand/Capacity related also Corridor Mobility Index (CMI), Speed Reduction Index, Travel Time, Travel Time Index (TTI), Travel Rate Index (TRI), Buffer Index, Roadway Congestion Index, Lane-Mile Duration Index. Researchers also classify the various data collection methods like Fixed Sensor Based Techniques, Dual Loop Detector Based Techniques, Magnetic Sensor Based Technologies, Image Sensor Based Techniques, and Probe Vehicle Based Techniques. So overall researcher summaries and suggested a range of features for a measure of congestion.

2. Benjamin Coifman and Edgar Ergueta, “Improved Vehicle Re identification And Travel Time Measurement on Congested Freeways” (Journal of Transportation Engineering © ASCE/ September/ October 2003/475, Volume/29), October 2003.

In this research paper researchers showed an improved algorithm for matching individual vehicle measurements at a freeway detector station with the vehicle. Corresponding measurement taken at another detector station located upstream. By introducing this paper, researcher tries to illustrate the method using existing dual loop detectors to measure vehicle lengths. Due to the limited accuracy of the existing loop detector measurement under free flow conditions, it is restricted to matching vehicles during congested traffic conditions. This paper contains some of the results obtained over two different segments of the Berkeley highway laboratory (BHL) and demonstrates that the algorithm matches a sufficient number of vehicles for the purpose of travel time measurement. Researchers also gives the basic algorithm, it also gives the vehicle length measurement and the length measurement equations. Researcher gives the vehicle match matrix and possible matches, lane change maneuver and best matches, they also includes the four tests for improvement in the performance of the basic algorithm like filter test and cone tests for lane change maneuvers while the multiple lane change test is for search. Each test is designed to run independent of the other tests. So overall the researcher not only increased the number of vehicles matched, but also obtained accurate travel time measurements with an off- ramp between the detector stations and a higher frequency of lane change maneuvers.

3. S. Vasantha Kumar And R. Sivanandan, “Congestion Quantification Measures And Their applicability To Indian Traffic Conditions”.(Proceedings Of International Conference On Advances In Architecture And Civil Engineering, Vol.1, June 2012.

In this paper researcher present the review of various approaches to quantify congestion and associated performance measures based on comprehensive literature search and the applicability of these measures to Indian traffic conditions. Research data collection involved use of GPS units in personal vehicles such as two-wheelers, auto and car, as well as public transport bus. This paper introduces the review of congestion quantification studies. The performance measures found in various literatures for congestion quantification were compiled and the necessary inputs for calculating them are reported.

Researcher explains the various overview of methods to quantify congestion like Highway Capacity Manual (HCM) based method, methods based on queuing measures and travel time based methods. They also evaluate the “Suitability of performance measures under Indian traffic conditions” and by “A pilot transit buses as probe” they evaluate the congestion index equation.

$$\text{Congestion Index (C.I.)} = (\text{Actual travel time} - \text{Free flow travel time}) / (\text{Free flow travel time})$$

From this they extract the data and plotted it by a graphical representation of congestion index for bus and congestion index for Two-wheeler separately. So in this research paper the pilot study was demonstrated using correlation and regression analysis, on the use of congestion index calculated using GPS data of public transit buses for estimating other personal vehicle congestion index in a typical urban bus route in the metropolitan city of Chennai, India, and the results are shown promising through further evaluation and enhancement of approach is desirable.

4. Ibitoye A. Biliyamin And Mrs. Bello A. Abosede, “Effects Of Congestion And Travel Time Variability Along Abuja-Keffi Corridor In Nigeria”(Global Journal Of Researches In Engineering Civil & Structural Engineering, Volume 12 Issue 3 Version 1.0), 2012.

In this research paper researcher identify the traffic influencing events causing congestion; determine the travel time variability along Abuja-Keffi corridor and to make suggestions for effective traffic related measures in reducing congestion along the

selected route. In this study of Nigeria researchers describe that Abuja is a city in the central park of Nigeria and the federal capital of Nigeria. The city centre Abuja is crowded with a mix business and retail outlets which attracts customers from all parts of the country. This concentration of activities as well as the high traffic levels explains the recurring traffic congestion at peak periods and the need for traffic management operations to maintain acceptable levels of traffic performance.

According to the researchers population growth of Abuja with respect to vehicle registration per year is increased tremendously to overcome this situation they have defined the travel time variability and its methodology. According to the methodology they have taken two hours video coverage each was recorded for both peak and non-peak periods at the three critical congested locations along the road. The travel time of vehicle during peak and non-peak period at each location was analyzed using random selection method while playing back the video at 15 minutes interval. By conducting the survey they have discovered four scenarios in travel time reliability as follow (1) widening of the road (2) construction of by-pass (3) Replacing of car usage with improved public transport and (4) provision of bus stops at critical locations were examined in determining the most appropriate mitigation measures for the corridor. From the results they gave graphical representation of weekday travel time during peak hour, weekday travel time during non-peak hour. From this survey researcher conclude that the study has been able to identify congestion and its causes, estimate the travel time and determine the variability of average travel time. Therefore like many countries Nigeria should try to improve the performance of the existing transport system in order to enhance mobility and safety, reduce demand for car use, and improve traffic fluidity.

5. Bhargab Maitra, P.K. Sikdar And S.L. Dhingra, “Modeling Congestion On Urban Roads And Assessing Level Of Service” (Journal Of Transportation Engineering, ASCE), Vol. 125 (6), Pg. No. 508-514, 1999.

In this paper researcher present a unified methodology for the quantification of congestion on urban midblock sections, relates the level of congestion to the causal influences of traffic movement by modeling and demonstrates the potential use of modeled congestion as a measures of effectiveness for assessing the level of service. The methodology for modeling congestion and its use as a measure of effectiveness has been demonstrated through the application on three different road sections that are operating under mixed traffic, but have two, three and four lanes respectively in each direction. Therefore, the objective relates to the quantification and modeling of congestion as well as for capturing the influence of roadway, traffic and control congestion level on quality of traffic operation. However the scope of this paper has been limited to the application of the model on roadway condition in terms of traffic lanes only.

The researchers described the method of quantification of congestion by “Traditional method” which also includes “Influencing factors and Basis for quantification” and “Conceptualization”, Researchers also develop several equations by “Modeling congestion”. They also used the IRC guidelines (1990) and HCM (1985,1994) to defined the level of service as the semi-quantitative measures for describing the operational conditions for a traffic stream as it is felt and perceived by drivers/passengers from the use of the roadway section. From the result and discussion researchers concluded that taking into account both the operational and volume characteristics congestion has been quantified on the basis of observed speed-flow variation. The contribution of each vehicle type of the total congestion in a mixed traffic operation has been captured through the parameters of a congestion model using congestion models developed on three road sections, the limiting service volumes for different levels of service have been estimated and related to the variation in carriageway width. It has been shown that the quantified congestion can be used as a tool for assessing the efficiency and estimating the benefits from additional traffic lane(s) or the level of demand management required for a desired LOS.

6. Iam C. Mauricio, Jose Regin Fregidor, Ronald C. Santos, Noriel Christopher C. Tiglaio, “Travel Time And Delay Analysis Using GIS & GPS”, (Proceedings Of The Eastern Asia Society Of Transportation Studies), October 2003.

In this research paper researchers come up with mainly two types of objectives of the study, first is primary objectives which contains (1) Demonstration of the use of GPS technology in determining the travel time and delay condition along the stretch of commonwealth avenue and EDSA. (2) Compare travel time and delay data from conventional method to data from GPS/GIS method through statistical and graphical means. (3) Determine the limitations of the handy GPS units, and the secondary objective contains obtain results that may serve as input to a dynamic database that will be used in Advanced Traveler Information System (ATIS), also this study will test the effectiveness of GIS/GPS in measuring travel time and delays and it will try to make useful recommendations for the improvement of the knowledge in time travel and delay.

The study is geared towards the analysis of travel time and delay, including factors affecting time delay, utilizing data required through the use of Global Positioning System and Geographical Information Systems.

7. Md. Aftabuzzaman, “Measuring Traffic Congestion A Critical Review”, Institute Of Transport Studies, Monash University, Melbourne, Victoria, Australia, 2007.

In this research paper the researcher tried to propose a framework for developing measures of public transport congestion relief. It is suggested in this paper that none of the measures of traffic congestion provides information on how much traffic congestion is relieved by public transport. In addition, previous studies related to traffic congestion relief have not quantified the relationship between the presence of public transport and the amount of traffic congestion of a city. This paper aims to develop a systematic and comprehensive approach for establishing a measure of the congestion relief impacts of public transport. In this research paper the second section provides a definition of traffic congestion. The third section reviews the desirable attributes of an appropriate traffic congestion measure and set criteria for assessing a congestion measures. The fourth section provides a critique of traffic congestion measures section five provides the assessment of traffic congestion measures on the basis of the criteria set in section three. Section six describes some simple methods for measuring traffic congestion relief of public transport. Section seven proposes a systematic and comprehensive approach for developing a measure of the congestion relief impacts of public transport, followed by concluding section.

8. Panayotis Christidis, Juan Nicolas Ibanes Rivas, “Measuring Road Congestion”, Joint Research Centre Scientific and Policy Reports, 2012.

In this research paper the methodology presented here allows to measure and monitor road congestion across Europe using data from TomTom in-vehicle navigation system. The approach is based on the analysis of a large number of real vehicle speeds that have been measured on each road link and the application of algorithms that allow the estimation of congestion indicators for specific types of roads during selected time periods. The results include the detailed mapping of recurrent congestion both geographically and temporally, as well as the comparison of the quality of service of road networks between different zones.

III CONCLUSION

According to some researcher’s point of view, There are two principle categories of causes of congestion, and they are micro-level and macro level. Researcher discussed the existing practices of respective study areas After the study of existing study areas congestion can be measured by various techniques like Wi-Fi signal emitting device, demonstrates the algorithm, GPS units, GIS units, demonstrates the potential use of model etc. in respective research papers, and using these techniques they suggest best remedial to counteract congestion like widening of road, over bridge construction, car-pooling method. So that’s way if we will properly follow researcher’s remedial measures we could easily get rid from the current congested traffic condition.

IV REFERENCES

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